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Deadly anchor: Gender bias under Russian colonization of Kazakhstan

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ABSTRACT

We study the impact of a large-scale economic crisis on gender equality, using historical data from Kazakhstan in the late 19th–early 20th century. We focus on sex ratios (number of women per man) in Kazakh population between 1898 and 1908, in the midst of large-scale Russian in-migration into Kazakhstan that caused a sharp exogenous increase in land pressure. The resulting severe economic crisis made the nomadic organization of the Kazakh economy unsustainable and forced most Kazakh households into sedentary agriculture. Using a large novel dataset constructed from Russian colonial expedition materials, we document a low and worsening sex ratio (in particular, among poor households) between 1898 and 1908. The theoretical hypothesis that garners most support is that of excess female mortality in poorer households (especially among adults), driven by gender discrimination under the increasing pressure for scarce food resources.

1. Introduction

Despite enormous economic growth of per capita income over the last two centuries and substantial legislative progress towards promoting gender equality, discrimination against women remains pervasive throughout the world. In recognition of this fact, improving the well-being of women constitutes one of the Millennium Development Goals. Beside ethical considerations, the expectation is that a greater level of growth would result from enabling women to fully exploit their capabilities. Moreover, a host of development outcomes (e.g. child health, education, fertility decisions) are crucially linked to the welfare of mothers. Thus, for economists it is crucial to understand whether economic growth entails gender equality, and whether economic crises and structural transformations can jeopardize the progress made towards this objective.

Basic measures of gender inequality include gender bias in mortality rates (excess female mortality) and the resulting number of "missing women", i.e. the difference between the actual number of women in the population and the hypothetical number of women that would exist under gender-unbiased birth rates and access to vital resources. In economics, the pioneering work by Sen (1990), inspired by his analysis of Indian society, estimated the number of missing women worldwide as being roughly 100 million.[1] Later work (Coale, 1991, Klasen and Wink, 2002) improved on Sen's methodology and corrected the estimates as being around 60 to 90 million. More recently, Anderson and Ray (2010) examined proximate causes of this phenomenon, by decomposing the number of missing women by age and cause of death. They found that most missing women in India and China were among adults and that as a fraction of total female population, the number of missing women was highest in sub-Saharan Africa. Moreover, the authors argue that a comparable fraction of female population was missing in the United States in the early 20th century.

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[1] For an excellent survey of studies on gender bias and excess female mortality in India, see Bhaskar and Gupta (2007).

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Beyond these descriptive analyses, economic historians and development economists have been extensively studying how large-scale economic transformations and severe crises have affected the relative well-being of women (as compared to that of men). While some studies find that during famines, men are more likely to die than women (see studies in Dyson and Grada, 2002), most studies conclude that women fare worse than men (see Humphries, 1991; Nicolas and Oxley, 1993; McNay et al., 2005; Horrell et al., 2009; Humphries and McNay, 2009 for the Industrial revolution in Great Britain, Baten and Murray, 2000 for the potato crisis Bavaria, Klasen, 1998 for 18th and 19th century Germany, Edvinsson and Lindkvist, 2011 for 19th century Sweden). Studies of recent economic crises concentrated mostly on the relative well-being of female children (as compared to male children) during economic crises. Girls' welfare appears to be more sensitive to income fluctuations than that of boys, in terms of nutrition (Chapter 4 in Dreze and Sen, 1989; Behrman and Deolalikar, 1990; Rose, 1999), health and education (Schultz, 1985; DeTray, 1988; Alderman and Gertler, 1997) or infant mortality (Bhalotra, 2010).[2]

Three broad theoretical mechanisms have been proposed to account for differential well-being outcomes between women and men. The first explanation is the so-called lifeboat (or risk-minimization) argument (Wright and Kunreuther, 1975; Stiglitz, 1976; see Chapter 8 in Ray, 1998, for a brief synthesis). This argument states that concentration of resources on a subset of household members may be necessary for the future survival of all household members. This would be the case if, for example, the capacity curve (linking the work capacity of an individual to his/her vital resources, i.e. food or income) were convex in its lower part. In that case, the concentration of resources may increase their return. An alternative theoretical explanation (see Section 3.2 of Bergstrom, 1997, for a detailed review) builds on bargaining models of intra-household resource allocation, where the share of the resources obtained by an individual in the household depends on his/her bargaining power and the outside option (his/her payoff in case of the break-up of the household). Because women have less favorable outside options than men, women have access to a disproportionately low share of household resources. At low levels of income, this unequal access to vital resources is more likely to harm women's health and to lead to excess female mortality. Finally, the third explanation, the most consistent with historical evidence from Britain during industrialization, is that if the sharp division of tasks and responsibilities within the household adjusts too slowly to a structural change in the economy that implies a deeper involvement of women in paid work, the resulting double burden on women (i.e. paid work and domestic work/child-rearing) might consitute an increased insult on women's health and well-being (Humphries, 1991; Tabutin and Willems, 1998; Humphries and McNay, 2009).

Few studies analyze the effect of economic hardship and/or structural transformation of the economy on women in *different* wealth categories and *different* age groups, in the *same* population (an important exception is Horrell et al., 2009). Such analysis is important to get a complete picture of gender discrimination in a society. In particular it allows answering such questions as: Are women of younger age hit stronger, and if so, does this occur in the poorer or the richer strata of society? Does higher wealth guarantee that the burden of an economic hardship is not shifted disproportionately on female children, adolescent girls, and adult women?

In this paper, we provide an attempt to fill this gap, by studying the effect of a long-run economic crisis on gender bias in different age and wealth groups, in the context of Kazakhstan under Russian Empire from the second half of the 19th century until 1917. We do this by exploiting a unique dataset that we have constructed from the records of the Russian Imperial statistical expeditions in Kazakhstan, conducted in two waves (1896–1903 and 1906–1915), which we supplement with the data from the Russian Imperial Census of 1897. We also rely extensively on ethnographic studies by Russian and Soviet researchers, given the extreme scarcity of other written sources for the Kazakh society in that period (essentially, because of the dominance of oral culture over the written one; a major exception to this are the recorded rules set by customary judges, see *Ancient World*, 2005).[3]

Using this dataset and secondary sources, we study sex ratios in the Kazakh population in the period when large-scale Russian peasant in-migration into Kazakhstan caused a sharp increase in land pressure and provoked a severe economic crisis among the nomadic Kazakh population. This crisis made the nomadic organization of the Kazakh economy unsustainable and rapidly forced most Kazakh households into sedentary agriculture. Our main finding is that adult women were affected by the crisis more severely than female children. We document a low and worsening sex ratio (in particular, among poorer households) between 1898 and 1908, with most of the decline occurring in the group aged over 14 years old. Next, we consider several theoretical hypotheses to explain these patterns. The hypothesis that garners most support in our data (as well as in descriptive historical sources) is that of differential mortality—biased against women—in poorer households, caused by gender discrimination in access to vital resources.

This paper makes two additional contributions. First, we contribute to the debate on the cross-sectional analyses of gender bias and wealth. Generally, development economists found no evidence of a monotonic relationship between wealth and gender bias in mortality. Sen (1990) states that, comparing across Indian regions, worse sex ratios are found in more wealthy Indian states. This leads to a hypothesis that the relationship is U-shaped, i.e. that the gender bias is highest at the intermediate ranges of wealth distribution. Economic historians (e.g. Edvinsson and Lindkvist, 2011) find, contrarily, that women of the upper socio-economic classes had a clear advantage in survival, compared to their lower-class counterparts. In our data, we also find a monotonic relationship: gender bias is worst at the lower end of the wealth distribution and is consistently better for higher-wealth households.

Second, we contribute to expanding the geographic scope of studies that look at gender bias and its economic determinants. Until now, most studies focused on Eastern Asia (India, China, and Indonesia) and Western Europe (Britain, Ireland, Germany, and Sweden). However, we believe that the geographic and temporal extent of the set of facts to be explained by a theory of gender bias should be wider. Otherwise, there is a risk of developing explanations around some cultural factor(s) specific to a particular region of

[2] Important exceptions are Levine and Ames (2003) and Gertler et al. (2004) who find no gender bias in Indonesia during economic crises.
[3] E.A. Masanov (1966) provides an excellent discussion of the Russian and Soviet historiography of Kazakhstan.

the world. In this respect, our study (i) covers a part of the world for which currently there is very little data; and (ii) analyzes a society that traditionally was based on nomadic pastoralism—a social structure that substantially differs from the sedentary cultures of Eastern Asia or Western Europe.

The rest of the paper is organized as follows. In Section 2, we describe the historical and institutional context from which our data and estimates come. This should help the reader to understand better the empirical results presented in Section 3. Sections 4 and 5 analyze alternative explanations in the light of our statistical findings. Section 6 discusses the broader implications of our findings and suggests avenues for future work.

2. Historical context

2.1. Organization of Kazakh economy and households before Russian in-migration

Before the massive Russian in-migration in the late 19th–early 20th centuries, the economic organization of Kazakh society was based on nomadic pastoralism and was mainly determined by the climatic and geographic characteristics of the land area that Kazakh tribes populated. The fundamental characteristic of this economy was seasonal transhumance, which consisted in changing physical location of the economic unit four times during the year, i.e. once in each natural season. Livestock (horses, sheep, goats, camels in some areas, and—in later periods—cattle) was both the principal asset and the main production input. The principal economic activity consisted of herding and animal husbandry. Regular back-and-forth moves from summer to winter pastures (with relatively shorter stays on autumn and spring stops) guaranteed the provision of fodder throughout the year. The distances between the winter and summer pastures were often large. Taizhanova (1995: 29) and Chermak (1899:170) report that whereas in Northern Kazakhstan these distances were around 50–70 km, in Central Kazakhstan the nomads often traveled up to 1000 km (one-way) during transhumance. Fig. 1 shows the main transhumance routes on the territory of Kazakhstan (the tip and the start of the arrow indicate summer and winter pastures, respectively). Fig. 2 shows the positions of different seasonal pastures along a typical transhumance route in Central Kazakhstan.

As Kazakh historians argue (Taizhanova, 1995: 10–11), cooperation networks were organized on the basis of kin; thus, the notion of kin is central for understanding economic relationships among Kazakh nomads. The winter stops were organized around extended families (the so-called *aul-q'stau*), which typically consisted of several nuclear households (usually, closely related by kin) living together during winter. Each household (virtually all households were monogamous nuclear families) consisted of a married couple and their young children. Summer pastures, instead, were organized on the basis of larger kin groups (the so-called *jazgy aul*, which broadly corresponds to communes), made of several extended families (again, mostly related by kin).

Property rights on land were defined both at the extended family and at the commune level. Winter stops were closed-access common property resources of extended families, whereas summer stops were common property resources of communes. These were also generally closed-access, but the access was less strictly enforced, given the relative abundance of summer pastures. Individual households had no property rights on land but had private property rights on livestock.

