Human Capital Strategies for Big Shocks: The Case of the Fall of the Ming*

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This draft: April 3, 2024

Abstract

This paper employs unique genealogical data to study human capital decisions over seven generations as people in a Central Chinese county responded to the fall of the Ming dynasty. The setting allows us to focus on the responses of interlinked families, rather than on conditions in the places in which they live. The shock reduced China's overall population by some 16%, a scale of destruction mirrored in Central China. Exploiting variation in destruction levels across villages within Tongcheng, we show that the shock drastically reduced human capital acquisition of men that experienced the shock first-hand in their lifetimes. And yet, human capital acquisition reversed: from the third to the fifth generation, descendants of first-generation men who suffered the heaviest losses acquired more human capital than descendants of those that suffered less in the first generation. We argue that trauma associated with the loss of land and property led to higher preferences for the relatively portable human capital, and this change in norms was transmitted from generation to generation. Evidence comes from showing that sons benefit from the human capital of their fathers and grandfathers among first-generation treated but not among first-generation control family lines. In addition, this difference exists after but not before the shock. Migration is crucial for the reversal in human capital. Comparing historically destroyed with not destroyed regions instead of treated with control family lines gives depressed human capital levels even after five generations, because families that outmigrate immediately after the shock tend to invest more in human capital given their relatively young age and affluence.

Keywords: Intergenerational Transmission, Migration, Preference Formation, Persistence

*Thanks for comments to David Autor, Lee Branstetter, Pauline Grosjean, Taylor Jaworski, and Shang-jin Wei, as well as to Marco Tabellini, our formal discussnat. We have also benefited from suggestions of audiences at several presentations. Shiue acknowledges support from the National Institutes of Health (NICHD) through Award HD 042731-01 "Intergenerational and Interfamily Economic Links".

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1 Introduction

Do big shocks have long-run effects, and if so why? From epidemics over military campaigns to colonialism, the roots of economic development are often found in history. Yet current understanding of the scope of past shocks is limited because data showing how a trail of the chain of events unfolded for subsequent generations over centuries typically does not exist. To address this issue, we use unique genealogical data to study the evolution of human capital decisions within family lines in response to a big shock over more than three hundred years.

The shock we study is the fall of the Ming dynasty (1368-1644), which through war, famine, and disease cost the lives of some 36 million, or one in every seven Chinese people. Our analysis focuses on seven clans in a single county of Central China, Tongcheng, exploiting village-level variation in destruction to estimate the shock's causal impact on human capital acquisition for multiple generations. In the year 1644, the economy was based on agriculture though human capital acquisition to pass China's civil service examination was the primary alternative to land-based wealth (only men were eligible to participate). The fall of the Ming is a good natural experiment for estimating long-run effects because China was a pre-industrial economy not experiencing other big shocks until the mid-19th century.[1]

Four hundred-ninety Tongcheng couples who witnessed the fall-of-Ming shock in their lifetime first hand are analyzed together with the families formed by all their male descendants in the next four generations. The complete sample yields roughly 16,000 observations on husbands and wives. We define a family as treated if in the first generation–during the fall of the Ming–it resided in a heavily destroyed town or village of Tongcheng. Control families lived in less destroyed areas. This treatment assignment is carried forward to each family's subsequent four generations, and we refer to it as treatment of people. This is not the same as the difference in outcomes in historically treated versus control villages, called the treatment of regions, to the extent that there is migration. Information on the families' migration flows in the data allows us to compare treatment of people with the treatment of regions.

The set up allows us to examine the behavior of subsequent generations who did not live through the shock, but were descendants of people who did. The response within families is something on which relatively little is known. We find that among men living during the fall of the Ming, in the first generation, those residing in treated regions acquired significantly less human capital than those in control regions.

[1] First Opium War (1839-42), Taiping Rebellion (1850-64).

This is plausible given that wars and famines would make it more difficult to study. Moreover, the impact is economically important: for every three control men who acquire human capital, only two treated men do so. We also show that the shock reduced the chance that a couple's son is able to marry and thus form the next generation in the first place.

Furthermore, even in the fifth generation, the fall of Ming has a significant impact on human capital acquisition. With about 34 years between one generation and the next, the fifth generation typically was alive 170 years after the fall of Ming shock, but in some family lines the fifth generation only arrives three hundred years after the shock. Clearly, these results are consistent with deep historical roots for economic development.

Human capital effects are not monotonic in time. Rather, we find that there is a reversal; losses in the first generation turn into human capital gains starting in the third generation. Moreover, cumulatively over five generations, treated men acquire more human capital than control men despite the heavy losses in the first generation. Clearly, first-generation human capital losses did not discourage these family lines to make human capital investments in later generations. Our analysis demonstrates that the long-run impact of the shock might be quite different from a faded version of the shock's short-run impact.

We show that it is important to distinguish treatment of people and treatment of regions because the impact of the fall of the Ming has qualitatively different signs on them. Specifically, over five generations the cumulative impact on regions remains negative, in contrast to the cumulative impact on people which turns positive. Key to this difference are choices made by the second generation, the children of those living through the times of the shock firsthand. Escaping heavily destroyed areas raises human capital acquisition, and families that outmigrate are predominantly young and from affluent families. At the same time, the shadow of heavy regional destruction does not prevail for more than one generation. Starting in the third generation, human capital acquisition is primarily determined by whether a family line is treated or not, irrespective of the historical destruction of the region where the family line currently lives.

Critical to the estimation of causal effects is that families living in heavily destroyed areas, as opposed to families living in less destroyed areas, would have followed the same trends in the absence of treatment. However, high human capital families might have foreseen to a greater extent which areas of Tongcheng would be particularly dangerous in case the Ming falls, and the post-shock human capital trends could simply be the continuation of pre-shock differences. To shed light on this issue, we examine the ancestors of the families in the two generations *before* the shock, going back to the early 1500s. We find that there are no major pre-shock differences between treatment and control samples, in particular, there are no significant differences in human capital of either fathers or grandfathers of the fall-of-Ming generation.

The second half of the paper examines reasons behind the reversal in human capital acquisition. The transition from Ming to Qing could have been accompanied by developments that would favor human capital investments. Improvements in the administration of the civil service exam may have raised human capital returns; and, the abolishment of tax exemptions for land owners might have shifted investments towards human capital as well. Another possibility is that some families came to develop a higher preference for human capital over other forms of wealth–land and property–because human capital is a relatively portable form of wealth. Given what we know about preference formation, this explanation helps us to understand one key motivation for the difference in human capital acquisition between treated and control families. In particular, first-generation couples in heavily destroyed areas would have experienced disproportionately more trauma through their loss of land, house, and property. The resulting scarring in the first generation might have led to a higher preference for human capital, which these families subsequently transmitted from one generation to the next through the numerous ways in which parents shape the preferences of their children. Consistent with the hypothesis that norms in Tongcheng changed towards a higher preference for human capital is that clan rules laid down in the early Qing put an increased emphasis on education.

Evidence that there was a differential shift in human capital preferences is provided by changes in the intergenerational human capital linkages between son and father. To the extent that higher human capital preference means that parental resources towards raising child's human capital become more effective, well-known models predict an increase in the intergenerational regression coefficient (Becker and Tomes 1979, 1986, Shiue 2023). We show empirically that, indeed, after the shock the intergenerational regression coefficient for sons from treated family lines is higher than for sons from control family lines. Consistent with a higher preference for human capital among treated families, sons benefit from father (and grandfather) human capital–as exhibited by higher intergenerational correlations–whereas control sons do not. Moreover, treated descendants exhibit more upward human capital mobility and lower downward human capital mobility than control descendants. In addition, results suggest that this difference is *because* of the shock, as we do not find a comparable difference in human capital mobility between treated and control families before the shock.

We consider alternative explanations for the reversal, including that the shock has driven a wedge between treated and control families in terms of other attitudes and behaviors, such as those on health and material welfare. While our data does not allow us to fully distinguish these (correlated) factors, evidence for health or material well-being factors is weaker than for human capital preference. Furthermore, we examine robustness using more similar samples that sharpen the focus of the treatment-control analysis, finding broadly consistent results.

This paper makes several contributions. First, there is a large literature on the impact of historical shocks on long-run development. Shocks come in various forms, including colonial institutions, famines, diseases, environmental catastrophes, and warfare.[2] By studying the multi-faceted fall of the Ming the present study provides an integrated assessment of several dimensions, and by focusing on a single county we do so for an economy that is not subject to the heterogeneity often present at higher levels of aggregation.

Moreover, the long horizon of the present analysis is similar to persistence studies, which document deep roots of economic development by establishing relationships between regional or country characteristics over centuries (surveys include Nunn 2020, Voth 2021). It is difficult to determine the impact of a shock based only on outcomes of people who live in that region centuries later, especially when there is migration.[3] Migration plays a similar role in work on local labor markets, which are defined as non-overlapping divisions of geographical space between which workers do not move (see Autor, Dorn, and Hanson 2013, Manning and Petrongolo 2017). Defining treatment at the level of family lines—descendants of those who live in historically treated regions—gives a complementary perspective to studying the impact of shocks on regions that focuses on the intergenerational transmission of family norms, and the comparison of treatment of people with treatment of regions provides new evidence on the role that migration plays in mitigating (or aggravating) shocks.

[2]For example, Dell (2010) shows that the 1573 mining *mita* has increased the prevalence of stunted growth in Peru's children today, O'Grada and O'Rourke (1997) document that the Great Potato Famine (1845-52) has caused a permanent effect on Ireland's economy due to outmigration to the United States, Pamuk (2007) shows that the Black Death is responsible for differential development paths leading to a persistent advantage of northwestern over southern Europe, Hornbeck (2012) examines the impact of the 1930s American Dust Bowl on long-run population impacts across the Plains during the 20th century, and Davis and Weinstein (2002) show that US atomic bombing of Hiroshima and Nagasaki did not produce a lasting change to Japan's city size distribution after 1945, respectively.

[3]Voigtlaender and Voth (2012) show that regional persistence is diluted in the presence of migration.

Second, the focus on human capital parallels its central importance for turning points in world history such as the escape from the Malthusian trap and industrialization (Galor and Weil 2000, and Mokyr 2005, respectively). Changes in human capital incentives may result, for example, from technology-skill complementarity (Acemoglu and Zilibotti 2001) and religious motives (Botticini and Eckstein 2005, Becker and Woessmann 2009). By emphasizing the advantage of human capital's relatively high portability in the face of conflict our research connects to Brenner and Kiefer (1981), and, more generally, our finding that emigration from heavily destroyed regions increases human capital acquisition is in line with the view that migration in fact is one of the major forms of human capital investment (Schultz 1961).[4] Closely related to our proposed mechanism is that a major shock may change a population's norms or preferences. Shocks may have large impacts on preferences (Rice and Robone 2022), preferences are intergenerationally transmitted (Bisin and Verdier 2001), and as a form of non-cognitive skills preferences are important for human capital formation (Heckman and Rubinstein 2001). Recently, Becker, Grosfeld, Grosjean, Voigtlaender, and Zhuravskaya (2020) explain the higher levels of education of those Poles today who have a family history of forced migration after World War II with the expulsion causing an increased preference for human capital (on the related issue of habit formation, see Atkin 2013, Sarvimaeki, Uusitalo, and Jaentti 2022).

Based on five generations of individual-level human capital measures starting in the 16th century in China, the present analysis not only provides new perspectives in temporal as well as regional dimensions but also provides direct evidence on higher human capital preferences by documenting relatively strong intergenerational human capital relationships among treated descendants in post-shock generations. In addition, we isolate the role of uprootedness in the response to the shock by separating families that migrated from those that did not.[5]

This research also contributes to work employing intergenerational analysis in fields such as labor, health, and public finance.[6] Research in historical settings typically concerns intergenerational mobility, such as the performance of children of immigrants since 1880 in the United States (Abramitzky, Boustan, Jacome, and Perez 2021) or the persistence of human capital in Malmo (Sweden) since 1865 (Lindahl,

[4]The human capital reversal estimated in this paper also resembles findings in the aftermath of a 1973 volcanic eruption in Iceland (Nakamura, Sigurdsson, and Steinsson 2022).

[5]See also Lowes, Nunn, Robinson, and Weigel's (2017) analysis of migrant data to infer the impact of the norms of Central Africa's Kuba kingdom on the behavior of descendants hailing from there.

[6]Examples from these fields are Oreopoulos, Page, and Stevens (2008), McCord, Bharadwaj, Kaushik, and Raj (2021), and Chetty, Hendren, Kline, and Saez (2014), respectively.

Palme, Sandgren-Masih, and Sjogren 2015), and data tends to come from official surveys or censuses. Employing Chinese family genealogies allows to push the starting point several centuries earlier; this comes at the cost of additional representativeness and data concerns, which we will discuss below.

Genealogical data is increasingly employed to improve the intergenerational linking of official data (Price, Buckles, Van Leeuwen, and Riley 2021, Buckles, Price, Ward, and Wilbert 2023). Recently, a small but growing literature has used data from Chinese family genealogies to study long-run aspects of Malthusian responses, environmental-induced diseases, and migration constraints (Hu 2023, Che 2023, and Hess 2023, respectively).[7] Compared to this work, we can make stronger claims to estimate the causal impact on long-run human capital acquisition by employing the fall of the Ming as a historical quasi-experiment.

In the remainder of the paper, the following section 2 provides background on the Ming-Qing dynastic transition in general and what happened in Tongcheng county in particular. Section 3 summarizes the data and describes our approach to estimate causal effects. The main finding of a human capital reversal over five generations is presented in section 4. The following section 5 shows using intergenerational human capital analysis that the shock has led to a higher preference for human capital among treated families that has been transmitted from generation to generation. Additional results based on samples that sharpen identification are shown in section 6, and some concluding observations are provided in section 7. The Appendix includes further discussion of the dataset, additional robustness checks, and it shows that the shock also led to shorter family lines by reducing the probability that a son would marry.

2 The Fall of the Ming

2.1 General Developments in China

Several factors contributed to the collapse of the Ming dynasty in the mid-17th century. They include a decline in the fiscal accounts of the state that was hastened by corruption within the state and military and the increasing expenditures of the imperial court. A series of natural catastrophes in the late 1620s and 1630s increased the price of grain, leading to famine, epidemics, and crises (Brook 2010). International affairs played a role as well. Prior to the 1630s and 1640s, about half of the silver mined in Japan and

[7] Using related data from Tongcheng family genealogies for the period 1300 to 1900, Shiue (2024) studies trends in social mobility while Shiue (2017) examines changes in the child quantity-quality trade-off.

the New World ended up in China, but by the end of the Ming, ongoing military campaigns and an international economic depression led to a shortage of silver in China, which, according to some analysts, was associated with increased demand for taxes and economic depression in China. These downturns were compounded as banditry increased, and as Ming and Qing armies fought to win control over the empire. Finally, climatic conditions contributed to the fall of the Ming (Lee and Zhang 2013).

Throughout China's history, dynastic transition usually entailed violence and political fighting, but even by these metrics the end of the Ming Dynasty in 1644 was an exceptionally devastating interlude. Ge (1999) estimates that during the Ming-Qing transition, population dropped from 221 million in the year 1630 to 185 million in 1680 (see also Cao 2022). In the twenty years between 1626 to 1646, China experienced a reduction of more than 11% of its population (Lee and Zhang 2013). Other sources hold that the fall of the Ming Dynasty began with the campaign of the Jin khan Nurhaci against the Ming that resulted in the capture of Fushun (Liaoning province) in 1618. Irrespective of the particular source, the fall of the Ming ranks among the largest negative shocks in world history, especially among those not caused by a pandemic.

2.2 Destruction in Tongcheng[8]

During the final decades of the Ming dynasty, Tongcheng county witnessed many local uprisings. One of them, by the former serf Chang Ju in 1634, led eventually to the attack on Tongcheng's capital town and initiated ten years of violence, bloodshed, and devastation. Moreover, Tongcheng county became a battleground as it was located directly in the path of the Qing armies of the north-west, notably that of Chang Hsien-chung (the so-called butcher of Sichuan), as they pushed agains Ming armies that sought to defend their dynasty from the South. As a consequence, there was a "succession of sieges and battles, the comings and goings of government and rebel troops [...], famines, and plagues", and during this period almost all rich families had their property burned and plundered (Beattie 1979a p.45).

One common response to the fall of the Ming turmoil, especially by the relatively wealthy, was to flee. Taking advantage of the fact that Tongcheng is located just north of the Yangzi river, as early as 1636 many of Tongcheng's residents had fled south across the river, and by 1642, more than half of Tongcheng's high-status population was gone. Another common response was to move to the capital city of Tongcheng,

[8]See Beattie (1979a), pp. 43-48, as well as three editions of the local gazetteers of Tongcheng: Tongcheng (1490; 1696; 1827).

which was protected by a city wall since 1576. By 1642, the siege of this city by Chang Hsien-chung and his army meant that the city's wells were polluted, pestilence was spreading, and food was in such short supply that people were reduced to eating the flesh of corpses. When the situation further deteriorated, the people in the city were preparing to kill themselves if help did not arrive. Troops of the Manchu conquerors (the Qing) finally arrived in 1645, which stopped the situation from further deteriorating.

Accounts of Tongcheng in 1645, after peace returned, suggest conditions were desolate, with a huge loss of life and laying waste of land. According to some estimates, in a single year 160,000 people had been killed, and by 1643 it was said that 70-80% of the cultivated land of the county had been devastated (Tongcheng 1827).[9] While there is little question on the scale of destruction during the fall of the Ming in Tongcheng, the long-run impact of the shock on the economic fortunes of Tongcheng remains far from clear.

2.3 Loyalities, Land, and Human Capital[10]

This paper contrasts the human capital strategies of Tongcheng families that resided during the fall of the Ming in more versus less destroyed locations (treatment versus control). Evidence will be presented that treated families exhibited a higher preference for human capital as the result of the shock. The following describes key features of the general setting in Tongcheng at this time as they applied to all families, both treated and control.

2.3.1 To Support the Ming or Support the Qing?

One factor that could influence how individuals fared during the Ming-Qing transition might be whether they welcomed the new rulers or not. In some regions not far from Tongcheng, for example in Yangzhou (Jiangsu), Manchu and defected Han Ming soldiers committed mass killings of residents both as punishment for participating in resistance efforts and to teach a lesson of what happens to those who resist to the Qing. In Jiangyin (Jiangsu), the 1645 Qing hair dress code –"either you lose your hair or lose your head" – inflamed the sentiment of local Han people so that they heroically defended the walled city against the siege of Qing troops. What about Tongcheng–are there any signs of comparable resistance?

[9]The officially registered population of Tongcheng county fell by 57% between 1631 and 1645 (Beattie 1979a, page 133). Tongcheng population levels are considered to be underestimates because after the 1383 census Tongcheng population growth was undercounted, as was true elsewhere in China. However, the *change* in population between 1631-45 gives some evidence on the magnitude of the fall of Ming shock.

[10]See Beattie (1979b) and Tongcheng (1827).

By the late 16th century, Tongcheng county was home to a number of government officials at various levels of government, which in itself would create apparent loyalities to the Ming dynasty. At the same time, loyalities to the Ming were diminished because Ming troops tasked to defend Tongcheng depleted local grain resources, causing people to live in constant fear of famine as Ming troops pillaged scanty grain supplies. Also, the Ming government did not support local miltary defense efforts, because in Tongcheng as elsewhere in China Ming authorities were reluctant to let military power slip into the hands of local elites (Wakeman 1971).

Furthermore, no reaction to the July 1645 hair-cutting edict is recorded for Tongcheng, the new rule that is considered more than any other act as a sign of utter submission to a barbarian regime. Overall, in terms of loyalities for the Ming versus Qing, the behavior of Tongcheng's population (including its elites) was primarily characterized by shifting alliances and collaboration instead of outright resistance.[11]

2.3.2 Local Triggers of Discontent

In the prelude to the fall of the Ming, Tongcheng witnessed years of internal warfare which pitched not Ming loyalists against Qing supporters but certain factions of Tongcheng against each other. To some extent the conflict was between elites on the one and small-scale tenants and (former) serfs on the other side, or, between rich and poor. The relative welfare of the rich is a likely determinant of human capital acquisition because it is these elites who command the resources needed to consider the path to official position by participating in the civil service exam.

