Kinship Structures and Survival: Maternal Mortality on the Croatian-Bosnian Border

1750-1898

E. A. Hammel
Department of Demography

Aaron Gullickson
Graduate Group in Sociology and Demography
Abstract

Automated family reconstitution of 23,307 marriages, 112,181 baptisms, and 94,077 burials from 7 contiguous Catholic parishes of south central Slavonia (Croatia) 1714-1898 is used to analyse maternal survival of up to 13,202 mothers in 56,546 parturitions. Analysis employs a proportional hazard model with time varying covariates. Physiological factors have usually expectable effects. General economic and social conditions plausibly related to withdrawal of male labor from family farming, consequent on military mobilisations and growing levels of wage labor, increase maternal risk. Membership in large patriarchal kin groups decreases risk, but both the presence of classic rivals (husband's brothers' wives) and being married to a husband junior among his brothers increase risk. Analysis demonstrates the sensitivity of maternal survival to macrolevel changes such as the collapse of feudalism, military involvement, economic stagnation, and monetisation, as well as to microeconomic and micropolitical factors at the household and local kin group level.
Introduction

This paper explores the effects of the microeconomics and micropolitics of patriarchal
kin groups on maternal survival, in the presence of physiological and macrolevel social,
political, and economic factors, using parish record data from historical Slavonia. It
confirms earlier results (Hammel and Gullickson 2000) on the physiological and the
macrolevel factors, most importantly on those that resulted in episodic or secularly
increasing withdrawal of male labor from family farming. Deepening these results
through ethnographic insight, it finds that women from larger kin networks and/or
married into larger kin networks had improved survival chances. It further finds that
women with larger numbers of husband's brothers' wives (HBW) and those whose
husbands were relatively young with respect to their brothers had decreased chances of
survival.

We attribute the effect of the size of women's natal kin networks to the ability of
large kin groups to command respect and offer assistance to their daughters, and that of
the size of women's husbands' networks to the economies of scale in large, corporate, and
relatively autarkic patriarchal groupings. We attribute the decreased chances of survival
in the presence of HBWs to the classic rivalry between such women and that of women
with junior husbands to strong age ranking in patriarchal groupings and the ability of
more senior men to receive better care for their wives. The kinship effects are strong.
Historical Overview

Slavonia is the triangle of land between the Sava and Drava rivers of Croatia, its apex pointing toward Belgrade in Serbia, its base approximately at the Ilova (Fig. 1). It was occupied by the Ottomans from 1526 to 1683, when it was retaken by Habsburg forces but was not completely pacified until about 1700. The Sava became the border between the Habsburg and Ottoman lands; the parishes studied here are in the zone facing Bosnia across the Sava. The Habsburgs imposed a “new feudalism” on the region, granting large tracts to favorites of the Court and enserfing the peasantry -- those peasants in the immediate vicinity of the border in a military capacity; those farther from the border as civil serfs, although the territorial distinction was sometimes fuzzy. In 1745 the institutional distinction between the military Border (Vojna Krajina, Militärgrenze) and civil Croatia (Banska Hrvatska) was formalised. Civil serfs paid money taxes and/or a portion of their production, plus labor service to their landlord; military serfs were obliged to serve as frontier guards and fight in foreign wars, and also to engage in fortress and road construction and maintenance. Civil serfdom was abolished in 1848, but serfs were obliged to amortise the value of the land granted to them over a period of about 20 years, a process that did not begin in earnest until the 1860s and led to great immiseration. Military serfs were freed in 1871, had no amortisation burden, and unlike civil serfs had unrestricted access to the commons. The two zones were united in 1881. Mobilisation of military serfs was frequent, although it is impossible to discover the local impacts of such mobilisation; there were 14 military crises in the study period that affected some, if not all, regiments of the border forces. Roughly a third of able-bodied
male military serfs were on frontier duty at any one time, and another third or more could be called up for foreign wars. Migration into the study area was intense in the early years after the reconquest but slackened thereafter. Natural growth continued, but slowed after about 1780 as peasants began to control fertility to avoid excessive parcellisation. Medicinal and mechanical abortion are attested at least from the 1760s, and the region was notorious in the 19th century for its low fertility.²

Fig. 1 about here

Although there were great estates in the civil zone, commercial agriculture was little developed, partly because transportation of bulky goods was difficult. Only military serfs were permitted to hold land in the Military Border. Agriculture in both zones was non-intensive and devoted largely to subsistence. Stock raising was a major activity, especially of swine, which were a source of money income along with wage work for civil landlords or for road construction and haulage in the military zone. There was virtually no commercial or industrial development until after 1900. Railroads did not reach the study region until 1871, development having been blocked by competing Austrian and Hungarian interests.

Kinship and Household Organisation

While household organisation between the Alps and the Mediterranean, and between the Adriatic and the Carpathians varied widely, the study area has a long tradition of complex
household formation and the predominance of local agnatic (“patrilineal”) groupings. Usually, sons remained in their natal household at marriage, while daughters moved to their husband’s father’s household. This residence pattern could persist for several generations, so that as the older generations died, the household core of adult males consisted of brothers, then cousins. Eventually, such households fissioned, sometimes on the death of the founding couple, sometimes not until several generations later. Even after fission, agnatically related households tended to reside close to one another, forming hamlets or wards of villages. Corporate interests were strongest within the agnatic household itself, with all productive property typically held in common, but some corporate interests and the sharing of resources such as plow oxen, labor exchange at peak seasons, access to pasture, etc., persisted in the broader agnatic group. There was substantial labor differentiation in complex households with males typically specialising in the care of particular stock, smithing, etc., women in particular aspects of household production such as weaving, tailoring, etc. Creche care of children and surrogate nursing were common. Complex households were most frequent in the Military Border, where they were encouraged by the military authorities in the interest of permitting continued subsistence production even when some men were called for military duty. Status in a household was a function of gender and age; usually males dominated females, the elder dominated the younger. In-marrying women were regarded with some suspicion; their status improved as they bore sons. The relationship between an in-marrying woman and her husband’s parents, especially his mother, was characterised by clear dominance of the latter. That between the wives of brothers, i.e. mutually husband’s brother’s wives (HBW) was one of rivalry, often of dislike and suspicion. The folklore (and informants’
explicit statements) often attribute the fission of complex households to disputes between HBWs, each seeking advantage for her own children.  