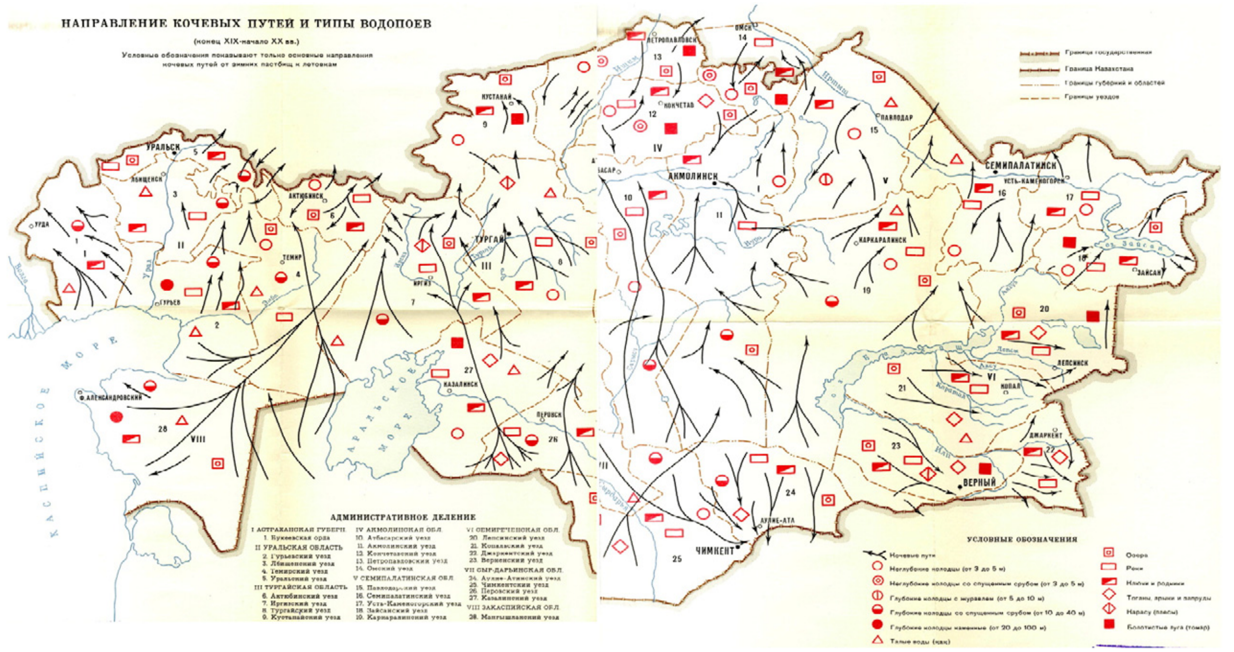

Fig. 1. Transhumance routes in Kazakhstan before sedentarization (Source: *Kazakh Economy*, 1979).

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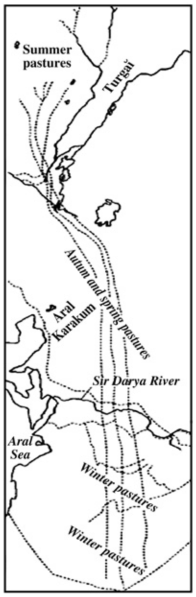

Fig. 2. A transhumance route and seasonal pasture in central Kazakhstan.
Source: Geiss 2003.

2.2. The social and economic status of Kazakh women

In Kazakh nomadic families, women married relatively early. In his ethnographic study of Kazakhs, Zeland (1885: 26) states that the median age at marriage for Kazakh women was around 15. Similarly, Usenova (1986: 30) also confirms, on the basis of the 1897 Census, that the median age was between 15 and 16; however, it was not unusual to find women being married as early as 12. Typically, the poorer families tried to marry their daughters earlier; on the contrary, it was frequent to find wealthy parents who married their daughter when she was 20 years or older (Stasevich, 2011: 41). Almost always, the marriages were arranged by the parents, and often the arrangement took place much earlier than the actual marriage (sometimes even at birth of the future bride).

Marriages implied the payment of a brideprice: the parents and the extended family of the groom made a transfer to the bride's parents. For the value of the brideprice and other regulations related to the marriage, we can rely on the recorded rules set by the customary Kazakh judges at their meetings (which, under the request of the Russian administration, recorded and codified the running customs and traditions). For instance, the customary judges' meeting in 1885 at Qaramola (North-Eastern Kazakhstan) regulated that the value of brideprices was set at 47 heads of large livetock for the wealthier families, and 17 heads—for the poorer families (*Ancient World*, 2005: 191).[4] Similar figures are registered at the customary judges meeting at Almaty (South-East Kazakhstan) in 1904 (*Ancient World*, 2005: 275). These represented a relatively large value, as compared to the total wealth of a Kazakh nomadic family, in particular for the poorer strata of the Kazakh society (the lowest amount of brideprice was 7–9 heads of large livetock, as noted by Malyshev, 1902: 45–50; Makoveckii, 1886: 5–6).[5]

The family of the bride gave her a dowry (one part at the moment of the marriage, while the rest at the birth of her first child or after one year of marriage; see Stasevich, 2011: 50), which can be considered as an *inter vivos* inheritance, given that daughters were excluded from bequests (Zeland, 1885: 31), similarly to the pattern found in numerous other parts of the world (Botticini and Siow, 2003).

Once married, women in Kazakh nomadic families, had relatively few children, and infant mortality was high. For instance, Zeland (1885: 59) notes that in his sample, women gave birth to 4.21 children on average, but only 2.7 children survived into adulthood. Children usually started to help their parents with household tasks starting at the ages of 6–7, with a clear gender separation of tasks: boys helped their fathers to herd livestock, while girls helped their mothers with cooking, washing clothes, and taking care of their younger siblings (Stasevich 2011: 39).

In general, women had to support a heavy workload, taking part both in herding activities and in the management of the household. Numerous historical sources state that women's economic role was extremely important, despite their relatively low

[4] Interestingly, towards the late 19th century, the form of the brideprice starts to change: money and valuable objects start to replace—at least in part—livestock (see Grodekov 1889). This evolution is most probably caused by sedentarization, the development of markets, and the increasing circulation of money in the Kazakh society.

[5] In our data for 1908, households had on average 7.6 horses and 14.8 heads of cattle. The poorest households had none.

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social status (as compared to that of men). For instance, in a detailed analysis of customs in the nomadic Kazakh society, Makoveckii (1886) writes:

> "*While severely limited, from the point of view of customary law, in terms of her proprietary and social rights, a Kazakh woman commands nevertheless an important role. The fact that her life is restricted to the boundary of aul [i.e. nomadic village] implies that all of the domestic economy and property lies in her hands. Whereas a Kazakh man spends most of the year on the horseback, in continuous moves, taking care of social affairs of the kin, district, and village, his wife remains the real head of the household and manages all of it, thus reducing her husband to the role of the nominal head*" *(p. 31)*.

Stasevich (2011: 89–95) presents a detailed critical summary of the pre-Soviet ethnographic analyses of women's status in Kazakhstan. She notes that despite conflicting view on the formal legal and economic rights of women, most researchers agree that Kazakh nomadic women had a considerably larger freedom and a higher status than their counterparts in the sedentary agricultural areas of Central Asia.

2.3. Russian in-migration: its causes, size, and consequences for Kazakh economy

The pre-1917 Russian migration into Kazakhstan started in the 17th century and continued until the October Revolution. It developed in two large waves (Demko, 1969). The first wave consisted of Cossack military migration and was relatively small in size. In contrast, the second wave was massive. It started in the 1880s and had as its main cause the abolition of serfdom in Russia in 1861 (Galiev et al., 2009: 223; Demko, 1969: 52). Subsequently, the landless peasants started to move in large numbers into the European part of Russia, thus creating substantial tensions in and around large cities. The solution that the Czarist administration adopted was the 1889 law, which offered these peasants land "for free", in the amount of 15 desyatinas (approximately 16.4 ha) per household, in the Asian part of the Russian Empire (Olcott, 1995: 87). This triggered a large-scale peasant migration from the European part of Russia into Central Asia, with the bulk of this flow moving into Western, Northern, and—later—Central and South-Eastern Kazakhstan. According to Russian historian Ivan Popov, "[Russian] peasants ran from their beggarly allotments, famines, hunger, and social disorder" (cited by Demko, 1969: 55).

Table 1 illustrates the size of Russian in-migration relative to the size of Kazakh population of the four regions in the West and the North of Kazakhstan. The growth of Kazakh population in the period 1897–1916 was relatively low, whereas that of Russians was massive. For instance, in Turgay region, the population of Russians increased from 35,000 people in 1897 to over 300,000 in 1916. The change was also huge in terms of the fraction of the total population. For example, whereas Russians made about one-third of the total population in Akmolinsk region in 1897, by 1916 they already accounted for almost 60% of the total population.

Despite some positive impact that Russian migration brought to Kazakhstan (agricultural technology transfer for crop cultivation, modernization of education and health facilities), our quantitative findings in Section 3 indicate that it came bundled with the reduction of pastures and the resulting struggle for survival and conservation of nomadic life among Kazakhs—a struggle that eventually failed. This reduction also had profound negative consequences on the Kazakh society.

2.4. Crisis in Kazakh nomadic economy and the forced sedentarization

The fundamental reason why the second wave of Russian migration caused a crisis of the Kazakh nomadic economy was the increased pressure on land. Russian migrants occupied land that was considered "free" (or unoccupied) by Russian administration—as typical of a sedentary bureaucracy towards the territories of nomads—and this considerably limited the grazing land available for the pastoralist Kazakhs.[6] A substantial fraction of the occupied land was the scarce winter stops, on which kin-level property rights were carefully regulated among Kazakhs. Moreover, the occupied land often covered the transhumance routes between winter and summer pastures, thus obligating the nomads to change their long-established routes and lengthening (sometimes substantially) the time devoted to transhumance. Fig. 3 shows the variation in the territory covered by Russian peasant settlements. From these figures, one sees clearly how the peasant settlements progressed from North towards South in barely fifteen years.

The detailed account how this crisis evolved is given by T. Sedelnikov, a Russian political thinker who lived in Kazakhstan in the period of sedentarization. In his 1907 book entitled *The fight for land in the Kazakh steppe*, he describes that given a massive increase in land pressure, the only alternative that Kazakh nomads faced was to switch to sedentary agriculture. He writes:

> "*Reduction in pastures led to increasing death of livestock in winter, and this forced weaker and poorer tribes to re-consider their future: given that the previous form of the economy could not provide their subsistence, they had to look for another one, that better corresponds to the new situation… And now these tribes sedentarize in the north to live there for the entire year …*" (Sedelnikov 1907: 23).

The Russian colonial administration calculated the amount of land considered as sufficient for Kazakhs. Anything above this bureaucratically determined need was considered "excess land," which could then be confiscated and passed to incoming

6 From the legal point of view, the 1891 *Rulings Concerning the Administration of Akmola, Semipalatinsk, Semirechinsk, Ural, and Turgay Regions* stated (Article 119) that the land occupied by nomads was declared the property of the State (see *Ancient World*, 2005: 500–518). According to this regulation, nomads were granted usufruct rights to the land that they occupied for pastures, but in case some land was to be considered "in excess", the usufruct rights on such lands were to be revoked (Article 120). The ruling also officially gave the nomads rights equivalent to those of Russian peasants (Article 11).

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Table 1
Population by ethnicity in selected regions of Kazakhstan, 1897–1916 (in thousands).
Source: Demko (1969, various tables); our calculations.

	1897		1905		1916		Annual growth rate in %, 1897–1916	
Region	Kaz.	Rus.	Kaz.	Rus.	Kaz.	Rus.	Kaz.	Rus.
Uralsk	460	164	477	268	480	278	0.224	2.817
Turgay	411	35	440	120	507	305	1.111	12.069
Akmolinsk	427	229	488	374	527	765	1.114	6.554
Semipalatinsk	605	68	669	82	665	200	0.499	5.842

peasants for agricultural development (Olcott, 1995: 87–88). However, the amount of land that Russian land surveyors considered necessary to feed 24 domestic animals (without consideration of soil quality or water access) was clearly insufficient for a Kazakh household's subsistence.[7] Ever increasing quantities of traditionally nomadic pasture and migration land was set aside for peasant settlement. In 1909, the final bulwark against land confiscation was removed, when a new law ruled that: "Previously designated [Kazakh] structures for household needs or temporary shelter do not serve as barriers to seizure." (Martin, 2001: 73).

3. Missing Kazakh women: statistical evidence

3.1. The data

Our main data sources are the unique statistical materials of two waves of Russian colonial expeditions (Shcherbina, 1903a,b; Khvorostanskij, 1912; Khvorostanskij, 1914). In order to regulate the peasant migration flows, Russian colonial administration financed a first expedition in summer of 1896, headed by a prominent Russian statistician, F.A. Shcherbina. The expedition covered 12 sub-regions in 3 regions in Western, Northern, and Central Kazakhstan, and overall took seven years to complete (the surveys in the last of the 12 sub-regions were completed in 1903). The outcomes of this expedition were rich datasets at the level of households and extended families. *De facto* these constitute highly detailed agricultural censuses (i.e. virtually all households living on the territory of these 12 sub-regions are included). The main aim of this expedition was to calculate how much land could be freed up (to host Russian peasant migrants) if Kazakhs were to convert from nomadic pastoralism to sedentary agriculture. A few years later, the Czarist administration financed another wave of expeditions, which started in 1907 (and finished in 1915). This second wave covered 21 sub-regions, including the original 12 covered by the first-wave expedition.