Local histories indicate that one reason for the internal warfare in Tongcheng before 1644 was that the social contract that existed throughout much of the Ming between more and less affluent parts of the population was increasingly broken. Large landowners and other local elites started leading an extravagant lifestyle and became absentee landowners by moving to Tongcheng capital. The rich looked increasingly after their own narrowly defined self-interest. One example is the 1581 attempt by the county magistrate to re-survey Tongcheng's cultivated land acreage, which would have led to a new and more uniform scheme of converting actual to fiscal area. Because this would have harmed disproportionately the rich, powerful landowning interests organized protests upon which the project was abandoned.

[11]While we do not information on the allegiance of specific clans in the sample, our treatment versus control definition typically cuts within clans in the sense that some members of a given clan are treated while others are part of the control sample.

Furthermore, local elite families used their influence to extend the landholding tax privilege of their degree-holding to other members of their families. Subsequently, this tax avoidance triggered successive increases in land taxes which were borne by the remainder of the population, who were less able to escape these taxes. By the 1620s, social tensions had risen, and it has been argued that the elite's selfish and disruptive exploitation of excessive tax privileges had not only drastically eroded the foundations of the Ming fiscal system but also helped bring about social chaos at the end of the dynasty.

2.3.3 Developments After the Fall of Ming

Even though the new Qing rulers had a different ethnicity than the Ming rulers (Mongol, not Han) there was a considerable degree of continuity in the matters of state administration. For one, the civil service examination process to recruit officials at all levels of government was kept in place. In addition, the fundamental approach to local government remained the same: the Qing rulers, as had the Ming before them, sought to delegate many of the state's tasks to local elites. Because this meant that the Qing rulers depended on their cooperation, they had to placate them to some extent. Despite this general continuity, the Qing rulers put several changes in place that reinforced each other.

First, in 1657 the Qing rulers abolished generous exemptions for officials and degree holders from the land tax. Moreover, there is evidence that these tax changes were enforced, for example in the case of the so-called Chiang-an tax case (Oxnam 1973, Atwell 1986). Because the tax burden for landless officials and degree holders would not change while that of landowning officials and degree holders went up as a consequence, this amounted to an increase in the return to human capital relative to land.[12]

Second, the approach of seeking political influence during the Ming by forming alliances with other local groups gave way during the early Qing to a more direct approach to influence through a family member or friend who would be part of the provincial or central government (Wakeman 1970).[13] Given that, the obvious path to power during the Qing was to compete for examination success and attain provincial or central government office. Indeed, it has been noted that with the transition from the Ming to the Qing Tongcheng's families increased their efforts to compete in the civil service examinations, which required more focus on human capital investments.

[12] China-wide, the return to human capital also rose with the transition of the Ming to the Qing because the civil service exam was held more regularly every three years (Shiue 2017).

[13] The former approach may be termed 'horizontal' because multiple groups at the same hierarchical level work together, in contrast to a more 'vertical' approach using influence at a higher hierarchical level during the Qing.

Third, the early Qing is also the time during which many clans felt the need to compile new rules of behavior. Clan rules are important instruments of social control during this time in China, and detailed rules might not have existed before, or they may have been lost during the turmoil of the Ming-Qing transition (especially handwritten rules). Comparing typical Qing clan rules in Tongcheng with earlier rules shows that clan rules became both more strict and more comprehensive, in the sense of prescribing socially respectable behavior in a broader set of areas (e.g., no tax abuse or avoidance, decent treatment of tenants); this was due in part to the 'broken social contract' leading to Tongcheng's internal warfare during the final years of the Ming dynasty. Importantly, prescribed behavior often included the pursuit of socially respectable occupations and education as the way to status and social esteem. More than during the Ming, now the families' energies and resources were channeled into competition for academic advancement.

These changes are consistent with an increased emphasis on human capital investments throughout the Tongcheng area. In the analysis below, we will ask whether those families subject to greater destruction appear to have increased their preference for human capital by more than other families in Tongcheng.

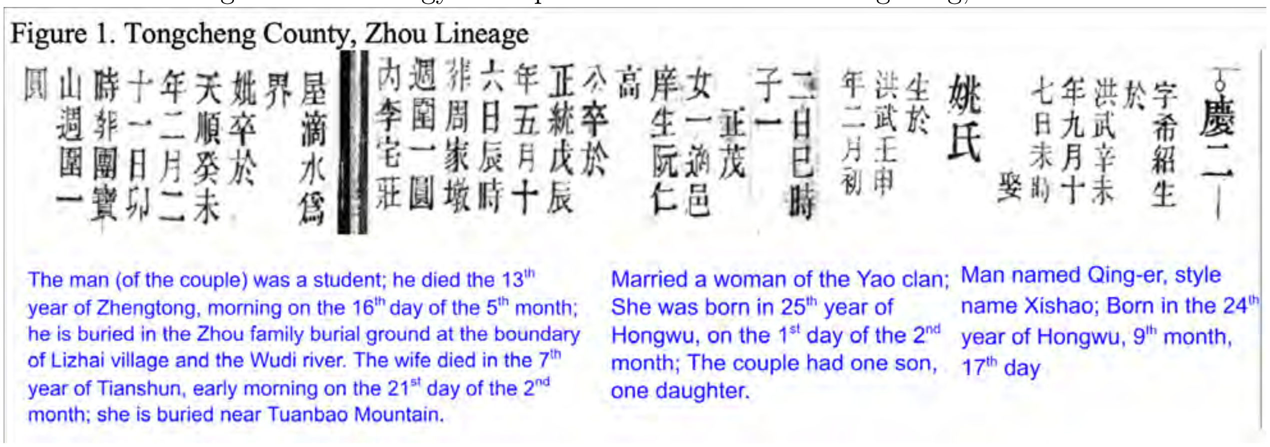
3 Data

3.1 Genealogies as Data Source

This study uses genealogical data for seven clans in Tongcheng county, part of Anhui province. Genealogies, essentially annotated family trees, are a classic source of socio-economic data for China. Recent estimates put the number of them currently existing into the tens of thousands (Wang 2008), and dozens of them have been employed in earlier research on Tongcheng (e.g., Beattie 1979a, 1979b). Because documenting intergenerational links is a key purpose, genealogies are particularly useful in the present context as they yield longitudinal family information over the long term. In addition to the record of time of birth and death, as well as achievements, marriage and children, genealogies provide information on the location of the burial site, and sometimes other information. Figure 1 shows part of the Zhou genealogy of Tongcheng.

Information in genealogies is self-reported, and there are no penalties from the state for misrepresentation–genealogies are private documents. A key reason why this study employs genealogies as opposed to official data is that for our sample period, state-provided data for Tongcheng county does not compare in quality and consistency to the clan records, see Figure A.3.

Figure 1: Genealogy Example: The Zhou Clan of Tongcheng, Anhui



Notes: Authors' translation.

3.2 Accuracy and Representativeness

One concern with genealogies is that the self-reported information might be exaggerated because the clan has an incentive to make itself "look good". This is tempered by the fact that genealogies fulfilled key economic functions that required accuracy. First of all, property rights turn on information recorded in genealogies, because they establish and sustain village settlement rights for specific clans. Second, genealogies are critical as a means of defense, including war, because by determining who is member of the clan and who is not it defines allegiances, rights, and responsibilities in times of conflict (both versus other clans and versus the government). Third, genealogies provide information on taxation and public goods provision. On the one hand, the state delegates to local clans the right to tax as well as the responsibility to fund public works such as irrigation. On the other hand, a clan's genealogy specifies assessments (essentially taxes) on their members to found and maintain common clan property. With these functions of the genealogy for the clan, one would expect the data to be accurate, especially given that they are costly to produce.

The main concern with genealogies is upward selection. While illiteracy was common during the sample period, preparing a genealogy requires literacy, at least for some clan members. Therefore, employing all extant genealogies for Tongcheng would likely lead to positive selection.[14] The sample of this study is constructed using a targeted approach with the explicit goal of a relatively high representativeness. Three

[14]Similarly, there is upward selection in studies based on recent crowdsourced genealogical information; for example, life expectancy conditional on living until age 30 in The Netherlands according to genealogies is 2.5 years longer than according to national life tables once the latter exist (late 19th century; Stelter and Alburez-Gutierrez 2022).

criteria are applied. First, the sample consists of a mix of heterogeneous–richer and poorer– clans so that sample moments are close to well-known estimates for China at this time. In particular, about 20% of the sample belongs to the upper class as defined by Fei (1946), and the fraction of local and provincial civil service examination graduates is comparable to 2% as reported by Chang (1955).[15] Second, conditional on including a given clan in the study, all entries of the genealogy become part of our sample. A fundamental principle of Chinese genealogies is that all males are members of the clan irrespective of their achievements, and it ensures that the sample majority are lower-class individuals, as in China overall.[16] Third, we employ genealogies with relatively complete (raw) records. It is well-known that the quality of family genealogies varies. In a survey of more than nine hundred genealogies, e.g., Telford (1986) finds that while on average about three quarters report vital dates for both husbands and wives, genealogies from Hunan province are more likely to have vital records than those from Shandong (93% versus 31%, respectively). In our sample, vital records exist for more than 90% of the sample, and it is shown below that results do not depend on observations with estimated vitals.

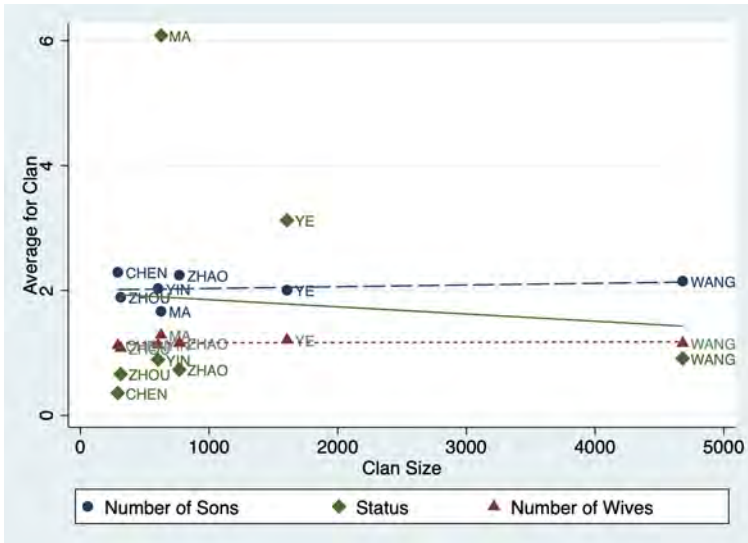
The clans in our sample are the Chen, Ma, Wang, Ye, Yin, Zhao, and Zhou. They yield a broadly representative sample in part because the clans are quite different from each other. First, clan size differs. Wang clan members account for about half of all men, while the Zhou clan has a share of about 1%. Second, the clans differ in terms of the average level of resources. The data report several proxies for resources, including (i) each adult male's social status, (ii) the number of female partners of each male, and (iii) the number of children of each male. These are lifetime measures and will be discussed below.

Cross-clan variation in resources allows us to evaluate the extent to which the sample is selected in the sense that individuals from richer clans are more likely to be included in the sample or not. Figure 2 plots each of the three resource proxies against the number of men from each clan in the sample. If the sample would disproportionately include men from rich clans the relationships in Figure 2 would be positive. In contrast, there is hardly any relationship between the resources of a clan and the number of its members in the sample (Figure 2). In particular, there is no evidence for an overrepresentation of rich clans. Moreover, this results continues to hold when focussing on changes within clans using longitudinal data (see Table A.1). We have examined the representativeness of the sample further, and find no evidence

[15] Additional comparisons to external evidence are shown in section B.1.

[16] Exclusions from the clan of men born to a clan father are virtually non-existent. Adoptions do occur but are rare; we have dropped this handful of cases from the sample.

Figure 2: Clan Resources and Representation in the Sample



Notes: Figure shows three relationships, between average (i) number of sons, (ii) status, and (iii) number of females per man, each with the number of clan members for seven clans.

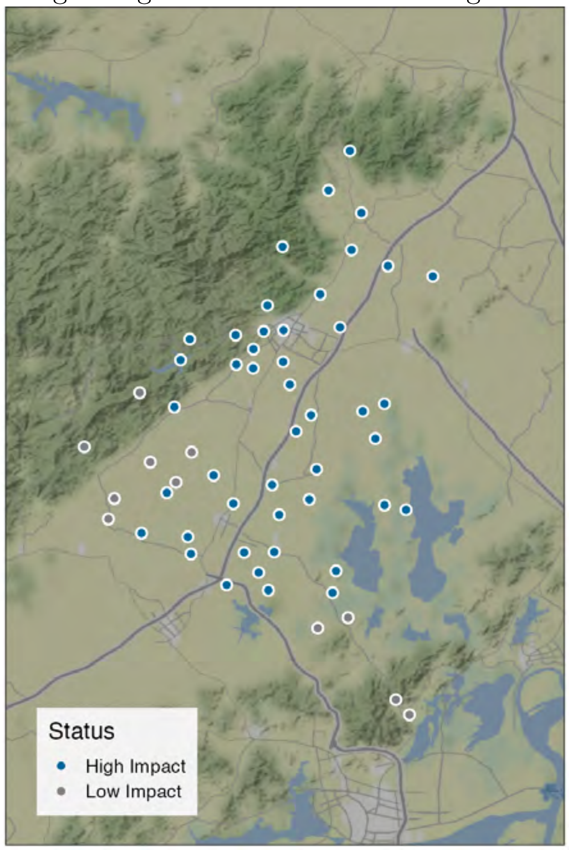
that various type of selection biases including recall bias, progenitor bias, and survivor bias play a major role in our sample (see section B.2).

3.3 Treatment of People versus Treatment of Regions

We begin by defining the set of people who are potentially treated by the fall of Ming shock, which has both a temporal and a spatial dimension. Temporally, we define as potentially treated those couples in which the male was born between the years 1590 and 1644. This definition implies that males 44 years old or younger at the onset of the heavy destruction in Tongcheng in the year 1634 can be treated, and by including males as young as 1 year old by the time the Ming dynasty fell (1644) we account for the fact that the turmoil was not immediately over once the Qing came to power. We show below results for changing this time window of treatment.

With this assumption, the sample has 490 couples who are potentially affected ('treated') by the fall of Ming shock. We will refer to this as the treatment generation, or first generation couples.

Figure 3: Tongcheng Villages and Destruction during the Fall of the Ming



Notes: Figure shows the villages of Tongcheng country in which the treatment generation couples lived. High Impact is defined as at least moderately destroyed (treated), while Low Impact is defined as little or not destroyed (control). One village with low impact in remote eastern area not shown. Source: Telford (1992).

Figure 3 indicates the locations in which the treatment generation couples lived in Tongcheng county. The county's capital city, Tongcheng, is located about 200 kilometers southwest of Nanjing (Jiangsu) and 60 kilometers north of Anqing, the capital of Anhui province. Tongcheng county is located just north of the Yangzi river (shown in the lower-right of Figure 3). Spanning 100 kilometers east-west and 60 kilometers north-south, in the late 18th century Tongcheng is estimated to have had about 1.5 million inhabitants (Beattie 1979a).

The different colors in Figure 3 distinguish two sets of towns and villages, those with "High Impact" versus "Low Impact", which indicate the level of destruction during the fall of Ming shock, thus defining treatment in the spatial dimension. Specifically, first-generation couples who lived in "High Impact" regions are treated, while those living in "Low Impact" regions are control observations. About three quarters of villages were treated according to that definition, and 89% of the treatment generation couples are. The relatively high extent of treatment is in line with the high level of destruction in the county during the Ming-Qing transition (see section 2.2). This spatial definition of treatment is based on Telford's (1992) analysis of crisis mortality by region during the years 1635-1645. Because the majority of locations escaping heavy destruction are located in the less central and more mountainous areas of Tongcheng, our treatment definition is in line with evidence that rugged terrain makes it more difficult to persecute people (Nunn and Puga 2012).

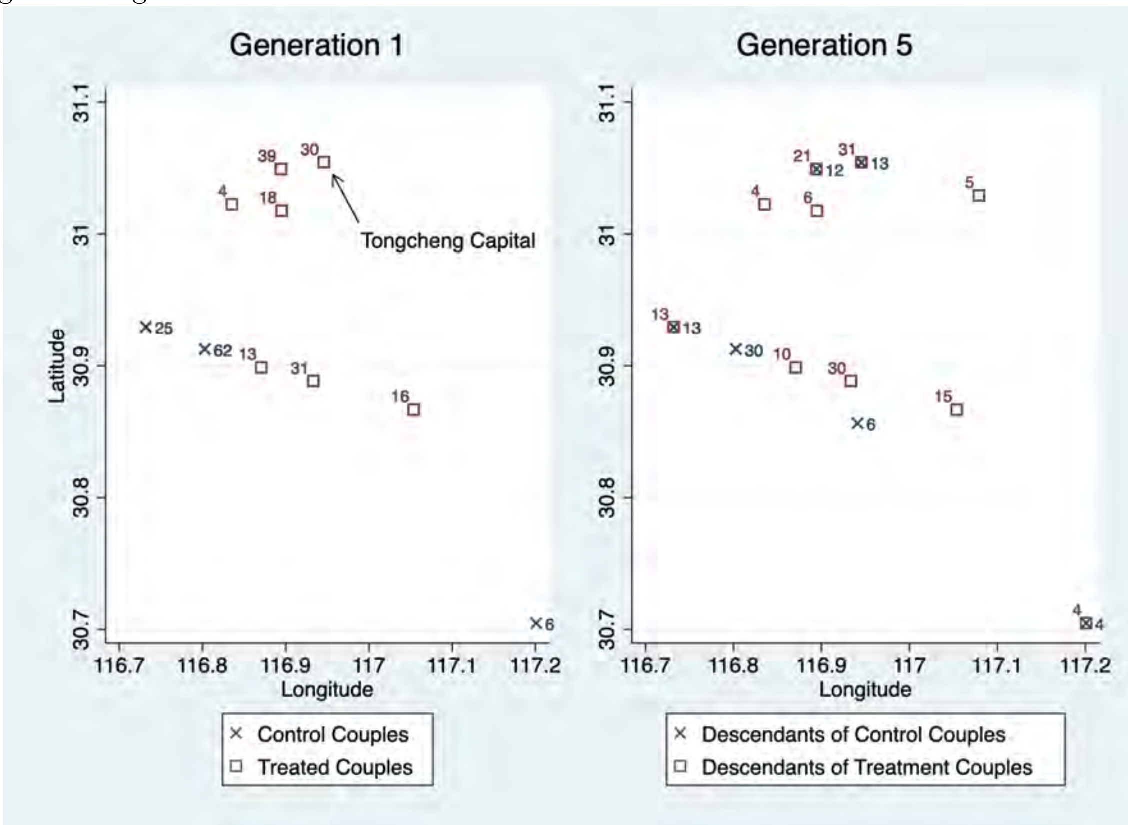
A sample of five linked generations is formed from the treatment generation couples and their next four patrilineal generations, that is, sons, grandsons, great-grandsons, and great-great-grandsons, together with their spouses and children. Treatment assignment from the first (fall of Ming) generation is extended to subsequent generations: anyone who is descendant of a couple residing in a treated location during the fall of Ming is defined to be treated, whereas anyone descendant of a first-generation control couple belongs to the control observations. This is referred to as treatment of people.

In addition to treatment of people, information on migration movements allows us to define a second form of treatment for the sample. Consider Figure 4, which depicts the location in which members of one of the clans resided in the first and in the fifth generation. Numbers in these panels report how many families of the Ma clan lived in a particular generation in each of the locations. For example, in Generation 1, 30 Ma families resided in Tongcheng Capital, the most northern location with members of the Ma clan.[17]

Figure 4 distinguishes treated couples from control couples; they are marked as squares and crosses, respectively. Treatment and control couples never live in the same location in the first generation (left panel), because the distinction of treatment versus control couples is based on each location's destruction in that generation. By the fifth generation, however, a given location can have both treated and control descendants. For example, $31 + 13 = 44$ Ma families reside in Tongcheng Capital (right panel). Of these, 31 families are descendants of Ma couples that lived in the first generation in a heavily destroyed region of Tongcheng, while 13 families are descendants of Ma couples who resided in low-destruction regions during the fall of Ming.

