THE EFFECTS OF SCHOOL QUALITY ON FERTILITY IN A TRANSITION ECONOMY

Vasilaky, Kathryn

University of Maryland - College Park

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Author:
Kathryn Vasilaky

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Abstract

This paper investigates the effects of school quality on fertility in a transition country. It aims to explain the slowing fertility and shrinking rural sector of a post Soviet country, Ukraine, through the decline in the quality of public services, in particular, school quality. It builds on earlier work of Rosenzweig (1982), which tests for the effects of a change in the price of child quality, measured here by school quality. Estimates from a generalized Poisson model of fertility show that school quality has a positive and significant effect on household fertility. Specifically, a 10 % increase in teacher quality is associated with a 3+% rise in fertility. This positive relationship between education and fertility distinguishes itself from the negative relationship that is commonly observed between these two factors. It also suggests that Ukraine should reconsider its population policies that are aimed at increasing fertility, from short term income transfers for rural families to long term investments into the quality and equality of their education system.

Key words: quantity-quality, fertility, transition

JEL classification:

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1. Introduction

Within the past century, fertility decline has become and will continue to be a pressing theme within economic development. As countries develop, particularly for those classified as developing countries, fertility decline is viewed in a positive light and seems to move in tandem with economic growth. In transition countries, fertility decline has not signaled such a positive transition. Its economic consequences: a falling labor supply and reduction in human capital, can threaten a country's long run growth. In this paper, the fertility crisis of a representative transition country, Ukraine, is examined, whose population, at current growth rates, will have gone from 52 million in 1991 to 36 million in 2041 (US Census).

Our point of focus is on rural areas in Ukraine. Sustained economic development, particularly in agricultural and industrial economies like Ukraine's, begins with increased human capital and technological advances in the rural economy (Huffman and Orazem, 2007). Greater productivity in rural areas results in an outflow of skilled labor to urban areas, which promotes further economic growth in services and trade. In contrast, as Ukraine aspires to integrate with western economies in its post Soviet era, its slowing fertility, and crumbling rural infrastructure may thwart its efforts along such a development path.

While much of Eastern Europe shares the experience of a transition from a planned economy to a market economy, the success of this transition has varied across countries (Kohler et al., 2002). In many instances, population decline is a result of greater economic prosperity (Stark and Kohler, 2002) and signals the entrance into a second demographic transition. In Ukraine, a decline in real wages, job uncertainty, increasingly unequal returns to education between urban and rural areas [2], and the end of high quality public services in education and health care are among the many realities of the post Soviet transition. Indeed, as Adadjanian and Makarova (2003) points out, "market reforms brought about social disintegration, widespread poverty, and inequality rather than quick prosperity." The latter was the social and institutional backdrop during much of Ukraine's fertility decline from which emerged an aging population and shrinking labor force (Rivkin-Fish, 2003). In general, transition countries with a rapidly declining population are weary of their ability to support pension and social security systems, and fear that long-term innovation and economic growth will be stifled. (Stark and Kohler, 2002; Maksymenko, 2008; Rozhen, 2005; Meyers et al.; Bezrukov and Verzhikovskaya, 1994; Volobuyev, 2008).

This paper focuses on linking the impact of deteriorating school quality on fertility occurring in post Soviet rural Ukraine. We choose to focus on education from among the several deteriorating

[2] Figures 3-5 shows our estimations to the returns to education for all of Ukraine, and rural and urban areas separately. The overall country estimates closely match (Gorodnichenko and Sabirianova-Peter, 2005; **?**)

factors concomitant with Ukraine's fertility decline in the last decade, because of its fundamental role in building a country's human capital (Osipian, 2008), which demographers, researchers and policy makers fear is dwindling as a result of depopulation (Bezrukov and Verzhikovskaya, 1994; Rozhen, 2005). Improvements to school quality may serve as a stimulus for families to invest in a greater number of high-quality children than Ukraine's current policies, which provide income transfers to large rural families. If households tradeoff quantity for quality of their children, as in Becker and Lewis (1973), then an exogenous variation in the quality of a child's education, a primary input into the quality of a child, should have a significant impact on the quantity of children that a household chooses. This is particularly true in a country like Ukraine. Educational attainment remains high (figure 6) at the secondary school level, but school quality has undergone considerable dispersion between urban and rural areas since the fall of the Soviet Union and the reduction of state spending on public services (Bekh et al., 2007).

The results confirm that school quality is a factor with significant influence on fertility. Using household level data from the Ukrainian Longitudinal Monitoring Survey in 2003, and the Ukrainian School Survey of 2005, the estimates reveal that a 10% increase in teacher quality increases fertility by 3+% in rural areas. These results remain robust even after controlling for other possible trends that may account for school quality's significant effect on fertility.

This finding runs counter to the commonly observed negative relationship between education and fertility. The view that schooling and fertility are substitutes follows from Becker and Lewis (1973), whose research shows that if a household trades off quantity for quality in their children then the shadow prices of each variable are a function of the other respective variable. Consequently, a rise in household income will result in an initial decline in fertility, assuming greater income elasticity of quality vs. quantity of children, followed by an additional drop in fertility due to the rising shadow price of quantity as quality increases. Rising incomes coupled with a household's quantity-quality tradeoff, results in the household's substitution away from quantity of children into quality of children. Empirical confirmation of this theory is mixed. Hanushek and Wössmann (2007), Rosenzweig and Wolpin (1980), and Todd and Wolpin (1973) find a negative correlation between children's education attainment and family size, while Angrist et al. (2006) find no evidence of a quantity-quality tradeoff.

The latter pattern of development, of rising incomes and declining fertility, in addition to declining adult mortality (US Census), and postponement of age at first marriage and birth, cannot explain the demographic and economic patterns of Ukraine from 1991-2003. Real wages, and the total fertility rate (figures 7 and 8) were both declining until 2000, and the disparity in poverty between rural and urban areas rose through 2003 (Murragara, 2005). Age at first marriage has not declined (figure 9), and adult mortality has risen (US Census). Ukraine's story does not mimic the evolution of developing countries like Bangladesh, India, or Brazil, where rural livelihoods have improved over the past century while fertility rates have slowed (Asefa, 2005). Nor does it match the trends of its western European neighbors, such as France or Italy, where fertility rates are also among the world's lowest, but marriage and first births are being postponed, adult mortality is declining, and whose economies have been developed for decades (Gabriel, 2005).

Some past work on transition countries, nevertheless, points to the decline in real income as a causal factor of fertility decline. (Wanner and Dudwick, 1999; Adadjanian and Makarova, 2003). However, these analyses are limited in their analysis of institutional factors that were weighing on parental decisions beyond changes in income.[3] During Soviet times, "Many of the costs commonly associated with parenthood in Western countries were actually externalized from family resource allocation problems. While these state subsidies did not result in huge families, they effectively mitigated the relationship between a couple's personal finances and fertility decisions" (Grogan, 2006). Therefore, it is relevant and requisite that we look at, in addition to income, the effects of other economic determinants of fertility, particularly since one of the most detrimental aspects of the dissolution of the Soviet system was the sudden demise of high quality public services, as with education and health care (Wanner and Dudwick, 1999). The worsening of socio-economic prospects came as a considerable blow, particularly in rural areas, to a nation with high standards in education (99% literacy (CIA World Factbook)) and high expectations for their children.

By studying the impact of public services on fertility, such as education quality, which directly affects the cost of children, we are considering how the price of children affects the quantity-quality tradeoff in children in addition to the more commonly researched affects of household income. The implications of a price effect can potentially explain the economic and demographic patterns of Ukraine contrary to the implications of a change in income. Unlike Becker's proposed negative relationship between fertility and income, the effect of rising child costs on fertility is theoretically ambiguous, and has been shown to be empirically negative, though statistically insignificant, in Rosenzweig (1982). Therefore, the deterioration of education quality, synonymous with rising child quality prices (Glewwe, 1999), may be a significant and theoretically plausible explanation for this transition country's fertility decline and a dwindling rural economy. We also control for labor and non-labor income, where non-labor income generally exhibits a negative effect total fertility, and real male wages exhibit a positive effect.

[3] They also fail to differentiate between labor and non-labor income, where the the Becker household theory actually refers to changes in non-labor income, not real wages. Our results confer with Becker's negative effects of non-labor income on total fertility.

In Section 2 the predictions of a change in the price of child quality on child quantity for a household are presented, demonstrating the ambiguous effect of rising child quality prices. Section 3 describes the data and variables used to estimate the effect of school quality on household fertility. Section 4 lays out the empirical specification to test the theoretical model, and confirms that school quality has a significant impact on household fertility. Section 5 examines the robustness of the findings by including additional explanatory variables, which may account for school quality's impact on fertility. Section 5.1 and 5.2 employ three additional estimations with the data. Section 6 concludes and discusses the policy implications of the results in contrast to the Ukrainian government's current policies.

2. Model

To predict the effects of changes in the price of quality we formulate a model where households value the quantity of children, N, and quality of children, Q, in addition to commodities, S, represented by the utility function

$$U(N,Q,S)$$

(Becker and Lewis, 1973). The household budget constraint is given by

$$F = NQ\Pi + p_N N + p_Q Q + p_S S$$

as in Rosenzweig and Wolpin (1980), where F denotes full income, Π is the price of child quality, reflected by the school quality that a household faces, and p_N, p_Q, and p_S are the fixed cost prices for N, Q, and S, independent of the levels of each of the other variables[4]. $NQ\Pi$ is a non-linear term of the budget constraint which generates quantity and quality shadow prices that are a function of the other variable.