Given the political motivation behind these studies, one could question the reliability of the data collected during the expeditions. However, numerous sources confirm—using both qualitative and quantitative arguments—the attention devoted by the expedition administration and data collectors to data accuracy and the resulting high quality of the dataset. Two prominent Russian statisticians—Rumyantsev (1910) and Kaufman (1907)—critically assessed the data collected by Shcherbina expedition. The first author stated that the classification of households by livestock wealth was occasionally incorrect, whereas the second questioned the potential under-declaration of livestock wealth by Kazakhs and pointed out several mistakes in the calculation of agricultural land use by Kazakhs. Both conclude that overall the data collected by the expeditions is of high quality and correctly reflect the socio-economic situation of the area covered by the expeditions. Secondly, Kazakh historians (e.g. Shahmatov (1964), Tolybekov (1971)) note that the Shcherbina expedition materials are in line with the qualitative evidence on principal socio-economic characteristics of Kazakhstan in the period under study. Finally, Volkova (1982, 1983) conducted a full-fledged quantitative analysis in which she studied the correlation of ten principal variables from the Shcherbina expedition data (at the sub-region level) with the same variables coming from administrative records (registered in 1893). She found that the correlation between variables from the two datasets was extremely high, which confirms quantitatively the quality of the Shcherbina dataset.

Our secondary data sources are the Russian National Censuses of Population, conducted in 1897 and 1926 (*First General Census*, 1905; *All-Union Census*, 1928). These censuses cover a larger geographic area, but contain only the demographic information (i.e. no information on economic behavior and social organization of households was collected).

Statistical materials of the expeditions were published in Russia between 1897 and 1916 in several volumes. For these publications, the household level information was aggregated at different levels (extended family, commune, and wealth groups). These publications are considered as rare books. We were able to locate four volumes (two for the first wave, and two for the second) and encode the data contained therein.

The data that we use for our analysis comes from two North-Western sub-regions (Aktyubinsk and Kustanay), in particular from the so-called combinatory tables (Tables V in the original publications). In these tables, cumulative numbers are given, at each district (administrative units below sub-region, called *volost*) level, for household units separated according to wealth (measured in livestock wealth) and principal economic activity category. In other words, an observation in the original dataset is

[7] The calculation by Olcott (1995: 98) shows that before Russian in-migration, an average Kazakh household needed about 150 heads of livestock which required 150 desyatinas of land under pastoralism and at least 30 desyatinas if animals were stalled all winter. Obviously, the comparison with the above numbers shows that sharply increasing land pressure left the Kazakhs with the only option: to convert to sedentary agriculture.

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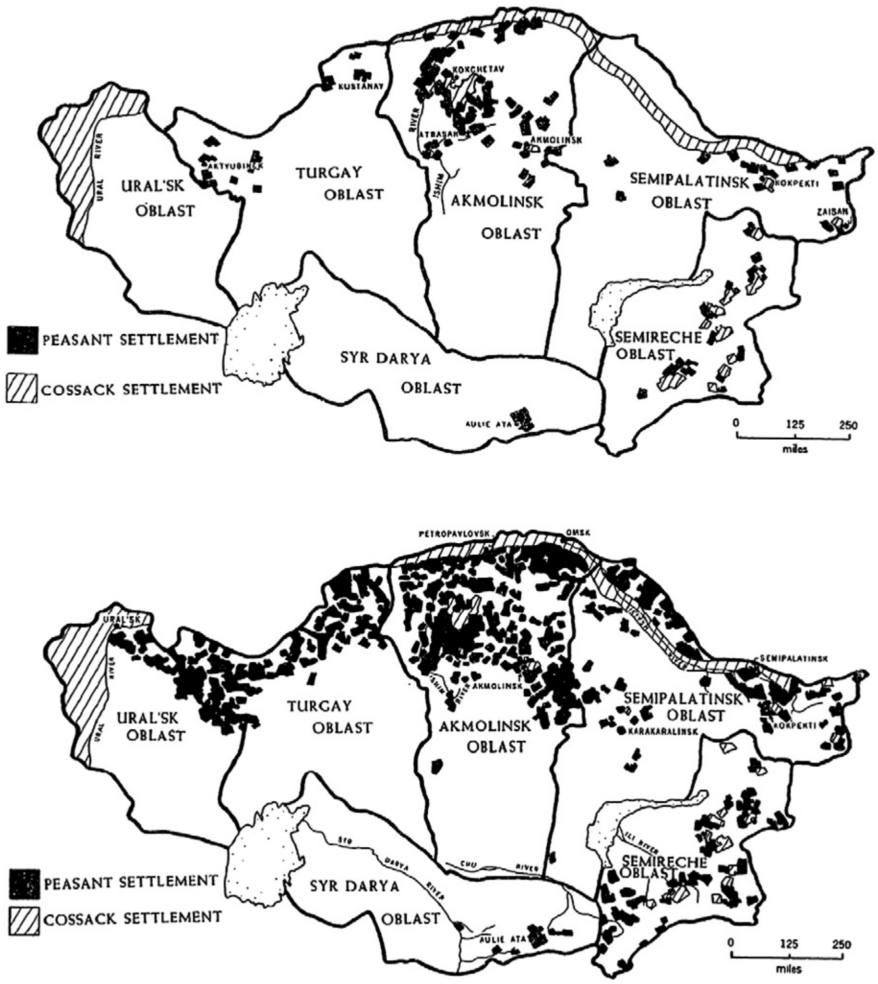

Fig. 3. Settlement pattern of Russians in Kazakhstan, 1900 and 1915 (Source: Demko 1969).

an aggregate of households that belong to a given category. In the first expedition a category is defined by the district to which a household belongs and the number of horses it owns (0, 1, 2–5, 6–10, …, 100 or more). In the second expedition, categories are finer as households are also grouped according to their participation in the labor market. The four main labor market categories are: "Households that have members hired out in agriculture", "Households that have members working as craftsmen", "Households that are labor-autarchic" (i.e. neither hiring in nor hiring out), and "Households that hire in agricultural labor".

3.2. Kazakh population and sex ratios by age categories in 1898 and 1908

The two sub-regions under scrutiny exhibit low population growth and highly biased sex ratios both in 1898 and in 1908. Table 2 reports, for the entire Kazakh population in these sub-regions and for three different age categories (over 14, below 12, and below 1 year old): population size, the sex ratio *sensu stricto* (we use the ratio women to men) and the proportion of males, together with the 95% confidence interval.[8]

The total Kazakh population in the two sub-regions increased from 214,690 individuals in 1898 to 228,214 individuals in 1908. This corresponds to an average annual growth rate of 0.6%. Compared to the average growth rate of 1.6% in the European part of

[8] We prefer using the proportion of males for statistical analysis, because—contrary to sex ratios sensu stricto—it is symmetrical (a decrease of 10 in the number of women will increase the proportion by the same amount that an increase of 10 in the number of women would decrease it) and it follows a well-behaved distribution. Assuming that the sex of an individual is a random draw from a Bernoulli distribution, the proportion of males (or females) follows a binomial distribution that can be approximated by a normal distribution if the sample size is large enough. Hardy (2002) discusses the problems related to the use of the sex ratios sensu stricto in statistical analysis.

Table 2
Population, sex ratios and confidence intervals by age categories, 1898–1908.

	1898	1908	Definition/precisions
Population	214,690	228,624	Total population in both sub-regions
Sex ratio	0.8725	0.8573	#women/#men
Proportion male	0.5340	0.5384	#men/population
Confidence interval	[0.5320,0.5361]	[0.5364,0.5404]	For the proportion of male
Population >= 14	135,764	143,943	# individuals aged 14 and above (>= 14)
Sex ratio >= 14	0.8287	0.8203	#women >= 14 /#men >= 14
Proportion male >= 14	0.5201	0.5494	#men >= 14/population >= 14
Confidence interval	[0.5175,0.5227]	[0.5468,0.5520]	For the proportion of male
Population <12	68,141	73,183	# individuals aged 11 and below (<12)
Sex ratio <12	0.9408	0.9235	#women<12 /#men<12
Proportion male <12	0.5153	0.5199	#men<12/population<12
Confidence interval	[0.5115,0.5190]	[0.5163,0.5235]	For the proportion of male
Population =<1	8123	1958	For 1898 : # individuals aged 1 and below (<=1) For 1908: # individuals below 1 (<1)
Sex ratio =<1	0.947	1.059	For 1898 : # women <= 1/# men <= 1 For 1908: # women <1/# men <1
Proportion male =<1	0.5136	0.4857	for 1898 : #men <= 1/population <= 1 for 1908: #men<1/population<1
Confidence interval	[0.5027,0.5245]	[0.4636,0.5078]	For the proportion of male
Population >60	11,917		# individuals aged more than 60
Sex ratio >60	0.8513		#women > 60 /#men > 60
Proportion male >60	0.5402		#men > 60/population > 60
Confidence interval	[0.5312,0.5491]		For the proportion of male

the Russian Empire, this figure is very low. Kazakh demographers attribute such a low rate to a combination of high infant mortality rate and a highly biased sex ratio (in favor of men) in the fertile age group (Asylbekov and Zharkenova, 2001: 9).

The sex ratio in the total population is 0.8725 (women per one man) in 1898. This ratio declines further to 0.8573 in 1908. In order to verify whether these low and declining sex ratios are dramatic but geographically concentrated episodes (i.e. in some parts of the area under study) or whether we are looking at large-scale changes occurring everywhere in the Kazakh society, we constructed Fig. 4. It reports the sex ratios in 1908 for each district in the two sub-regions as a function of the corresponding sex ratios in 1898. All but one district lie below the 45° line: the sex ratios have declined basically everywhere across the period 1898–1908. Therefore, the overall drop in the sex ratio is relatively evenly geographically distributed.

These ratios are extremely low in comparison to present day ratios in countries where gender imbalances are perceived to be high. India's overall ratio of women versus men population was 0.932 in 1998–1999, while in China in 2000 it was 0.943. To further discuss whether sex ratios in Kazakhstan are heavily biased we need a benchmark to which they could be compared. For this purpose, we use the Model Stable Populations Tables constructed by Coale et al. (1983) that uses demographic data from Europe in the late 19th and early 20th centuries. The authors group the countries from which data are available into four areas (West, North, East and South). For each area, the Model Stable Populations Tables provide the age distribution in a stable population for different level of mortality and gross reproduction rates (or population growth).[9] Klasen (1998) discusses the mortality patterns in these tables in the context of high mortality environments and argues that the four regions exhibit excess female mortality, with the problem being generally less acute in the North table. We thus choose the North table to compute our first benchmark sex ratios.[10] As a second benchmark and for robustness checks, we use the East tables as it corresponds to the geographical area closest to Kazakhstan. [11]

To compute benchmark sex ratios, we then need to pin down three parameters: a level of mortality, a gross reproduction rate and a sex ratio at birth. We follow Klasen's (1998) study of Germany for the slightly earlier period and choose a high mortality environment with a life expectancy at birth of 30 years for women (level 5 in the Model Tables). For the gross reproduction rate, we choose a level of 2.5, which corresponds to a growth rate for the population of about 5%. We performed sensitivity analysis and computed sex ratios and the implied numbers of missing women for a very wide range of gross reproduction rate (from 2—a rate that implies a negative population growth rate—to 4 which is a rate that implies a population growth rate of more than 17%). The corresponding change in the total number of missing women is small, i.e. our analysis is not sensitive to the assumption about the gross reproduction rate. Finally, the choice of an appropriate biological sex ratio at birth is more delicate and has greater consequences on our results. The difficulty is that unbiased sex ratios at birth vary substantially by ethnicity. Data from the United States show that there are around 1.03 male births for one female birth among African Americans compared to 1.07 for Chinese (Anderson and Ray, 2010). As we have no precise estimate for Kazakh people, we decide to use two different sex ratios at birth for our computations: the first is the median sex ratio at birth for all ethnic groups (1.059 male per female birth or a sex ratio of

[9] The gross reproduction rate is defined as the average number of daughters that would be born to a woman if she survived at least to the age of 29.
[10] While the North table have the lowest overall level of excess female mortality, this is not true for the youngest age category. We discuss this point when comparing the number of missing women obtained with the two benchmarks.
[11] Data for the North tables stem from Norway, Sweden and Iceland and for the East tables from Germany, Austria, Czechoslovakia and Northern Italy.