[17]Over the five generations, members of the seven clans resided in more than 80 different locations of Tongcheng county. Movements outside of the county can be tracked as well but they are very rare.

Figure 4: Migration Movements of the Ma Clan: Locations in the First and Fifth Generation



Notes: Left panel shows locations of the Ma couples in the first (treatment) generation, with squares (crosses) indicating those living in destroyed (undestroyed) locations. Right panel shows locations of the 5th generation descendants of those in the right panel, with squares indicating those descendants whose ancestors resided in generation 1 in destroyed locations. Numbers indicate the number of heads-of-households of a particular type in that location.

The human capital treatment-of-persons effect for the Ma clan in the fifth generation is the average difference between squares (treated) and crosses (control) in the right panel, no matter where they live. In contrast, the human capital treatment-of-regions effect from the Ma clan in the fifth generation is the average difference between the human capital of those living in historically treated versus control locations in the right panel. One of these historically treated regions in Tongcheng Capital (see Figure 4, left panel). As a consequence, the 13 Ma families who live in the fifth generation in Tongcheng Capital but are descendants of couples living in low-destruction regions during the fall of Ming are treated in a sense of region but control in a sense of people.

Of these two forms of treatment effects, treatment of regions is what has been typically analyzed. One may ask whether the difference between treatment of regions and treatment of people effects is

Table 1: Human Capital Measures

(1)	(2)	(3)	(4)	(5)	(6)
Group	Description	Human Capital	Alternative HC	N	Fraction (%)
A	Educated, scholar, no degrees or office; editor of genealogy; refused office, or prepared but did not pass exam	1	1	275	3.4
B	*Shengyuan*, *shengyuan* w/ office; Official Student; Imperial Academy student	1	2	1,131	14.1
C	Military *juren* or *jinshi*; civil *juren* or *jinshi*	1	3	176	2.2
D	No human capital	0	0	6,430	80.3
All				8,012	100.0

Notes: Table gives information on a man's human capital (HC) in the main five linked generations estimation sample. Further human capital differences and information on status is given in Table A.3.

quantitatively important. Clearly, the answer depends on how persistent location choices of families are. In our sample, families move in 19% of all transitions from one generation to the next between locations (although not necessarily between the sets of treatment and control regions). Irrespective of how frequent migration movements are, treatment of people provides a new perspective on how shocks affect the welfare of inter-generationally linked families, which in turn may provide additional insights on the mechanisms that underlie long-run economic effects.

3.4 Variables and Summary Statistics

Human capital in this analysis is an indicator that a man acquired a substantial amount of skill during his lifetime. This includes all men who participated in China's civil service entrance exam at either the local, provincial, or national level. Figure 1 from the Zhou clan, for example, the man passed the local exam and was an official "student" preparing for higher-level exams. The exam was the primary standardized form of skill acquisition during the sample period. One can think of these skills as human capital in a modern sense because the exam was the main gateway to wealth in China, and it required years of studying, that is, foregone labor income.[18] Table 1 provides sample information on this human capital variable, as well as an alternative, non-indicator human capital measure.

Table 1 shows that 20 percent of the men in the estimation sample have human capital while 80 percent do not. Our main specification employs an indicator variable, shown in column (3). We treat men who prepared for but did not pass the exam as having acquired human capital. Furthermore, men coded with

[18] Passing the examination was necessary for obtaining an official position, and passing at a higher level would typically lead to a higher-level and more lucrative official position. See sections C.1, C.2 for additional information.

human capital include those who were known to be educated or scholars but they did not participate in the civil service examination. The alternative human capital variable presumes a higher level of human capital if a man has passed the civil service exam at a higher level (column (4)); a man who passes the local exam is a *shengyuan*, while a man who pased the provincial level exam is a *juren* and a graduate of the national exam is a *jinshi*. Employing the alternative human capital variable leads to similar qualitative results.

The 490 couples who witnessed the fall-of-Ming shock in their lifetime first hand are the basis for the intergenerationally-linked analysis. For two reasons, the inter-generationally linked sample is a subset of all observations in the clan genealogies. The first reason is that a particular couple does not have a male child. Given that the genealogy is organized patrilineally, a branch of the family without male heir is terminated by construction. While having a male child or not is to some extent biologically determined and random, there is scope for selection because in the absence of a male child with a given female partner, a rich man may have another female partner whereas a poorer man is less likely to be able to afford this. At the same time, there is no major difference in fertility for males with multiple female partners between treatment and control samples, which suggests that the influence of this for the long-run impact of the Ming-Qing transition is limited.[19]

The second reason why the inter-generationally linked sample is a subset of all clan observations is that even though the couple has a male child, that child may not be able to form a household himself. One reason for non-marriage is that the male child dies early on in life, which may be influenced by the fall of Ming shock but also by the health and resources of the parents. Another reason for non-marriage is that the male child lacks the resources to marry given the prevailing sex ratio. It is therefore likely that the five-generation linked sample is upward selected compared to the sample of all clan observations. We provide analysis of the fall of Ming impact on the shortening of family lines in section D. To get a sense of magnitudes, we compare the set of village locations in which members of the seven clans lived for (i) the overall sample and for (ii) the five-generation linked sample. The five-generation linked sample includes 80 percent of all of the locations in the overall sample, see Figure A.9. This suggests a moderate effect due to the five-generation linked sample constraint. Section D provides additional analysis.

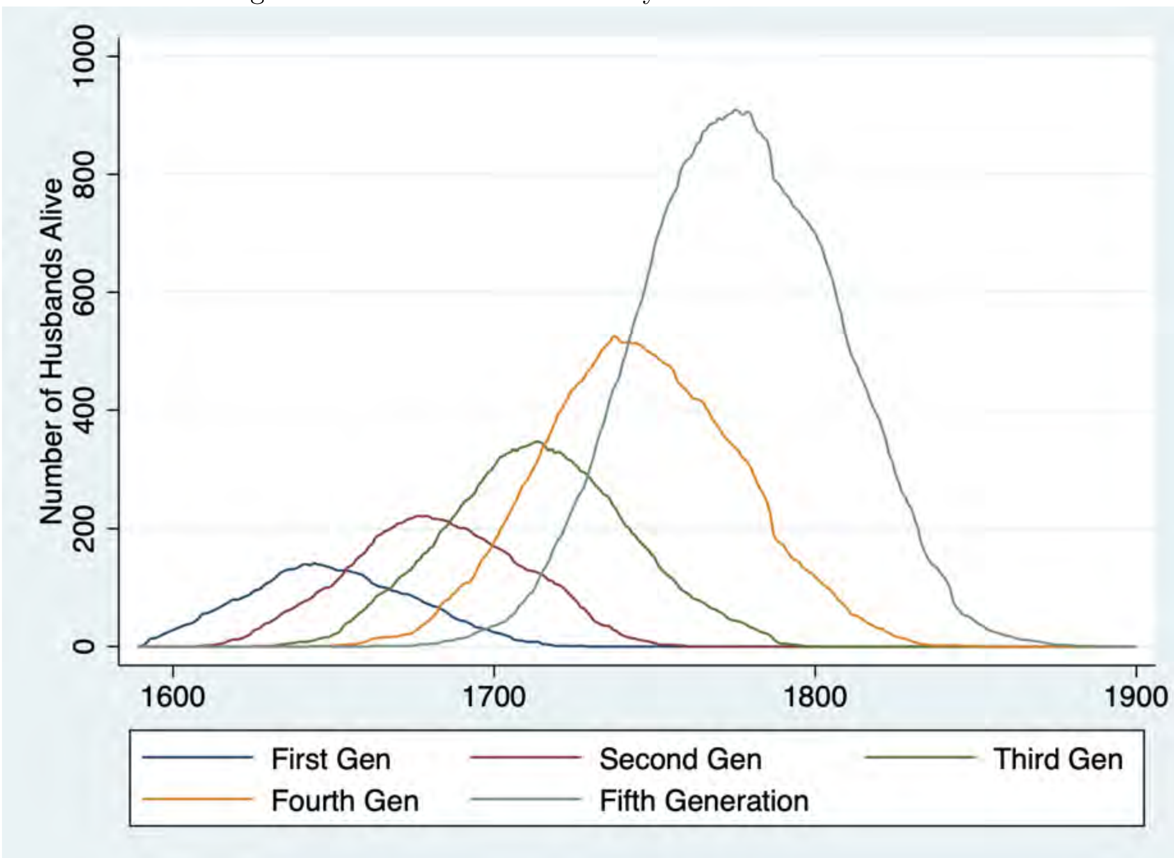
[19]For first-generation males with more than one female partner, the ratio of total sons to number of sons with a given female partner is 1.77 in the control and 1.74 in the treatment sample (n = 15 and n = 81, respectively; p-value of 0.94). Below, a male who has two female partners during his lifetime would correspond to two distinct couples in the dataset.

Table 2 presents summary statistics for the sample of all descendants of the 490 first-generation couples that (patrilineally) can be linked forward four times. The number of observations in the five-generation linked data set is about 8,000 couples (Panel A). Linking the first generation forward four times, the couples of the fifth generation are unique, and the male in each of these couples is the great-great grandson of the treatment generation couple. Because some males in the fifth generation are brothers, the number of unique couples in the fourth generation is lower than 1,600, in the third generation even lower, and so on, until in the first generation in which there are 170 unique couples.[20] The cross-sectional unit of observation is the roughly 1,600 branches of the family tree (family lines), and with five generations we have $5 \times 1,600 = 8,000$ observations each on husbands and wives. Figure 5 shows the number of husbands across each of the five generation as a function of calendar time.[21]

[20]Thus, about 35% of the 490 treatment generation couples and their descendants have at least one male child that becomes a head of household over four generations.

[21]While in principle each family line is observed in each of the five generations, in practice the number of observations falls somewhat from first to fifth generation because identifying data for birth or death year can be incomplete. Nevertheless, 91% of the first generation men are linked to the fifth generation (= 1,515/1667).

Figure 5: Number of Husbands by Generation over Time



Notes: Figure shows the number of husbands alive in each of the five generations in relation to calendar time.

The range of typical lifetimes is illustrated in Figure A.11.

Panel A. of Table 2 shows statistics for men by generation. Looking at the vitals on the left, the first generation typically experienced the transition from the Ming to the Qing in 1644, while the second generation did not. Moreover, the typical lifetime of the fifth generation reached into the early 19th century, with the latest death year being 1886. The father with the earliest birth year of any of the first generation males–employed in the pre-shock analysis of Table 3 below–was born in the year 1542. This means that the range of the data over these six generations is close to 350 years.

Table 2 provides more detail on the human capital measure by presenting a breakdown of human capital levels by generation (Panel A, center). Over time, average human capital levels in the sample fell, as was the case for China overall.[22] Status is a lifetime measure of the social standing of a man which is

[22]Competition in the civil service examination increased as population went from 100 to 400 million during the Qing,

Table 2: Summary Statistics: Five-Generation Linked Sample

	Male								Female	
Panel A. Generation	N	Birth Year	Death Year		Human Capital	Status	Migration	Sons	First Wife	Sons
		Median	Median	Max			Mean			
1	1,667	1619	1678	1728	0.259	4.320	0.198	3.272	0.104	2.998
2	1,661	1653	1718	1759	0.264	4.320	0.276	3.667	0.092	3.517
3	1,632	1686	1743	1796	0.200	3.540	0.229	3.322	0.071	3.222
4	1,609	1716	1778	1850	0.145	2.505	0.147	3.391	0.049	3.275
5	1,515	1748	1803	1886	0.106	1.998	0.104	2.224	0.096	1.929
All	8,084				0.196	3.366	0.189	3.193	0.083	3.005

Panel B. Clan	Chen	Ma	Wang	Ye	Yin	Zhao	Zhou
N	373	903	4,527	1,175	513	531	62
(%)	(4.6)	(11.2)	(56.0)	(14.5)	(6.3)	(6.6)	(0.8)
Human Capital	0.064	0.581	0.146	0.288	0.018	0.049	0.032
# Wives	1.078	1.289	1.240	1.286	1.105	1.056	1.226
Total Sons	3.456	2.685	3.335	3.062	3.162	3.119	1.952

Notes: Shown are statistics for five-generation linked sample; number of observation varies to some extent by variable; value for N given in Panels A. and B. is for male birth year. Migration is equal to 1 if head of household resides in generation x in a different town or village than in generation x-1. Total Sons is number of sons of a male from all female partners; First Wife is an indicator that the female is the female to be married at the earliest date of all females that lived consecutively or sequentially in the household; # Sons (# Daughters) is the number of sons (daughters) born to that female.

based on a range of descriptors in the genealogies. Social standing is highly correlated but not identical to income and wealth. The status variable has an ordinal range from 0 to 22, see Table A.3. About 70% of the men have lowest status, and they would be commoners living close to subsistence.

Information on migration comes from the place of residence of a head-of-household; the variable is equal to one if the head of household resides in a different location compared to his father, which is the case in just under 20% of all generation-to-generation transitions. We also employ information on the number of sons a male has from all his relations with females; it averages at about 3.2. Women in Chinese genealogies do not have status independent of the male, however, we have information on the timing of marriage and the role the female played in the household. Table 2 shows that about 8 percent were the first (earliest) wife of several in their husband's household, compared to 80% of all females who were the single lifetime wife of their husband, and about 2.5% concubines (unmarried females). Females in our sample had on average close to 3 sons.

The lower Panel B. provides information on each of the seven clans. The clans are different in multiple ways, which helps to obtaining a sample that is broadly representative. The two larger clans are the Wang and the Ye, while the Zhou is the smallest clan. Clans differ substantially in terms of human capital, fertility, and affluence, here measured as the average number of females per head of household. The Ma and the Ye have the highest human capital levels, while the Zhao clan had the lowest.

3.5 Pre-Shock Analysis

A central identification condition to causal estimation is that in the absence of the shock, human capital outcomes for treatment and control observations would have been similar. A well-known approach to provide evidence on the likelihood of this is to examine treatment and control samples in the pre-shock period. By linking the treatment generation couples backwards in time, we can compare treatment and control samples in the two generations *before* the fall of Ming. Table 3 presents the results.

Panel A, section I of Table 3 reports tests of the equality of the mean of various characteristics of the treatment generation males' fathers. Human capital levels of the fathers turn out to be similar; in both treatment and control samples, about 1 in every 3 men had human capital (Table 3). Lifespan and

while the number of top positions stayed roughly the same. One could account for this non-stationarity of the distribution of human capital as in Shiue (2024), however, the inclusion of birth year fixed effects together with taking the difference between treated and control observations suffices to deal with the issue.

Table 3: Differences between Treatment and Control Samples Before the Shock

	Control	Treatment	Difference	p-value
	N = 54	N = 436		
A. Test of Equality of Means				
I. Generation (-1): Father				
Human Capital	0.31	0.32	-0.01	0.93
Social Status	6.00	5.18	0.82	0.37
Birth Year	1589.16	1586.90	2.26	0.37
Lifespan	55.86	53.78	2.08	0.25
II. Generation (-1): Mother				
First Wife of Several	0.11	0.12	-0.01	0.82
III. Generation (-2): Grandfather				
Human Capital	0.46	0.38	0.08	0.23
Social Status	5.22	5.62	-0.40	0.64
B. Tests of Equality of Distribution				
Generation (-1): Father Status				0.31

Notes: Lifespan is age in years at death. Test for equality of distribution is Kolmogorov-Smirnov.

social status among control fathers is somewhat higher than among treatment fathers, but the difference is not statistically significant, and neither is their typical birthyear.[23] We can also assess pre-shock characteristics in terms of the mothers in the treatment generation. In particular, the share of mothers of treatment generation males who were the first among several married female partners in their husband's households was similar in treatment and control samples (section II of Table 3).[24]

Table 3 also presents results on the grandfathers of the treatment generation males (second pre-shock generation). Some of these men were born in the early 1500s, more than a century before the fall of the Ming dynasty. Grandfathers of the treatment generation males in the treatment and control samples turn out to have had similar human capital levels, a finding that is also obtained for social status (Panel A., section III.). Since status is not an indicator variable but defined in terms of 23 categories (see Table A.3) one can compare the entire distribution of social status in the treatment and control samples. They turn out to be similar, as the p-value of 0.31 indicates (Table 3, section B.). Overall, this analysis does not find evidence for large pre-shock differences between treatment and control samples.

[23]Lifespan here is higher than in China overall at this time because the figures in Table 3 are conditional of surviving to adulthood and being able to marry. Section D.2 on the effect of the fall of the Ming on being able to marry shedslight on these margins.

[24]Most husbands have a single married wife during their lifetime (80%). In the remainder, the majority is husbands who have sequentially married wives because the first wife dies.

4 The Impact of the Fall of the Ming on Human Capital Acquisition

4.1 Treatment of People

This section asks whether the fall of the Ming had a differential impact on those living in areas that were more heavily impacted, and if so, whether this differential impact was still present in any of the four following descendant generations. We refer to this as the treatment effect on people. The human capital variable is related to a treatment indicator, d_p, the level of destruction of the village or town in which the couple resided in the first generation (see Figure 3), using the following OLS specification

$$h_{ic(p)g} = \alpha + \beta_g \left[I \left[t = g \right] \times d_p \right] + \beta_f hfstat_{c0} + \eta_g + X'\gamma + \varepsilon_{ic(p)g}, \qquad (1)$$

where $h_{ic(p)g}$ is human capital of man i belonging to couple c in generation g who is a descendant of pair p in the treatment generation. The term $I[t = g]$ is an indicator function equal to one if observation t belongs to generation g, and zero otherwise, while η_g are fixed effects for each of the five generations. Equation (1) also includes the status of the father of the male in the first generation couple, denoted by $hfstat_{c0}$. Conditioning on (a proxy of) father income is common in intergenerational analysis because it helps to address omitted variables concerns (Oreopoulos, Page, and Stevens 2008). We have shown above that there is no significant average difference in $hfstat_{c0}$ between treatment and control samples (Table 3).

Equation (1) includes also a vector X of additional variables. First, it includes fixed effect for each of the men's birth years. Lifetime in terms of calendar time varies substantially within a given generation (see Figure 5), and including birth year fixed effects helps to account for secular changes and shocks. Second, we include a fixed effect for each of the seven male clans, denoted by m, $m = 1, ..., M$. They capture time-invariant differences, for example in the level of clan resources, that may affect an individual's response to the fall of the Ming. Similarly, equation (1), adds a fixed effect for each of the wives' clan-of-origin (130 different clans), denoted by f, $f = 1, ..., F$; also characteristics of the wife's clan might affect the human capital response of the husband.[25] The error term $\varepsilon_{ic(p)g}$ is assumed to be mean-zero but possible heteroskedastic. We cluster by couple of the treatment generation (p) and by generation (g). The shock may trigger effects that last for more than one generation, and if intergenerational adjustment strategies

[25] We do not include the clan subscripts m and f in equation (1) to simplify the notation.

play a role the behavior of members of the same family line in different generations will not be independent. We allow for dependence of observations in the same generation because these observations are typically affected by the same subsequent shocks (if any) in terms of calendar time. Conditional on the included variables, we assume that β_g gives the mean difference in $h_{ic(p)g}$ due to the fall of the Ming in generation g.

The sample consists of all men and women that are descendant couples of the treatment generation in generation two to five, plus the individuals of the treatment generation. Results are presented in Table 4.