Data

The data for this analysis consist of ecclesiastical records of 23,307 marriages 1717-1864, 112,181 baptisms 1714-1898, and 94,077 burials 1717-1898 from 7 contiguous Catholic parishes of south central Slavonia. The 7 parishes came into existence at different times, partly by division; all were recording marriages by 1790 at the latest. The detail of priestly recording improved after about 1750, and we restrict analysis to data after that point. We collected marriage data only up to 1857-64, so that the parity of recorded births appears to increase soon thereafter, since no new marriages contributed low parity births. Baptismal data were recorded until almost the end of the century for several of the parishes.

The quality of the data is quite good by comparison with many parish registers. The priests were generally diligent. The data are rich, especially after about 1750, including first and last names of (usually) all persons involved in an event, maiden names of brides, full names of baptismal and marriage sponsors, places of birth, burial, marriage, and often of residence of the principal actors (including the ritual sponsors), parish of record, etc. Marriage records include the name of the father of groom and bride or of the previous husband of a remarrying woman. This richness and redundancy make reconstitution more reliable. We rejected links in which the data did not provide at least 3
of the first and last names of both principal actors, e.g. of parents on a baptismal record or spouses on a marriage record, or both names on a burial record. Reconstitution of these data had been done previously by a combination of computerised nominal data linkage and manual resolution of ambiguous cases. For this analysis we have used completely automated linkage routines (written in the Perl language), because the computer scripts provide an exact record of the resolution of ambiguities.

Methods

The rate of maternal mortality is often used as an indicator of the quality of life and of the relative position of women in society. It has sometimes been estimated for historical populations (Andersson et al. 2000, Cortes-Majo et al. 1990, Henry 1987, Humphries 1991, Imhof 1986, Knodel 1986, Schofield 1986, Wrigley et al. 1987). In historical estimation, one is usually obliged to rely on a temporal definition, since death or burial records for past populations seldom contain reliable clinical diagnoses. Since almost all deaths clinically diagnosed as maternal deaths occur quite soon after parturition, deaths in historical records that so occur are typically evaluated as instances of maternal death. However, since deaths from other causes may also occur soon after parturition, it is necessary to estimate this “background” mortality; the difference is the incidence of net maternal mortality.

We count as gross maternal mortality all deaths to mothers occurring within 60 days of parturition. We estimate background mortality by counting deaths to mothers
from 61 days to 2 years from their date of giving birth. We use background mortality as a covariate in analysis of gross maternal mortality; thus the effects of other covariates can be construed as those on net maternal mortality.

We estimate the model of maternal mortality using a Cox proportional hazards model, allowing for time dependent covariates. Each woman contributes a variable number of 60-day observation periods to the data, depending on the number of children produced. At each such interval, new values for the covariates are computed.\textsuperscript{10}

Mothers are known to us because they appear on the baptismal records of their children. We examine a mother’s experience only in her first marriage. There are three kinds of mothers in our data set.

Some mothers are linked to their marriage record and from that to their own baptismal record.
Some mothers are linked to their marriage record, but not to their own baptismal record.
Some mothers cannot be linked either to a marriage or their own baptismal record but are known only from the baptismal records of their children.\textsuperscript{11}

We attempt to link all three types of mothers to burial records. However, because we have the most detailed information on mothers in the first category, we are more likely to be successful in making those links.\textsuperscript{12}
Overall, there were 94,258 baptismal events (childbirth) occurring to 29,677 mothers. Table 1 breaks this down by the type of mother (above). Forty-four percent of the mothers were linked to their marriage, and they accounted for 60 percent of the baptisms. The number of births per woman where there is no linkage between a child’s baptism and the marriage and/or baptism of its mother is about half that in the other types of linkage. Mothers without such linkages are likely to have migrated into the catchment area after their marriage so that we can capture only part of their childbirth histories. Notice that these mothers cannot be included in an analysis that examines age, parity, lifetime average birth interval, or any other factor that requires information on the entire reproductive history.

Table 1 about here

Because one model we wish to examine includes variables on both agnatic and consanguineal kin, we must take a subset of this population. In order to find consanguineal kin for a mother, we must have her own baptismal record, which allows us to collect her parents and siblings. This necessity restricts our sample to the women in the first category of Table 1. In order to find her husband’s consanguineal kin, we must also have the baptismal record of the father. We are thus obliged to look only at the subset of the population where both the father's and mother's baptismal record is known for a particular birth event. As Table 1 shows, the data for a model including affinal and
consanguineal kinship are reduced to 37,757 birth events occurring to 8,737 women, about a third of the original corpus, about 40 percent of the original corpus.