Maximizing (1) subject to (2) yields the first order conditions for an interior solution:

(3) $U_N = \lambda[\Pi Q + p_N]$
(4) $U_Q = \lambda[\Pi N + p_Q]$
(5) $U_S = \lambda p_S$
(6) $F = NQ\Pi + p_N N + p_Q Q + p_S S$

[4]For example, p_Q may reflect the price of living in a certain neighborhood, and p_N may reflect the price of necessary child products.

The total effects of changing the cost of child quality on fertility is obtained by totally differentiating (3)-(6) and solving for $\frac{dN}{d\Pi}$ and $\frac{dQ}{d\Pi}$[5].

(7) $\frac{dN}{d\Pi} = \frac{\lambda Q \phi_{22}}{\Phi} - \frac{\lambda N \phi_{23}}{\Phi} + NQ\frac{dN}{dF}$

(8) $\frac{dQ}{d\Pi} = \frac{\lambda Q \phi_{32}}{\Phi} - \frac{\lambda N \phi_{33}}{\Phi} - NQ\frac{dN}{dF}$

The impact of a change in the price of child quality on the number of children chosen by a household, $\frac{dN}{d\Pi}$, will depend on the three factors: cross price effects, own price effects, and an income effect. The first term in (7) reflects the negative own price effects of a change in Π, such that a rise in the price of child quality reduces the fertility of a woman. The second term reflects the positive cross price effect on the number of children. Namely, a rise in the price of child quality causes child quantity to become relatively cheaper, increasing N. The third term reflects that the magnitude and sign of $\frac{dN}{d\Pi}$ will depend on the household's response to changes in income.

As in Rosenzweig (1982), for compensated changes in the price of school quality, Π, the change in N is negative if own price effects dominate cross price effects. Namely, a rise in the price of child quality will lead to a decline in fertility, because each child is costlier to raise. Conversely, the change in N with respect to a change in Π is positive if cross price effects dominate own price effects[6], and the quantity of children is relatively cheaper.

We expect that negative own price effects will dominate positive cross price effects for a country like Ukraine. Firstly, we believe that preferences for child quality are high as revealed by consistently high national literacy rates, and traditionally high expectations for state schooling. Therefore, a rise in the price of child quality is expected to trigger declines in the number of children in order to maintain a constant level of child quality. This assumes however, that there are no strong complementarities between public provision of inputs into child quality, such as school quality, and parent's own provision of inputs into their child's quality. For instance, if the price of child quality were to decline, such that school quality improves for secondary education and the first term on the right hand side of (7) is positive, parents may complement this by increasing their investments into their child's tertiary education. This would ultimately make each additional child more costly if complementarities are strong enough, and could actually reduce household fertility, represented by a negative sign on the second term of the right hand side of (7). This scenario could describe how parental investments are made in a country like the U.S., but it does not describe the typical child investment of Ukrainian families. In Ukraine, an individual's

[5] See appendix.

[6] See appendix for derivation.

educational fate is deemed largely as a product of the state and deserving students are awarded a free higher education. One could bribe their child's way through the university system, which could be a considered as an investment into a child's higher education, but this is often feasible only for children of parents with disproportionate levels of wealth that were accumulated after the fall of the Soviet Union [7]. Lastly, at least in rural areas, the returns to higher education have been steadily declining over time (figure 4), rendering formal higher education a less profitable endeavor than say entering the informal business sector. [8] Therefore, we view a change in state school quality independently from any endogenous parental choices for child quality, and believe that negative own price effects will dominate.

3. Data

The Ukrainian Longitudinal Monitoring Survey 2003 (ULMS) is based on a national stratified random sample of 4096 households. The survey began only in 2003, but includes retroactive wage data for 1986, 1991, and continuous wage data from 1997 to 2003. The 2003 data span individual characteristics of household members such as age and timing of births, marital history, education and skills, changes in residence, health, and attitudes on politics and ecology.

The Ukrainian School Survey 2005 (USS) is a cross section of 417 Ukrainian public primary and[9] schools selected to match with a random sample of settlements chosen for Ukraine's Annual Health and Living Condition Survey, which is conducted by the State Statistics Committee of Ukraine. The 2005 cross-section was conducted under the auspices of the World Bank's project "Equal Access to Quality Education in Ukraine" with the intentions of creating a follow-up survey in 2009, when the project is completed. The USS contains information on physical infrastructure of the school, teachers' qualifications, hours, and satisfaction, student absenteeism, and school resources.

It would be ideal to utilize the full panel data of the ULMS as other papers have done, which study its wage data (Gorodnichenko and Sabirianova-Peter, 2005; Lehmann et al., 2006), however, due to the cross sectional nature of the USS this is not possible as of yet. In matching these datasets by oblast[10] and settlement types, it is assumed that school quality in 2005 is a good proxy for the school quality that women of childbearing years in 2003 confront when deciding on whether or

[7] called "New Russians"

[8] The returns to higher education has been steadily rising over time in urban areas, but it is likely to do unobservable characteristics of those attending higher education, namely children of oligarchs and the "New Russians".

[9] The Ukrainian education system includes preschool, elementary (primary), lower-secondary, upper-secondary, and tertiary education (Bekh et al., 2007).

[10] There are 24 oblasts and the Autonomous Republic of Crimea in Ukraine. An oblast is comparable to a state in the US.

not to have additional child.

3.1. Variables

The dependent variable is the number of children born to a female up to 2003[11]. Estimates are presented for rural and urban areas for comparative purposes, but our main point of focus is on rural areas [12]. Cohorts younger than forty have not yet completed their fertile years in our sample, so age effects must be controlled for with the year a female was born. Similarly, cohort effects, namely, that our results are driven by the behavior of a particular cohort of women, should be controlled for. Estimations are therefore repeated for smaller samples of women of only 10 year age intervals.

Although this research examines the impact of school quality on fertility, it is actually the slowing of child-births, not reduced fertility that can be determined. Without observing all females to the completion of their fertile years, we are unable to determine whether a lower total fertility rate (TFR)[13] is the result of persistently lower fertility or simply delayed child bearing.

Nonetheless, the previous decade showed no indication that declining TFR's were being driven by a postponement of first child-births, greater spacing between children, or delayed first marriage (Philipov and Dorbritz, 2003), suggesting that low TFR's are a long term trend unlikely to reverse itself. In fact, as shown in figures 9 and 10, mean age at first marriage (MAFM) and mean age at first birth (MAFB) have remained fairly stable since the fall of the Soviet Union through 2003, at 22-23 for MAFM, and 23-24 for MAFB in our sample (Perelli-Harris, 2005; Philipov and Dorbritz, 2003). The real decline seems to be driven by a drop-off in second and third order births (Perelli-Harris, 2005). These types of changes in family size are not reflected in a measure like the TFR.

Income of the household is separated into non-earnings income and wages of the male. Females' wages are not controlled for directly, as fertility has an effect on a female's decision to work, therefore her income is clearly not exogenous. The opportunity cost of a woman's time will be controlled for by including predicted female wages. Because all members of a household record identical total household income, the latter is divided by the number of adults in the household

[11]To avoid endogeneity of the age variable from teenage pregnancies, the sample is restricted to females who have passed the age range for secondary education. Because we have detailed data on household structure, we are able to identify females of reproductive age in each household and the number of children that they have.

[12]We classify rural areas as settlement types labeled as"village" or"settlement of a town significance". The full classification of settlement types includes: "village", "settlement of town significance", "small town" (up to 20,000), "medium town" (20,000 - 99,000), "city" (100,000 - 499,000), and "big city' (more than 500,00)

[13]The TFR is the sum of age-specific fertility rates (ASFR) for a given year, assuming that all women face the ASFR's of a given year, and survive through their reproductive years.

to account for family size[14]. For husbands who report that they are working, but whose wages are not available, predicted wages are used[15]. In some instances married females' husbands were not interviewed, and therefore a predicted wage based on the male's individual characteristics is unattainable. In such cases, the mean male wage associated with a female of a given age, education, state and settlement type is assigned to the female. This assumes that some degree of assortative mating based on individuals' age, education and location is occurring. Additional household characteristics are controlled for later as we aim to rule out other possible explanations for the significance of school quality in explaining household fertility.

3.2. School Quality

A substantial literature involving measurements of school quality exists in the labor economics literature, primarily within the context of estimating the returns to education. Several studies use per pupil expenditures (Rosenzweig, 1977; Johnson and Stafford, 1973; Rizzuto and Wachtel, 1980). However, such a measure would be inappropriate for this study. In Ukraine, some education authorities must rely on their personal connections to reach a reasonable level of educational funding. Therefore, a published expenditure statistic would poorly represent actual per pupil funding, particularly if corruption plagues the eventual allocation of those funds as well (Shcherbatyuk, 2007). Other studies turn to school quality variables that can be seen as policy instruments as opposed to schooling outcomes: student teacher ratios, relative teacher pay, extent of computer use and training, percentage of teachers with a masters degree or higher, books per student, and type of school (Behrman and Birdsall, 1983; Card and Krueger, 1992; Boozer et al., 1992; Betts, 1995, 2001; Dearden et al., 2002).