Table 4: The Impact of the Fall of the Ming

	(1)	(2)	(3)	(4)
Gen 1	-0.330^{**}	-0.305^{**}	-0.251^{**}	-0.351^{**}
	(0.041)	(0.040)	(0.034)	(0.069)
Gen 2	-0.024	-0.053	-0.035	0.007
	(0.044)	(0.056)	(0.068)	(0.092)
Gen 3	0.254^{*}	0.200^{**}	0.196^{*}	0.202^{*}
	(0.062)	(0.039)	(0.064)	(0.064)
Gen 4	0.178^{+}	0.132^{*}	0.126^{+}	0.119^{+}
	(0.066)	(0.044)	(0.055)	(0.043)
Gen 5	0.143	0.111	0.113	0.132^{+}
	(0.069)	(0.060)	(0.061)	(0.060)
Father Status	0.029^{**}	0.025^{**}	0.018^{*}	0.018^{**}
	(0.005)	(0.004)	(0.004)	(0.004)
Fixed Effects				
Generation	Y	Y	Y	Y
Birth Year	N	Y	Y	Y
Male Clan	N	N	Y	Y
Female Clan	N	N	N	Y
Mean d.p.	0.197	0.197	0.197	0.197
N	8,064	8,062	8,062	8,029

Notes: Dependent variable is human capital indicator; sample consists of all men and women in generations 2, 3, 4, and 5 that constitute couples formed by male descendants of the treatment (first) generation, as well as the treatment generation couples themselves. Estimation of equation (1) by OLS. Father Status is status of the husband's father in treatment generation. Gen stands for generation, d.p. stands for dependent variable. Robust standard errors two-way clustered at the level of treatment generation couple and generation in parentheses; **/*/+ indicates significant at the 1%/5%/10% level.

We begin with a specification that has only fixed effects for each generation, see column (1). In the first generation, the coefficient on treatment is estimated at -0.33. This says that for every three men in the control group that acquire human capital in the first generation, due to the shock only two treated men did. It is plausible that war, famine, and disease would make it more difficult to acquire human capital. Analysis in Table A.5 shows that the shock has made it both harder for sons of human capital fathers to acquire human capital themselves and for sons of fathers without human capital to advance in terms of human capital beyond their fathers. For the second generation, the treatment coefficient β_g is close to zero, whereas point estimates are positive for the following generations (column (1), Table 4). This points to a reversal of human capital, which indeed is confirmed by further analysis. The father status variable $hfstat_{c0}$ enters with a positive sign, which reflects that acquiring human capital is costly so that men with higher-resource fathers have an advantage.

Actual lifetimes of men in each of the five generations vary in terms of calendar time, and different shocks may be present at different calendar times. To account for that we include birth year fixed effects. They do not drastically change the point estimates although precision becomes somewhat higher (see column (2)). The following two specifications introduce male and female clan fixed effects to the specification. While the size of the negative impact in each generation varies somewhat, the overall pattern, from negative in the first to positive by the third generation, is the same as before, and in the specification with all four sets of fixed effects the shock's impact in the fifth generation is significant at standard levels (column (4)). Thus, compared to control men, the shock has initially a negative impact on human capital which turns positive in later generations.

To recap, even though the shock caused lower human capital in the treatment (first) generation, by the second generation human capital acquisition of the descendants of treatment vs control couples is comparable, and from the third generation on descendants of treatment couples acquire more human capital than descendants of control couples. Thus, the heavy human capital losses have not discouraged descendants of treatment couples, instead, the evidence is consistent with treated descendants being disproportionately encouraged to make human capital investments in later generations. One explanation consistent with the historical evidence from above is that the shock has increased the preference for human capital among treated descendants. We will evaluate this explanation below.

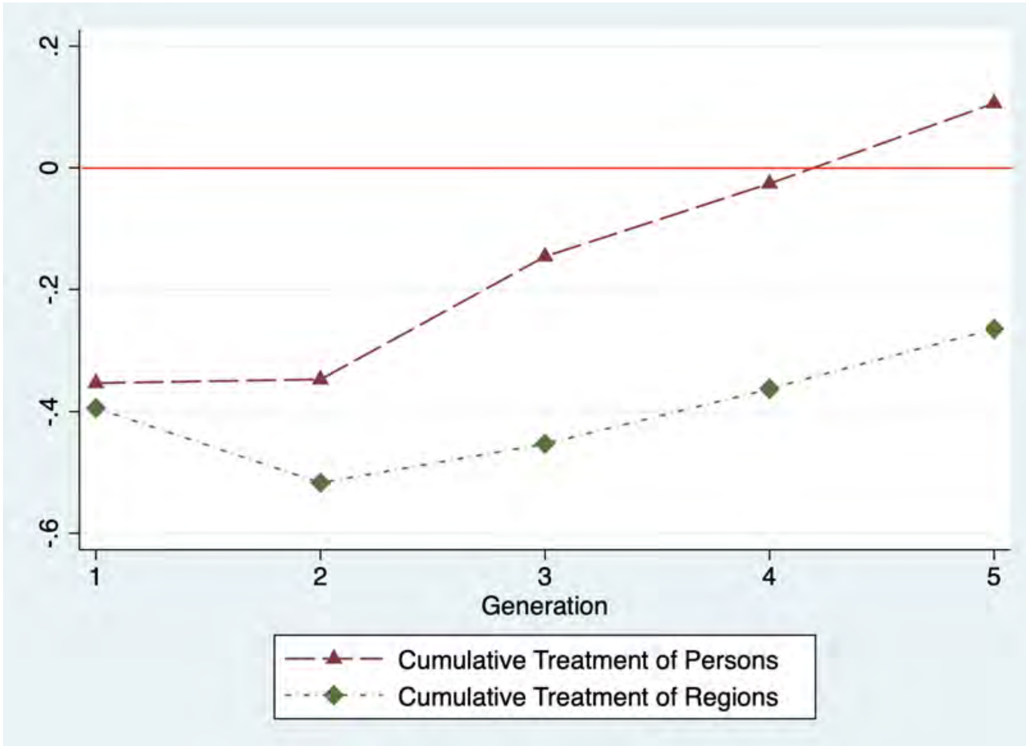
4.2 Treatment of Regions

Before explaining this human capital reversal, it is useful to compare the fall of Ming impact on 'people' (the descendants of couples living in heavily destroyed villages) with the fall of Ming impact on 'regions'. The latter compares human capital outcomes of those living in generations 2, 3, 4 and 5 in regions that were historically treated in generation 1 with the human capital outcomes of those living elsewhere, both in the treatment generation 1 as well as generations 2 to 5. Treatment of people follows descendants of treated vs control families wherever they migrate to, whereas treatment of regions is based on whoever has stayed in, or immigrated into a historically treated region. We estimate the following equation by OLS:

$$y_{icg} = \alpha + \delta_g \left[I \left[t = g \right] \times I \left[r = 1 \right] \right] + \delta_f hfstat_{c0} + \eta_g + X'\gamma + \varepsilon_{icg}, \quad (2)$$

where $I[r_{ig} = 1]$ is an indicator function equal to one if individual i in generation g resides in a historically destroyed location, and zero otherwise. This exploits cross-sectional variation across regions, with one treatment coefficient δ_g per generation. Equation (2) is estimated on the same inter-generationally linked sample as that underlying Table 4. Figure 6 shows cumulative point estimates from applying equation (2) with human capital as the dependent variable, with full estimation results given in Table A.6.

Figure 6: Treatment of People versus Treatment of Regions



Notes: Treatment of Regions shows cumulative point estimates of column (2), Table A.6 (equation (2)); Treatment of People shows cumulative point estimates of column (4), Table 4, based on equation (1).

Figure 6 shows the cumulative impact of the fall of the Ming on regions as the lower of the two series, while the upper series is the cumulative impact of treatment of people (from Table 4, column (4)). The impact on regions tends to be more negative than the impact on people, both because there is an incremental negative impact on regions in generation 2 and because the recovery of human capital acquisition in generations 3, 4, and 5 is somewhat slower. Overall, the cumulative impact on regions in the fifth generation is -0.27, compared to 0.11 for the impact on people.[26]

By necessity, the difference between the impact on regions and the impact on people is explained by migration. Figure 6 indicates that given the residence of people in destroyed versus not destroyed locations in generation 1, on net men who moved into one of the destroyed location acquired less human capital in generation 2 than those that left the destroyed locations.[27] These results show that the long-run impact

[26]The small difference between impact on region and the impact on people in generation 1 is due to constraining the birth year and clan fixed effects to be the same across generations to save on degrees of freedom. If one estimates generation by generation (as in Table A.7), coefficients for impact on regions and impact on people are identical in generation 1.

[27]Stayers–those family lines that stay for generation 2 in their generation 1 location–cannot explain the difference between treatment of regions and treatment of people in generation 2.

of a shock on people can be qualitatively different from the long-run impact of the same shock across regions. In the present case the long-run outlook on regions is particularly dire because families in-migrate to historically destroyed regions invest disproportionately little into human capital.

Underlining the importance of regional destruction in the short term, further analysis shows that human capital acquisition in the second generation is relatively high for treated families that migrate to control regions while it is relatively low for control families that migrate into treated regions. Starting in the third generation, however, treated family lines' human capital acquisition is similar whether they reside in treated or control regions, and net migration flows from treated into control regions come to a halt by the fourth generation. Compared to stayers, families that migrate from treated to control regions are (i) relatively young, (ii) have more resources, and (iii) have less old-age caretaking commitments because the husband's mother died relatively early. These results are presented in section E.7.

5 Mechanisms

5.1 Greater Preference for Human Capital

Why was there a human capital reversal for those whose ancestors suffered heavily from the shock? This section examines the hypothesis that the shock might have increased the preference for human capital of those affected by the shock that is transmitted from generation to generation.

The emphasis on human capital acquisition of the descendants of those first-hand impacted by the fall of the Ming, to the point that they have more than made up their ancestors initial losses (Figure 6), is *prima facie* evidence of the increased importance of human-capital based wealth for these families. The main alternative in this economy was land-based wealth. Historical accounts emphasize that the shock had a large negative impact on agriculture. Even though devastated land will become arable again after some time, the difference in portability between land and human capital in the face of a big shock increases incentives to pursue upward mobility based on human capital.

The relative vulnerability of immovable land compared to human capital would have been observed both by those that experienced heavy fall of Ming destruction first-hand and by those that did not. However, it is plausible that the destruction made a stronger impression on the former compared to the latter. First-hand exposure may create attitudes and beliefs that generate a persistent difference between descendants of treated versus control couples because attitudes are internalized and passed down from generation to generation.

If the destruction during the fall of the Ming has led to a greater emphasis on human capital among the descendants of treated couples, it would tend to increase their human capital acquisition relative to the control descendants, as seen in Table 4. Moreover, to the extent that the transmission of this attitude is important, one expects that greater emphasis on human capital among treated descendants is reflected in a stronger intergenerational human capital relationship.[28] To assess this, we employ the well-known framework of intergenerational mobility that relates son characteristics to father characteristics using an OLS regression:

$$h_{ic(p)g} = \alpha + \omega_1 h_{ic(p)g-1} + X\psi + \epsilon_{ic(p)g}. \tag{3}$$

Here, $h_{ic(p)g}$ is human capital of the son, $h_{ic(p)g-1}$ is human capital of the father, and the vector X includes the male's father status in generation 1 and generation, birth year, and male as well female clan fixed effects. The higher is ω_1, the more is the son's level of human capital influenced by his father's human capital, so higher ω_1 means higher human capital persistence (lower human capital mobility). Equation (3) is separately estimated for the descendants of generation-1 treated couples and the descendants of generation-1 control couples. Results are shown in Table 5, columns (1) and (3).

Table 5: Post-Shock Human Capital Mobility by Treatment Assignment

	(1)	(2)	(3)	(4)
	Treated		Control	
Father Human Capital	0.258^{**} (0.033)	0.223^{**} (0.033)	-0.033 (0.143)	-0.154 (0.215)
Grandfather Human Capital		0.081^{**} (0.028)		0.184^{+} (0.103)
Included Generations	3, 4, 5	4, 5	3, 4, 5	4, 5
N	4,236	2,751	411	247

Notes: Dependent variable is human capital of the son. Also included are the male father's status in generation 1 as well as generation, birth year, and male as well as female clan fixed effects. Robust standard errors clustered at the level of the treatment generation couple; **/*/+ indicates significant at the 1%/5%/10% level.

[28] See Becker and Tomes (1979, 1986) for workhorse models of parental investments into the human capital of their children in order to raise their lifetime incomes, and Shiue (2024) for evidence on changes in mobility in China using regressions of son status on father status for the period 1300-1900.

For the descendants of treated couples, the parameter ω_1 is estimated at 0.258 (column 1). It means that among descendants of couples that were subject to the fall of Ming shock, the son of a father with human capital has a 26% higher chance to acquire human capital himself compared to a son whose father has no human capital. In contrast, among control descendants, there is no benefit from having a father with human capital (column (3)). This differential level of human capital persistence is consistent with the hypothesis that the fall of Ming shock has increased the emphasis on human capital among the descendants of those couples that were affected first-hand.

The son's human capital acquisition may not only be affected by his father's human capital but by earlier generations as well (multigenerational mobility). In fact, a change in attitude towards human capital would likely involve many members of the family, including grandparents but also (grand-)uncles and (grand-)aunts. To examine some aspects of this we add the human capital of the grandfather to the specification:

$$h_{ic(p)g} = \alpha + \omega_1 h_{ic(p)g-1} + \omega_2 h_{ic(p)g-2} + X\psi + \epsilon_{ic(p)g}. \tag{4}$$

The coefficient on grandfather human capital, ω_2, is 0.081 and indicates that an educated grandfather is also associated with higher human capital acquisition of the son (column 2). The sum of the coefficients of father and grandfather human capital is about 0.30. It means that, typically, a son from a line of human capital father *and* grandfathers has a chance of 30% to acquire human capital himself. Among the control descendants, in contrast, the sum of father and grandfather point estimates is close to zero (column 4).

The previous analysis has compared relative human capital mobility among treated versus control descendants. To see whether the difference between treatment and control observations is present in terms of absolute human capital mobility, we examine transition matrices that relate human capital of the son to that of his father. Table 6 shows the results in Section I. We begin with downward mobility. Notice that three quarters of sons among descendants of those couples not exposed to the shock do not retain their father's human capital, wheres among descendants of treated couples this is the case for only half on the sons (75.3%, versus 51.9%, respectively). Thus, downward mobility is lower among descendants of treated couples. Another way to look at these results is in terms of human capital persistence. Close to half of sons of descendants of treated couples retain their father's human capital level, in contrast to only a quarter of the control descendant sons.

Turning to upward mobility, sons of control descendants rise at a rate of 3.4% from no human capital

Table 6: Human Capital Mobility and the Fall of Ming

Section I: After the Shock

Panel A: Control Descendants

		Father: No HC	Father: HC
Son	No HC	96.6%	75.3%
	HC	3.4%	24.7%
		100%	100%

Panel B: Treated Descendants

		Father: No HC	Father: HC
Son	No HC	92.5%	51.9%
	HC	7.5%	48.1%
		100%	100%

Section II: Before the Shock

Panel A: Control Descendants

		Father: No HC	Father: HC
Son	No HC	82.8%	52.0%
	HC	17.2%	48.0%
		100%	100%

Panel B: Treated Descendants

		Father: No HC	Father: HC
Son	No HC	81.5%	45.5%
	HC	18.5%	54.5%
		100%	100%

Notes: Table shows transition matrix for intergenerational mobility in human capital (HC). Section I. is for post-shock period using generations 3, 4, and 5. Section II. is for the pre-shock period, using the generations of the treatment generation's fathers and grandfathers (as in Table 3). Columns sum to 100 percent. Total number of observations N = 4,741 in Section I and N = 490 in Section II.

to having human capital (Panel A, lower left cell). In contrast, sons of treatment descendants do so at a rate of 7.5%, more than twice the rate among control descendant sons. Overall, the higher human capital persistence estimated above is due to both lower downward and higher upward mobility for descendants of fall of Ming treated couples.

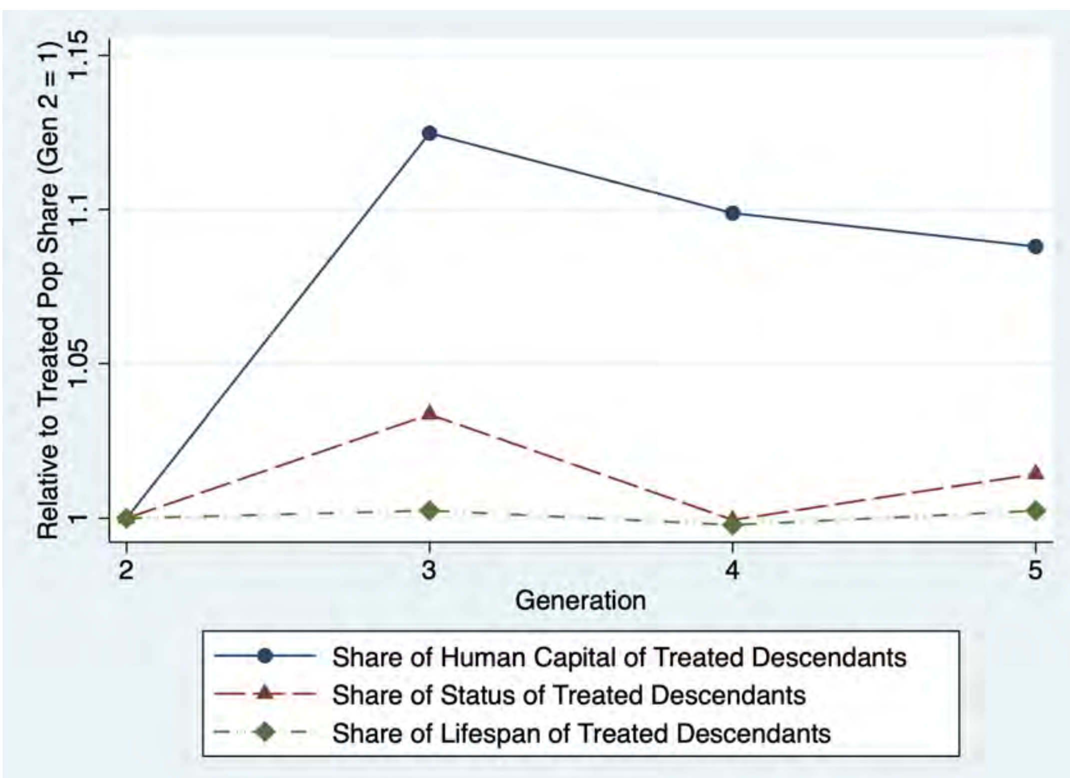
Furthermore, is the higher human capital persistence among treatment descendants really a consequence of the shock, or was it perhaps present already before the shock? Section II. of Table 6 examines human capital mobility in the first and second generation before the shock. The results show that human capital mobility was more similar for treatment and control observations before the shock, certainly much smaller than after the shock. For example, the rate of upward mobility is 17.2% for control and 18.5% for treatment ancestors according to Table 6, Section II.; this a difference of about eight percent, which compares with a difference of more than 100% after the shock. This is evidence that the difference in intergenerational human capital mobility found for the post-shock era is a new development.

5.2 Alternative Explanations

The previous section has shown evidence in support of the hypothesis that the shock has increased the preference for human capital over several generations. But could the patterns in the data be explained by other mechanisms? In particular, is there something specific about human capital, or has the shock simply incentivized descendants of the historically treated couples to perform better overall?

The following presents evidence on alternative mechanisms. First, consider sample size. For any of the five generations, the historically treated couples and their descendants account for about 90 percent of the population in the linked sample. This is by construction because the analysis is net of any break in the family lines, and given our cohort approach there is no entry in later generations. Even though the share of the treated population is approximately constant, if behavior changes as the result of the shock, the share of treated descendants in other dimensions might vary. Figure 7 shows this share for several variables.[29] All figures are relative to the share of treated descendants in the sample.

Figure 7: Human Capital Preference and Alternative Explanations



Notes: Figure shows the share of treated descendants in terms of three different variables, relative to the share of treated descendants in the sample. Lifespan is computed as death year minus birth year. Values for Generation 2 are set to equal 1.

[29] Generation 1 is omitted from this figure in order to focus on post-shock developments.

First, consider income, which is proxied by status. One might believe that the traumatic experience of the shock with the resulting hardship and poverty might induce a greater emphasis on income. Figure 7 shows that the treated descendants' share of the sum of treated plus control status in generations 3 to 5 hovers around 1.02, that is, only 2 percent higher than in the baseline period (generation 2). In contrast, the treated descendants' share of total human capital is around 1.1 between generations 3 and 5, that is, five times as high. This is evidence for an emphasis on human capital relative to other investment strategies to generate income.