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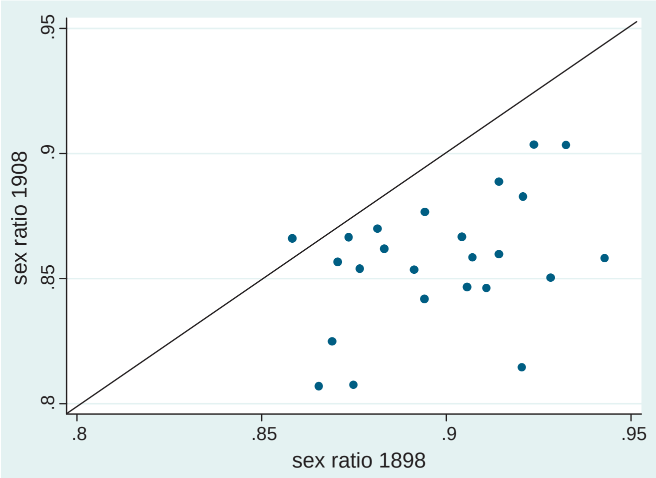

Fig. 4. Overall sex ratios in 1908 as a function of sex ratios in 1898 by district.

0.944) and the second is the sex ratio at birth for Chinese (0.935). The later implies very conservative estimates of the number of missing women.

Table 3 reports the benchmark sex ratios obtained for the overall population and for the under-12 years old and above-14 years old categories.[12] A comparison of the proportions of men by age category in the Kazakh data (Table 2) with the benchmark proportions reveal that for all age categories, all benchmark proportions are outside the 95% confidence intervals of the proportion of male in the Kazakh population. Thus, the Kazakh sex ratios are abnormally biased against women. Moreover, the confidence intervals in 1898 and 1908 do not overlap. This implies that the proportion of men significantly increased over the 1898–1908 period. In other words, the already biased sex ratio worsens over this period.

Looking across age categories, in both years, the sex ratios in the Kazakh population are monotonically decreasing in age. In the youngest age group, the sex ratios in 1898 and 1908 are 0.947 and 1.059, respectively. The sex ratios for children under 12 are worse (0.941 and 0.924), whereas the worst ratios are for the population aged 14 and above, with less than 830 women per 1000 men in both years. This worsening of sex ratios over age is in stark contrast with the age profile of benchmark sex ratios presented in Table 3. In fact, Coale (1991) notes that in all European populations since the mid 19th century, male mortality at all age has been greater than female mortality: while "biologically" slightly more boys are born than girls, sex ratios are improving with age.

Based on the benchmark sex ratio, we have computed an estimate of the number of missing women in the Kazakh population. Table 4 reports the number of missing women by age category and year of census, as the number of women that should be added to the population in order to reach the benchmark—holding constant the number of men. The number of missing women depends on the benchmark used, especially in terms of the choice of sex ratio at birth. When we use a conservative estimate of this parameter, the overall percentage of missing women in the female population decreases from 18.9% to 17.6% in 1898 (Model North). The sheer size of the missing-women phenomenon in the Kazakh population is daunting. Even using the most conservative specification, the observed sex ratios translate into over 17,000 missing women in 1898 and over 20 100 in 1908. Thus the stock of missing women represents about 17% of the total female population in 1898 and 19% in 1908. The break-down by age categories shows again that it is among the adult population that the problem is the most acute. Missing women above 14 represent 23.7% of the above-14 female population in 1898 and 24.9% in 1908. Supposing that these figures are the result of excess female mortality (as we argue in Section 4), they suggest that an additional 25% of women aged 14 and above would have been alive if the excess female mortality in Kazakhstan were no greater than in Western European countries at that time.

More insights are gained by examining distributions of sex ratios in the population, thereby exploiting the fact that demographic information is available by household category, where a category is defined by wealth (measured by livestock in adult horse equivalent) owned by the household and the district the household is living in.[13] Those groups have different sizes, with a median of 240 individuals, a minimum of 10 and a maximum of 5105 in 1898. To take this feature into account, we weight the data points proportionally to the size of population in the group when constructing kernel densities of the proportion of men by category. Figs. 5 to 12 compare the distribution of the proportion of males in our data to the distribution of hypothetical proportions based on benchmark sex ratios (we use the East benchmarks for both birth sex ratios). These hypothetical proportions are generated by assuming that the number of men in each category is drawn from a binomial distribution with a mean equal to the benchmark

[12] For the below 12 sex ratio we use the below 10 sex ratio readily computable from the table. The below 15 sex ratio, also readily computable is similar (1.058), we are thus confident that the below 12 would be very similar to the below 10.

[13] In 1908, in addition, the grouping is based on the household participation to the labor market. To generate comparable distributions across year, we aggregate the 1908 data by wealth and districts, so as to have the same structure as in 1898.

Table 3
Benchmark sex ratios (SR) and proportion of men.
Source: Model Stable Population Table, Coale et al., 1983 (Mortality: 5, GRR:2.5).

	Model North		Model East	
	Median SR at birth	Chinese SR at birth	Median SR at birth	Chinese SR at birth
Benchmark sex ratio (all)	1.0372	1.0265	1.0321	1.0215
Benchmark sex ratio (<12)	0.9973	0.9871	1.0254	1.0148
Benchmark sex ratio (>14)	1.0582	1.0473	1.0355	1.0249
Benchmark proportion of men (all)	0.4910	0.4935	0.4921	0.4947
Benchmark proportion of men (<12)	0.5007	0.5032	0.4937	0.4963
Benchmark proportion of men (>14)	0.4859	0.4884	0.4913	0.4934

The median and Chinese sex ratios at birth are 0.944 and 0.935 respectively.

Table 4
Missing women in the Kazakh population in 1898 and 1908 for various levels of benchmark sex ratios.

	Model North		Model East	
	Median SR at birth	Chinese SR at birth	Median SR at birth	Chinese SR at birth
1898				
Number of missing women	18,859	17,636	18,284	17,068
Number of missing women (<12)	1992	1632	2977	2607
Number of missing women (>14)	17,030	16,222	15,345	14,554
Missing/women pop	0.189	0.176	0.183	0.171
Missing/women pop <12	0.060	0.049	0.090	0.079
Missing/women pop >14	0.277	0.264	0.249	0.237
1908				
Number of missing women	22,092	20,782	21,477	20,173
Number of missing women (<12)	2812	2422	3879	3478
Number of missing women (>14)	18,797	17,937	17,002	16,160
Missing/women pop	0.210	0.197	0.204	0.191
Missing/women pop <12	0.080	0.069	0.110	0.099
Missing/women pop >14	0.290	0.276	0.262	0.249

proportion.[14] Figs. 5 and 6 present the results for the overall proportion of male in 1898 and in 1908, respectively. Figs. 7 and 8 present the distributions for the under-12 year old population and Figs. 9 and 10 for the above-14 year old population.

The distributions of the proportions of men in the data in both years and in all age categories are clearly located at the right of the benchmark distributions. The shift of distribution is particularly striking for the above-14 category: there is very little common support between the benchmark and the observed distribution, especially in 1908. This confirms the worsening of the situation between the two census years and suggests that compared to Western European populations of the same period, nearly all wealth/district categories of the Kazakh population in the area under study exhibit a much larger proportion of men.

For the youngest age group (below 2), we perform a similar analysis and use the benchmarks provided by the East tables for the age category 0 to 1 for two different levels of sex ratios at birth. Figs. 11 and 12 report the benchmark distributions for 1898 and 1908 respectively, along with the observed distribution in our data. These figures suggest three facts. First, in both years the proportion of males in the youngest age category is remarkably close to the hypothetical distributions. There is therefore no evidence of excess female mortality in the youngest age category. Second, the comparison of the real to the hypothetical distribution reinforces our confidence in the quality of the data and speaks against a systematic undercounting of women (see also Section 4.1). Finally, the distribution flattens across survey years due to much lower numbers of individuals in the youngest age category in the second year.[15] Note that the composition of the youngest age groups is different across two years: in 1898 the youngest group consists of children of age 1 and younger, while in 1908 it is restricted to children strictly less than 1 year old. However, the sharp decrease of the size of the youngest population is only in part explained by the change in definition of the youngest age category. Indeed, in a stable population with constant fecundity, the size of the age category 0–1 would be greater than one-half of the size of the age category 0–2 (because of infant mortality). Instead, here the group of children under 1 in 1908 represents less than one quarter of the group aged 1 and below in 1898. Thus the flattening of the distribution is probably related to either a strong drop in fertility or a remarkable gender-neutral increase in infant mortality.[16] This dramatic change in population dynamics over one decade confirms that the Kazakh population in our area under study was undergoing a major crisis.

[14] If the gender composition of each group would be the same as the gender composition of the European population from the time used as a benchmark, the number of men in a group of size X would follow a binomial distribution (X, p) where p is the benchmark proportion of men.

[15] In smaller groups, proportions of males are more widely distributed: if, for instance, there are only three individuals in one category, a male proportion of one is far more likely to be observed than if there were 30 individuals.

[16] Ideally, we would like to look at the change in the absolute number of women of childbearing age, in order to compute the change in the fecundity rate. Unfortunately, our data is not sufficiently disaggregated by age.

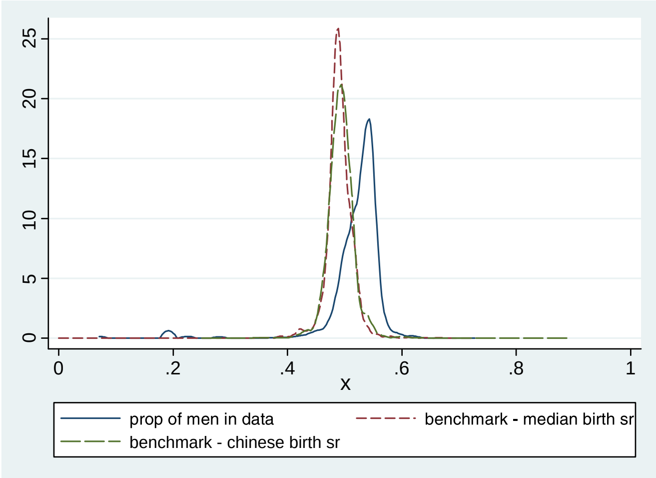

Fig. 5. Distribution of proportion of men in sample (by wealth category) compared to benchmarks (East Model Stable Population Table) in 1898.

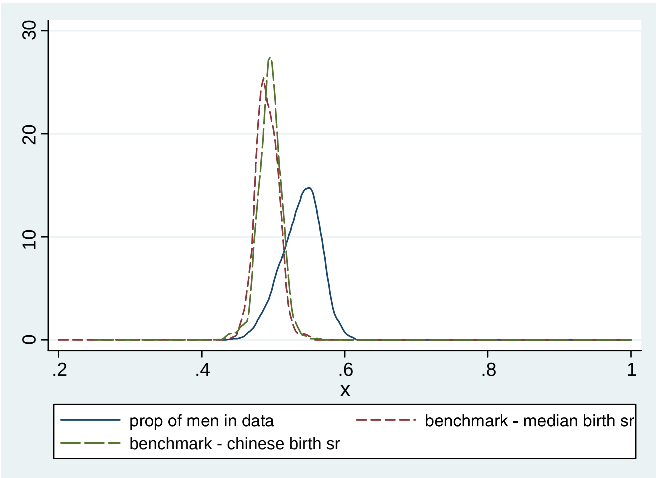

Fig. 6. Distribution of proportions of men in sample (by wealth category) compared to benchmark (East Model Stable Population Table) in 1908.