This study uses school quality variables which reflect the human capital of schools. Physical quality variables are avoided as they are particularly vulnerable to issues of endogeneity. In general, the majority (99.7%) of state general education establishments are subordinated to the Ministry of Education and Science of Ukraine (Paraschenko, 2004), and therefore state funded. For additional funding, the local education department can request additional funds from either the community, which can then forward the request to the regional level and further to the government, or cut back on its own funds in terms of utility services and investment programs (Lukovenko and Kopets, 2001). The remainder of funds can often come from individuals or community organizations

[14] Income is also scaled by 100,000.

[15] Wages for adult males of working age were estimated using a two-step Heckman procedure. The first stage estimation for the ith male to work is given by $work_i = x_i * B = a + b * maritalstatus_i + c * numberofchildren_i + d * education_i + e * age_i + f * oblast_i + g * settlementtype_i + error_i$, where $work_i = 1$ if male worked and zero otherwise. The prediction of wages is given by the Mincerian estimation: $ln(wage)_i = \alpha + \beta * education_i + \gamma * age_i + \delta * age_s quared_i + \varepsilon * \lambda_i + error_i$, where λ is the Inverse Mills ratio= $\frac{f(x_i * B)}{F(x_i * B)}$. Marital status ranges from "single", "in a registered marriage", "in a non-registered marriage", "separated", "divorced" or "widowed".

to help supply schools with better equipment. For instance, the International Centre for Policy Studies (ICPS) in Ukraine states that wealthy parents may supply resources to schools to improve conditions (Shcherbatyuk, 2007). Hence, physical quality variables are likely to be correlated with unobservable household characteristics that we cannot control for in cross-sectional data. For this reason, variables, which seem less vulnerable to household specific control of school quality, are chosen. Following Behrman and Birdsall (1983), the quality of teachers is controlled for with the percent of teachers with a higher degree (masters and specialists). The second control for school quality is student-teacher ratios.

As in Behrman and Birdsall (1983), Card and Krueger (1992), and Ulubas-og and Cardak (2007), aggregate measures of school quality are assigned to each household. We first calculate school quality values by oblast and settlement type, and then assign a household their corresponding school quality by the oblast and settlement type in which they live.

3.3. Addressing Endogeneity of School Quality

For both school quality variables we argue that our measures are exogenous to fertility choices in rural areas. The lack of available substitutes for public schooling in rural areas, restricted choice amongst public schools, and exogenous deterioration of public school quality following the collapse of the Soviet Union, provides us with a method of identifying the effects of school quality on fertility.

There is, however, the possibility that both variables may be endogenous to fertility decisions, hindering our identification, via sorting, selection effects, or reverse causality. Possible reasons for concern include whether parents are able to sort to areas with with higher school quality, parents are able donate funds to their local public school to improve conditions, or if past local levels of fertility affected school quality in areas where a large proportion of the voting population had school age children (Grob and Wolter, 2007). The first is a possibility if private schooling options are available, as in urban areas (Shcherbatyuk, 2007). However, private options are rarely available in rural areas, and, furthermore, beyond the means of rural incomes. Furthermore, by the Ukrainian“propiska" system (a system of civil registration within one’s district), children are required to attend the public school in their district supporting our identification of school quality. Lastly, to control for the reverse causality mentioned above, we include a lag of crude birth rates (CBRs) by settlement type and oblast [16], that is a five year average of CBRs from 1995-1999 [17]

[16] CBR=$\frac{numberbirths}{totalpopulation}$

[17] A lagged five year average from 1995-1999.

It is also possible that teacher quality is endogenous due to parental donations to local public school. Namely, wealthier families may donate more money to their public school, which can then hire higher quality teachers. This seems unlikely, however, since paying a sufficient teacher salary to attract better teachers takes considerable coordination and more income than funding school supplies. Furthermore, wages and incomes in rural Ukraine are often so low that donations could not amount to substantial school improvements. In 2000, 31% of the Ukrainian population lived on less than $2 dollars a day (Food and Agriculture Organization of the United Nations). In rural Ukraine, between 20 and 30% of the population[18]was found to live in poverty in 2003[19].

Nevertheless, if unobservable household characteristics, which determine income, can also affect school quality through parental donations, then controlling for parental donations should account for some of these unknowns. We therefore control for average parental donations to schools per student per year in tables 3-4 and 6-7, which range from an average of $9 US dollars per student per year in rural areas to an average of $20 per student per year in large urban cities.

Another possible concern is that households with higher incomes or education may be moving to areas with better schools. To see whether there are significant differences across observable household characteristics, such as income and education for areas with lower and higher school quality, the data are summarized over four quantiles of school quality in rural areas in table 2. The reported F-statistics indicate that there are significant differences in income, age, and education of mothers between areas of the lowest and highest quantiles of school quality. For non-earnings income (HHinc), this relationship is not linear, such that households with more assets do not necessarily sort to areas with better schools, while it is for male wages (lnmwage). Fortunately, we are able to control for male wages and their type of job. We will also be able to control for whether a household has moved, which may serve as a proxy for the mobility of a household and other unobservable characteristics that would enable a household to sort to areas with better school quality. That is, districts with better school quality may be comprised of, not necessarily more wealthy households, but households which are somehow more mobile or better connected to relatives.

[18]20% in small settlement type towns, and 30% in villages.

[19]"Poverty is defined as those individuals whose consumption falls below a level sufficient to cover the cost of a food basket of about 2500 calories per day, plus a significant allowance for non-food goods and services. This level of calories reflects the country's minimum calorie requirements according to the consumption patterns and the demographic composition of the populations. The cost of this basket is UAH 151 per person per month in 2003" (Bekh et al., 2007).

4. Empirical Specification

To estimate the effects of school quality on fertility a count data model is used. Specifically, a generalized Poisson model[20] is employed to account for possible under or over-dispersion in the fertility data. As Wang and Famoye (1997) and Winkelmann and Zimmermann (1994) point out, the number of children in a household tends to exhibit under-dispersion when the mode is equal to two. However, our data appear to be over-dispersed, with a mode of one for the number of children per household, and standard deviation of 1.8[21].

The mean of fertility for the *ith* woman, who faces the school quality of the *kth* oblast and *jth* settlement type is given be:

$$\mu_i = exp(\alpha + \beta * age_i + \gamma * HHinc_i + \delta * lnmwage_i + \varepsilon * teachq_{kj} + \zeta * stratio_{kj})$$

where "HHinc" is non-earnings income per adult household member[22], "lnmwage" is the natural log of males' wages, "teachq" is teacher quality or percent of teachers with a degree beyond the bachelors, and "stratio" is the student teacher ratio. Summary statistics for both rural and urban areas of females ages 20-40 in 2003 are included in tables 1a and 1b.

4.1. Results

Elasticities evaluated at mean values for women, aged 20-40, and for the smaller ten year cohort 25-35 in rural areas are reported in tables 3-5. Standard errors are corrected for heteroskedasticity and clustering of the residuals at the village level. For rural tables, z statistics are also computed using block-bootstrapped standard errors.

The dispersion statistics reported for each model indicate that the data are over-dispersed as hypothesized earlier, as α, the dispersion parameter, is positive for all sub-samples. This confirms that a standard Poisson model would produce inefficient estimates. Furthermore, the AIC statistic

[20] The generalized Poisson distribution is given by

$$f(y_i|\mu,\alpha) = \frac{\mu}{1+\alpha\mu}_i^y \frac{(1+\alpha y_i)^{y_i-1}}{y_i} exp(\frac{-\mu(1+\alpha y_i)}{(1+\alpha\mu)})$$

where y_i=0,1,2,... and $\mu_i = exp(x_i\beta)$. The mean and variance of y_i are $E(y_i|x_i) = \mu_i$ and the $V(y_i|x_i) = \mu_i(1+\alpha\mu_i)^2$. Note that when α, the dispersion parameter, equals zero, the generalized Poisson distribution reduces to the Poisson distribution.

[21] Under-dispersion occurs when the variance of a variable is less than its mean, and conversely for over-dispersion. Estimates from a Poisson regression model, which assumes equi-dispersion, will be consistent but not efficient. Hence, test statistics based on the standard errors are no longer valid.

[22] Child benefits and alimony were excluded from "HHinc" to avoid endogeneity.

indicates the in all cases the generalized Poisson is a better fit than the standard Poisson, given the smaller values for the AIC under the generalized Poisson.

For the full sample, non-earnings income, “HHinc" [23], has a negative effect on household fertility, as Becker and Lewis (1973) predicts. This is also true for the 25-35 cohort, whereas the natural log of male wages (“lnmwage") has a positive and significant effect on the total number of births to a female.

The school quality variables are both significant, and indicate that better outcomes (higher teacher quality and lower student teacher ratios) in school quality have a positive effect on fertility in rural areas. In table 3, estimates for the full sample of women reveal that a 10% reduction in student teacher ratios increases fertility by 1.4%, while a 10% increase in teacher quality increases fertility by 3%. This suggests that the negative own price effects of a change in the price of child quality dominates the cross price effects, as better school quality (or a decline in the price of child quality) leads to higher fertility. This is consistent with Rosenzweig’s (1982) results, though our results are statistically significant. This lends evidence to the hypothesis that even after controlling for the negative effects of income on fertility, a rise in the price of child costs can significantly reduce fertility.

Furthermore, controlling for “parentDon", average parental donations per student per year (in hryven), “moved", a dummy variable for whether a family has moved, and “cbr" [24], which are meant to proxy for some unobservable household characteristics, does not affect the significance of school quality’s impact on fertility. “Moved" has a positive and significant effect on fertility in table 3, column 4, as does “cbr" in table 3, column 5, while the effect of “parentDon" is negative and significant in table 3, column 3. Therefore, average parental donations per student to schools may reflect an additional negative income effect on fertility, the mobility of a family is perhaps effective at reducing the cost of a child, and reverse causality does not appear to be driving our results.