Another hypothesis is that the shock has increased human capital acquisition because treated descendants live longer, as this, e.g., gives them a better chance to obtain a high-ranking position. Longevity can also be seen as a proxy for health and attitudes towards risk. Figure 7 shows that the treated descendants' share of all (male) years lived virtually did not change after the shock. Thus, the increase in human capital is not due to longer lifetimes; rather, it points to a higher investment into human capital per year of life.

Overall, the pattern of human capital in the post-shock era is different from those proxying for income, health, and attitudes towards risk. This provides additional support for the hypothesis that the shock has led to greater preference for human capital that is transmitted from generation to generation.

6 Robustness

6.1 Sharpening Inference: More Similar People

Individuals and families vary in their characteristics which might make them subject to different shocks. This section performs analyses on subsamples that are more similar to sharpen identification. The idea behind it is the same as in a treatment of regions analysis that applies a spatial regression discontinuity approach around the 'border'. Three dimensions along which samples become more similar are considered, the clan, the individual, and the temporal dimension. Human capital is the dependent variable in all specifications, with only the sample changing. Table 7 gives the results. Results with the full sample are given again for convenience in column (1).

Clan Dimension While there are genealogical principles that virtually all Chinese clans adhere to, some clan rules are heterogeneous for various reasons. If clan rule differences are correlated with clan responses to treatment, this heterogeneity might lead to spurious results, and analyzing a subset of clans will tend

Table 7: Impact with More Similar People

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Constraint		Clan				Individual		Temporal	
Type		Treat & Control	< 95% Treated	Higher Status	Lower Status	Higher Status	Lower HC	Born by 1634	Lifetime during 17th C
Gen 1	-0.354^{**}	-0.281^{**}	-0.295^{*}	-0.362^{**}	-0.323^{**}	-0.351^{**}	-0.349^{+}	-0.419^{**}	-0.403^{*}
	(0.070)	(0.047)	(0.096)	(0.074)	(0.071)	(0.069)	(0.154)	(0.057)	(0.095)
Gen 2	0.006	0.016	−0.061	0.014	0.068	−0.004	0.132	−0.068	-0.257^{*}
	(0.093)	(0.060)	(0.066)	(0.096)	(0.116)	(0.090)	(0.094)	(0.084)	(0.077)
Gen 3	0.202^{*}	0.179^{*}	0.086^{+}	0.195^{*}	0.272^{*}	0.143^{*}	0.190^{*}	0.201^{*}	0.158
	(0.064)	(0.059)	(0.036)	(0.059)	(0.087)	(0.040)	(0.040)	(0.064)	(0.087)
Gen 4	0.119^{+}	0.106^{+}	0.126^{*}	0.127^{+}	0.102	0.123^{+}	0.091	0.117^{+}	0.082^{*}
	(0.043)	(0.038)	(0.045)	(0.046)	(0.061)	(0.052)	(0.049)	(0.045)	(0.029)
Gen 5	0.132^{+}	0.123^{+}	0.108^{+}	0.144^{+}	0.151	0.135^{+}	0.031	0.128^{+}	0.122^{+}
	(0.060)	(0.055)	(0.042)	(0.064)	(0.076)	(0.058)	(0.045)	(0.056)	(0.052)
Father Status	0.018^{**}	0.017^{**}	0.017^{**}	0.017^{**}	0.017^{*}	0.024^{**}	0.018^{*}	0.014^{**}	0.015^{*}
	(0.004)	(0.003)	(0.002)	(0.004)	(0.006)	(0.003)	(0.005)	(0.003)	(0.004)
Fixed Effects									
Generation	Y	Y	Y	Y	Y	Y	Y	Y	Y
Birth Year	Y	Y	Y	Y	Y	Y	Y	Y	Y
Male Clan	Y	Y	Y	Y	Y	Y	Y	Y	Y
Female Clan	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	8,021	7,577	3,059	7,491	7,121	4,682	6,948	7,113	4,460

Notes: Dependent variable is human capital. Estimation of equation (1) by OLS. Column (1) is for full sample; column (2) focuses on clans that have both treatment and control families (drops Chen & Zhou); column (3) focuses on clans with < 95% observations in generation 1 treated (drops Chen, Zhou, and Wang); column (4) drops clan with the lowest average father status in generation 1 (Zhao); column (5) drops clan with the highest average father status in generation 1 (Ma); column (6) drops family lines for men in generation 1 whose father has status level 0; column (7) drops family lines for men in generation 1 whose father has status level 10 or higher; column (8) defines the treatment generation to be couples in which the male was born between 1589 and 1634; column (9) defines the treatment generation to be couples in which the male was born between 1599 and 1644 and had died in 1695 or earlier. Father Status is status of the husband's father in treatment generation. Gen stands for generation, HC for human capital. Robust standard errors two-way clustered at the level of treatment generation couple and generation in parentheses; **/*/+ indicates significant at the 1%/5%/10% level.

to reduce this source of bias. A downside of dropping particular clans from the sample is that the degree of representativeness of the analysis might be lowered.

Clans vary in the degree to which they are exposed to the shock. To the extent that clan characteristics shape the individual responses of their clan members, the response for individuals from exposed clans might systematically differ from that of individuals from non-exposed clans. There are two clans in the sample that have only members in locations destroyed by the shock, the Chen and the Zhao. It turns out, however, that results are broadly similar when members of the Chen and Zhao clans are dropped from the sample (column (2)). Along the same lines, among the remaining five clans is one, the Wang, whose members reside in historically destroyed locations to a greater extent than members of the other clans. The Wang clan also matters simply due to its size, having more than three times as many members as the second-largest clan. Dropping members of the Wang clan in addition to the Chen and Zhao leads to the broadly similar results of column (3).

Irrespective of the distribution of members in treated versus control observations, clans might shape the responses of their clan members in systematic ways. If so, focusing on clans below or above a certain threshold level of resources will make the estimation sample more similar. The next two columns of Table 7 show that dropping the poorest or the richest clan, as proxied by average pre-shock status, does not qualitatively change the pattern of the results (column (4) and column (5), respectively). We have also explored the possibility that instead of the first moment (mean) the second moment (dispersion) of clan resources matters for individual responses, finding little evidence for it.

Individual Dimension Focusing on observations that are relatively similar in an individual dimension is another way of obtaining a more homogeneous sample. We first focus on relatively rich family lines by dropping those from the sample for which the pre-shock father status is the lowest level. This reduces the sample to 58% of its original size, yet results are broadly similar to before (column (6)).

Next, we turn to human capital responses for family lines that are relatively poor. Clearly, a certain minimum level of heterogeneity in the sample is needed, otherwise, human capital responses to the shock cannot be estimated. Yet, about half of the human capital holders in the sample do not belong to the group of top officials holding national and provincial degrees from the civil service examination (*jinshi* and *juren*, respectively). Column (7) shows that broadly similar results are obtained when the highest levels of human capital holders are dropped from the sample.

Temporal Dimension The remaining two specifications create more homogeneous samples by varying the definition of the treatment generation (or, the first generation). In the main analysis, these are couples in which the male is born between the years of 1590 and 1644. First, we explore the implications of reducing the treatment generation definition to the range of birth years from 1590 to 1634. The sample becomes more homogeneous both because less weight is given conditions in Tongcheng in post-Ming (post-1644) times, and by ensuring that all treatment generation males have lived through the heavy destruction in Tongcheng during the years 1634 to 1644. Column (8) shows that results are broadly similar.

Second, the focus is shifted to couples in which the male is born between 1600 and 1644 at the same time when his year of death is 1695 or earlier. It may be that the heavy destruction during 1634-44 has a differential impact on those aged 34 to 44, perhaps because they are too advanced in their life to still consider human capital acquisition. By shifting the start of the treatment generation definition to 1600, the oldest treated individuals are 34 years of age by the start of the most heavy destruction in 1634. Also, one may want to limit the definition of treatment to those who have completed their lifetime in the 17th century because there may be different shocks in the 18th century. Column (9) shows that one implication of this concentration of the definition of treatment generation (later start in terms of birth year, and earlier end in terms of death year) is that the impact of the shock on human capital acquisition in the second generation is still negative, as opposed to zero as in the baseline in column (1). At the same time, there is still a reversal in human capital acquisition, and estimates for the fourth and fifth generation are positive as before.

Overall, while there are some nuances, the broad patterns of the human capital response found earlier is present in all specifications of Table 7. In particular, relative to those living in historically undestroyed locations, the fall of Ming has caused a loss in human capital for men in the first generation, and this loss reverses to a gain in human capital among their descendants in later generations, typically by the third generation.

6.2 Additional Robustness Checks

The robustness of our main findings has been examined in a number of other dimensions. First, we have generalized the human capital indicator variable to one that gives higher values to top-level civil service exam graduates versus lower exam graduates, and find that it yields a similar human capital reversal from the first to the fifth generation (Table A.7). Second, we have confirmed that the results from estimating human capital impacts with five stacked generations, as in equation (1), are similar to estimates that are obtained if one estimates generation by generation (Table A.7). Third, we have employed randomization inference as an alternative to the two-way clustered standard errors, finding similar results (Figure A.12). And fourth, robustness analysis shows that the role of estimated vital statistics for our results is limited (Figure A.13).

7 Conclusions

Do big shocks have a permanent effect on the economic fortunes of people, or are the effects from big shocks transitory? This paper examines the fall of the Ming Dynasty (1644), a shock that cost the lives of 1/7 of China's population, and the economic responses over three centuries in a sample of men and their families in Central China. The impact of the shock is estimated by comparing the behavior of couples who were living in villages that were more heavily or less heavily destroyed by the turmoil of the fall of the Ming, a shock that is plausibly exogenous.

We find that the shock has a negative impact on the human capital acquisition in the first generation. Moreover, the impact is sizable. For every three men acquiring human capital in the not destroyed areas, only two do so in the destroyed areas. However, the negative impact on human capital does not persist. Instead, by the third generation (the treatment generation's couples' grandsons), those with ancestors that lived in historically destroyed areas acquire more human capital than those with ancestors in historically not destroyed areas. Furthermore, this positive human capital response persists to the fifth generation, which includes individuals living 250 years after the fall of Ming. We also show that the human capital reversal is a robust finding.

As explanation we evaluate the hypothesis that the shock has led to a greater preference for human capital for those first-hand affected by the fall of the Ming, and that these families have transmitted this change in norms from one generation to the next. In support of this, we find that in the post-shock era, descendants of treated couples exhibit both a higher rate of intergenerational upward mobility and a lower rate of downward mobility than descendants of control couples. Moreover, among descendants of treated couples, both father and grandfather human capital play a role for son's human capital, while they do not for descendant sons of control couples. These findings are consistent with a greater emphasis on human capital for descendants of treated couples. Clan externalities support the intergenerational transmission of the focus on human capital at the level of the nuclear family.

Another important finding is that the shock's impact on human capital over any time horizon is strongly related to the impact on treated couples and their descendants. Human capital results are not strongly affected when we distinguish those that currently live in historically destroyed regions from those that have moved to historically not destroyed regions. This also supports the hypothesis that new norms are transmitted from one generation to the next irrespective of where families currently live. Further, the shock's impact on human capital preference is unique, as we do not find that the shock had a similar impact on status or health of the families in our sample.-

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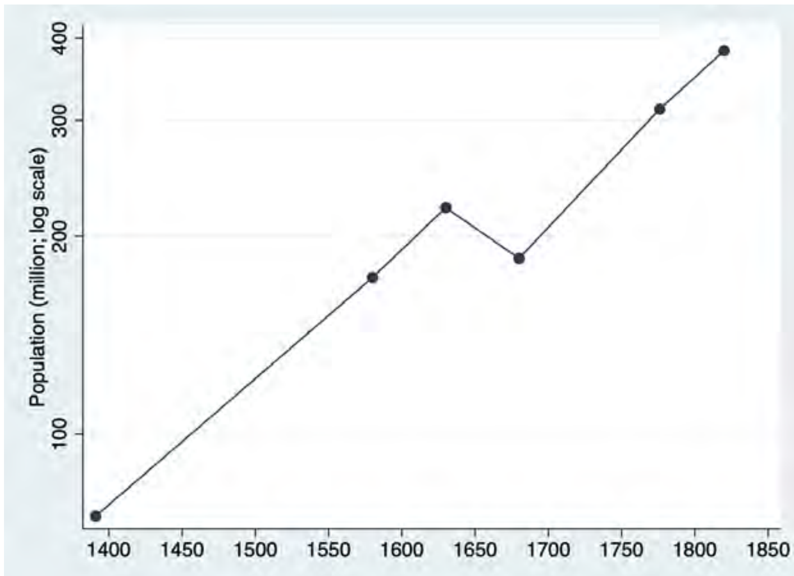
A The Fall of the Ming as a Shock

Figure A.1 shows the evolution of China's population from the late 14th to the early 19th century. In 1630, population is estimated at 221 million, compared to 185 million in the year 1680 (a 16% decline).

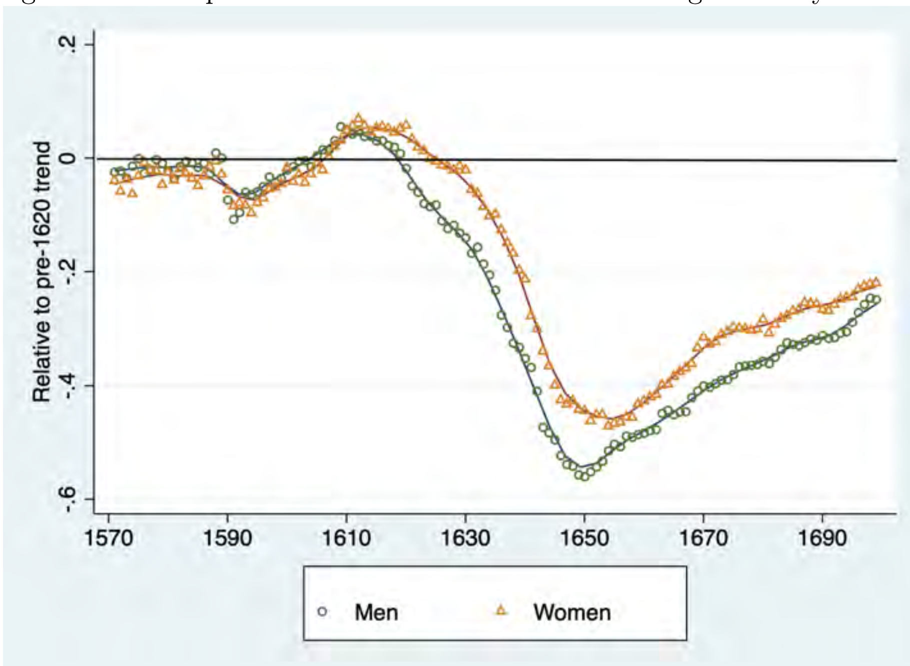
Figure A.1: China's Population and the Fall of the Ming



Notes: Source is Cao (2022), based on Ge Jianxiong (1999).

Figure A.2 shows the population developments in the sample between 1570 and 1700 relative to the pre-1620 trend for both men and women. Growth for both gender is relatively close to the pre-shock trend until the year 1620. Between 1620 and 1650, the male population falls by more than 50% relative to pre-shock trend growth, before it slowly recovers. The onset of the female population decline is somewhat later, and its trough is with around 45% somewhat above that for men. This might be due to men being more vulnerable to war activity or food crises compared to women.

Figure A.2: Sample Trend Growth and the Fall of Ming Shock by Gender



Notes: Figure shows the log difference between male (female) population and its trend fitted on pre-1620 data with circles (triangles).

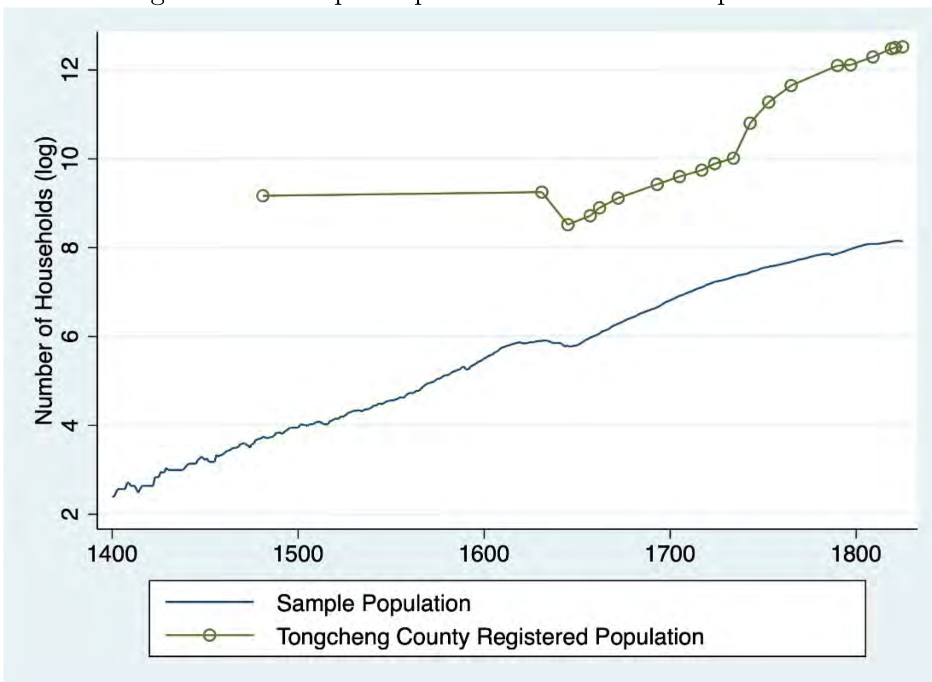
Even by the end of the 17th century the number of both men and women remains more than 20% below the trend.

B Representativeness

There would be no need to rely on clan records if high-quality data would be available for the economy in question. Thus, we begin by comparing the sample clan population with the available official data. Figure A.3, lower series, shows the evolution of Tongcheng population between 1400 and 1825 based on the seven clan genealogies of this study. Growth of the population is fairly steady over this period, with the exception of the years of the Ming-Qing transition in the middle of the 17th century.[30]

[30]More details on sample population developments around the fall of the Ming are presented in the Appendix, Section A

Figure A.3: Sample Population and Official Population



Notes: Sample Population is authors' computation of total of heads-of-households across seven clans; Tongcheng County Registered Population is the official number of households from Beattie (1979a), Table 3.

The upper series in Figure A.3 shows figures for Tongcheng's population based on official data, the tax registers. First, there are only twenty-one annual observations, less than 5% of what is available based on the clan total. Second, the official data does not record any population growth between the late 15th and the beginning of the Qing dynasty (1644). Overall, Figure A.3 suggests that Tongcheng population developments are better described by the clan figures than by official population figures.

B.1 Comparisons to External Evidence

A first check is to consider mortality rates by age group. Population figures at the regional level are typically based on gazetteers (local histories about a certain place). Three county-level gazetteers about Tongcheng cover the period under analysis; they are *Tongcheng xian zhi* (1490), *Tongcheng xian zhi* (1696), *Tongcheng xuxiu xian zhi* (1827). In addition, there are official accounts for subsets of the population, such as the Qing population registers, which are the product of the Eight Banner registration system.[31]

[31] These data are available for areas in China's northeast, in today's Liaoning and Heilongjiang Provinces; these lands were organized under the Imperial Household Agency and the Jilin Military Yamen, an office in the General Office of the Eight

Telford (1990) compares demographic patterns in the Tongcheng genealogical data and the Eight Banner populations for 1774 to 1873, when the latter starts to become available. He finds a very similar variation in the probability of dying for different age categories across the two sources (see Telford 1990, Figure 2).

To further assess representativeness we examine top individuals, in part because much of the available estimates focuses on the upper groups. Chang (1955) takes the view that *shengyuan* holders and above were in the upper class, and estimates that they were in the top 2% of the total population in the later half Qing period. In the present analysis, the part of the population corresponding to Chang's (1955) definition account for 3.3% of the sample, which is comparable.[32] Fei (1946) presents a wider estimate of the upper income groups, at 20%. In our analysis, groups 2 to 22 in Table A.3 correspond to Fei's definition of high status—and the share of these groups in the sample is 20.2%. Both these comparisons indicate that the data is fairly representative of China's population as a whole with respect to the size of top income groups as well as the relative size of higher versus commoner groups.