4. Missing Kazakh women: competing explanations

What can explain the patterns described above? There are three main candidate explanations: (1) Misreporting or systematic undercounting of women; (2) Net migration biased by gender; (3) Differential mortality. In this section we analyze these three potential mechanisms, discard the first two and argue in favor of the third. We claim that differential mortality is driven by an unequal access to resource and present additional empirical evidence to substantiate this assertion.

4.1. Systematic undercounting

The first possibility is systematic misreporting of women in the surveys conducted by the expedition members. Given that culturally the role of women in the Kazakh society was inferior to that of men, normally the survey respondent would be a senior male member of the household. The strong virilocal and exogamy norms might also imply that the female children in the family are considered as the future members of another extended family. Given this, the respondents might have omitted to mention some of the female children when asked about the number of children by gender. Another reason for failing to report women would be the fear of kidnapping of Kazakh women by the invading Russians. In either case, if Kazakhs systematically under-reported the number of their women, our statistics on sex ratios would be biased downwards.

Given the high quality of the dataset (as attested by the sources cited in Section 3.1), it is unlikely that such systematic misreporting took place and went unnoticed by the data collectors. We found no discussion of such potential data problems anywhere in the introductory sections of the expedition publications, whereas for other variables—e.g. livestock wealth—the

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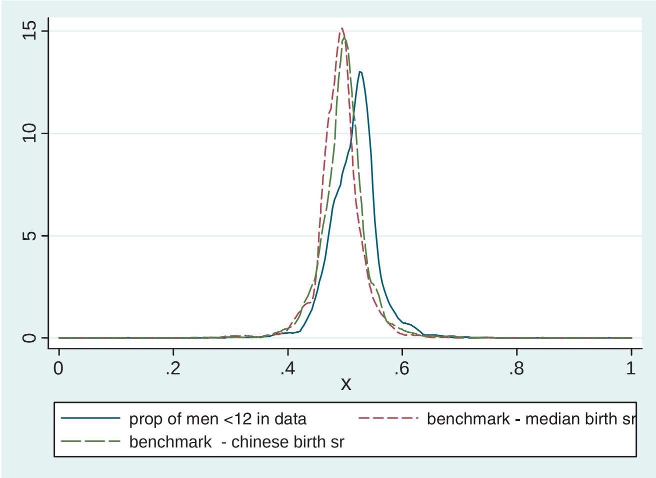

Fig. 7. Distribution of proportions of men below 12 (by wealth category) in sample compared to benchmark (East Model Stable Population Table) in 1898.

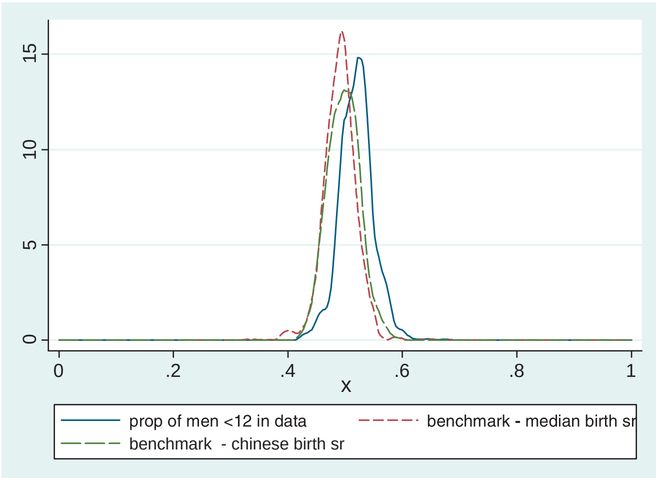

Fig. 8. Distribution of proportions of men below 12 (by wealth category) in sample compared to benchmark (East Model Stable Population Table) in 1908.

expedition administration explicitly mentioned the difficulties and potential mis-measurement problems on several occasions (Volkova, 1988: 178–179).

Furthermore, two characteristics of the data patterns speak against this hypothesis. First, the distributions of sex ratios among infants presented above are remarkably close to theoretical distribution, suggesting that for this age category, counting was probably accurate. Furthermore, if household heads would hide the presence of women for the fear of kidnapping, we would expect the under-reporting to be stronger for younger women. In particular, sex ratios in the population above 60 is less likely to be affected. At the bottom of Table 2 we report the sex ratio in this age group in 1898 (the data does not allow us to do the same for 1908). At a level of 0.8513, the sex ratio for the above 60 is significantly worse than the ratio of 0.8725 in the general population, speaking against a misreporting targeted to women of prime age. Note finally that the drop in sex ratios over time is difficult to attribute to misreporting, because this would imply that misreporting worsened over time.

To further probe into the quality of the demographic data we verify whether it obeys Benford's law. This law predicts the distribution of first digits in data sets. In particular, first digits should follow a monotonically decreasing distribution (the probability that a given observation starts with 1 is larger than the probability that it starts with 2, which in turn is larger than the probability that it starts with 3, etc.) with specific probabilities associated with each first digit.[17] This law has been used for fraud detection in elections and in firms' accounts (Nigrini, 2012). Judge and Schechter (2009) show how this law can be applied to assess the quality of large household surveys and to detect systematic mismeasurement errors. In order to verify whether our data conforms to Benford's law, we test whether the occurrence of first digit in the number of men and women below 12 and above 14

[17] Specifically, this probability is $Prob(first\ digit\ is\ d) = log_{10}(1 + (1/d))$. While the monotonicity of the first digit distribution is rather intuitive, the specific logarithmic formula is less straightforward. It was established as an empirical regularity and various theories have been proposed to explain it (Judge and Schechter, 2009).

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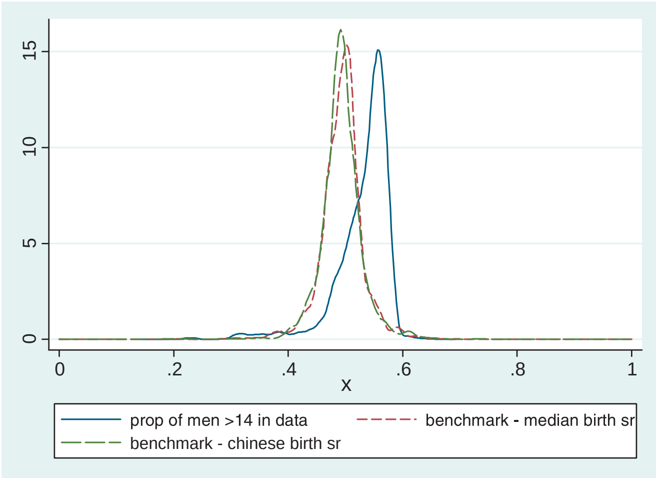

Fig. 9. Distribution of proportions of men above 14 (by wealth category) in sample compared to benchmark (East Model Stable Population Table) in 1898.

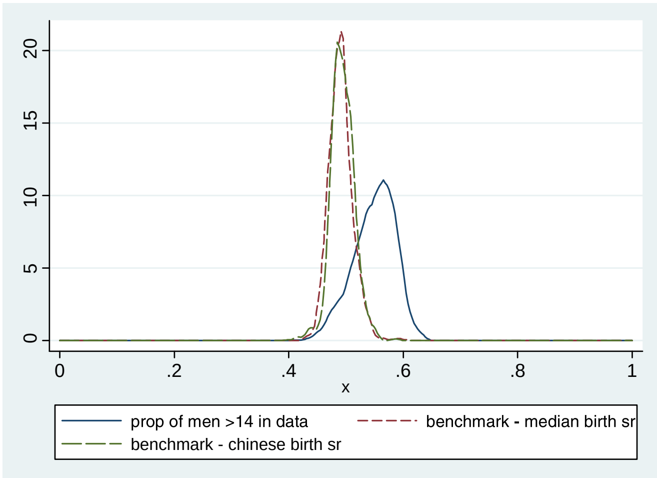

Fig. 10. Distribution of proportions of men above 14 (by wealth category) in sample compared to benchmark (East Model Stable Population Table) in 1908.

is distributed according to the law. Tables 5 and 6 present the results for the two years of survey.[18] It indicates the occurrence of each possible first digit for the four variables of interest, along with the prediction from Benford's distribution. The last rows of the tables report the p-value from a chi-square goodness of fit test. All p-values are very large, indicating that we cannot reject the null hypothesis that the data is distributed according to Benford's law. We take much comfort from these results as they testify against the presence of miscounting of either men or women in our data.

4.2. Massive female out-migration

The second possibility is that there is an important out-migration within the period under study, especially for women. This can have two forms: geographical population displacement that is biased towards women and inter-marriages with Russians (which would imply that young Kazakh women move to live with Russians and quit Kazakh households; thus, they would not be counted in the expedition data). The historical evidence speaks against the first possibility. Contrarily, there was some regional out-migration of young men towards the mining areas of Eastern Kazakhstan, given the labor-intensive technology that was used in the mines (Abuseitova et al. 2001: 416–418). Moreover, the Russian empire censuses of 1897 and 1926 indicate that there were extremely few ethnic Kazakhs living outside the territory of Kazakhstan. Finally, in the neighboring regions (for which we have less detailed information) and overall in Kazakhstan, the sex ratios are highly similar to those in our area under study.

[18] An observation in the first year is defined by the district and horse ownership category, while in the second year the data is further disaggregated by labor market participation.

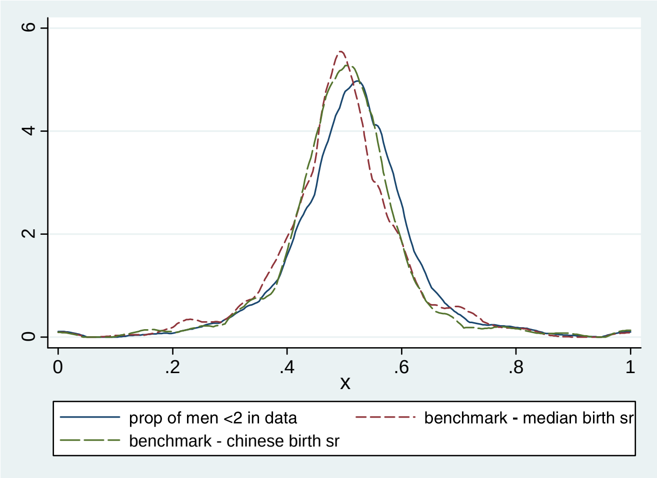

Fig. 11. Distribution of proportions of men below one (by wealth category) in sample compared to benchmark (East Model Stable Population Table) in 1898.

Theoretically, if Russian migration were heavily male-biased, if Russian men married with Kazakh women, and thus many Kazakh women moved to live with Russians, then these women would not appear in our dataset. It is unlikely that such phenomenon explains the low sex ratio that we document. First of all, the Russian migration was principally the migration of families. Demko (1969: 93) notes that 47.4% of Russian migrants were women. Second, the inter-ethnic marriages were extremely rare in Kazakhstan until the post-WWII period (Carrere d'Encausse, 1959). This can be explained by large linguistic, cultural, and religious differences across the two ethnicities. Finally, the analysis of the 1926 census data also helps to discard this hypothesis. The 1926 census provides information about the Russian language skills of inhabitants, as well as their native language. It reports extremely few women of Kazakh origin who were able to speak Russian, suggesting that intermarriages were very rare.

4.3. Excess female mortality

This leaves us with the third possibility: women die more frequently than men, more so at adult age, and the differential mortality gets stronger between 1898 and 1908. There are two main potential mechanisms behind differential mortality. The first is biological, i.e. gender-differentiated biological or medical factors. The second is behavioral, i.e. resource allocation (or work burden) biased against women. There is no historical evidence of gender-biased disease incidence in the period under study and, overall, little support for the first mechanism in the literature. As mentioned above, Coale (1991) notes that in all the European countries from the middle of the 19th century until now, male mortality rates have been higher at every age, conditional on the relatively unbiased access to nutrition and health conditions (and this over the range of life expectancy from 35 to 80 years).