The kinship variables in our model are based on counts of particular types of kin. Such counts may conflate the effects of kin with local health environments, because networks with large numbers of kin are networks with large numbers of surviving kin. We attempt to control for this difference, which may reflect the local health environment, by including a random effect term in the model that captures the clustered maternal mortality within affinal agnatic networks. For the $j^{\text{th}}$ mother in the $i^{\text{th}}$ cluster, the hazard model is:

$$h(t_{i,j} \mid w_{i}) = w_{i} \lambda_{0}(t_{i,j}) e^{x_{i,j} \beta}$$

where $\lambda_{0}(t_{ij})$ is some unspecified baseline hazard, $x_{ij}$ is a vector of time-varying covariates for the $j^{\text{th}}$ mother in the $i^{\text{th}}$ cluster, and $w_{i}$ is a random frailty effect specific to each affinal agnatic cluster. This frailty effect is assumed to be drawn from a gamma distribution with an expected value of 1 and a variance of $\phi$. This distributional assumption, although more restrictive than a non-parametric approach, is well-established in the literature on frailty effects (Guo and Rodriguez 1992, Powers and Xie 2000, pp.196-199, Sastry 1997a ) and allows for an intuitive interpretation of the $\phi$ term. Under the gamma distribution, $1+\phi$ can be interpreted as the proportional increase in the odds of death in an observation period for every other death occurring in the cluster. The use of a clustered frailty term allows us to both explore the degree to which maternal mortality
clusters in particular agnostic networks and to control for the potential bias of shared health environments on estimates of the contribution of kin of particular types to the risk of maternal mortality.

Covariates

Our covariates are divided into three broad groups: physiological, socio-economic, and kinship. Table 2 shows means and standard deviations for these and other variables.

Table 2 about here

Most studies of maternal mortality focus on physiological variables such as age and parity (Högberg 1985, Loudon 1992, Schofield 1986, Wrigley et al. 1997, Yerushalmy 1940a, 1940b, 1945, inter alios). From the literature we expect that first births will have the highest risk, but that risk will again increase from the second to higher order births. At each parity, we expect risk to increase with age. Multiple births are more dangerous. Because unusually long birth intervals may indicate prior reproductive difficulties or unrecorded stillbirths, we expect long intervals to be positively correlated with mortality at the next birth. Conversely, a history of short intervals should increase maternal depletion and should be associated with higher mortality. Background mortality should be positively correlated with (gross) maternal mortality.
In the models, we include age as a continuous variable. We include parity as a set of categorical variables: parity one, parity two through four (the omitted category), parity five through seven, and higher parity. We include a dummy for multiple birthings. We include both a measure of the birth interval since the last birth (or marriage in the case of first births) and the average birth interval over the woman’s reproductive career. Background mortality is the crude mortality rate for the entire sample in the 61 day to two-year window after a birth for the year in which the reference birth took place.

The economic and social variables involve military vs. civil status, using parish dummies, with the civil parish omitted. They include whether a birth occurred within a year following a mobilisation ("crisis"), and the calendar year of the birth (as a difference from 1815). Several of these factors involve the withdrawal of male labor from subsistence farming, so that women endured a heavier burden of agricultural work and had less time to nurture parturients. The regular withdrawal of as much as a third of the male labor force among military serfs for frontier duty would have imposed a burden on women, as would the heavy labor obligations for fortress and road construction. Major mobilisations in excess of those requirements would have intensified such withdrawal; there were 14 such crises in the study period. In the civil zone, and in the military zone in the last part of the 19th century, land shortage, immiseration, and increasing dependence on wage labor would have pulled men away from family farming, leaving more tasks for women.13
With respect to kinship variables we first caution that the kinship relationships we can deduce from the reconstitution are not necessarily congruent with household boundaries. For example, we estimate the influence of the number of husband's brothers' wives on a parturient's survival. Some but not necessarily all of these individuals were most likely coresident with her. If not, they were almost surely on the same farmyard or in the same street, ward, or hamlet. On the other hand, where we estimate the influence of a woman's own consanguineal kin, we can usually be sure that none of them were in the same household, and fewer of them would be close by, although they must have been in the same set of 7 parishes, most likely in the same parish, else we would have no knowledge of them.\textsuperscript{14}

We operationalise kinship relationships by including counts of living mother’s same generation kin over age 15, of two types: affinal and consanguineal.\textsuperscript{15} Given the household arrangements in this area discussed earlier, we expect the affinal kin count to have a stronger relationship to maternal mortality, as it more directly reflects the economies of scale operating in the household or network of the parturient’s residence. We nevertheless expect that women with large consanguineal networks may have had some assistance and protection from them. However, since we also know that HBW’s were not always a resource but also in a competitive position, we include a count of HBW separately in the models. This allows HBW’s to contribute both to the overall affinal network and separately as a distinct entity. We predict that these contributions will run in opposite directions.
Additionally, because a woman's position in her husband's agnatic network would be a function of his age rank among his brothers, we expect that the more junior a woman was, the higher was her risk. Wives married to senior brothers were often in an advantageous situation.\textsuperscript{16} To capture this potential dynamic, we include a relative rank measure. Senior wives are coded as one and the most junior wife is coded as a zero. Intermediate wives were scored at equidistant values between the most senior and most junior wife.\textsuperscript{17} This measure preserves the relationship between the most senior and most junior wives regardless of network size. Furthermore, it assumes that intermediate wives of the same absolute rank will have a more senior relative rank in larger households. We find this to be intuitively appealing. This measure is problematic for women who have no HBW’s. For these women, we impute a value of one, treating them like senior wives but also assign them a dummy variable. Due to the dummy variable, the imputation has no effect on the estimate of the relative rank coefficient. The coefficient on the dummy variable also indicates how incorrect our imputation might be. If this number is negative, women without HBWs do better than senior wives. If it is positive, then they do worse.

Because many of these variables are intercorrelated and some may reflect unobserved conditions, we try to control for such factors as much as the data permit. For example, after the first birth to a woman in the network, first births tend to be to successively junior in-marrying women; thus juniority and parity are related. Similarly, the risk of death in childbirth may be related to the mortality and morbidity in the network, perhaps because the disease environment carried particular risk, or the network
had particular access to midwives, and so on. As noted, some control over these factors is provided by the parish dummies and some by the clustered frailty measure.