Given the genealogy is a written document, if literate individuals only recorded information about themselves their and immediate kin, the percentage of top income people in the genealogy should be very high. Alternatively, if genealogies recorded extended family who were not of high income—rules of ritual say that all adult male members are eligible, regardless of income—the percentage of top income should typically be low. How does the share of top status groups in the present sample compare with other evidence? In his classic study based on national lists of *jinshi*, which are extremely reliable, Ho (1967) reports that during the Qing in Anhui there were 41 *jinshi* per one million population, or, 0.0041 percent. There were regional variations, and the province of Anhui was below the provincial average in terms of *jin-shi* per capita in Qing China (Ho 1967, p. 228). In the Tongcheng data, there were a total of 14 *jinshi* during the Qing in Shiue's (2019) study, which is about 0.045 percent of the population in the data. Thus, there are about ten times more *jinshi* in the sample than in Qing Anhui overall.

At the same time, *jinshi* were rare, and some parts of Anhui province did not produce a single *jin-shi* over centuries. Furthermore, Tongcheng was not among the areas of China where top individuals were most prevalent. Some areas had more *jin-shi* by an order of magnitude compared to Tongcheng.[33] Therefore, while the number of men in the highest status group in Tongcheng was higher than in the

Banner Command. See https://www.icpsr.umich.edu/icpsrweb/ICPSR/series/265. For the imperial household dynasty, there are observations going back to the seventeenth century (Lee et al. 1993).

[32]In Table A.3, column (1), they are groups 13 and above.

[33]Specifically, Zhejiang and Jiangsu were among the provinces with high densities of *jinshi* (Ho 1967).

local surrounding area, Tongcheng was noteworthy at a local, perhaps provincial level, but it was not an unusual region in China.

Finally, the list of people who are recorded in the data to have obtained the highest status level, *jinshi* degree, can be compared against other lists of degree holders from Tongcheng County (Fang 2010; Cao 2016; Wang 2017). There were over 51,000 *jinshi* degree holders from the Yuan, Ming, and Qing dynasties. Information on top degree holders can be cross-checked for accuracy by referring to known lists of *jin-shi* degree holders from the Chinese state, which give the name, the date on which someone received his degree, and his hometown. We have verified that the information on the *jinshi* in the sample is consistent with the information of these official lists.

In summary, the information in the dataset is consistent with what we know and expect based on other sources for larger parts of China. To a significant extent this is because the dataset is based on seven genealogies that each describe rather different clans, so that combining them yields a diverse sample.

B.2 Cross-Clan Analysis

Next, we shed light on a number of possible forms of selection by exploiting differences across the seven clans in the data over the sample period. As shown in Table 2, the clan's average status varies substantially. A first concern is that genealogies begin with a particularly noteworthy man, who then becomes the progenitor of the clan. Part of his noteworthiness might come from being educated, which is one of the most important signs of status and one of the consistently reported characteristics of noteworthy persons. Alternatively, perhaps later generations were more likely to *ex-post* select a particularly noteworthy progenitor. In either case, the implication would be a trend of declining status over time.

Selection would arise if the records contain more entries of success compared to failure. We have shown in the text that average clan status is virtually unrelated to size across the seven clans (2) There is no evidence that on average, richer clans have more entries in the genealogies. Here this analysis is extended by examining the temporal correlation between status and clan size across twelve birth cohorts.[34]

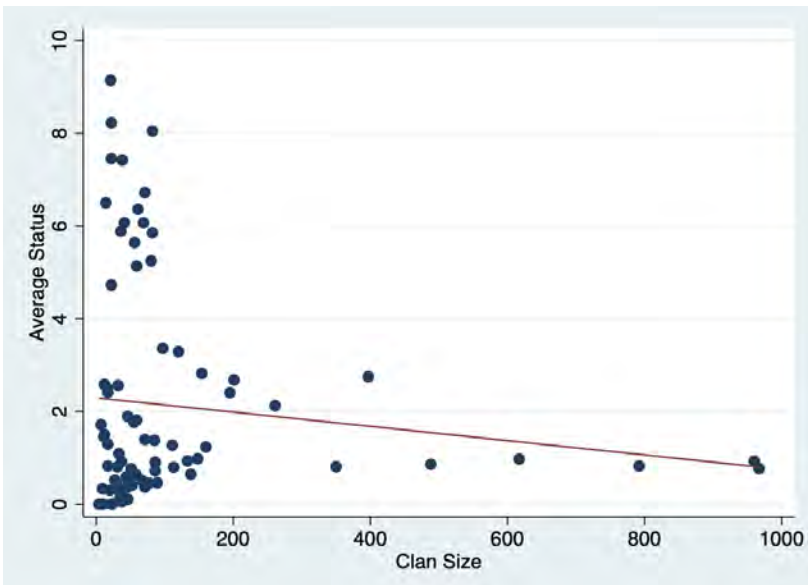
[34]The birth cohorts are 25 year periods, except (1) all years before 1575 and (2) all years after 1825; see Figure A.7.

Table A.1: Clan Size versus Status, Fertility, and Female Partners per Man

	Status			Fertility			Female Partners per Man		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Clan Size	−0.154 (0.142)	−0.074 (0.165)	−0.078 (0.109)	0.012 (0.026)	0.016 (0.028)	−0.019 (0.037)	0.005 (0.007)	0.001 (0.008)	−0.009 (0.009)
Birth Cohort FE		Y	Y		Y	Y		Y	Y
Clan FE			Y			Y			Y
N	81	81	81	81	81	81	81	81	81

Notes: Results from OLS regressions of the variable on top of the column on the number of men born (size), both averaged by clan and by birth cohort. Clan size in 100s of men. Fertility is measured as the number of male children. FE stands for fixed effects. Standard errors in parentheses.

Figure A.4: Clan Size and Status: Birth Cohort Analysis



Notes: Shown is the size of each clan as measured by the number of men born in each of twelve birth cohorts, versus average clan status in that birth cohort; N = 81.

Figure A.4 shows that there is no strong relationship between status and clan size using information by birth cohort, and to the extent that there is a relationship it is negative. Thus, there is no simple positive selection into the sample based on status. The following extends this analysis in two ways. First, we consider the relationship between clan size and other variables. Second, the focus is placed on different parts of variation in the data by including different sets of fixed effects. See Table A.1 for the results.

Results indicate that there is no positive relationship between status and clan size, in fact there is no strong relationship of either sign. In particular, accounting for changes that are common to all clans

Table A.2: Clan Success and Recall Bias

	Clan Size		
	(1)	(2)	(3)
Clan Status (-1)	−0.098 (0.096)	−0.026 (0.098)	−0.061 (0.157)
Birth Cohort Fixed Effects		Y	Y
Clan Fixed Effects			Y
N	74	74	74

Notes: Dependent variable is clan size, measured by the number of men born in a cohort (in units of 100s). Clan Status (-1) is average clan status lagged by one birth cohort. Estimation by OLS. Standard errors in parentheses.

by including birth cohort fixed effects does not yield a significant relationship (Table A.1, column (2)). Furthermore, there is no significant within-clan relationship between status and size either, as Table A.1, column (3) indicates.

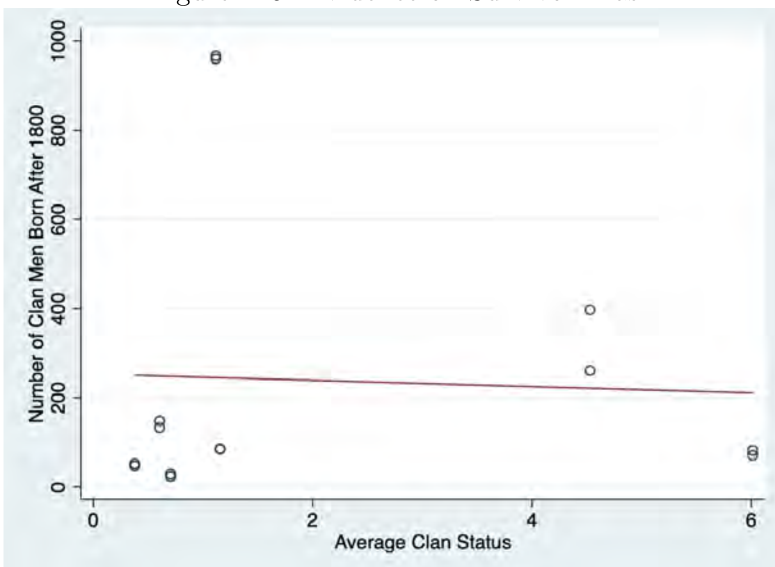
There is a positive coefficient for fertility and clan size, however, it is not significant at standard levels (Table A.1, column (4)). Moreover, the positive point estimate turns negative (still insignificant) when we account for time-invariant differences across clan size by including clan fixed effects (column (6)). Qualitatively similar results are obtained for the relationship between clan size and the number of female partners per man, see columns (7) to (9). Overall, there is little evidence that a clan's representation in the sample in terms of size is related to key economic variables.

Other concerns about selection and representativeness derive from recall bias and the retrospective nature of how genealogies are compiled. One way this bias could manifest itself is that after a clan member attains a particularly high level of status, the clan reports many new members—it could be that the clan uses its resources to confirm the significance of their achievements or ex-post, people who were not previously part of the clan might try to establish an ancestry relationship to the high status individual. Table A.2 evaluates such hypotheses of recall bias using regression analysis.

With a coefficient on lagged clan status that is negative and insignificant, there is no evidence for recall bias in the sense that recent successes for the clan translate into more clan members. This result does not change with the inclusion of birth cohort and clan fixed effects, see Table A.2, columns (2) and (3).

A related concern is survivorship bias: over time, this type of bias could result in a disproportionately fraction of high-achieving (high skill) individuals compared to low-achieving (low skill) individuals. One implication is that towards the end of the sample period the distribution becomes skewed towards relatively high-achieving clans. As Figure A.5 shows, however, there is little evidence that the distribution of the sample towards the end of the sample period is becomes skewed towards high-status clans.

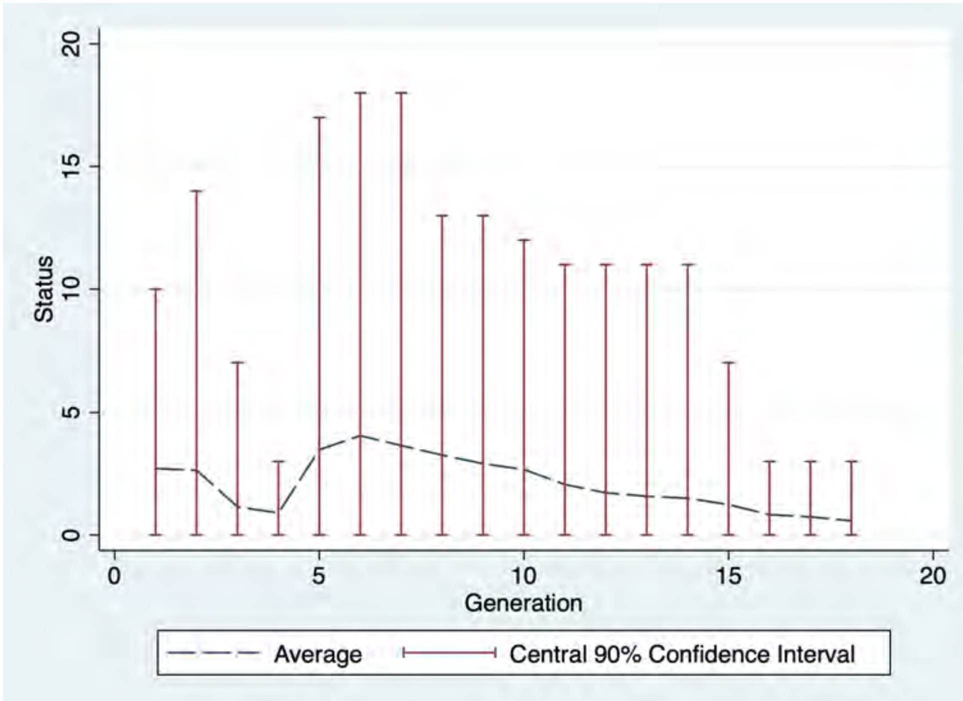
Figure A.5: Evidence on Survivor Bias



Notes: Figure shows number of clan men born in periods 1800-1825 and post-1825, both versus average clan status.

One might also ask why the genealogy of a given clan begins in a particular year. If the genealogy of a clan is established precisely because one of the clan members had achieved extraordinarily high status, this might yield a mechanical tendency of average status falling over time, and one might be concerned that this might also affect the estimate of intergenerational mobility over time. To examine this, Figure A.6 shows average clan status by generation.

Figure A.6: Clan Status by Generation

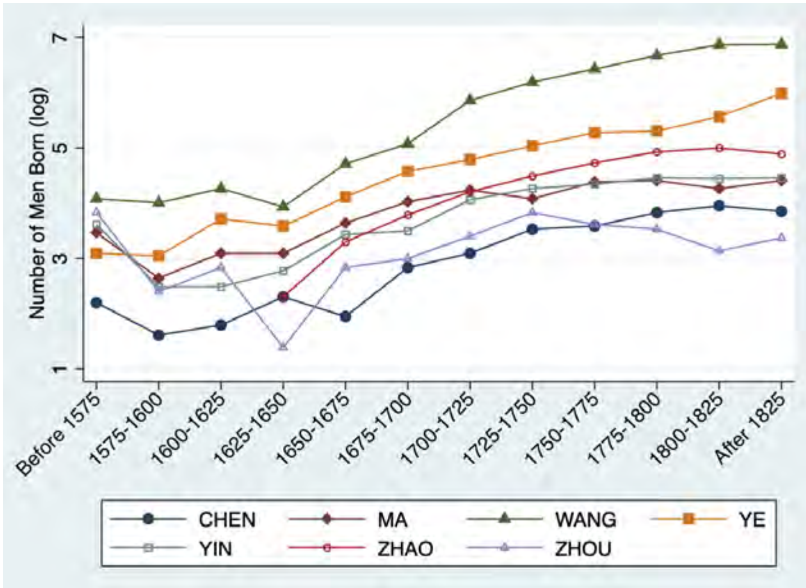


Notes: Shown are clan average status and the central 90% confidence interval of clan status for the first to eighteenth generation.

We can see that average clan status does not monotonically fall across generations. In particular, average clan status from the 5th to the 10th generation is higher than in the first generation. Thus, the dynamics of clan average status do not support the hypothesis that the sample genealogies typically begin with the life of an extraordinarily successful progenitor.

Figure A.7 shows the size of each clan in terms of the number of men born in each birth cohort. Over the sample period, all clans are present during the period from 1575 to 1825.

Figure A.7: Sample Size over Time



Notes: Shown is the size of each clan as measured by the number of men born in each of the twelve birth cohorts shown.

In general, size grows for all clans, although growth rates vary by period; for example, the growth rate is negative for three clans in the birth cohort 1625-1650, which includes the dynastic transition from the Ming to the Qing (1644). Some clans grow faster than others, however, sustained overtaking in terms of clan size is rare.

Overall, the evidence for various forms of selection bias is limited. This provides evidence that as a set, the genealogies underlying the present sample are broadly representative for Tongcheng. A different form of selection, due to intergenerational linking, is examined in section D.2 of the paper.

C Data

C.1 Human Capital and Status

This section lays out the human capital classification employed in the paper, see Table A.3. The classification draws on on work by Telford (1986, 1992) ans well as Chang (1955, 1962), Eberhard (1962), and Ho (1967). The genealogies have descriptors that summarize each man's lifetime achievements in various areas. One important aspect is whether the man ever participated in China's civil service examination, because that would require years of skill acquisition. In the baseline, our human capital variable is equal to one if a man passed the civil service examination at any level (local, provincial, and national), see column (3). Human capital is also equal to one if a man was editor or performed other high cognitive skill activities, even if the man did not pass the civil service examination. This includes the case of men who prepared but did not succeed to pass the civil service examination (group 6, column (3) of Table A.3).

To account for different levels of human capital, we explore an alternative that gives higher values to the human capital of men who passed the examinations, and at a higher level (column (4)). Distinguishing different levels of human capital does not change our qualitative findings. A concern with this human capital variable might be that given the important role of the civil service examination for coding, the human capital variable captures to a greater extent literary than scientific skills. To the extent that scientific as well as practical skills matter more for economic development than high levels of literacy, it would be the case that focusing more on literary skills has implications for growth of China's economy. While this is a question worth re-visiting, in terms of the human capital investment decision of individual men and their families, the usefulness of a certain type of human capital for industrialization and growth is not of primary importance, rather, it matters that investments into skills have a substantial return. That preparing and passing the civil service examination had such a return is well-established. For details on the income and wealth of top-level exam graduates (*jinshi*) as well as officials, see the discussions by Chang (1962). The sample includes also wealthy mean who are not also *jinshi* and top-level officials, but their number is relatively small (one percent of the sample, see column (6) for group 8). This is because status and income through official position was so high that even members of the wealthiest sought to acquire the human capital to pass the civil service exam. For example, several of the Cohong merchants engaged in the lucrative bi-lateral monopoly trading relationship with Western countries in Canton (Guangzhou) in the early 1800s sought to rise to the highest government offices requiring *jinshi* degrees, without success, so they stayed at lower level positions (Chang 1955). Passing the civil service examinations was "the ultimate source of power", as noted in the seminal work by Ho (1967).

Table A.3: Human Capital and Social Status Classification

(1) Group	(2) Description	(3) Human Capital	(4) Alternative HC	(5) N	(6) Fraction (%)
0	No title, degree, and evidence of wealth	0	0	4,399	54.5
1	Honorary or posthumous title; village head; other honors	0	0	46	0.6
2	Multiple wives in consecutive marriage (two or more not living at the same time)	0	0	434	5.4
3	Evidence of moderate wealth of 1st degree family, incl. minor and expectant official, lower level degree *(shengyuan, jiansheng)*, and official student	0	0	1,015	12.6
4	Wealthy family member 2nd degree, incl. official, *juren*, *gongsheng*, and *jinshi*	0	0	20	0.2
5	Wealthy family member 1st degree, incl. official, *juren*, *gongsheng*, and *jinshi*	0	0	20	0.2
6	Educated, scholar, no degrees or office; editor of genealogy; refused office, or prepared but did not pass exam	1	1	273	3.4
7	Two or more wives or concubines at the same time	0	0	180	2.2
8	Substantial evidence of wealth and property; set up lineage estates, large donations, philantrophy; wealthy farmer, landowner, or merchant	0	0	79	1.0
9	Official Student (Province)	1	2	529	6.6
10	Military *shengyuan*, minor military office	0	0	0	0.0
11	Purchased *jiansheng* and/or purchased office	0	0	188	2.3
12	Student of the Imperial Academy	1	2	400	5.0
13	Civil *shengyuan*; minor civil office	1	2	199	2.5
14	Expectant official; no degrees	0	0	36	0.4
15	Expectant official one of the lower degrees	1	2	5	< 0.1
16	Military *juren*, *jinshi*; major military office	1	3	2	< 0.1
17	Civil official with no degree, minor degree, or purchased degree	0	0	68	0.8
18	*juren*, *gongsheng*, with no office	1	3	38	0.5
19	*juren*, *gongsheng*; with expectant office	1	3	53	0.7
20	*jinshi*, no office	1	3	0	0
21	*jinshi* with official provincial post or expectant official	1	3	1	< 0.1
22	*jinshi* with top-level position in Imperial bureaucracy (Hanlin Academy, Grand Secretariat, Five Boards, Prime Minister)	1	3	83	1.0
All				8,068	100.0

Notes: Table gives information on a man's human capital (HC) and social status in the six-generation linked sample. Based on Telford (1986, 1992), Chang (1955, 1962), Ho (1967), and Eberhard (1962).

The final two columns of Table A.3 report the size of each group in the inter-generationally linked sample. Employing the baseline definition in column (3), 19% of the men have aquired human capital during their lifetimes, while the large majority of the sample does not have human capital. That a large majority of men does not have a substantial level of human capital is consistent with other evidence on Tongcheng and China overall during this period. At the same time, a value of 19% for human capital is higher than reported in other work on these clans of Tongcheng (Shiue 2017). The reason for this is that the sample shares in Table A.3, column (6) are for those individuals that can be intergenerationally linked over six generations. This is more likely for human capital holders than for non-holders, so the restriction on inter-generationally linked men implies positive selection. Section **??** in the paper is devoted to the influence of the Ming-Qing transition shock for this selection by studying the impact of the shock on the continuation of family lines.