A major cause of mortality for women may have been maternal mortality, which, at first sight, appears orthogonal to discrimination in resource allocation. However, discrepancies in levels of mortality of women of child bearing age across groups having access to the same medical technology are largely explained by differences in nutrition levels. This argument is developed by Ransel (1991) in his study of infant care in the Russian Empire, where he explores differences in infant mortality and women survival across ethnic groups within Russia over our period of interest. He notes that while infant mortality rates are smaller among Muslim ethnic groups, these rates are negatively correlated to women's mortality in childbearing years (contrarily to non-Muslim groups, where women's mortality rates are positively correlated with infant mortality rates). He argues that this is related to Muslim mothers having to breastfeed their children until the age of two without access to adequate nutrition, which led to depletion of their physical forces and provoked serious health problems, especially after giving birth to several children. Secondly, using highly detailed genealogical data for the 18–19th century Germany, Klasen (1998) convincingly shows that despite a high rate of maternal mortality, it can account only for a small portion of "the extraordinary survival disadvantage of women." Finally, even if maternal mortality accounts for part of the gender imbalance in 19th century Kazakhstan, explaining the worsening of the sex ratio over time would require a sharp increase in maternal mortality, which is not confirmed by historical sources.

We now turn to evidence in support of the biased resource allocation hypothesis. In particular, we show in the next section that low sex ratios strongly correlate with vital resource scarcity.

5. Uncovering the mechanism behind differential mortality: competition over scarce resources

5.1. Wealth and sex ratios

We exploit the two cross-sections of data to highlight the correlation between sex ratios and wealth. A first indicator of wealth is the number of horses that a household owns. Tables 7 and 8 present the proportion of men (along with the 95% confidence

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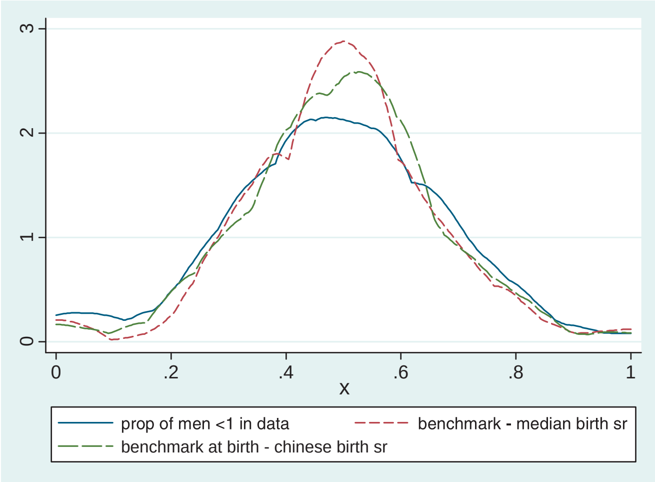

Fig. 12. Distribution of proportions of men below one (by wealth category) in sample compared to benchmark (East Model Stable Population Table) in 1908.

interval) by wealth category, for 1898 and 1908, respectively. The last line of Table 8 provides evidence on the correlation between our measure of wealth (horse-ownership) and average cash expenditure per person (in each category).

In both years, overall sex ratios, above-14 sex ratios and below-12 sex ratios increase monotonically with wealth (the only exception is for the below-12 sex ratio in the wealthiest category in 1908). For 1898, only in the two wealthiest categories, accounting for less than 4% of the population, the overall proportion of males in the population is not significantly greater than the benchmark ratio of 0.492 (East Table, median birth ratio). In 1908, the situation is worse across wealth levels; only in the last category, representing less than 5% of the population, the overall proportion of males is not significantly greater than the benchmark ratio of 0.492. Below-12 proportions of males are lower than above-14 but significantly larger than the benchmark of 0.494 except for the three wealthiest categories in 1898 (accounting for 9.8% of the population), and for the poorest in 1908. This last fact is probably driven by the small size of that category (114 individuals younger than 12), which leads to a very wide confidence interval. The increase in the proportion of men in the below-12 category throughout the wealth spectrum across survey years is particularly striking. The picture is similar for the above-14 age category. It is only in the three wealthiest categories in 1898 that the proportion of men above 14 is not significantly greater than the benchmark of 0.491. Given the small total size of the population of below-1 children, the confidence intervals on the proportion of males for this age group are very wide.

Looking at the change over the two periods, we observe a worsening of the sex ratios across the board despite the overall increase in wealth (as measured by livestock ownership in adult horse equivalent units) and the shift of the wealth distribution to the right. Fig. 13 illustrates the distribution of population by wealth for the two survey years and the change in sex ratio. The simultaneous increase in wealth and decrease in sex ratios may appear puzzling at the first sight. However, one should remember that the sex ratio captures the differential survival rates of men and women across their lifetime (and thus depends on the economic conditions over a relatively long time span), while horse ownership reflects the current-year economic situation in the nomadic population (i.e. it is highly sensitive to climatic shocks). As discussed earlier, in a nomadic pastoralist economy, year-to-year fluctuations in livestock may be very large, with particularly dramatic consequences for the households at the bottom of the wealth distribution. For instance, Tolybekov (1971) writes:

> "*[During jut] many pastoralists in some one-two months almost entirely lost their wealth. Sometimes even the wealthier households become the middle-class, or—occasionally – the poor families. The less wealthy households of middle-class and poor*

Table 5
Distribution of first digits in the sample and according to Benford law (1898 data).

First digit	Benford distribution	Women >14	Men >14	Women <12	Men <12
1	130	131	144	119	124
2	76	82	82	71	70
3	54	51	40	49	54
4	42	29	40	49	45
5	34	36	26	34	38
6	29	25	30	37	27
7	25	30	30	24	28
8	22	26	21	23	21
9	20	21	18	22	17
Chi-square test of goodness of fit					
p value		0.54	0.35	0.7	0.97

Table 6
Distribution of first digits in the sample and according to Benford law (1908 data).

First digit	Benford distribution	Women > 14	Men > 14	Women < 12	Men < 12
1	151	151	164	152	157
2	88	91	94	83	74
3	63	51	52	75	60
4	49	51	46	57	37
5	40	39	30	38	41
6	34	32	38	26	32
7	29	35	27	25	30
8	26	31	26	23	23
9	23	17	22	22	19
Chi-square test of goodness of fit					
p value		0.61	0.58	0.55	0.59

Table 7
Population and sex ratios by age category and wealth in 1898.

	0 horse	1–5 horses	6–10 horses	11–25 horses	26–50 horses	51–100 horses	> 100 horses
Population	7492	118,899	32,575	34,670	12,487	5099	3468
Sex ratio	0.8053	0.8251	0.8888	0.9560	0.9935	1.0619	1.1044
Proportion male	0.5539	0.5479	0.5294	0.5112	0.5016	0.4850	0.4752
Confidence interval	[0.5427,0.5652]	[0.5451,0.5507]	[0.5240,0.5348]	[0.5060,0.5165]	[0.4928,0.5104]	[0.4713,0.4990]	[0.4586,0.4918]
Population > = 14	4611	76,265	20,441	21594	7696	3100	2057
Sex ratio > = 14	0.7660	0.7689	0.8444	0.9369	0.9922	1.1204	1.1517
Proportion male $\geq$14	0.5663	0.5653	0.5422	0.5163	0.5019	0.4716	0.4648
Confidence interval	[0.5519,0.5806]	[0.5618,0.5688]	[0.5354,0.5490]	[0.5096,0.5230]	[0.4901,0.5131]	[0.4540,0.4892]	[0.4432,0.4863]
Population < 12	2470	36,832	10,476	11,257	4160	1729	1218
Sex ratio < 12	0.8643	0.9267	0.9513	0.9666	0.9914	0.9540	1.0237
Proportion male < 12	0.5364	0.5190	0.5125	0.5085	0.5022	0.5118	0.4941
Confidence interval	[0.5167,0.5561]	[0.5140,0.5241]	[0.5029,0.5221]	[0.4992,0.5177]	[0.4870,0.5174]	[0.4882,0.5353]	[0.4660,0.5222]
Population $\leq$1	239	4236	1230	1415	558	250	195
Sex ratio $\leq$1	0.7704	0.9431	0.9680	0.9252	1.0440	0.9380	1.0526
Proportion male $\leq$1	0.5649	0.5146	0.5081	0.5194	0.4892	0.5160	0.4872
Confidence interval	[0.5020,0.6277]	[0.4995,0.5296]	[0.4802,0.5361]	[0.4934,0.5455]	[0.4477,0.5307]	[0.4540,0.5780]	[0.4170,0.5573]
Household size	4.23	5.25	6.21	6.95	7.79	8.60	10.17
Household size < 12	1.39	1.63	2.00	2.26	2.60	2.92	3.57
Area cultivated per person (desyatinas)	0.40	0.66	0.59	0.77	1.07	1.55	2.69

> *Kazakhs became destitute. The mass of people, having lost its main production tool and the only source of subsistence—livestock—had to face famine and death*". (p. 541).

Thus, the observed increase in horse ownership does not necessarily reflect an increase in the permanent income. In fact, the winter of 1897–1898 was particularly harsh, i.e. it was the so-called *jut* year with substantial livestock deaths in winter (Tolybekov, 1971: 79).

5.2. Nutrition and sex ratios

The detailed data on food consumption collected by the expeditions enables us to dig deeper into the correlation between sex ratios and the resource availability. Kazakhs consumed three broad types of food: meat, dairy products and grain. For each type of food we have information about the average quantity available in each category of households. For meat, we know the type and number of animals slaughtered over the last 12 months (separately during winter and in other seasons). For dairy products, we can estimate milk production based on information about the number of cows, ewes, goats, camels and mares that gave birth over the last 24 months. Finally, for grain, we know the quantity consumed over the last 12 months. Using realistic assumptions about the nutritional value of these food items, we estimate calorie availability per equivalent adult for each group of households (recall that a unit of observation is a group of households living in the same district and belonging to the same wealth category).[19] It is important to note that while it is relatively easy to evaluate the nutritional value of grain, the estimation of the calories available

[19] To express the population size of each group in adult equivalent, we use the recommended dietary allowances (RDA) for 1989. The exact weights and details about calorie calculations are available upon request. We do not report them here, to economize on space.

Table 8
Population and sex ratios by age category and wealth in 1908.