Results

Table 3 summarises the results of the Cox regressions. We provide p-values for all parameter estimates, even though our data are not drawn from a random sample. There is inherent noise generated in any life history reconstitution, in addition to the natural variability involved in life course processes. By including p-values we hope to provide some measure that our parameters are not capturing this noise.18 While we have confidence in the integrity of the data, we realise that a particular reconstitution, no matter how consistent it appears nor how carefully constructed, is in some sense a sample from a universe of possible reconstitutions from the same underlying data. We do know from examination of the reconstituted data that marriages recorded tended to be parish endogamous, ritual sponsors tended to be selected from nearby, and most children of a family were baptised in the same parish. These factors make good linkage more likely.19 There was, however, significant migration into the study area, but mostly before 1750, and some migration out of it, although the historical sources are not very informative on this. There is some suggestion that families with high fertility, facing land shortages for their heirs, relocated. The fact that mean parity in our data increases in the last part of the data, because marriage records were not recovered up to 1900, may impart some bias to estimation of change over time, but the effect of that would be the opposite of the observed increase in maternal mortality over time, since primiparous births are the most
dangerous. These and similar considerations lead us to be cautious in our conclusions. Nevertheless, the results seem strong.

Table 3 about here

For comparative purposes, we begin with a model which includes only physiological and socioeconomic factors. This model uses a larger subset of the data (groups 1 and 2 from Table 1) and thus provides better estimates of these variables.

The physiological variables act very much as we would expect from the literature, and the results are strong for parity 1, age, multiple birthing, previous birth interval (PBI) and lifetime mean birth interval (MBI). A long PBI suggests prior reproductive difficulty; a long MBI suggests lower levels of maternal depletion. Even though PBI and MBI are problematic (and identical) at parity 1 we note that that interval, if long, can certainly suggest unrecorded stillbirths, abortions, inability to conceive, or other health problems. We are surprised that risk does not increase at parities over 4, as one would expect from the literature. It is possible that strong selection effects are at work, such that women with a history of childbirth difficulties took steps to limit births sooner than those who gave birth easily. Given the crudity of technique, such steps might easily result in infertility.

Parish identity is fairly consistent, the military parishes generally having higher mortality than the civil parish. We attribute this difference to the greater withdrawal of male labor from family farming in the military zone, both for regular frontier duty and for
military construction and maintenance. The effect of military crises in the Border is uniformly positive as well, strengthening our view of the importance of male labor to female survival. We take note, however, that if the 14 crises are used individually in analysis, not all have a significant effect (not shown). However, all have a positive sign. One could surmise that the effect of such crises was to increase maternal mortality by the transmission of disease from returning soldiers to their wives, not because their labor had been withdrawn. However, in major campaigns, which took place in Italy, Prussia, and other distant locations, the return of soldiers was delayed (they had to walk back). The effect we see in the regressions is that of mortality risk within a year of a crisis. Further, disease transmission would affect background mortality beyond the 60-day window, and the regressions control for that.  

In the same vein we note the increase in maternal mortality over historical time. We attribute this to the known increase in wage labor among military (and former military) serfs as foreign interests began to exploit forest resources and to the increasing dependence of civil serfs on wage labor. Indeed, land shortage for both classes of serfs, and the obligation to amortise emancipation grants for civil serfs, led both to enter wage labor increasingly at the expense of subsistence farming.

The second model in Table 2 includes the kinship factors, and thus the sample size is reduced significantly. The effects of the physiological and socioeconomic variables are consistent, although their statistical strength is not as strong, owing to the reduction in sample size.
The larger is a woman's affinal network, the lower is her risk of death. We attribute this to the substantial economies of scale achieved in joint households and in their embedding networks. We know from the scattered library status animarum for Cernik that many households were quite large, with membership in the 30s (including children), while small nuclear households were rare. Within large households, labor was finely divided, as earlier indicated. Even if a household were not large, it would have some economies if its embedding network were large. We know that oxen were probably shared within agnatic groups but not beyond them (Hammel and Kohler 1997, Kohler and Hammel 2001). Labor exchange was a common tactic in peak seasons or for tasks in which extra labor might be required, such as raising a roof, or the plowing of boggy fields with a heavy wheeled plow. Of course we cannot overlook the fact that large networks might have been more prosperous, even if only because their numerical strength gave them political advantage in the community. But such prosperity need not result in lower mortality unless it affected basic housing and nutrition.

Similarly, the size of a woman's own consanguineal network has a negative, although small and statistically insignificant, effect. We expected that women with a strong network would enjoy political support and pressure for nurturance. But households and networks were autarkic. Agnatic networks were exogamous, and women often came from a different village even if the same parish. The lineage system was strong, and women tended over their lifetime to be socially incorporated into their husband's lineage (even if not as consanguineal members). These factors may weaken the anticipated effect of support from consanguines.
The number of HBW in a woman’s network is positively related to her risk of death, controlled for the size of the adult affinal network. This means that the greater is the proportion that HBWs comprise of those adults, the higher is the woman’s risk. To what should we attribute this nefarious influence of HBWs? The relationship between women who are the wives of brothers is, in folklore and ethnographic observation, strained. But it would be a harsh judgment to suggest that HBWs did their sisters in law in. We must recognise that in the developmental cycle of fraternal joint families, all actors realise that some day the unit (whether it be a household or a lineage) will fission. Over the cycle, and over the life cycle of actors, that anticipation leads to a pursuit of self-interest. The wives, who are viewed as the nuclei of dissent and division, will begin to reserve some resources for themselves. In particular, they will direct their own labor increasingly to the interests of their own maturing conjugal families, leaving less to contribute to the nurturance of those outside it.22

The relative rank of a woman's husband among his brothers is an important influence. The strong negative value indicates that more senior wives had lower hazards of maternal mortality. We interpret it as an element in the gender/age politics of households and networks. Age dominance was an important feature of kinship relations (see especially Erlich 1940, 1964). By itself, the effect of age rank would be ambiguous. The age gap between spouses was not large or greatly variant, and the age of the parturient is taken into account in the regressions already. What is at issue is the relative rank, thus the dominance position of the husband. To be sure, the more junior a woman
was, the more likely it would be that the birth of interest was at parity 1, and thus more
dangerous, but parity is controlled in the regressions. Our interpretation is that the less
dominant a man was in his fraternal set, the less care he could expect by deference or
demand for his wife. Similarly, the more junior he was, the more likely it would be that
he would be called up for military duty, since younger men were called first, thus leaving
his wife at least some of his chores and on her own to negotiate her nurturance.