Descriptors that determine a man's human capital and status in the genealogy are shown in column (3) of Table A.3. If there is nothing other than vital statistics in the individual's biography, and this person had no evidence of wealth, degrees, or titles, then he is coded as a member of group 0 (first line of Table A.3). These individuals would have lived close to subsistence during the sample period, and one can think of them as commoners.

Among the civil service exam degrees, *shengyuan* was the lowest degree of the recognized categories of government education, conferred upon those who had passed the local degree threshold. The *shengyuan* who were more competent were awarded with the *gongsheng*, "imperial student" title; above them in rank were the *juren* (graduate of the provincial examinations), and above the *juren* were the *jinshi* (graduate of the national metropolitan examinations). The levels are building up on each other, that is, in order to have the *jinshi* degree one must have the *juren* and the *shengyuan*, and in order to be *juren* one must have passed the *sheng-yuan* examination. There were no age requirements or limitations for advancement, but since the examinations required a high level of literacy and years of study, the earliest that one could attain the *jinshi* degree would be in the low twenties, and it was not unheard of for a man in his fifties to still be a *shengyuan*. Not all *shengyuan* advanced to the next levels, and those who didn't may have given up and turned instead to working for officials in a secretarial capacity, or, helping to manage local affairs—settling disputes, organizing local public goods projects, improving welfare and security interests, or providing education in their community (Chang 1962). In that sense, acquiring human capital by preparing for the civil service examinations had returns even for those who did not pass, let alone pass at the highest levels of the examinations.

C.2 Status and Income

Status in society translated into income and wealth differences. There is no systematic information on the income or wealth of individual men, but having passed a certain level of degree made a person eligible for a certain level of official position. For example, there were nine levels of civil positions during the late

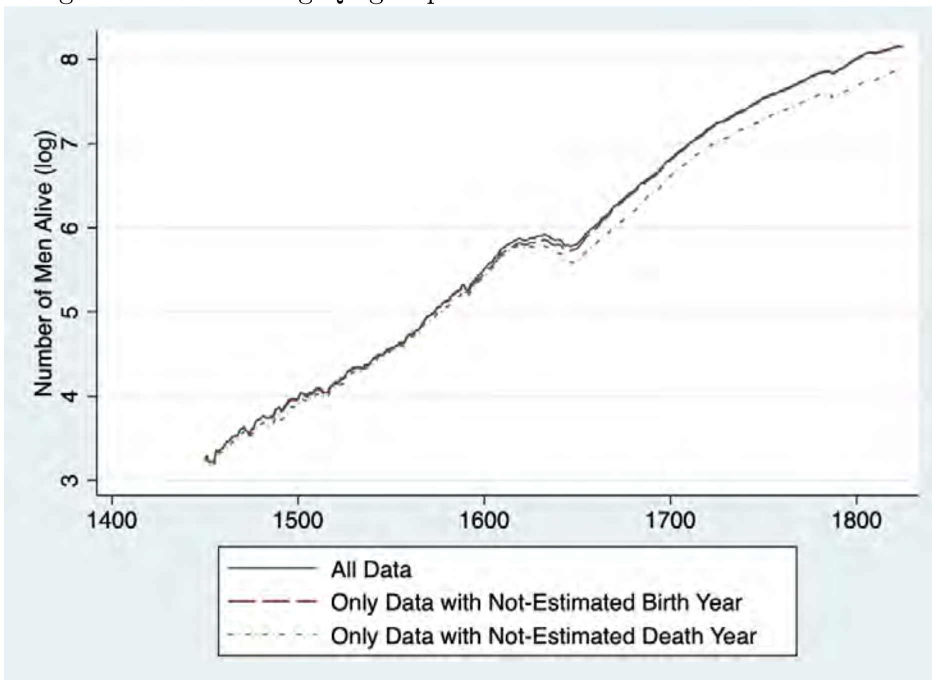
19th century (Chang 1962, Table 1). A district magistrate would be seventh-ranked civil official, while a provincial governor would be a second-level civil official. The mapping between degree and official position was not deterministic, however, the level of office was increasing in the degree that a man had obtained. Becoming a top-level official in the imperial bureaucracy with only a *shengyuan* (local) degree was almost impossible, and conversely, most *jinshi* had better-paid positions than being a district magistrate. The level of degree is useful because they are consistently mentioned in the data.

At least for certain periods, the salaries of government officials at different levels are known (see Chang 1962). However, official salaries accounted for only a small part of the total compensation of government officials; the larger portion of their income were other contributions on which there is less systematic data. At the same time, high-level officials were also expected to contribute to local public goods to a substantial degree. Arguably the best information on differences across status groups comes from assessment schedules of clans to their members who have reached higher positions. This can be thought of a tax on the clan member who has achieved a significant level of status. There is little reason to believe that the clans' assessment schedule would not be consistent with the income generated by each of these achievements. The status levels in this study are consistent with the available clan assessment schedules (see Chang 1962).

C.3 Estimation of Vital Statistics

Figure A.8 shows fall of Ming population shock using the full sample as well as dropping observations with estimated vital statistics.

Figure A.8: The Ming-Qing Population Shock and Estimated Vitals



Notes: Figure shows the size of the population shock in the Ming-Qing transition using all data versus two samples that drop observations with estimated vitals.

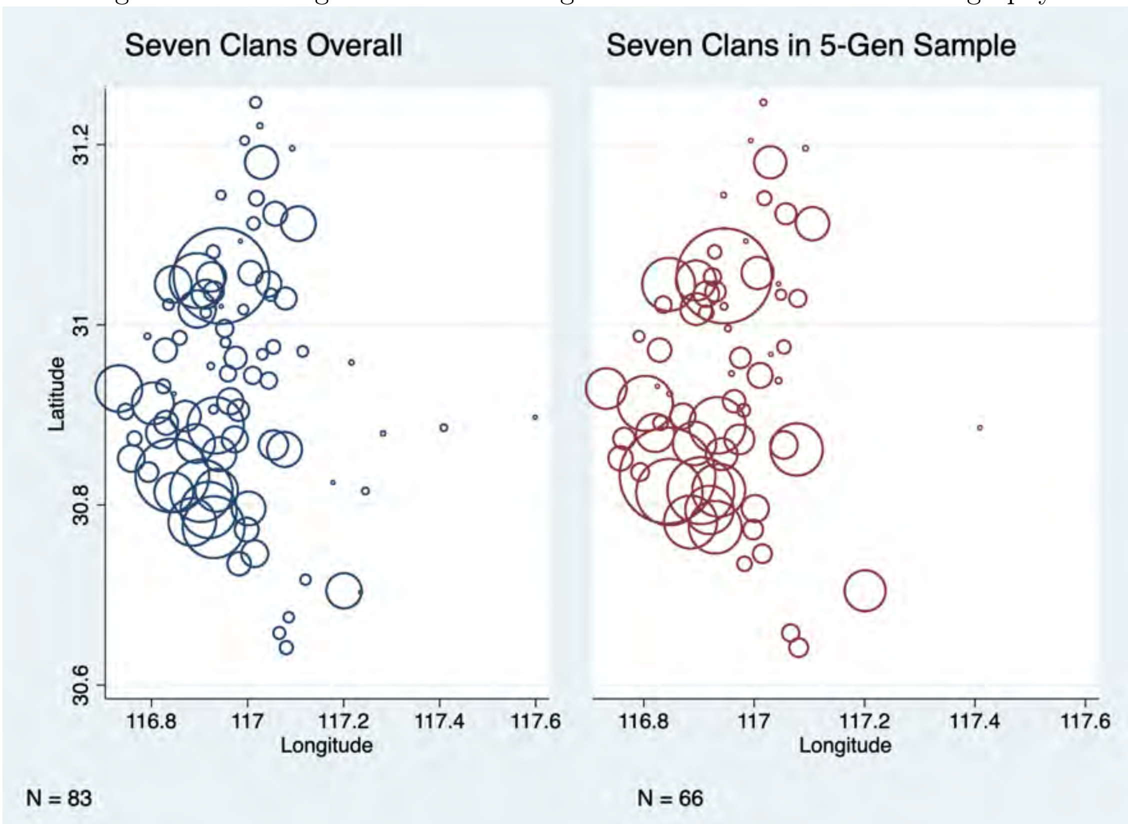
Notice that the negative Ming-Qing transition population shock is not due to the estimation of vital statistics. If anything a focus on non-estimated data would increase the size of the shock, as one would expect if the estimation introduces classical measurement error.

D The Five-Linked-Generations Subsample

D.1 Selection in Terms of the Set of Residence Locations

Figure A.9 shows the extent to which the five-generationally linked sample is a subset of the clan records overall in terms of villages that are included. Specifically, there are N = 83 locations in the sample overall, and this number shrinks to N = 66 in the sample that conditions on quintuplets of intergenerational links (son to great-great grandfather).

Figure A.9: Inter-generational Linking and Selection in Terms of Geography



Notes: Shown are residence locations of members of the seven male clans (1) overall on the left, and for (2) couples in the five-generation linked sample on the right. Size of circle is proportional to number of heads of household.

Furthermore, we see that it is primarily locations with relatively few households that disappear through the linking.

D.2 Impact on the Continuation of Family Lines

Selection is present in intergenerational analysis if being able to make intergenerational links is not orthogonal to the outcome of interest. Here, the existence of an intergnerational link depends on a male child being able to marry, which could, e.g., be influenced by parent resources. Factors such as race, ethnicity, or surname play less of a role here, because all individuals in the sample share the same race and ethnicity, and given information in the genealogies, intergenerational links are established with virtual certainty. Because there is consistent information on male children in our sample, it is possible to analyze major margins of selection by using information on male children together with that on males that we know have married.

One determinant of whether a given male would marry later in life is clearly whether he would survive childhood to reach a marriageable age. Figure A.10 shows the distribution of the length of life time of second-generation males by marriage status. For non-married males (left panel), the distribution of age at death is bi-modal, and the highest density of males is for those that do not live beyond three years of age. The main reason for this is infant mortality. Another, local maximum of those that do not marry is around 60 years. The main reason that these males do not marry is that given the prevailing male-female sex ratio of larger than one, these men are not rich enough to marry. In comparison, the distribution of longevity for married men has a single maximum around 52 years (Figure A.10, right side).

Figure A.10: Age at Death by Marriage Status

Notes: Figure shows densities of age at death of two samples, the second-generation males that were able to marry and of the sample of second-generation males that were not able to marry, right and left panel, respectively.

Based on this we examine whether the fall of the Ming appears to have an impact on lifespan (age at death). The specification is given by

$$age_{i(p)2} = \alpha + \beta d_{i(p)} + \beta_f hfstat_{i0} + \eta_g + X\gamma + \varepsilon_{i(p)}, \tag{5}$$

where $age_{i(p)2}$ is longevity, measured as death year minus birth year, of individual i in generation 2 who is descending of pair p, the variable $hfstat_{i0}$ denotes the social status of individual i's pre-shock grandfather, and the vector X are male and female clan fixed effects. Table A.4 shows the results.

Table A.4: Impact on Longevity and Marriage Probability

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dep. var.			Longevity			Marriage	
Variable z_i			Human Capital	Longevity Father	Longevity Mother	Human Capital	Mother Longevity
Fall of Ming Shock	-4.514 (3.114)	-4.249 (3.527)	-9.959^{*} (4.315)	-39.896^{**} (13.274)	-37.610^{**} (10.538)	-0.061 (0.087)	-0.467^{**} (0.176)
Ming Shock x z_i			16.524^{**} (6.022)	0.617^{**} (0.229)	0.574^{**} (0.179)	-0.031 (0.113)	0.006^{*} (0.003)
z_i			-8.803 (5.664)	-0.217 (0.218)	-0.084 (0.218)	0.187^{+} (0.100)	-0.000 (0.003)
Father Status	0.336^{*} (0.169)	0.934^{**} (0.247)	0.109 (0.219)	0.361^{*} (0.177)	0.336^{*} (0.162)	-0.002 (0.004)	0.005 (0.004)
Birth Year FE	Y	Y	Y	Y	Y	Y	Y
Husband Clan FE	N	Y	N	N	N	N	N
Wife Clan FE	N	Y	N	N	N	N	N
N	774	761	774	774	767	801	789

Notes: Dependent variable is age at death (longevity) of male descendant of treatment generation couple in columns (1) to (5), and marriage indicator in columns (6) to (8); estimation of equation (5) by OLS. Robust standard errors clustered at the level of the treatment generation couple; **/*/+ indicates significant at the 1%/5%/10% level.

The coefficient for $d_{i(p)}$ is estimated at about -4.5 (column (1)). This indicates that on average, the shock tends to reduce age at death by more than four years (not significant). Adding fixed effects for each of the seven male clans as well as the clans of the in-marrying mothers (68 fixed effects) does not change the point estimate much (column (2)). The impact of the shock on the son's length of life might depend on family characteristics. Introducing the interaction of the shock with some variable $z_{i(p)}$, denoted by $z_{i(p)} \times d_{i(p)}$, the specification becomes

$$age_{i(p)1} = \alpha + \beta_1 d_{i(p)} + \beta_2 \left(z_{i(p)} \times d_{i(p)} \right) + \beta_3 z_{i(p)} + \beta_f hfstat_{i0} + \eta_g + \varepsilon_{i(p)}, \tag{6}$$

where $z_{i(p)}$ a characteristic of the treatment generation couple, p, is also included linearly. Results are shown in Table A.4. In the first of these specifications, variable $z_{i(p)}$ is the human capital of the father (man in first generation). Having a human capital holding father switches the shock impact on son's life time from negative to positive (-10 + 16.5 = 6.5), at the same time when sons of fathers with human capital in this generation generally tend to have a shorter life time (coefficient on $z_{i(p)}$ is -8.8, not significant). Son lifetime is not only related to the family's resource endowment but also to its genetic endowment. In the remaining two specifications, the longevity of father and mother is employed as measures of health (genetic endowment). Results show that controlling for health, the impact of the Ming-Qing shock on son longevity is significantly negative (columns (4) and (5)).

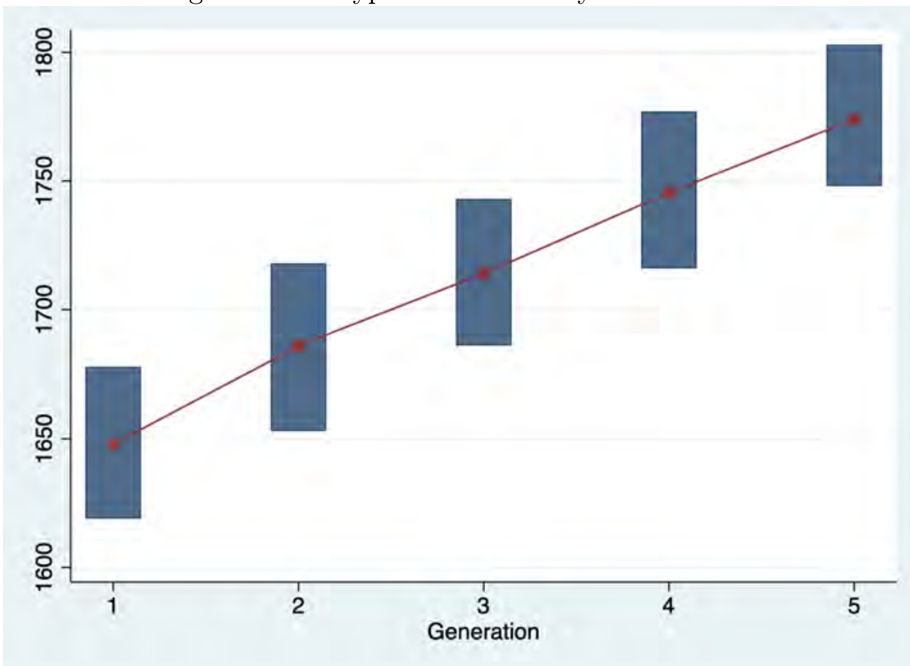
Turning to the impact of the Ming-Qing transition shock on marriage, Table A.4 shows the results on the right side. On average, sons of fathers with human capital have a roughly 19% higher chance to marry (column (6)). The fall of Ming shock tends to reduce the marriage probability by about 6 percent, and by about 9 percent if the father has human capital (not significant). Generally, the probability to marry is more closely related to the mother than to the father. Controlling for mother longevity, the shock leads to a significant reduction in the marriage probability, while for every ten years of mother longevity the probability to marry increases on average by a six percentage points ((column (7)). An analysis of the distribution of longevity by marriage status confirms that child mortality is a major channel through which the shock has cut off family lines (see Figure A.10).

This section has shown that the Ming-Qing transition shock has cut off family lines by shortening the life time of males and their ability to marry. The overall impact of the shock is composed of this shortening of family lines together with the effects on descendants that succeeded to have four generations.

D.3 Typical Lifetime of Generations

Figure A.11 shows the typical lifetime of each of the five generations.

Figure A.11: Typical Lifetimes by Generation



Notes: Bars show median birth and death year by generation, with the line giving the average life midpoint (1/2*(birth year + death year)) by generation.

E Additional Results

E.1 Source of Human Capital Losses in First Generation

In the treatment generation, the lower level of human capital for men in treated versus control villages can be explained by both higher downward mobility and lower upward mobility, as shown in Table A.5.

Table A.5: Intergenerational Mobility in Human Capital and the Ming-Qing Transition

Panel A: Not Destroyed

		Father	
		No HC	HC
Son	No HC	78.4% (29)	11.8% (2)
	HC	21.6% (8)	88.2% (15)
		100.0% (37)	100.0% (17)

Panel B: Destroyed

		Father	
		No HC	HC
Son	No HC	90.9% (269)	50.7% (71)
	HC	9.1% (27)	49.3% (69)
		100.0% (296)	100.0% (140)

Notes: Table shows presents transition matrix for intergenerational mobility in human capital (HC) between the pre-shock generation and the first (treatment) generation by treatment. Columns sum to 100 percent; figures in parentheses are absolute numbers.

In the not destroyed villages, 88.2% of fathers with human capital had sons that also acquired human capital over their lifetime, whereas the degree of intergenerational persistence in human capital in the destroyed villages is with a corresponding share of 49.3% much lower (Panel A, lower right, and Panel B, lower right, respectively). Put differently, the extent of downward mobility in human capital for treated sons is more than four times that of sons in control areas (50.7% versus 11.8%, respectively). Upward mobility in treated areas is also lower than in control areas (lower left corner, Panels B and A, respectively), but quantitatively, that the Ming-Qing transition reduced the ability of sons from high-human capital families to follow in the footsteps of their fathers is of greater importance. The negative impact in generation 1 on status is consistent with the negative impact on human capital acquisition (Table 4, column (4)).

E.2 Treatment of People versus Treatment of Regions

Table A.6 presents the estimation results underlying Figure 6 in the text.

Table A.6: Treatment of People versus Treatment of Regions: Estimation Results

	(1) Treatment of People	(2) Treatment of Regions
Fall of Ming		
Gen 1	-0.354^{**} (0.070)	-0.394^{**} (0.068)
Gen 2	0.005 (0.093)	-0.122 (0.064)
Gen 3	0.201^{*} (0.065)	0.064 (0.032)
Gen 4	0.118^{+} (0.043)	0.090^{*} (0.029)
Gen 5	0.132^{+} (0.061)	0.098^{*} (0.024)
N	8,024	8,024

Notes: Specification in column (1) assigns treatment to first generation couples living in destroyed towns and villages as well as to their descendants; identical to Table 4, column (4). Column (2) compares human capital levels in historically treated regions versus control regions for all five generations. Gen stands for generation, d.p. stands for dependent variable. Robust standard errors two-way clustered at the level of treatment generation couple and generation in parentheses; **/*/+ indicates significant at the 1%/5%/10% level.

E.3 Impact by Generation

Instead of stacking all five generations in a single regression, one can estimate the impact of the fall of the Ming generation by generation. This imposes fewer parameter restrictions, at the same time when it does not reflect the dynamics in the human capital effect across generations as much as the stacked regression.[35] Table A.7 shows that results using the generation-by-generation approach are qualitatively similar to those with five stacked generations (compare columns (2) to (6) to column (1)).