5. Trends and Robustness

Thus far our results show that the price of child quality, as measured by school quality, has a significant impact on household fertility. However, there are other economic factors in Ukraine that are leading to fertility decline as well; the decline in health care quality (Murragara, 2005; Philipov and Dorbritz, 2003; Buslayeva et al., 1999); a rise in the opportunity cost of women’s

[23] Sold goods and services are included in “HHinc".
[24] CBR= $\frac{numberbirths}{totalpopulation}$

time (Perelli-Harris, 2006), particularly for low wage earners as the gap between male female wage floors has narrowed (Ganguli and Terrell, 2005); and a structural shift from an agricultural and industrial based economy to services, telecommunications and trade (Philipov and Dorbritz, 2003), which could greatly affect the employment and wages of males in rural areas. There are other social factors, such as increased divorce and extra-marital birth rates, the spread of AIDS, and increased alcoholism, which have been related to decreased fertility in Ukraine. While the latter factors have moved in tandem with fertility decline (Philipov and Dorbritz, 2003), they too should be thought of as outcomes of the above mentioned economic shifts that had taken place over the previous decade. The acceptance of single parenting may have developed with the establishment and adjustments of the minimum wage, which substantially improved the male-female wage gaps within lower wage quantiles (Ganguli and Terrell, 2005). Alcoholism among men, particularly in rural areas, is often attributed to the contraction of agricultural and industrial sectors.

Therefore, the focus in this section is to acknowledge other economic factors of fertility decline in Ukraine, but more importantly, to ask whether controlling for these other factors in our estimation will then render school quality an insignificant determinant of household fertility. For example, if better schools are observed in areas with better infrastructure and increased job opportunities for women, then a significant impact of school quality on fertility may be capturing women's labor decisions to work more. To deal with this, predicted wages of women who work and do not work are estimated and controlled for[25].

Because the mean age at first birth is 24 (see figure 10), the birthing cohort that we will focus on for robustness is females ages 25-35 in 2003. Table 5, column 2 indicates that the log of predicted female wages has a negative though not significant impact on fertility. After controlling for mother's own education (column 3) the effect becomes positive, indicating that women of equal education with higher potential wages, holding all else constant, will have more children. School quality, nonetheless, remains significant.

We next include job type in our estimation to control for the contraction of agricultural and industrial sectors in rural areas. It is possible that areas with lower school quality are perhaps areas with more depressed economies due to the shift from agriculture and industry to services, telecommunications and trade. Therefore, a male's job type, rather than local school quality, may be the true cause for reduced fertility. "Agindust", a dummy variable indicating whether a husband's occupation is in the agricultural or industrial sector, does have a small affect on the level of significance of school quality in table 3, column 7, although, both school quality and student teacher ratios remain statistically significant. We would expect that school quality would be downward biased in this case since agricultural and industrial areas would be more economically

[25]The Heckman procedure for predicting female wages is the same as in the prediction of missing male wages.

depressed and have worse schools. Indeed, the estimates for teacher quality increase in absolute value after controlling for job type.

It is possible that school quality is acting as a general control for other public services, most notably health services, which have also been in decline since the fall of the Soviet Union (Philipov and Dorbritz, 2003; Buslayeva et al., 1999). Lack of reproductive health services, for example, could deter females from child bearing. However, not having data on health services we cannot control for its separate effect on fertility. Nevertheless, even if school quality is acting as a catch-all variable for the decline in government services in rural areas, this does not detract from the thesis that the price of child quality has a negative effect on fertility, as many public services can be thought of as an input into the quality of a child.

We are, however, able to control for a female's own health. This may serve as a proxy for quality of health care, as healthier individuals potentially have better preventative health care. The variable captures an individual's response to "How would you evaluate your health?", with the reported answer ranging from 1(=Very good) to 4(=Bad). Inclusion of this health variable in table 3, column 8 does not alter the results, nor is it significant in its affect on fertility.

In addition to controlling for economic factors that may be potentially driving our results, controls for household characteristics that may be associated with school quality should be considered. For example, language spoken at home creates a distinct separation among Ukrainian citizens: politically, religiously, and geographically. A clear majority of Russian speakers live in urban areas in eastern Ukraine, particularly in industrial cities, and are of the Eastern Orthodox rite. Stronger affiliation with one of these linguistic groups may be correlated with the school quality that a household faces, as well as their fertility. Prior to the breakup of the Soviet Union the majority of school instruction was in Russian. Now, all schools are required to teach in Ukrainian. Although we cannot posit a clear relationship between language and school quality, it is possible that the change in the language of instruction affected some schools positively and some negatively. Furthermore, Buslayeva et al. (1999) shows that language and fertility are correlated. Abortions are more common among Russian speaking eastern Ukrainians. The latter facts could be leading us to a spurious correlation between fertility and school quality. A similar argument can be made for religious affiliation and fertility. Catholic households in Ukraine tend to eschew abortion and exhibit higher birth rates than households of the Eastern Orthodox rite (Buslayeva et al., 1999). Controlling for language and religious affiliation[26] in table 3, column 5 and 6, with dummy variables for Russian speakers and households that consider themselves Catholic, does confirm that Russian speaking individuals tend to have fewer children, and

[26] language=1 if a Russian speaker and Catholic=1 if Catholic.

that Catholics tend to have larger families, through the effects of teacher quality remain significant.

Lastly, we control for marital status with “marital" in column 10, table 5 and table 8, where marital equal to one indicates that a female is in a registered or non-registered marriage and is single or alone otherwise. Not suprisingly, being in a relationship increases a female’s fertility, though school quality remains significant in the expected direction.

5.1. Robustness Check with Later Births

One criticism of the above specification is that some of the observed births occurred before the 2004-2005 USS survey. While school quality may have affected later births, of say a woman of 35 years of age in 2003, her first birth could have occurred a decade before that, such that 2004/2005 school quality data would not be relevant to her initial fertility decisions. To check that school quality has an affect on births occurring no more than 5 years earlier than the USS survey, namely from 1999 onwards, we tested the above model using two separate specifications. The first specification uses “lastbirths" as a regressand in generalized poisson model, which counts the number of births a female conceived from 1999 onwards, and controls for the number of “priorbirths" up until 1999. The second specification uses “Dlatebirths" as a regressand in a probit model, which is a dummy indicating whether a woman conceived a child in 1999 onwards, and “priorbirths" as a regressor. Women age 25-35 are included in this specification.

Table 9 indicates that teacher quality remains positive and significant for this cohort, and student teacher ratio is negative but not significant in both specifications. Therefore, school quality has significant affects on the decisions to conceive children for the period surrounding school quality measurement, even after controlling for prior births, year of female’s birth, household income, and male’s wages. This confirms that school quality is affecting female’s fertility decision for the period 1999-2003, where school quality in 2004 is a proxy for school quality for the five prior years.

5.2. Duration Analysis

The fertility decline in Ukraine has been attributed to a drop off in higher order births rather than childlessness, “providing evidence that Ukraine has not shifted to a Western European fertility pattern. (Perelli-Harris, 2005). We estimate the impact of school quality on the number of months between time between age at first marriage and first birth, and the number of months between first and second births using a gamma and log-log parametric hazard model. The graphs for duration between marriage and first birth and between first and second births are presented in figures 1 and

2. The marriage to first birth [27] smoothed hazard estimate is non-monotonic and is estimated using a gamma parametric model for the hazard function [28], while the first and second birth smoothed hazard estimate clearly follows a log-log or log normal shape hazard function [29].

Table 10, column 1 indicates that teacher quality slightly decelerates the time from first marriage to first birth by 4%, though the results are not statistically significant, while student teacher ratios have little effect. Table 10, column 2 indicates that higher teacher quality accelerates the time between first and second births by 85%. This supports Perelli-Harris (2005) the theory that fertility decline in Ukraine is driven by the drop-off in second births, while maintaining a fairly young mean age at first marriage, rather than the Western European demographic model of childlessness accompanied by a later mean age at first marriage (Gabriel, 2005).

These results reveal a very different story from that of a demographic transition for Ukraine. Concurrent with fertility decline in Ukraine, we do not observe the typical trends of a demographic transition in Ukraine: rising incomes, delayed first marriage and first birth, and a rise in childlessness over the decade succeeding transition. Therefore, we look beyond these measures to help explain fertility decline in Ukraine in the face of declining real wages, unchanged age a first marriage and first birth, and a dropoff of in second births. This section shows that the dissolution of at least one public service, school quality, can explain both the overall decline in fertility, but also the very source of that average decline, namely a postponement or cessation of higher parity births.

6. Discussion and Conclusion

The question of whether school quality affects fertility is motivated by the observed fertility declines and concomitant dispersion in school quality in Ukraine following the breakup of the Soviet Union. This research finds that the price of schooling, as measured by school quality, can have a significant impact on a female's fertility, particularly for those females who face few schooling options for their children, and who do not move to urban areas with greater choice in schooling options. As in Rosenzweig (1982), we find that the price of schooling has a negative impact on fertility, but our results are significant contrary to Rosenzweig's findings. This work is the first to provide a potential cause for fertility decline in rural Ukraine, as well to test the effects of price changes in child quality on fertility in the context of a quantity-quality household model.