	0 horse	1–5 horses	6–10 horses	11–25 horses	26–50 horses	51–100 horses	>100 horses
Population	494	20,869	41,020	79,158	48,886	25,370	12,784
Sex ratio	0.5107	0.7505	0.7886	0.8376	0.9041	0.9720	1.0392
Proportion male	0.6619	0.5713	0.5591	0.5442	0.5252	0.5071	0.4904
Confidence interval	[0.6202, 0.7037]	[0.5646, 0.5780]	[0.5543, 0.5639]	[0.5407, 0.5477]	[0.5208, 0.5296]	[0.5009, 0.5132]	[0.4817, 0.4990]
Population ≥14	363	13,716	26,146	50,092	30,327	15,539	7731
Sex ratio ≥14	0.4405	0.6985	0.7306	0.7874	0.8857	0.9808	1.1035
Proportion male ≥14	0.6942	0.5887	0.5778	0.5595	0.5303	0.5049	0.4754
Confidence interval	[0.6468, 0.7416]	[0.5805, 0.5970]	[0.5718, 0.5838]	[0.5551, 0.5638]	[0.5247, 0.5359]	[0.4970, 0.5127]	[0.4643, 0.4865]
Population <12	114	6181	12,822	25,121	16,087	8487	4360
Sex ratio <12	0.7538	0.8811	0.9061	0.9314	0.9316	0.9456	0.9257
Proportion male <12	0.5702	0.5316	0.5246	0.5178	0.5177	0.5140	0.5193
Confidence interval	[0.4793, 0.6611]	[0.5192, 0.5440]	[0.5160, 0.5332]	[0.5116, 0.5240]	[0.5010, 0.5254]	[0.5033, 0.5246]	[0.5045, 0.5341]
Population =<1	4	182	375	606	436	220	134
Sex ratio ≤1	1.0000	1.2195	1.4351	0.9675	1.0185	0.8966	0.8611
Proportion male ≤1	0.5000	0.4505	0.4107	0.5083	0.4954	0.5273	0.5373
Confidence interval		[0.3783, 0.5228]	[0.3609, 0.4604]	[0.4684, 0.5481]	[0.4485, 0.5423]	[0.4613, 0.5932]	[0.4530, 0.6217]
Household size	2.92	4.49	5.40	6.37	7.51	8.27	9.67
Household size <12	0.67	1.33	1.69	2.02	2.47	2.77	3.30
Area cultivated per person (desyatinas)	0.29	0.70	0.98	1.17	1.42	1.84	2.72
Expenditure per person	15.3	26.9	30.6	34.2	45.1	65.5	130.0

from meat and dairy is more complicated, for two reasons. First, the productivity of animals—both in terms of meat and milk production—depends heavily on the animal breed and nutrition. Given that we have imprecise information on animal characteristics, we follow historical and agronomic sources that provide average productivity for well-fed animals. Second, the nutritional values of milk and meat themselves depend on animal breed and nutrition, introducing an additional source of noise in our estimations. Available figures are, again, based on products from well-fed animals. Overall, our estimates of food availability are likely to be biased upwards, especially for poor households, who had less well-fed animals.

On average, we estimate that across the sample in both years about 3600 kcal were available per equivalent adult per day. About one fourth of the population had less than 2600 kcal available per day. Table 9 provides the exact descriptive statistics, broken by the type of food. While the average figures appear high, it hides substantial variation across the sample, as illustrated by Figs. 14 and 15 that show the distributions of calorie available per adult equivalent (per day) for the two years of study. Furthermore, energy needs for Kazakhs in 1898–1908 where substantially higher than nowadays, given the harsh climatic conditions that they faced and the important amount of hard physical work that they had to do. Experimental studies of nutritional needs in cold environments reveal that an active adult sleeping in a tent and experiencing outdoor temperature below −25 °C need on average 57 kcal per kg body weight per day. An average Kazakh adult at the end of the 19th century weighed 65 kg (Zeland 1885), which corresponds to the need of about 3700 kcal per day. This suggests that our estimated average energy

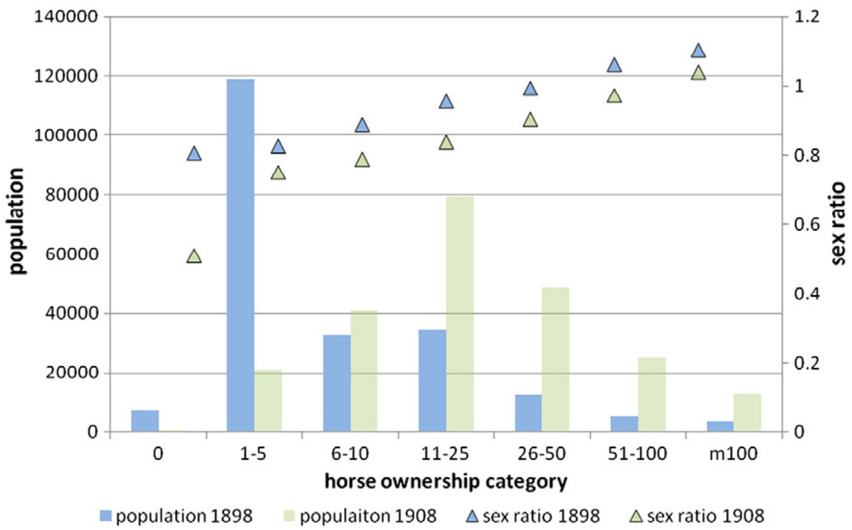

Fig. 13. Wealth distribution and decline in sex ratios, 1898–1908.

Table 9
Descriptive statistics of calorie availability per average adult (per day) (observations weighted by population).

	1898				1908			
	Mean	S.D.	Pc 25	Median	Mean	S.D.	Pc 25	Median
Kcal GRAIN	2269	804	1653	2148	1858	920	1495	1712
Kcal MILK	1013	788	637	784	1280	1026	678	959
Kcal MEAT	350	267	179	328	401	266	231	323
Kcal TOTAL	3632	1690	2597	3440	3540	1847	2466	3037

available falls below the average daily winter-period need. It is also clear that a substantial proportion of the population had inadequate food availability.

To investigate whether gender bias is systematically related to calories availability, we estimate the following econometric model:

$$\Pi_{ait} = \alpha_a cal_{it} + \beta_a^{'} X_{it} + \varepsilon_{ait} \tag{1}$$

where Π_{ait} is the proportion of men in the age category a in the group i in year t, cal_{it} is the number of calories available per adult equivalent in the group i in yea t, X_{it} is a vector of control variables including district and time fixed effects and, depending on the specifications, wealth category fixed effects, average household size and average area cultivated by households in group i, and ε_{ai} is an error term. We estimate the model separately for the 0–12 age category and for above-14 age category. We use two estimation methods: (i) ordinary least squares, and (ii) generalized linear model (GLM), which takes into account the fractional nature of the dependent variable.[20] Observations are weighted by the size of the population (of given age) in the group. Since the individual variables used to compute the total calorie available slightly differ across survey year, we allow the calorie variable to have a different effect in the two years through the introduction of an interaction variable between time and calories.[21] This interaction term is nearly never significant, so that the effect of calorie availability is not significantly different across survey years.[22] We thus report regression results without this term.

Table 11 reports the results of our estimations. The dependent variable for the estimation reported in rows R1 to R7 is the proportion of men in the above-14 age category, while the dependent variable in the rows R8 to R14 is the proportion of men in the below-12 category. The results are highly robust across specifications for the above-14 age category; the calories available per person are negatively correlated with the proportion of men, regardless of whether wealth-category fixed effects are included or not (R1/R2), whether the 5% of the population with the highest calorie availability is excluded or not (R3), and whether or not we allow for a non-linear effect of calorie availability (R4). The statistical significance of the coefficient on the square term suggests a concave relationship between calorie availability and proportion of men. When we use a GLM estimation method rather than OLS, the results are overall unchanged. Neither household size nor land area available per person are significant.

The results are slightly weaker for the below 12 age category. When wealth fixed effects are introduced, there is no correlation between food availability and proportion of men. This suggests that the significant effect of calorie availability in all other specification is driven by inter-category differences. Furthermore, the results in row R11 suggest that there is no concavity in the relationship.

To interpret the size of the coefficient, consider the results in row R3 (that concerns 95% of the population, i.e. excluding the 5% with the highest calorie consumption). The size of the coefficient suggests that, holding constant the size of the male population, an increase in 1000 kcal available (per day) per adult equivalent would translate approximately into an additional 15,838 women, i.e. an increase of 11.2%, relative to the size of female population within a given household category.[23]

The above evidence shows that the relative scarcity of resources is highly correlated with sex ratios. Intuitively, when the competition for resources intensifies, the less powerful members of the society are less likely to be able to satisfy their basic vital needs. In an environment with substantial prevalence of nutrition-sensitive diseases, this almost surely translates into excess mortality of those members. Descriptive historical sources (e.g. *Turgay Region Review* for 1908) indicate that smallpox, measles, scarlet fever, whooping cough, influenza, diphtheria, typhoid fever, scurvy, dysentery, and cholera had the highest frequency among all the diseases in the area of our study. In this environment, the scarcity of vital resources for women could have certainly led to the observed sex ratio patterns that we document.

[20] We use the strategy proposed by Papke and Wooldridge (1996) to handle proportion models with zeros or ones. Formally, we assume that the expected value of the proportion of men is: $E(\Pi_{ai}) = G(\alpha_a\ cal_i + \beta_a{'}X_i + \varepsilon_{ai})$, where G is a logistic function. To estimate the parameters, we use Bernoulli quasi-maximum likelihood estimators recommended by these authors.

[21] The food categories in the 1908 data set are more disaggregated. For example, while we have just an aggregate variable for horse meat from own production consumed over the last 12 months prior to the 1898 data collection, for 1908 we know the quantity consumed in winter and in other times. Similarly, while we have a generic variable for grain consumed in 1898, we know the individual quantities of wheat, barley and millet consumed in 1908.

[22] In the first set of regressions (above-14 age category), the interaction term is only significant in one case, when the sample is trimmed. In the second set of regressions (below-12 age category), the interaction term is only significant when the square of calories is introduced and it is also the only variable that is significant at conventional levels.

[23] We take the difference between the number of women in a given age category and the number of women that would be necessary to decrease the proportion of men by 0.0266, holding the overall number of men constant.

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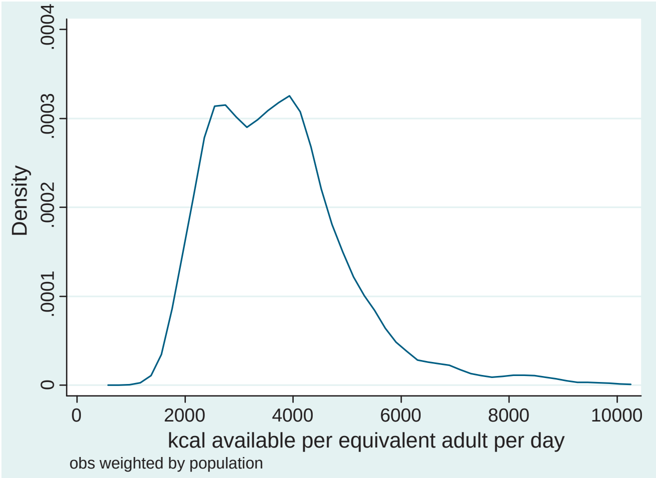

Fig. 14. Kernel density estimate of calorie availability in 1898.

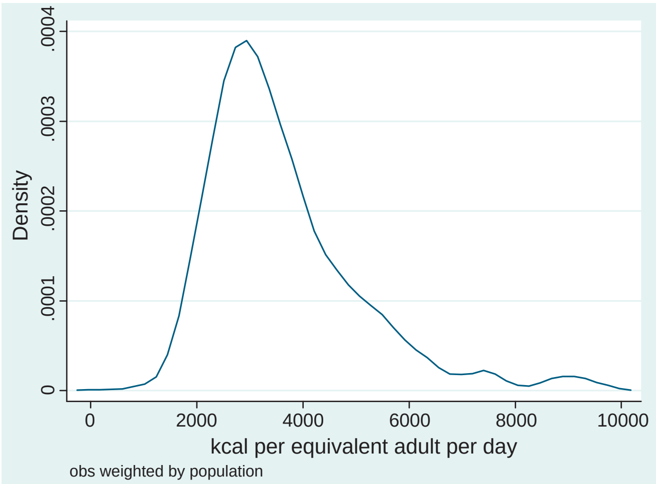

Fig. 15. Kernel density estimate of calorie availability in 1908.

As mentioned in the introduction, the finding that women paid the highest cost of the crisis following the forced sedentarization during the Russian colonization of Kazakhstan is hardly a historical anomaly. In fact, many studies in other societies and historical contexts found that women are more likely than men to be deprived of vital resources, in particular nutrition during hardships. Horrell et al. (2009) argue that English women suffered from severe nutritional deprivation during industrialization. Interestingly, in contrast to the situation in Kazakhstan, they find that increased resources do not reduce gender inequality. In the same context, Nicholas and Oxley (1993) show that the average height of English women decreased during the Industrial revolution while that of men was not affected. They conclude that women experienced a worsening in nutrition absolutely and relatively to English men and that they "bore the highest costs of industrialization". Baten and Murray (2000) find that in Bavaria, women's heights were significantly reduced by the 1840 potato crisis, while this crisis did not significantly affect men's heights. Similarly, using genealogical data from Germany in 1740–1860, Klasen (1998) finds that women died in greater numbers than men in months of the year that are associated with highest overall mortality and the most severe scarcity of vital resources.[24]

[24] In contrast, most studies of the gender differences during acute famines in Britain and Ireland (even those not related to violent military actions) find that men are more likely to die than women (see studies in Dyson and Grada, 2002). The main reason seems to be physiological: women are more resistant to starvation than men. This suggests that the more important is the literal starvation during a famine, the more likely it is that the gender imbalance in excess mortality is biased against men (Mokyr and Grada, 2002).