Women who had no HBWs in their affinal network possibly had lower risk than
women who were senior to other HBWs and certainly did not do worse, as evidenced by
the negative (although statistically insignificant) value of the “No HBW” variable. Based
on the values of the kinship variables employed here, we might hazard a guess as to the
network a women would prefer to live in or how her survivability would unfold over the
life course. Affinal kin were a benefit so long as they were not HBWs. Therefore, a lucky
woman would have the best chances in a large affinal network, which was made up of
unmarried husband’s brothers and unmarried husband’s sisters. As these husband’s
sisters started marrying out and husband’s brothers wives began marrying in, a woman’s
hazard would increase, independent of her own age and parity. However, if such a
situation were destined to be, a woman was in a far better position if she were the senior
member of these in-marrying wives.23 Fig. 2 shows these effects graphically, using the
risk factors from the proportional hazard model. It contrasts a hypothetical “single
woman” who marries into a household where her husband has two celibate brothers and
two sisters who marry out, the first after the woman’s first birthing, the second after her
second. Her risk increases with each loss of labor in the household. Her curve of risk is
paralleled by that of another “single woman”, whose husband has no brothers but two sisters. Her risk is higher because of the absence of the labor of two brothers. A third woman, the first to marry into a household with two husband’s brothers and two husband’s sisters, and thus the senior wife, shows a more complex development of risk. She loses a husband’s sister after her first birthing and again after her second, but she gains a husband’s brother’s wife at the same points. Her risk goes up more steeply than that of the other women, above, because the replacement of the labor of a husband’s sister by the labor of a competing husband’s brother’s wife increases her relative risk. Even more extreme is the risk profile of a junior wife, the last to marry into a household in which the sisters have married out and two other competing wives are already present. Her risk is high and stays high.

Fig. 2 about here

Some control over background conditions of morbidity and mortality is achieved by using background mortality for deaths to parturients in a two-year window. Parish identity also serves as a control over local health conditions. There was also strong clustering of maternal mortality within affinal networks as evidenced by the size of the random effect variance. This clustering reflects unobserved shared environmental conditions. While, many of these conditions may have been particular to households or networks, it is likely that they were common to villages and other, larger geographical groupings. Therefore, the affinal clustering probably overestimates the extent of clustering that is due to household or network level factors (Sastry 1997b). Be that as it
may, the value of this variable indicates that a woman’s baseline risk is increased by about 38 percent for every maternal death in her affinal network.

Conclusions

In this paper we have extended and refined earlier work on factors influencing maternal mortality among serfs and then emancipated serfs in civil and military regions of Slavonia 1750-1898. Our conclusions regarding physiological factors give us confidence in the quality of the data, since they are generally in accord with results in the literature. First and multiple births are more dangerous. Risk increases with age. Long preceding birth intervals probably signal obstetrical problems and increase risk. Short lifetime average birth intervals, leading to maternal depletion, increase risk. Higher levels of background mortality are associated with higher maternal mortality. Contrary to expectation, parities higher than four do not carry increased risk but may signal unobserved heterogeneity in steps taken to limit childbearing by women for whom childbirth was difficult. Macrolevel socioeconomic influences are plausibly attributable to secularly increasing and episodic withdrawals of male labor from family farming. Military parishes, more subject to such withdrawals even on a regular basis, had higher levels of maternal mortality.

Our particular intent in this paper was to examine the role of kinship structure and kinship relations on maternal survival. In the context of a strong patrilineal system and a tradition of agnatic corporacy and joint household organisation, we find strong and
consistent effects. Women married into a large agnatic network enjoyed economies of scale and had lower risk. However, the number of other wives in the network in their generation was a counter-influence and raised their risk, in consequence of the diverging self-interest and rivalry of the wives of brothers. Women coming from a large agnatic network had lower risk as well, probably enjoying political support and even intervention in their behalf, but the effect is weak. We attribute that weakness to the autarky of networks, distance between the network of origin and of marriage, and the gradual incorporation of wives into their affinal networks over the life cycle. The more junior was a woman’s husband in his own fraternal set, the higher was his wife’s risk. Wives in an agnatic network in which maternal death risk was high for the other wives, also had higher risk. This clustered frailty factor, with background mortality and parish identification, give us some control over the local health environment.

We conclude from estimation of these kinship factors that the cyclical dynamic of the household and lineage, with its changing producer:consumer ratio, the diverging self-interest of the fissionable parts of social units, with age dominance an important factor in personal relations, had strong effects on the life chances of women. The study of maternal survival is sharpened and enhanced by taking account of micropolitical factors even within a rapidly changing macrolevel environment. Indeed, demographic estimation of maternal survival in modern LDCs, in which strong agnatic structures and complex households often exist, would be furthered by the incorporation of ethnographic and historical knowledge.
Tables and Figures

Table 1. Baptismal events and mothers by type of link

Table 2. Descriptive statistics for sub-sample of births after 1750

Table 3. Cox proportional hazard analysis of the risk of dying within a 60-day observation period after giving birth

Fig. 1. Map: Croatia, Slavonia, and the Military Border

Fig. 2: Relative risk for a hypothetical group of women
Table 1. Baptismal Events and Mothers by Type of Link