[27] One hundred twenty-six observations are dropped for females conceiving their first child before first marriage.

[28] The gamma hazard function is specified as $\lambda(t) = \frac{x^{\gamma-1}e^{-x}}{\Gamma(\gamma)-\Gamma_x(\gamma)}$, given that it can take on multiple shapes, where $x \geq 0$ and $\gamma \geq 0$, and $\Gamma(.)$ is the gamma distribution.

[29] The log-log hazard function is specified as $\lambda(t) = \frac{\gamma\alpha t^{\alpha-1}}{1+\gamma t^{\alpha}}$, where $\gamma, \alpha \geq 0$ Wooldridge (2002). The estimates are not significantly or economically different, therefore, we just report the log-log estimates.

Thus far, the Ukrainian government's response to the fertility decline and contraction of the rural economy has been direct subsidization to rural households. President Yushchenko's 2008 presidential bill calls for a 50 percent increase in subsidies to large rural families. The payout plan is $2,378 for the first child, $4,955 for the second, and $9,910 for the third.

> "It pains me to see the dropping birth rate and outflow of dispirited young villagers to the cities. There's a lack of schools and teachers, bus programs have failed, and hospitals and first aid centers are closed. Not every village is linked by the bus service to its district town. There is no access to the internet. Let me assure you that I will not sign the 2008 budget into law until the needs of farmers and rural people are adequately met. " (Yushchenko, 2007).

Ukrainian demographers, however, are skeptical of such policies, which may speed up the tempo of births, as mothers aim to qualify for child subsidies, but will not increase the overall quantity of births per woman. Furthermore, short term income transfers may increase the rural labor force, but they do not address the fact that sustained economic development requires a constant flow of human capital that will foster entrepreneurship, attract foreign investment, and facilitate an equal balance of human capital between rural and urban areas.

Although, the Ukrainian government acknowledges the failure of public services in rural Ukraine, the connection between public good provision and fertility decline has not been recognized. What is needed are credible investments in public services, such as school quality, which will reduce the cost of having high quality children, and will be more likely to induce a change in households' permanent behavior. Allowing its rural economy to dwindle is not only unsustainable for Ukraine's long term growth, but is inefficient. Given that educational attainment in Ukraine remains high, a large pool of potential human capital exists. Investments into education where households face few alternative schooling options will encourage families to invest in larger families that will consist of increasingly higher human capital over time.

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7. Graphs

Figure 1-Smoothed Hazard Estimate-1st marriage to 1st birth

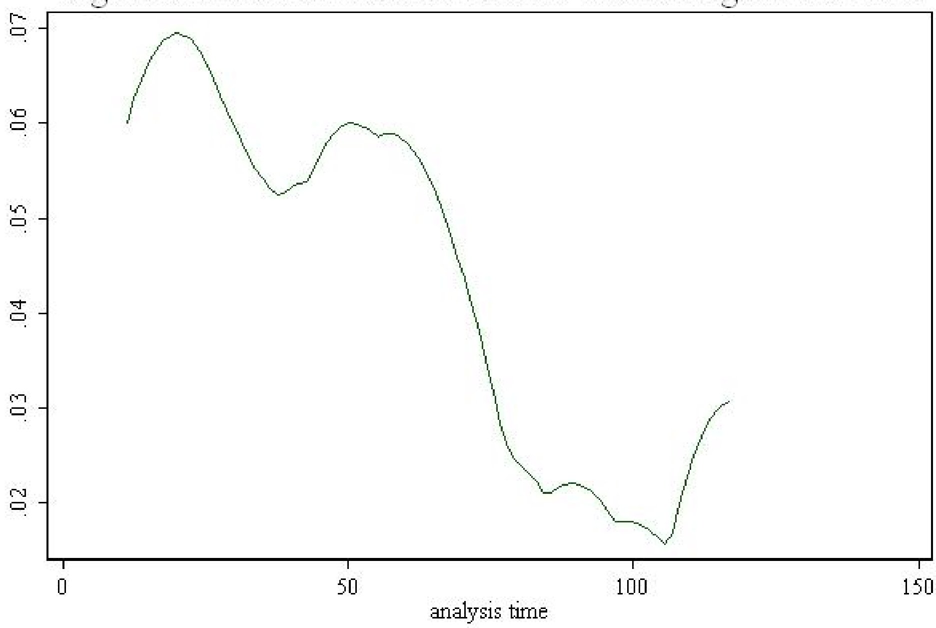
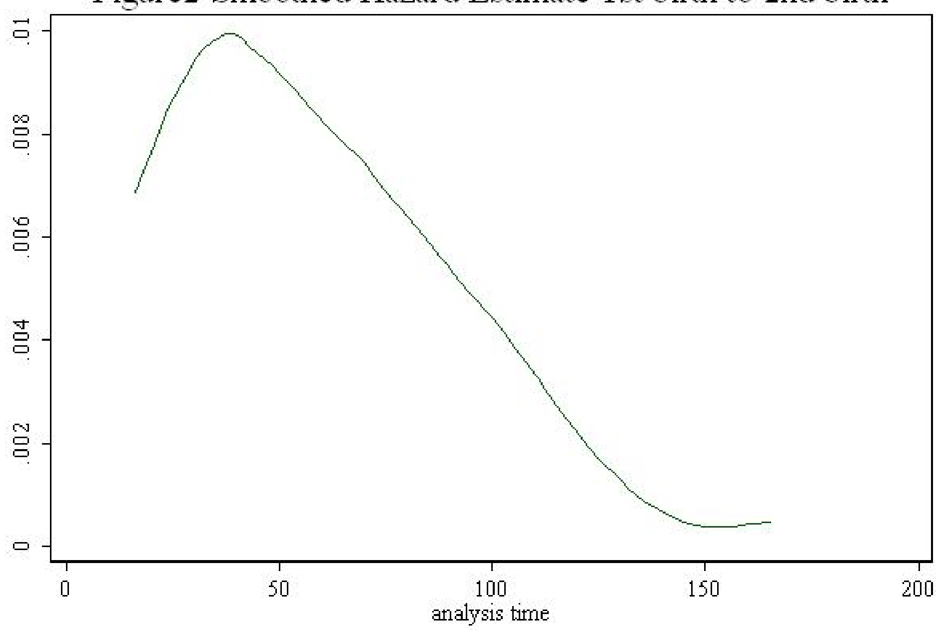


Figure2-Smoothed Hazard Estimate-1st birth to 2nd birth



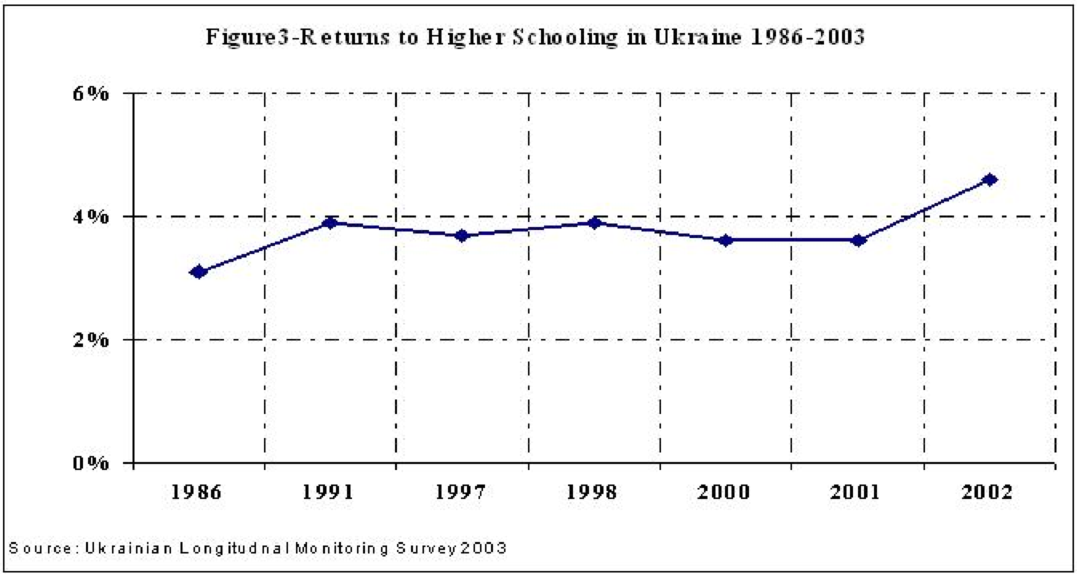


Figure3-Returns to Higher Schooling in Ukraine 1986-2003
6%
4%
2%
0%
1986
1991
1997
1998
2000
2001
2002
Source: Ukrainian Longitudnal Monitoring Survey 2003