Table 10
Population and sex ratios by age category and labor market participation in 1908.

	HHs with workers hired out	HHs with craftsmen	Labor-autarchic HHs	HHs with workers hired in
Population	32,172	40,997	68,268	67,490
Sex ratio	0.6347	0.7827	0.8609	1.0241
Proportion male	0.6117	0.5609	0.5374	0.4940
Confidence interval	[0.6064,0.6170]	[0.5561,0.5657]	[0.5336,0.5411]	[0.4903,0.4978]
Population ≥14	22,304	26,495	42,888	40,156
Sex ratio ≥14	0.5462	0.7283	0.8222	1.0761
Proportion male ≥14	0.6468	0.5786	0.5488	0.4817
Confidence interval	[0.6405,0.6530]	[0.5727,0.5845]	[0.5441,0.5535]	[0.4768,0.4866]
Population <12	8458	12,662	21,859	23,677
Sex ratio <12	0.8880	0.8997	0.9297	0.9407
Proportion male <12	0.5297	0.5264	0.5182	0.5153
Confidence interval	[0.5190,0.5403]	[0.5177,0.5351]	[0.5116,0.5248]	[0.5089,0.5216]
Population <1	255	437	535	581
Sex ratio <1	1.1429	1.2296	1.1063	0.8864
Proportion male <1	0.4667	0.4485	0.4748	0.5301
Confidence interval	[0.4054,0.5279]	[0.4019,0.4951]	[0.4325,0.5171]	[0.4895,0.5707]
Household size	6.03	6.57	6.26	7.16
Household size <12	1.59	2.03	2.00	2.51
Expenditure per person	26.76	33.01	31.76	72.97
Area cultivated per person (desyatinas)	0.72	0.99	1.19	2.10

5.3. Labor market participation and sex ratios

Data about household participation in the labor market help substantiate the argument of active discrimination as it suggests that women are less numerous precisely in the households were the returns to women labor are likely to be lowest. The 1908 data classify households into four major categories:

- Households in which (some) members are hired out as agricultural workers (and no one works as craftsman);
- Households with some members working as craftsmen and no agricultural worker is hired in;
- Household with no member hired out or working as craftsmen and no agricultural worker hired in;
- Households that hire in agricultural workers.

Table 10 reports sex ratios by age and household types. Sex ratios, expenditure per person and area cultivated per person are strongly correlated with household participation in the labor market. The worst situation is that of a household with members hired out as agricultural workers while the best is for those with that employ workers. Households autarchic in terms of agricultural labor (with or without craftsmen) are in an intermediate situation. Note that there is not a perfect correlation between labor market participation and wealth or nutrition. In fact, when we estimate the calorie regressions presented above (Eq. 1) and add controls for the labor market participation, the labor market participation categories have a significant impact on the proportion of men in both age groups: households with members working out exhibit higher level of bias in the proportion of men than those autarchic or hiring in.[25] Importantly, only men participated in the paid labor market, while many livestock-related tasks (e.g. feeding the animals) were performed by women. This implies that in households where a large part of the revenue is obtained from wage labor, men may contribute relatively more to the total household revenue and the returns from calorie intake may be greater for male household members. This may explain why, controlling for the availability of resources, discrimination against adult women and young girls was more acute in households where men worked for a wage.[26]

Alternatively a selection mechanism may explain the correlation of sex ratio and participation into the labor market: some households participate into the labor market because they have a large share of men. However, this explanation does not hold for the younger-than-12 age group whose members do not yet participate into the labor market. The fact that young girls appear less likely to survive in households where men work for a wage support the discrimination mechanism.

Again, our conclusion is similar to that reached by economic historians in other contexts. Klasen (1998) shows that when the relative value of female to male labor increases, women excess mortality decreases (in 18th and 19th century Germany). Qian (2008) examines sex ratios in Maoist China and finds that the proportion of women in the population increases when the value of crops that employ female labor increases. Hammel et al. (1983) find that the childhood sex ratios in the 19th century United States followed the pattern of regional economic specialization: in industrial urban areas of the North–East, the sex ratio was roughly equal or in favor of girls, whereas in the South and along the Western frontier (essentially agricultural regions), the sex ratio was biased in favor of boys.

[25] We do not report the results of these regressions here, for space constraints.
[26] In these households women may also have had a more limited control of the household budget and may have obtained less bargaining over resources.

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Table 11
Regression of the proportion of men on calorie availability and controls.

Dep. variable		Model	Regressors						Sample
			1000*kcal/cap	(1000*kcal/cap)^2	Avg HH size	Area/cap	Horse F.E.	District F.E.	
R1	Prop men > 14	OLS	−0.0141***				Yes	Yes	All
R2	Prop men > 14	OLS	−0.0181***				No	Yes	All
R3	Prop men > 14	OLS	−0.0266***				No	Yes	Trim top 5%
R4	Prop men > 14	OLS	−0.0428***	0.0019***			No	Yes	All
R5	Prop men > 14	GLM	−0.0740***				No	Yes	All
R6	Prop men > 14	GLM	−0.2908***	0.0193***			No	Yes	All
R7	Prop men > 14	GLM	−0.1849***	0.0086***	0.0150	−0.0225	No	Yes	All
R8	Prop men ≤12	OLS	−0.0019				Yes	Yes	All
R9	Prop men ≤12	OLS	−0.0020***				No	Yes	All
R10	Prop men ≤12	OLS	−0.0021*				No	Yes	Trim top 5%
R11	Prop men ≤12	OLS	−0.0029	0.0001			No	Yes	All
R12	Prop men ≤12	GLM	−0.0079***				No	Yes	All
R13	Prop men ≤12	GLM	−0.0117	0.0003			No	Yes	All
R14	Prop men ≤12	GLM	−0.0090**		0.0004	0.0026	No	Yes	All

* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

5.4. Concurrent explanation for the wealth gradient in sex ratios

A potential concurrent factor contributing to the wealth gradient in the sex ratio is that women born in poorer households could have moved into the wealthier ones. This explanation does not apply well to the under-12 population. While there is some anecdotic evidence that wealthier families employed girls from the poorer families for household chores, these girls continued to live with their parents (thus, they were counted as members of the poorer households). It is, however, possible that girls from poorer backgrounds married up. This would reinforce the wealth gradient in the above-14 population. As discussed earlier, the marriage market in the Kazakh society in the period under study was based on brideprices. Thus, the long side of the marriage market (i.e. grooms) was the buyer side. Therefore, if there is a shortage of brides, the richer grooms could outbid the poorer ones, leading to the upward mobility of girls. The key question is then whether there was a scarcity of women of marrying age. Statistical evidence based on the 1897 census of the Russian empire helps us answer this question.

Fig. 16 presents the percentage of men and women of a given age who are married, divorced or widowed in the rural areas of our two regions of interest in 1897.[27] It reveals that men marry later than women. While only 33% of the men aged 20 to 29 are married, close to 100% of women aged 20 to 29 are married. The question we would like to answer is whether this age difference in marriage guarantees that there is no shortage of brides despite the gender imbalance in the population.[28] Fig. 16 suggests that the difference in age at marriage between men and women is large enough to ensure a sufficient supply of brides to men of marrying age. In fact the number of women in the 20 to 29 age category is larger than the number of men in the 30 to 39 category.[29] As a result all men aged 30 to 39 could get married to a women aged 20 to 29. We know that most women marry before 20 while relatively fewer men marry before 30, we are therefore confident that the gender imbalance does not lead to strong tension on the marriage market.[30] In addition, as differential mortality is less pronounced in relatively wealthy families, more brides should be available in that category than among poorer families. Therefore if rich men prefer marrying a woman from the same background, there is no reason to believe that they may not find an appropriate bride. In conclusion, a “marrying-up” phenomenon is unlikely to account for a large part of the wealth gradient in sex ratios.

6. Conclusion

In this paper, we have studied the sex ratios in Kazakh population between 1898 and 1908, i.e. in the period when large-scale Russian in-migration into Kazakhstan caused a sharp increase in land pressure and a severe economic crisis. This crisis made the nomadic organization of the Kazakh economy unsustainable, and forced most Kazakh households into sedentary agriculture. Using a unique novel dataset constructed from Russian colonial expedition materials, we document a low and worsening sex ratio (in particular, among poor households) between 1898 and 1908. We consider several theoretical hypotheses to explain these data patterns. The hypothesis that gains most support in the data and descriptive historical sources is that in poorer households the crisis led to gender discrimination in access to vital resources, which resulted in differential mortality (biased against women).

[27] The 1897 data is not disaggregated by marital status and ethnic origin. As Russian migrants are mostly located in “towns” whereas few Kazakh live in these towns, we restrict attention to the “rural” population to make sure that focus on Kazakhs.
[28] I.e. whether the cumulative mortality of women of marrying age is lower than the cumulative mortality of men of marrying age.
[29] The absolute number of women aged 20 to 29 is 20017 while the absolute number of men aged 30 to 39 is 17,437.
[30] Delaying marriage for men could have been an endogenous response to the shortage of women. However, what matters for our analysis is that there is little reason to suspect that some categories of men would be unable to marry because of the shortage of women.

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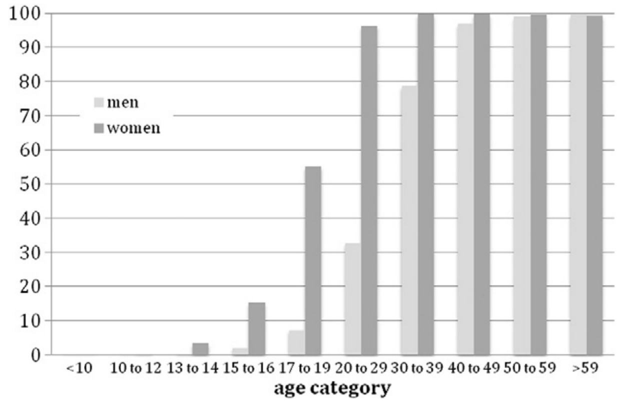

Fig. 16. Percentage of married (plus divorced and widow) individuals by age in rural Kustanay and Aktybinsk (Source: *First General Census of 1897*).

There is no doubt that the massive arrival of Russian peasants and the induced rapid sedentarization of Kazakhs brought much distress among the Kazakh population and that the transition into sedentary agriculture has been traumatic. During the period under study, several harsh winters reinforced the problem, leaving many Kazakhs with few or no animals and severe difficulties in procuring vital resources. Women seem to have been the first victims during this hardship.

A key question is whether the biased sex ratios we document are the outcome of a temporary subsistence crisis or whether it is also related to the changed economic role of women in the new system. Russian historical sources (Tillo 1873) note that in Kustanay sub-region (a part of our area under study), in early 1870s, the sex ratio among Kazakh population was around 0.96, i.e. much better than in the period of our analysis. Clearly, the transition into sedentary agriculture deeply modified the position of women within households and could have played an important role in determining the status of women (as has been argued by Boserup, 1970; see also Alesina et al. 2012). Secondary evidence suggests that the involvement of women in field cultivation was very low. A promising next step for research is thus relating more closely the evolution of key demographic variables such as sex ratios and fecundity to the change from nomadic life to sedentary agriculture and the subsequent change of the role of women in Kazakh society, by comparing, for instance, regions where the Russian in-migration had relatively little influence on the traditional economy to the regions that we study in this paper.

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[31] In Russian documents before 1917, the native population of Kazakhstan and Kyrgyzstan is denoted with under the same name of "Kirghizs".

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