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<th>Linkage</th>
<th>Mothers</th>
<th>Baptisms</th>
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<tbody>
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<td>Mothers linked to their own baptism and marriage</td>
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<td>37,757</td>
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<tr>
<td>(29%)</td>
<td></td>
<td>(40%)</td>
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<td>Fathers linked to their own baptism*</td>
<td>6,261</td>
<td>27,846</td>
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<td>(21%)</td>
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<td>(30%)</td>
</tr>
<tr>
<td>Fathers not linked to their own baptism*</td>
<td>2,476</td>
<td>9,911</td>
</tr>
<tr>
<td>(8%)</td>
<td></td>
<td>(11%)</td>
</tr>
<tr>
<td>Mothers linked to their marriage only</td>
<td>4,465</td>
<td>18,789</td>
</tr>
<tr>
<td>(15%)</td>
<td></td>
<td>(20%)</td>
</tr>
<tr>
<td>Subtotal, mothers linked to their marriage</td>
<td>13,202</td>
<td>56,546</td>
</tr>
<tr>
<td>(44%)</td>
<td></td>
<td>(60%)</td>
</tr>
<tr>
<td>Mothers known only from baptismal records of their</td>
<td>16,475</td>
<td>37,712</td>
</tr>
<tr>
<td>children</td>
<td>(56%)</td>
<td>(40%)</td>
</tr>
<tr>
<td>All</td>
<td>29,677</td>
<td>94,258</td>
</tr>
</tbody>
</table>

*This is a subset of the first category*
Table 2. Descriptive statistics for sub-sample of births after 1750

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mothers linked to a birth and/or marriage</th>
<th>Mean</th>
<th>SD</th>
<th>Mothers linked only to a real affinal network</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woman died in period</td>
<td></td>
<td>0.007</td>
<td>0.086</td>
<td></td>
<td>0.008</td>
<td>0.089</td>
</tr>
<tr>
<td><strong>Physiological variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>30.685</td>
<td>7.306</td>
<td></td>
<td>29.779</td>
<td>6.885</td>
</tr>
<tr>
<td>Parity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parity 1</td>
<td></td>
<td>0.229</td>
<td>0.420</td>
<td></td>
<td>0.225</td>
<td>0.417</td>
</tr>
<tr>
<td>Parity 2-4</td>
<td></td>
<td>0.478</td>
<td>0.500</td>
<td></td>
<td>0.480</td>
<td>0.500</td>
</tr>
<tr>
<td>Parity 5-7</td>
<td></td>
<td>0.223</td>
<td>0.417</td>
<td></td>
<td>0.226</td>
<td>0.419</td>
</tr>
<tr>
<td>Parity 8+</td>
<td></td>
<td>0.070</td>
<td>0.255</td>
<td></td>
<td>0.069</td>
<td>0.253</td>
</tr>
<tr>
<td>Previous birth interval</td>
<td></td>
<td>2.593</td>
<td>1.773</td>
<td></td>
<td>2.554</td>
<td>1.681</td>
</tr>
<tr>
<td>Lifetime mean birth interval</td>
<td></td>
<td>2.561</td>
<td>1.082</td>
<td></td>
<td>2.531</td>
<td>0.964</td>
</tr>
<tr>
<td>Multiple birth</td>
<td></td>
<td>0.026</td>
<td>0.159</td>
<td></td>
<td>0.026</td>
<td>0.160</td>
</tr>
<tr>
<td>Background mortality rate</td>
<td></td>
<td>.0124</td>
<td>.0065</td>
<td></td>
<td>.01284</td>
<td>.0061</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td><strong>Macrolevel variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parish</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parish B</td>
<td></td>
<td>0.040</td>
<td>0.195</td>
<td></td>
<td>0.044</td>
<td>0.205</td>
</tr>
<tr>
<td>Parish C (civil parish)</td>
<td></td>
<td>0.288</td>
<td>0.453</td>
<td></td>
<td>0.284</td>
<td>0.451</td>
</tr>
<tr>
<td>Parish G</td>
<td></td>
<td>0.231</td>
<td>0.421</td>
<td></td>
<td>0.171</td>
<td>0.376</td>
</tr>
<tr>
<td>Parish O</td>
<td></td>
<td>0.112</td>
<td>0.315</td>
<td></td>
<td>0.106</td>
<td>0.307</td>
</tr>
<tr>
<td>Parish P</td>
<td></td>
<td>0.175</td>
<td>0.380</td>
<td></td>
<td>0.185</td>
<td>0.388</td>
</tr>
<tr>
<td>Parish S</td>
<td></td>
<td>0.058</td>
<td>0.234</td>
<td></td>
<td>0.078</td>
<td>0.267</td>
</tr>
<tr>
<td>Parish V</td>
<td></td>
<td>0.096</td>
<td>0.295</td>
<td></td>
<td>0.133</td>
<td>0.340</td>
</tr>
<tr>
<td>Year</td>
<td></td>
<td>1816.671</td>
<td>29.85</td>
<td></td>
<td>1827.1</td>
<td>24.11</td>
</tr>
<tr>
<td>Crisis period</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.316</td>
<td>0.465</td>
<td></td>
<td>0.334</td>
<td>0.472</td>
</tr>
<tr>
<td><strong>Kinship variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Husband’s brothers’ wives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.400</td>
<td>0.668</td>
</tr>
<tr>
<td>All same generation affinal kin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.384</td>
<td>1.557</td>
</tr>
<tr>
<td>All same generation consanguineal kin</td>
<td></td>
<td>1.963</td>
<td>1.901</td>
<td></td>
<td>2.014</td>
<td>1.899</td>
</tr>
<tr>
<td>Husband’s absolute rank among brothers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.760</td>
<td>0.389</td>
</tr>
<tr>
<td>No husband’s brothers’ wives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.688</td>
<td>0.463</td>
</tr>
<tr>
<td>Number of mothers</td>
<td></td>
<td>13,202</td>
<td>6,261</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of births</td>
<td></td>
<td>56,546</td>
<td>27,846</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Cox Proportional Hazard Analysis of the risk of dying within a 60-day observation period after giving birth