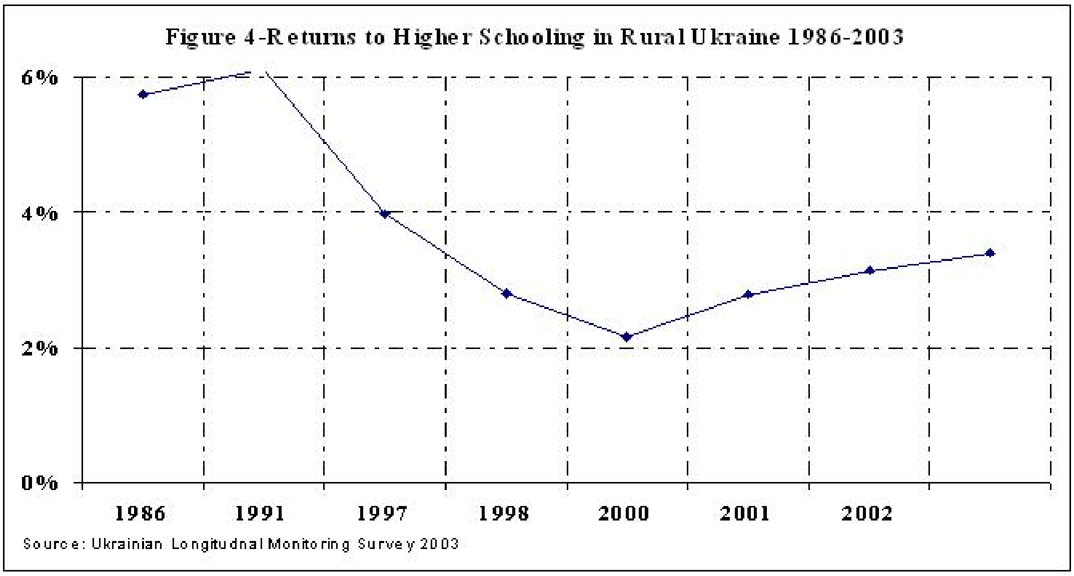
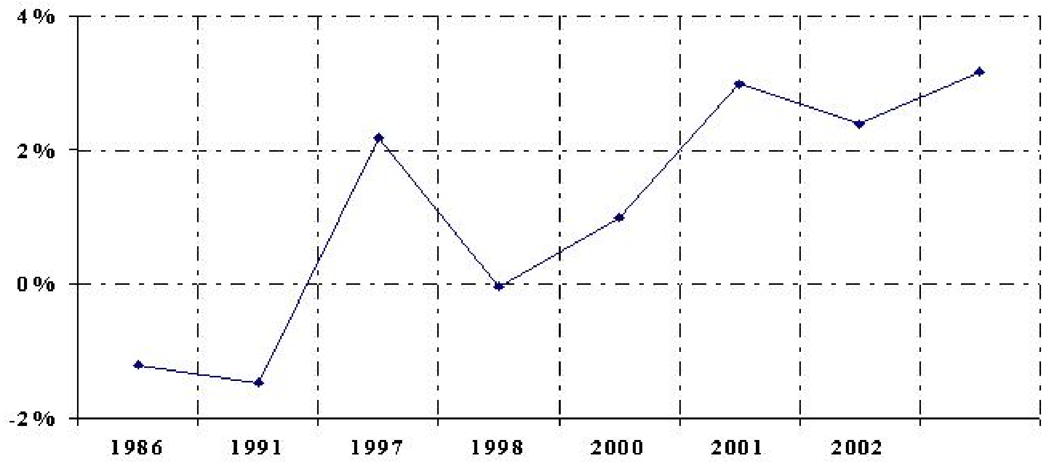


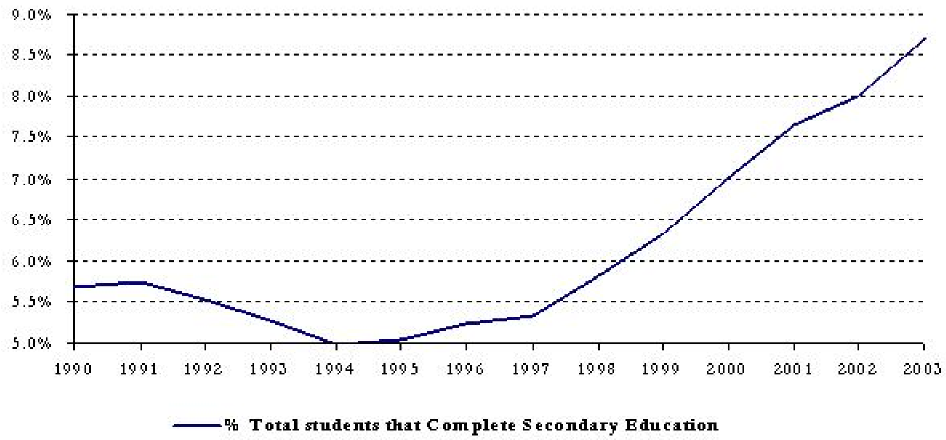
Figure 4-Returns to Higher Schooling in Rural Ukraine 1986-2003
6%
4%
2%
0%
1986
1991
1997
1998
2000
2001
2002
Source: Ukrainian Longitudnal Monitoring Survey 2003

Figure5-Returns to Higher Schooling in Urban Ukraine 1986-2003



Source: Ukrainian Longitudnal Monitoring Survey 2003

Figure 6 - Educational Attainment in Ukraine



Source: State Statistics Committee of Ukraine

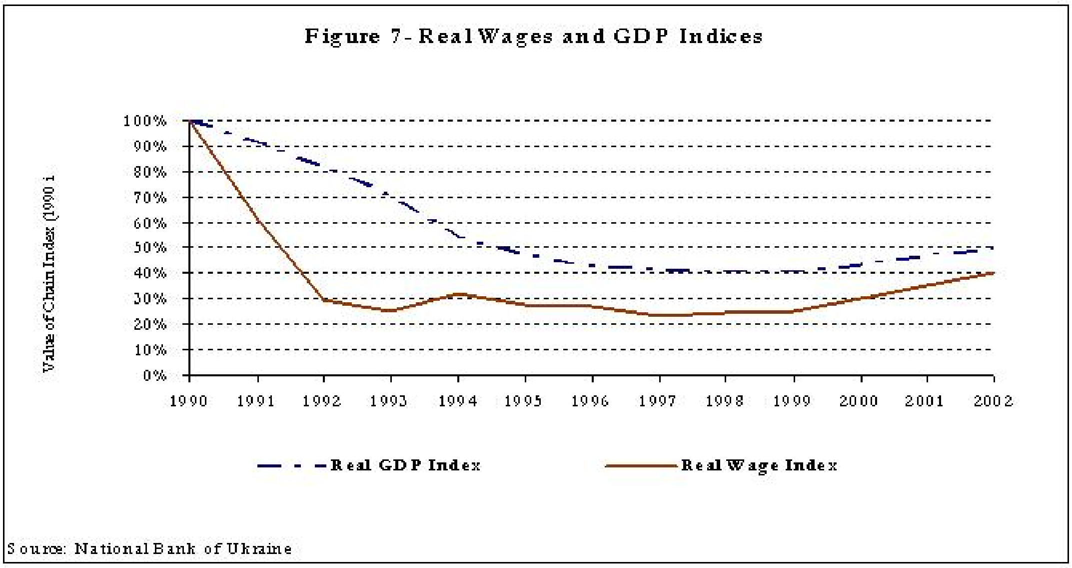


Figure 7- Real Wages and GDP Indices
Value of Chain Index (1990 i
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Real GDP Index
Real Wage Index
Source: National Bank of Ukraine

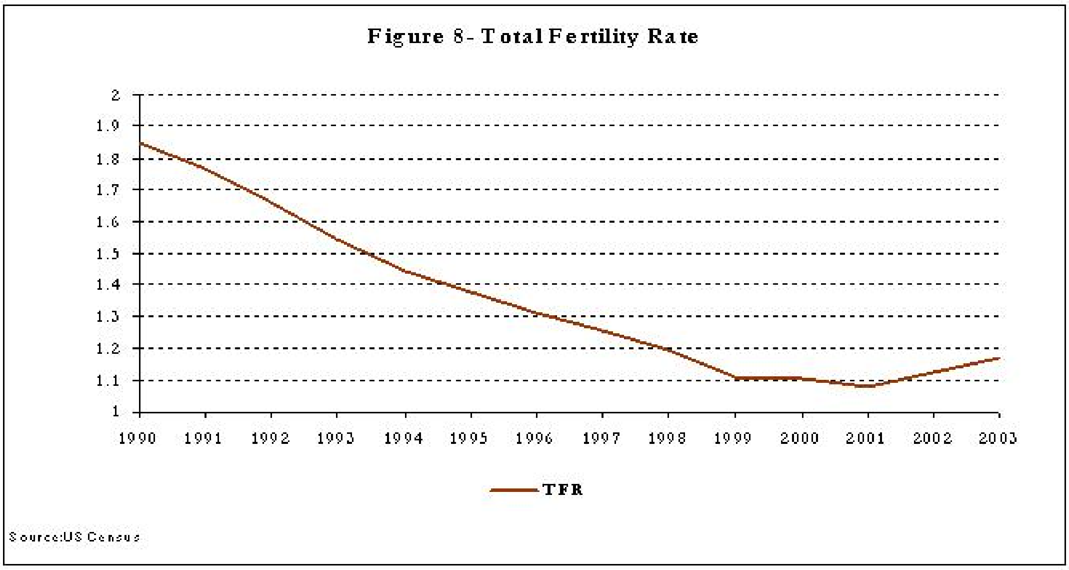


Figure 8- Total Fertility Rate
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
TFR
Source:US Census