Table A.7: Fall of the Ming and Different Human Capital Levels

	(1) Human Capital Indicator	(2)	(3)	(4)	(5)	(6)	(7) Four Human Capital Categories
Fall of Ming							
Gen 1	-0.351^{**}	-0.294^{**}					-0.632^{*}
	(0.068)	(0.094)					(0.148)
Gen 2	0.006		-0.105				0.082
	(0.092)		(0.114)				(0.187)
Gen 3	0.200^{*}			0.157^{**}			0.456^{*}
	(0.064)			(0.055)			(0.855)
Gen 4	0.118^{+}				0.114^{*}		0.223^{+}
	(0.043)				(0.056)		(0.090)
Gen 5	0.131^{+}					0.077	0.285^{+}
	(0.060)					(0.056)	(0.124)
N	8,012	1,669	1,657	1,625	1,600	1,500	8,012

Notes: Dependent variable at the top of column; sample consists of the couples formed by all male descendants of the treatment generation couples that can be linked forward over five generations. Estimation of equation (1) by OLS. Gen stands for generation. Fixed effects for birth year included, in columns (1) and (7) also fixed effects for generation, husband clan, and wife clan. Also included is the status of the husband's father in the treatment generation. Robust standard errors in parentheses; clustered at treatment generation couple and in columns (1) and (7) also at the level of generation; **/*/+ indicates significant at the 1%/5%/10% level.

E.4 Generalization of Human Capital Variable

We generalize the human capital indicator to a variable with four categories, as shown in Table 1. It turns out that there is also evidence for a reversal in human capital when more human capital categories are

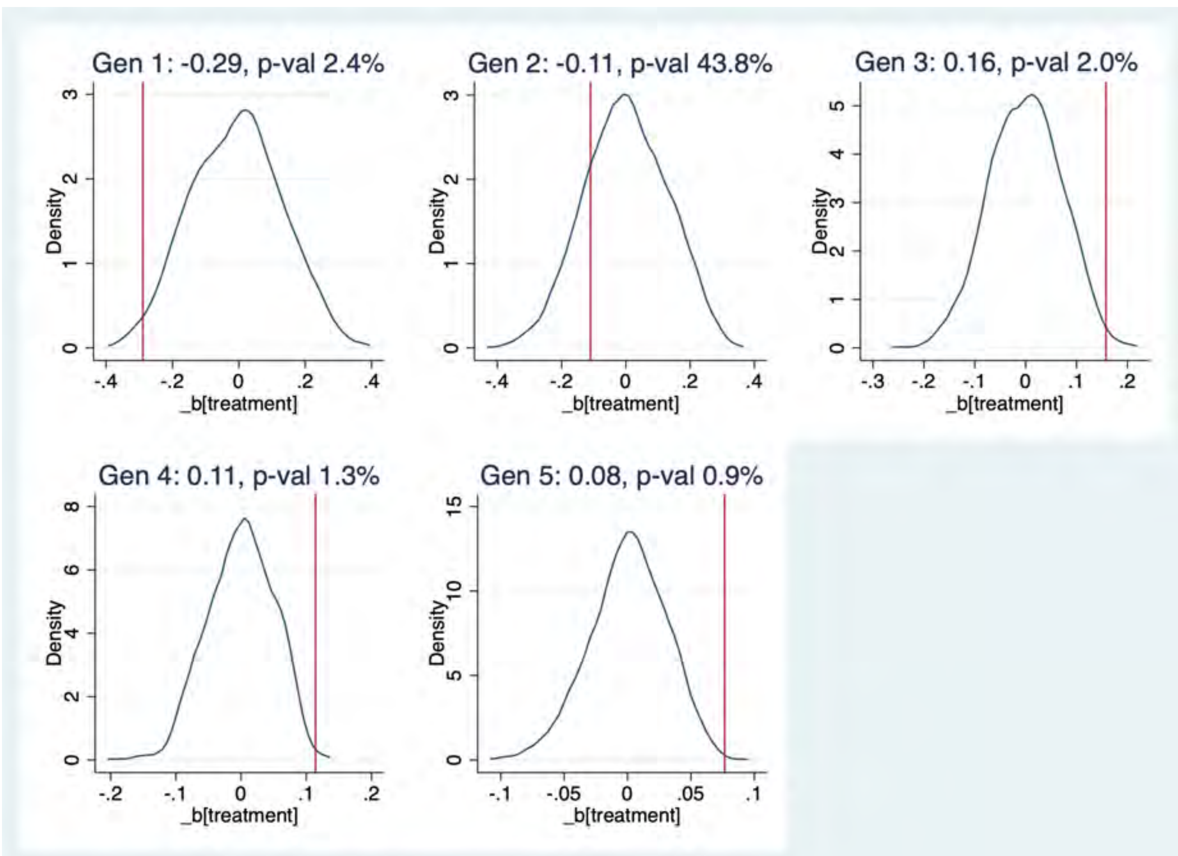
[35] Given the smaller number of observations in the generation-by-generation analysis, we drop male and female clan fixed effects from the specifications.

distinguished, see Table A.7, column (7).

E.5 Human Capital Impact: Randomization Inference

This section examines robustness of the shock's impact on human capital in terms of inference. If one thinks of the Ming shock as a quasi-experiment, randomization inference instead of the two-way clustered standard errors may be considered as the natural approach. Figure A.12 shows, for each generation 1 to 5, the results from randomly assigning treatment one thousand times and running with each simulation sample the OLS treatment effect regression.

Figure A.12: Human Capital Impact: Randomization Inference



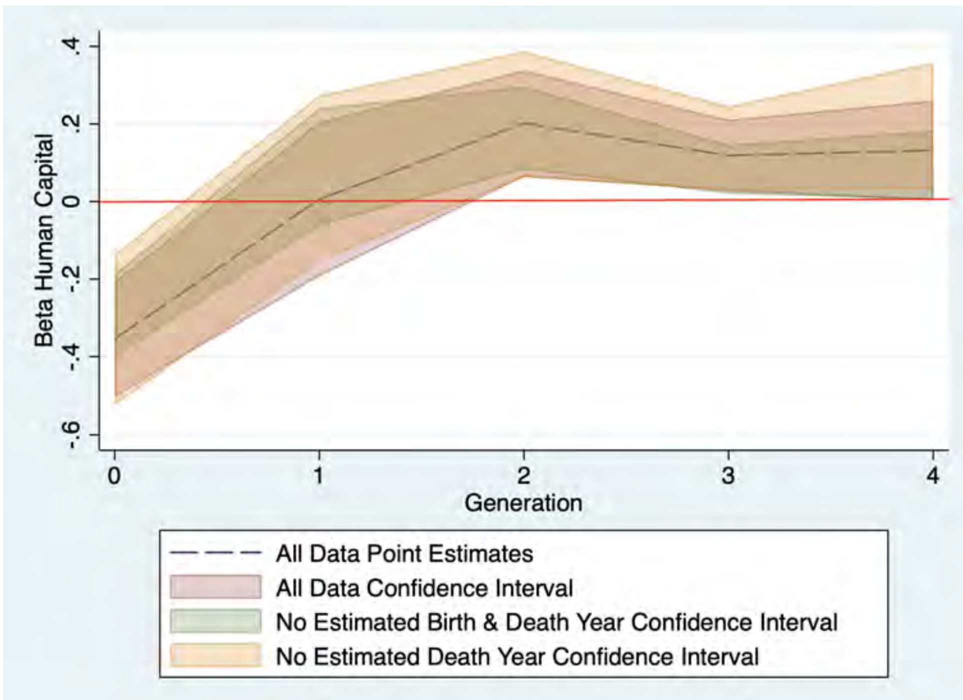
Notes: Figure shows the distribution of coefficients from estimating the impact on human capital using randomized assignment by generation, 1 to 5; red line indicates the estimate of observed assigned (columns (2) to (6), Table A.7); p-values from the empirical distribution based on 1,000 randomized assignments each. Gen stands for generation.

In each plot, the red line gives the coefficient estimated with the actual assignment, as shown in columns (2) to (6) of Table A.7. The p-values reported in Figure A.12 are of interest because unlike the clustered standard errors we employ elsewhere, the randomization p-values do not rely on sample variation. While the randomization p-values can be considerably smaller than the p-values based on clustering, for example for generation 5, overall, results using different approaches to inference lead to broadly similar results.

E.6 Human Capital Impact and Estimated Vital Statistics

This section compares results from the human capital specification underlying column (1) of Table 4 with results that exclude alternative sets of data if vitals are estimated. Results are shown in Figure A.13.

Figure A.13: Human Capital Reversal and Estimation of Vitals



Notes: Figure shows the size of the population shock in the Ming-Qing transition using all data versus two samples that drop observations with estimated vitals.

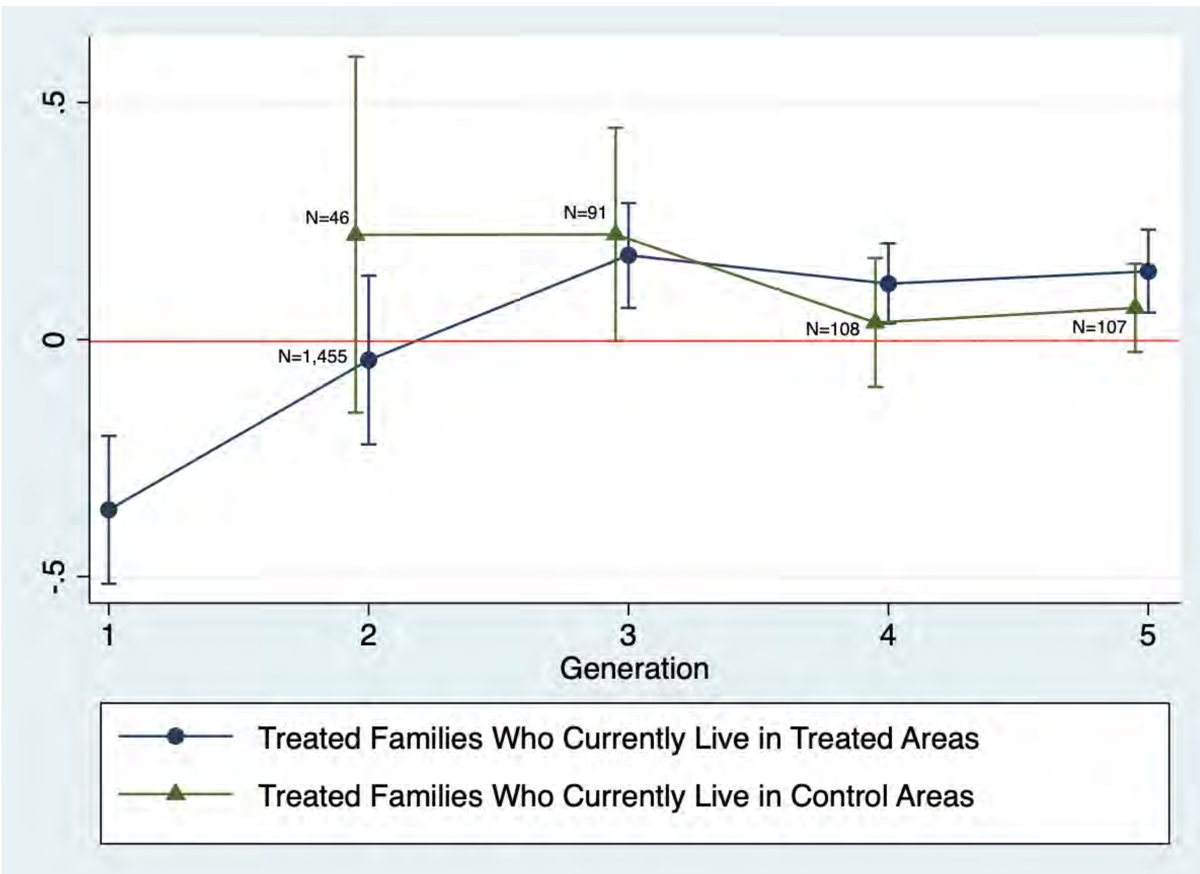
Figure A.13 indicates that the estimation of vital data in the sample does not change the finding that there was a human capital reversal from generation 1 to generation 5.

E.7 The Role of Migration

Figure A.14 shows a generalization of the analysis of treatement of people underlying Table 4, column (4) by distinguishing treated family lines that currently live in treated regions versus treated family lines that currently live in control regions.

Of all treated family lines in generation 1, about 3% move to a historically not destroyed region in

Figure A.14: The Role of Outmigration for Treated Families



Notes: Figure shows human capital acquisition of two sets of treated family lines, those who reside in a particular generation in any of the historically treated locations (circle), versus those who reside in any of the historically not treated locations (triangles). Estimation analogous to equation (1) by OLS. Omitted category is human capital acquisition of control family lines residing in historically not destroyed regions (the zero line). 90 percent confidence intervals based on standard errors clustered on first-generation couple.

generation 2 (N = 46, see Figure A.14).[36] Compared to those that remained in treated regions, husbands in family lines that outmigrated by the second generation tend to acquire more human capital. Point estimates are not statistically different, but the relatively high coefficient for treated family lines in control regions provides evidence that regional destruction is detrimental to human capital acquisition.

In contrast, in the third generation point estimates for the two sets of treated family lines turn out to be similar to each other. Similar human capital acquisition levels for treated family lines irrespective of whether they live in historically treated or control regions suggest that the regional dimension is a factor that matters primarily in the short- but not in the medium- and long-run. The idea that family lines transmit their norms towards human capital intergenerationally finds additional support in that the point estimates for the two sets of treated lines remain close to each other also in the fourth and fifth generation. Furthermore, in the third generation both sets of treated family lines acquire more human capital than control family lines residing in control areas (the zero line, as the omitted category). Net outmigration flows to historically less destroyed areas stabilize in the fourth generation at around 7 percent of all treated family lines.

Evidence on possible forces that determine migration decisions come from comparing treated family lines that outmigrated versus treated family lines that stayed in historically treated regions. The following analysis focuses on migration decisions in the second generation. Table A.8 shows the results.

Table A.8 indicates that families that outmigrate from historically destroyed areas are typically relatively young compared to families who stay behind (early birth year). This is because migrants who are relatively young have a longer time horizon over which to recoup the costs of migration (Bowles 1970). Other results reflect that migrant families tend to be those who have the resources to cover the cost of migration. For example, relatively rich households with multiple female partners are more likely to outmigrate than single-female households. One exception to this is that a relatively short lifespan of the mother in the first generation is positively correlated with the outmigration decision. The reason for that is that a relatively early death of the mother releases the younger generation from potential old-age caretaking duties, and thus it makes it more likely that the young family moves away.Figure A.15 adds evidence on the role of movements of control family lines into historically destroyed regions.

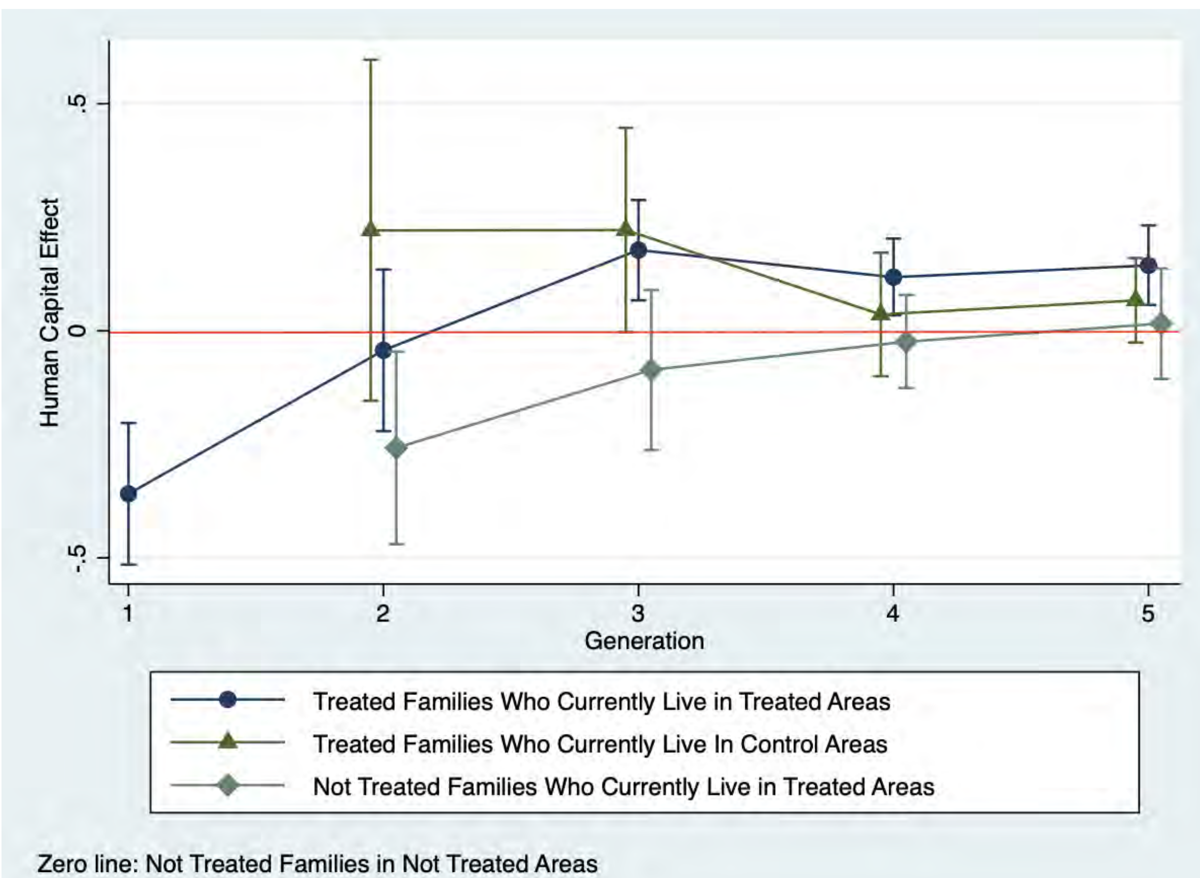
[36] Because residence of a family line in the first generation determines treatment of people, by construction there are no treated families residing in control regions in the first generation.

Table A.8: Correlates of Outmigration from Historically Treated Regions

	Stayers	Movers	Difference	p-value
	N = 1,456	N = 46		
Second Generation				
Husband Birth Year	1651.2	1661.2	10.0	<.01
Wife Birth Year	1655.4	1663.2	7.8	<.01
First Generation				
Human Capital	0.21	0.37	0.16	0.01
Social Status	4.05	4.26	0.21	0.80
Number of Females	1.30	2.15	0.85	<.01
Number of Sons	3.26	4.70	1.44	<.01
Husband Lifespan	59.16	62.07	2.90	0.18
Wife Lifespan	62.36	49.48	12.88	<0.01

Notes: Table compares means for two sets of treated family lines, those who remain in a historically treated region in generation 2 and those who move to a historically not treated region in generation 2. Number of observations for Wife Lifespan is N = 1,443 Stayers, N = 46 Movers.

Figure A.15: Migration and Human Capital Acquisition



Notes: Figure shows human capital acquisition of three sets of family lines, those who reside in a particular generation in any of the historically treated locations (circle), those who reside in any of the historically not treated locations (triangles), and not treated family lines residing in historically treated regions (diamonds). Estimation analogous to equation (1) by OLS. Omitted category is human capital acquisition of control family lines residing in historically not destroyed regions (the zero line). 90 percent confidence intervals based on standard errors clustered on first-generation couple.

Figure A.15 provides more evidence that high levels of regional destruction are detrimental for human capital acquisition in the short run by showing also control family lines who by the second generation have moved into historically treated regions; they acquire less human capital than family lines that stay in historically less destroyed regions, which is the omitted category (the zero line). At the same time, the pattern of this set of family's human capital acquisition converges to that of control family lines residing in control areas. This suggests that the role of regional factors for human capital acquisition fades over four generations.

Overall, these results not only help to understand the difference betweeen treatment of people and treatment of regions but they also accord well with what is known about the determinants of migration decisions.