<table>
<thead>
<tr>
<th>Covariates</th>
<th>Without kinship</th>
<th>With kinship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.012 (.009)†</td>
<td>0.017 (.013)†</td>
</tr>
<tr>
<td>Parity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parity 1</td>
<td>0.592 (.129)***</td>
<td>0.651 (.189)***</td>
</tr>
<tr>
<td>Parity 2-4 (reference)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Parity 5-7</td>
<td>-0.079 (.144)</td>
<td>-0.107 (.198)</td>
</tr>
<tr>
<td>Parity&gt;7</td>
<td>-0.064 (.223)</td>
<td>-0.115 (.301)</td>
</tr>
<tr>
<td>Previous birth interval</td>
<td>0.223 (.031)***</td>
<td>0.232 (.046)***</td>
</tr>
<tr>
<td>Lifetime mean birth interval</td>
<td>-0.624 (.081)***</td>
<td>-0.834 (.121)***</td>
</tr>
<tr>
<td>Multiplicity of birthing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single birth (reference)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Multiple birth</td>
<td>0.712 (.202)***</td>
<td>0.531 (.293)*</td>
</tr>
<tr>
<td>Background mortality</td>
<td>0.018 (.008)**</td>
<td>0.019 (.011)*</td>
</tr>
<tr>
<td>Parish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parish B</td>
<td>0.712 (.210)**</td>
<td>0.562 (.313)*</td>
</tr>
<tr>
<td>Parish C (civil parish, reference)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Parish G</td>
<td>-0.020 (.153)</td>
<td>0.099 (.226)</td>
</tr>
<tr>
<td>Parish O</td>
<td>0.330 (.173)*</td>
<td>0.327 (.250)†</td>
</tr>
<tr>
<td>Parish P</td>
<td>0.296 (.149)*</td>
<td>0.321 (.207)†</td>
</tr>
<tr>
<td>Parish S</td>
<td>0.244 (.212)</td>
<td>0.336 (.267)</td>
</tr>
<tr>
<td>Parish V</td>
<td>0.141 (.185)</td>
<td>-0.035 (.255)</td>
</tr>
<tr>
<td>Year of baptism (origin=1815)</td>
<td>0.004 (.002)***</td>
<td>0.003 (.004)</td>
</tr>
<tr>
<td>Year of baptism*Parity 1</td>
<td>0.009 (.004)*</td>
<td>0.005 (.007)</td>
</tr>
<tr>
<td>Crisis period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No crisis (reference)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Military crisis</td>
<td>0.312 (.105)**</td>
<td>0.289 (.149)*</td>
</tr>
<tr>
<td>Number of adult affines</td>
<td>-0.230 (.083)***</td>
<td></td>
</tr>
<tr>
<td>Number of adult consanguines</td>
<td>-0.032 (.038)</td>
<td></td>
</tr>
<tr>
<td>Number of husband’s brothers’ wives</td>
<td>0.472 (.236)*</td>
<td></td>
</tr>
<tr>
<td>Husband’s relative age rank</td>
<td>-0.409 (.249)*</td>
<td></td>
</tr>
<tr>
<td>No husband’s brothers’ wives</td>
<td>-0.046 (.337)</td>
<td></td>
</tr>
<tr>
<td>Clustered Frailty (φ)</td>
<td>0.387</td>
<td></td>
</tr>
<tr>
<td>Number of births</td>
<td>56,546</td>
<td>27,846</td>
</tr>
<tr>
<td>Number of mothers</td>
<td>13,202</td>
<td>6261</td>
</tr>
<tr>
<td>Number of maternal deaths</td>
<td>417</td>
<td>222</td>
</tr>
</tbody>
</table>

Cols. 2 and 3 show the coefficient, standard error, and p value.  
*** p < .001, ** p < .01, * p < .05, † p < .10
Fig. 2

**Relative risk for a hypothetical group of women**

- Senior Woman, 2hb, 2 hz
- Junior Woman, 2hb, 0hz
- Single Woman, 0 hb, 2hz
- Single Woman, 2 hb, 2 hz

hb = husband's brother
hz = husband's sister

plot showing the relationship between parity and relative risk.
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Sciences 237: 143-142.

Notes

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2 Most of the population in the study region was Catholic, and the contemporary commentary on birth control relates to that population. Ecclesiastical data on the Orthodox population were not of a quality that permitted reconstitution nor were they as available in the Archive of Croatia or at field sites. Some census data by regimental areas are available for the Military Border 1830-47, or for broader areas in 1871, 1900. Fertility decline in the Orthodox population may have lagged behind that in the Catholic population. Fertility decline did lag in areas to the west where the Orthodox population predominated (the region that came to be called the Krajina in the 1990s). Fertility decline seems to be strongest and earliest in a band running eastward from the study area into Hungarian Transdanubia. Useful references are Andorka and Balazs-Kovačs 1986, Hammel 1985, 1993, 1995, Hammel and Galloway 2000a, 2000b, Hammel and

3 The ethnographic and historical literature on household and kinship in Croatia and elsewhere in the Balkans is large and contentious. Two fundamental errors have been made by many analysts. The first is the assumption that complex households were universal across space. The second is that they were universal over the lifespan of persons or families. Spatial heterogeneity was substantial. Individual households grew and fissioned over the developmental cycle. Even where such households were apparently ideal, as much as half of all households at any point in time were nuclear. Useful references (including both Croatia and Serbia) are Čapo-Žmegač 1996, Erlich 1940, 1964, Halpern 1958, Halpern and Anderson 1970, Hammel 1968, 1972, 1980, 1990, Hammel and Kohler 1997, Hammel and Wachter 1996a, 1996b, Kohler and Hammel 2001, Todorova 1993.