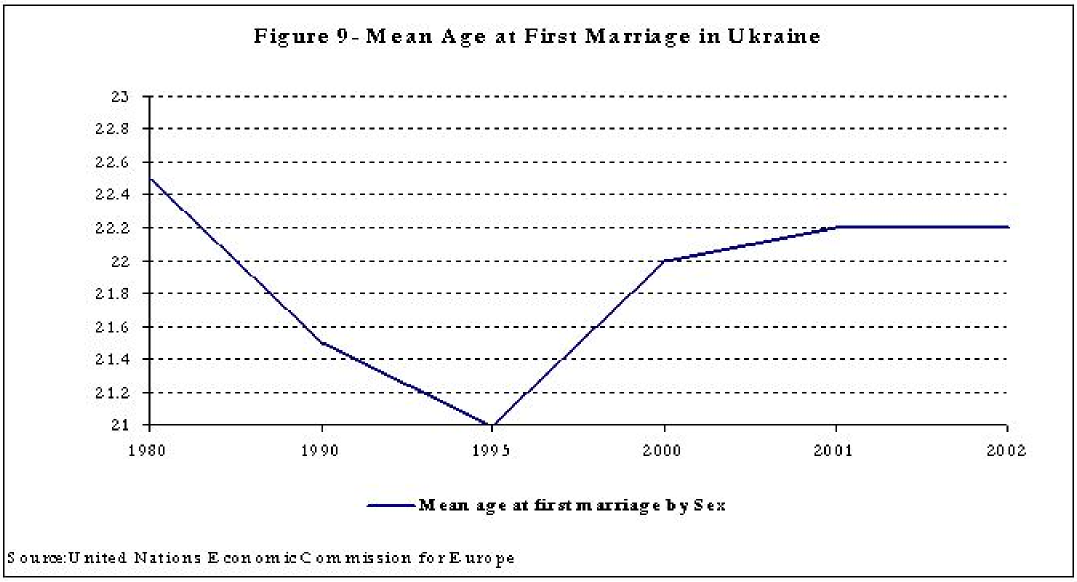


Figure 9 - Mean Age at First Marriage in Ukraine
23
22.8
22.6
22.4
22.2
22
21.8
21.6
21.4
21.2
21
1980
1990
1995
2000
2001
2002
Mean age at first marriage by Sex
Source: United Nations Economic Commission for Europe

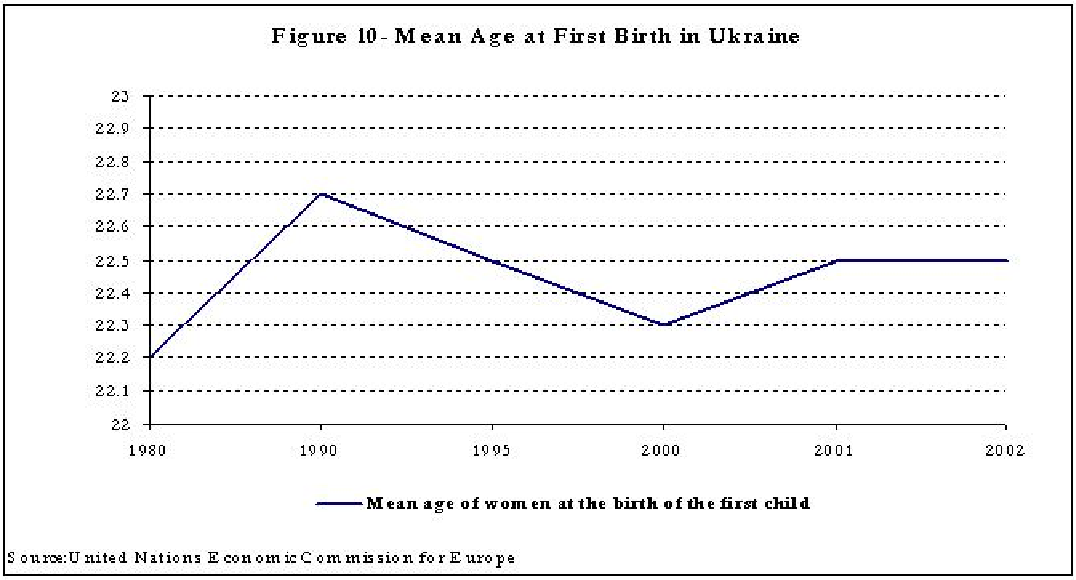


Figure 10 - Mean Age at First Birth in Ukraine
23
22.9
22.8
22.7
22.6
22.5
22.4
22.3
22.2
22.1
22
1980
1990
1995
2000
2001
2002
Mean age of women at the birth of the first child
Source: United Nations Economic Commission for Europe

8. Tables

Table 1a- Rural Summary Statistics Females 20-40

Variable	**Mean**	**Std. Dev.**
N_ch	1.321	(0.923)
age	30.171	(6.404)
HHinc	19.469	(15.089)
lnmwage	5.534	(.715)
lnfwage	5.650	(.060)
st_ratio	9.458	(3.108)
teachq	0.799	(0.136)
parentDon	8.943	(6.16)
moved	0.454	(0.498)
cbr	0.028	(0.011)
educ	5.792	(2.093)
language	0.338	(0.473)
catholic	0.139	(0.347)
agindust	0.156	(0.364)
health	2.841	(0.648)
cost_med	98.850	(958.930)
Observations	639	

HHinc (multiplied by a factor of 10,000), *lnmwage* (log male monthly wage), *lnfwage* (log female monthly wage) expressed in hryven. *st_ratio* is number of students per teacher. *teachq* is percent teachers with higher teaching degree. *parentdon* is hryven donated by parents to schools in the past month. moved is a dummy for having moved. *cbr* is the crude birth rate. *educ* ranges from group 1-9. language, catholic, and *ag_indust* are dummies for being catholic, a Russian speaker, or working in the agricultural/industrial sector. Health is a self evaluation of health: $1(= Verygood) to 4(= Bad).cost\_med$ is hryven spent on medical services in the past month.

Table 1b- Urban Summary Statistics Females 20-40		
Variable	**Mean**	**Std. Dev.**
N_ch	0.98	(0.830)
age	29.843	(6.335)
HHinc	29.93	(20.525)
lnmwage	5.922	(.685)
lnfwage	5.665	(.057)
st_ratio	13.262	(1.804)
teachq	0.894	(0.085)
parentDon	20.985	(23.046)
moved	0.401	(0.49)
cbr	0.023	(0.01)
educ	6.617	(2.38)
language	0.679	(0.467)
catholic	0.059	(0.236)
agindust	0.113	(0.316)
health	2.732	(0.628)
cost_med	63.724	(142.488)
Observations	843	

$HHinc$ (multiplied by a factor of 10,000), $lnmwage$ (log male monthly wage), $lnfwage$ (log female monthly wage) expressed in hryven. st_ratio is number of students per teacher. $teachq$ is percent teachers with higher teaching degree. $parentdon$ is hryven donated by parents to schools in the past month. moved is a dummy for having moved. cbr is the crude birth rate. $educ$ ranges from group 1-9. language, catholic, and ag_indust are dummies for being catholic, a Russian speaker, or working in the agricultural/industrial sector. Health is a self evaluation of health: $1(= Verygood)to4(= Bad).cost\_med$ is hryven spent on medical services in the past month.

Table 2-Quantiles of School Quality				
Quantile	HHinc	lnmwage	educ	age
1	1.891	1.683	5.562	30.858
	(0.118)	(0.204)	(0.166)	(0.472)
2	1.747	2.402	5.815	29.159
	(0.111)	(0.229)	(0.165)	(0.522)
3	2.363	2.362	5.627	29.968
	(0.132)	(0.229)	(0.161)	(0.498)
4	1.786	2.847	6.187	30.652
	(0.109)	(0.235)	(0.166)	(0.531)
Fstat	5.06	4.94	2.87	2.29

Table 3-Gpoisson: Females 20-40 in Rural Settlements

VARIABLES	(1) All ch: Poisson	(2) All ch: G Poisson	(3) parent donations	(4) moved	(5) CBR
year	-127.7***	-116.0***	-116.5***	-116.6***	-115.2***
	(-16.75)	(-13.44)	(-13.71)	(-13.37)	(-13.32)
	(-17.43)	(-12.14)	(-13.65)	(-11.51)	(-12.51)
HHinc	-0.125***	-0.0810**	-0.0710**	-0.0767**	-0.0688**
	(-3.544)	(-2.469)	(-2.226)	(-2.306)	(-2.122)
	(-3.371)	(-1.890)	(-1.677)	(-1.709)	(-1.457)
lnmwage	0.107***	0.0543***	0.0581***	0.0500***	0.0511***
	(5.872)	(2.985)	(3.167)	(2.724)	(2.872)
	(3.589)	(1.019)	(1.170)	(0.766)	(0.902)
st_ratio	-0.0812	-0.133**	-0.138**	-0.164***	-0.142***
	(-1.500)	(-2.489)	(-2.571)	(-2.981)	(-2.722)
	(-1.310)	(-1.973)	(-2.022)	(-2.362)	(-2.029)
teachq	0.208*	0.282**	0.288**	0.302***	0.269**
	(1.775)	(2.509)	(2.526)	(2.700)	(2.541)
	(1.493)	(2.006)	(2.001)	(2.001)	(1.953)
parentDon			-0.0559**		
			(-2.146)		
			(-1.321)		
moved				0.0368**	
				(2.091)	
				(2.105)	
cbr					0.0818*
					(1.669)
					(1.635)
Observations	639	639	639	639	639
dispersion		0.752	0.746	0.758	0.752
N_clust	102	102	102	102	102
AIC	1587	1465	1465	1465	1465

z statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

z statistics in parentheses. The second set of z statistics were obtained using block bootstrapping(with replacement, reps=500) when computationally possible. Significance (*) is based on non-bootstrapped standard errors.