4 Parishes are Bogićeveci, Cernik, Nova Gradiška, Orioviac, Staro Petrovo Selo, Štivica, Vrbje. They straddle the main road between Zagreb and Belgrade, about 130 kms. from the former and 240 kms. from the latter. They encompass the Croatian territory along the Sava that faces Bosnia between the Una and Vrbas rivers. Cernik, Staro Petrovo Selo, and Oriovac are at the edge of the hills, Štivica and Vrbje closest to the Sava, the rest in between. Cernik is the oldest parish, founded in the 13th C. Nova Gradiška is today the largest settlement, and there is no break in the sidewalk between the two towns, which were once 3 kms. apart.

5 The earliest surviving records are from 1714. See Hammel and Gullickson 2000 for details. This paper will be posted until its publication at www.demog.berkeley.edu/~gene/matmort/Arild.

6 See www.demog.berkeley.edu/~gene/matmort/Recon for details on the quality of recording.

7 Since parity and parish are both controlled in the analysis we do not regard these compositional shifts as producing bias.

8 Fragmentary evidence from libri status animarum and the Chronicle of the Monastery of Cernik indicates that baptisms were typically performed at birth by the midwife, thus diminishing the number of births followed by neonatal death that might otherwise go unreported. Information for baptismal recording was probably reported to the priest by the midwife, raising the possibility that data for people poorly known in
the local community, such as transients, might be erroneously reported. However, as discussed elsewhere in
the text, such persons are not likely to form part of this analysis.

9 The original programs in Fortran were written by Ruth Deuel and hand checked by Hammel and Jasna
Čapo. Subsequent elaboration was by Marcia Feitel. Hammel wrote the original Perl scripts, and these were
much improved by Gullickson. The Perl code and both the original and linked data files are available at
www.demog.berkeley.edu/~gene/matmort/Recon. It is worth noting that the automated procedures nicely
captured the intuitions underlying the original resolution of ambiguities; the results are extremely close.
However, since we have not yet automated linkage of successive marriages, we do not include higher order
marriages in this analysis.

10 This is the general approach for including time-varying covariates and does not deflate standard errors
despite including multiple exposure periods for each woman (Petersen 1995).

11 It is possible to also link mothers directly from the baptisms of their children to their own baptismal
records, without going though marriages, but we have not undertaken such a linkage at this point.

12 This selective factor may impart some bias to the analysis, since individuals who can be linked in this
way were probably longer resident, came from families longer resident, and were better known to midwives
and priests. Our conclusions must be interpreted with this potential bias in mind.

13 The military parishes were at a slightly lower elevation than the civil parish and closer to the Sava river.
Rates of malaria may have been higher in those locations; there is one mention in the chronicle of the
monastery of Cernik of a complaint by villagers who had been moved to a lower elevation. We have no
other specific information on malaria, except that it was endemic throughout the lowlands of the Sava and
Danube. Similarly, contamination of well water may have been more frequent at lower elevations where the
water table was high, but again we have no specific information. Nevertheless, the parish dummies give us
some control for these factors in the analysis.

14 In the rare instances in which a household contained no sons, the eldest daughter might remain on
marriage, with an in-marrying husband. Such women would not have other wives coresident, since the
other daughters would marry out. Their own parents and their unmarried sisters would be coresident.

15 We count a mother’s sisters only until they are married out of their natal group and mother’s brother’s
wives only once they are married into the parturient’s network of residence. We count only persons living
and over age 15 at the time of the reference birth. We count parents and siblings but not more distant kin. Thus we may undercount surviving grandparents, uncles and their wives, consanguineal aunts, and cousins. While some households in the surviving libri status animarum contain father’s brothers and their sons and those sons’ wives, they are rare. Thus our kin counts are only of the core of the agnatic network, the part most likely to be congruent with the household or a superset of it.

16 Age effects are complex. General ethnographic data indicate the advantages of seniority, both to a woman directly in the kind and amount of labor she was expected to perform, and to her husband, in the degree of influence he had in the household and the degree to which he would be exempted from military duty or other corvée. However, there are some counter-influences. As women aged, they not only gained position but also had more surviving children and were under more pressure to limit births by risky abortion techniques.

17 In mechanical terms, if A is the absolute rank where 1 is the most senior rank and there are W women in the network, then the relative rank is R=(W-A)/(W-1).

18 Note that all of our expectations are directional, so that if p-values are to be interpreted, it is the one-tailed values that should be employed. Thus if “five percent” is thought to be critical, it is p<0.10 that is the boundary.

19 Note, however, that these attributes could be the result of reconstitution and not the factors that make reconstitution reliable.

20 In a previous analysis (Hammel and Gullickson 2000) we also analysed the effects of these macrolevel factors on background mortality. The crisis variable had no significant effect on background mortality, reinforcing our view that the impact on maternal mortality was not related to disease transmission. It was the absence of men that affected maternal mortality, not their presence.

21 We also experimented with separate regressions on subsets of the data, e.g. only at parity 1 versus parities over 1, women who had never had a HBW, etc. The results did not differ importantly from those reported here.

22 For example, women assisted daughters in the preparation of their dowry and hoarded gold jewelry, which might be part of the dowry and which was handed down from mother to daughter, despite the
prevailing patrilineality of the descent system and the fact that females did not ordinarily inherit land, stock, or other communal property.

23 We considered the possibility that the effect of having a certain number of HBW’s might vary by the relative rank of the woman being considered. We modeled this using interaction terms. The effect is in the expected direction of HBW’s being less negative for senior wives, but the results were statistically dubious and thus not included here.