Table 4-Gpoission: Females 25-35 in Rural Settlements

VARIABLES	(1) All ch: Poisson	(2) All ch: G Poisson	(3) parent donations	(4) moved	(5) CBR
year	-94.65***	-88.75***	-89.57***	-89.13***	-85.02***
	(-7.427)	(-7.467)	(-7.621)	(-7.542)	(-7.722)
	(-7.480)	(-7.090)	(-7.087)	(-6.793)	(-7.300)
HHinc	-0.0901**	-0.0385	-0.0322	-0.0346	-0.0173
	(-2.316)	(-1.208)	(-1.000)	(-1.053)	(-0.530)
	(-2.357)	(-0.802)	(-0.634)	(-0.726)	(-0.348)
lnmwage	0.0444*	-0.0130	-0.00887	-0.0157	-0.0226
	(1.672)	(-0.512)	(-0.342)	(-0.614)	(-0.917)
	(3.320)	(0.713)	(0.906)	(0.637)	(0.377)
st_ratio	-0.126**	-0.183***	-0.187***	-0.194***	-0.203***
	(-2.221)	(-3.130)	(-3.166)	(-3.332)	(-3.600)
	(-1.878)	(-1.980)	(-1.974)	(-2.290)	(-2.089)
teachq	0.479***	0.479***	0.497***	0.481***	0.492***
	(4.334)	(5.038)	(5.118)	(5.072)	(5.345)
	(3.269)	(3.385)	(3.411)	(3.300)	(3.507)
parentDon			-0.0447		
			(-1.341)		
			(-1.120)		
moved				0.0134	
				(0.604)	
				(0.278)	
cbr					0.138***
					(2.777)
					(2.181)
Observations	405	405	405	405	405
dispersion		0.682	0.678	0.682	0.680
AIC	1087	967.0	967.6	968.7	963.7
N_clust	100	100	100	100	100

*** p<0.01, ** p<0.05, * p<0.1

z statistics in parentheses. The second set of z statistics were obtained using block bootstrapping(with replacement, reps=500) when computationally possible. Significance (*) is based on non-bootstrapped standard errors.

Table 5-Gpoission: Females Ages 25-35 in Rural Settlements

VARIABLES	(1) Baseline	(2) female wage	(3) female wage and education	(4) oblast and settlement type	(5) language	(6) language and religion	(7) agindust	(8) health	(9) medical costs	(10) marital
year	-88.75***	-84.86***	-172.4***	-90.89***	-91.48***	-91.22***	-89.28***	-92.18***	-92.62***	-89.13***
	(-7.467)	(-6.473)	(-2.912)	(-7.766)	(-8.107)	(-8.259)	(-7.327)	(-7.649)	(-7.613)	(-7.542)
	(-6.794)			(-7.380)	(-7.918)	(-7.494)	(-4.450)	(-7.343)	(-6.847)	(-7.82)
HHinc	-0.0385	-0.0319	-0.0367	-0.0308	-0.0142	-0.00989	-0.0389	-0.0269	-0.0259	-0.0346
	(-1.208)	(-0.994)	(-1.173)	(-0.940)	(-0.429)	(-0.316)	(-1.210)	(-0.835)	(-0.806)	(-1.053)
	(-0.764)			(-0.595)	(-0.238)	(-0.127)	(-1.029)	(-0.542)	(-0.479)	(-0.77)
lnmwage	-0.0130	-0.0154	-0.0134	-0.0122	-0.00834	-0.00821	-0.0129	-0.0208	-0.0235	-0.0157
	(-0.512)	(-0.610)	(-0.536)	(-0.486)	(-0.334)	(-0.325)	(-0.504)	(-0.830)	(-0.925)	(-0.614)
	(0.661)			(0.876)	(0.760)	(0.754)	(0.949)	(0.408)	(0.328)	(-1.63)
st_ratio	-0.183***	-0.188***	-0.182***	-0.148***	-0.104*	-0.0839	-0.184***	-0.186***	-0.189***	-0.194***
	(-3.130)	(-3.203)	(-3.071)	(-2.919)	(-1.957)	(-1.530)	(-3.120)	(-3.182)	(-3.192)	(-3.332)
	(-1.961)			(-1.744)	(-1.294)	(-0.942)	(-2.700)	(-2.172)	(-2.156)	(-1.91)
teachq	0.479***	0.500***	0.503***	0.467***	0.502***	0.474***	0.481***	0.504***	0.524***	0.481***
	(5.038)	(5.193)	(5.227)	(4.806)	(5.392)	(4.986)	(5.065)	(5.012)	(4.999)	(5.072)
	(3.289)			(2.639)	(3.656)	(3.107)	(4.990)	(3.186)	(3.103)	(2.66)
lnfwage		-5.068	83.79							
		(-0.929)	(1.371)							
educ			-1.098							
			(-1.447)							
oblast				-0.0291						
				(-0.595)						
				(-0.387)						
settl_type				-0.0923						
				(-1.253)						
				(-1.175)						
language					-0.0628***	-0.0590***				
					(-3.314)	(-3.079)				
					(-2.741)	(-2.386)				
catholic						0.0128				
						(1.221)				
						(1.077)				
agindust							-0.00298			
							(-0.269)			
							(-0.232)			
health								-0.0226	-0.0253	
								(-0.210)	(-0.233)	
								(-0.153)	(-0.176)	
cost_med									0.0102	
									(1.294)	
									(0.948)	
marital										0.248***
										(3.481)
										(2.98)
Observations	405	405	405	405	405	405	405	403	403	405
dispersion	0.682	0.682	0.679	0.678	0.668	0.670	0.681	0.675	0.676	0.682
AIC	967.0	968.3	969.1	969.3	959.4	959.7	968.9	957.9	959.1	968.7
N_clust	100	100	100	100	100	100	100	100	100	100

*** p<0.01, ** p<0.05, * p<0.1

z statistics in parentheses. The second set of z statistics were obtained using block bootstrapping(with replacement, reps=500) when computationally possible. Significance (*) is based on non-bootstrapped standard errors.

Table 6-Gpoisson: Females 20-40 in Urban Settlements

VARIABLES	(1) All ch: Poisson	(2) All ch: Gpoisson	(3) parent donation	(4) moved	(5) CBR
year	-143.1***	-123.5***	-124.0***	-124.1***	-122.0***
	(-17.29)	(-13.50)	(-13.64)	(-13.58)	(-13.77)
HHinc	-0.182***	-0.0936**	-0.115**	-0.0822*	-0.0915**
	(-3.671)	(-2.007)	(-1.991)	(-1.801)	(-1.971)
lnmwage	0.129***	0.113***	0.111***	0.119***	0.118***
	(8.173)	(6.492)	(6.205)	(6.813)	(6.796)
st_ratio	-0.141	0.0653	-0.0133	-0.00773	0.194
	(-0.959)	(0.442)	(-0.0842)	(-0.0491)	(1.635)
teachq	0.364	0.501**	0.508**	0.500**	0.383
	(1.425)	(2.003)	(2.011)	(2.060)	(1.590)
parentDon			0.0413		
			(1.296)		
moved				0.0554***	
				(3.838)	
cbr					0.127**
					(2.309)
Observations	843	843	843	843	843
dispersion		0.810	0.805	0.808	0.809
AIC	1843	1748	1747	1742	1745
N_clust	77	77	77	77	77

*** p<0.01, ** p<0.05, * p<0.1

z statistics in parentheses

Table 7-Gpoisson: Females 25-35 in Urban Settlements

VARIABLES	(1) All ch: Poisson	(2) All ch: Gpoisson	(3) parent donation	(4) moved	(5) CBR
year	-121.2***	-79.23***	-80.45***	-80.25***	-68.42***
	(-5.089)	(-3.084)	(-3.099)	(-3.119)	(-2.833)
HHinc	-0.228***	-0.165***	-0.179***	-0.171***	-0.160***
	(-3.653)	(-3.515)	(-3.222)	(-3.502)	(-3.522)
lnmwage	0.134***	0.0985***	0.103***	0.104***	0.107***
	(5.363)	(3.615)	(3.573)	(3.911)	(3.964)
st_ratio	-0.212	0.205	0.118	0.0705	0.383**
	(-1.162)	(1.173)	(0.539)	(0.421)	(2.123)
teachq	0.274	0.486*	0.495*	0.479*	0.287
	(0.976)	(1.716)	(1.730)	(1.710)	(1.002)
parentDon			0.0385		
			(0.951)		
moved				0.0762***	
				(3.016)	
cbr					0.168***
					(2.681)
Observations	401	401	401	401	401
dispersion		0.764	0.763	0.760	0.761
N_clust	69	69	69	69	69
AIC	939.3	872.6	873.5	868.3	870.5

*** p<0.01, ** p<0.05, * p<0.1

z statistics in parentheses

Table 8-Gpoisson: Females Ages 25-35 in Urban Settlements

VARIABLES	(1) Baseline	(2) female wage	(3) female wage and educ	(4) oblast and settlement type	(5) language	(6) language and religion	(7) agindust	(8) health	(9) medical costs	(10) marital
year	-81.66***	-64.52***	-51.64	-78.99***	-82.80***	-81.62***	-84.85***	-84.07***	-81.64***	-81.65***
	(-3.114)	(-2.608)	(-0.435)	(-3.068)	(-3.418)	(-3.410)	(-3.195)	(-3.312)	(-3.330)	(-3.137)
HHinc	-0.154***	-0.122***	-0.122***	-0.150***	-0.164***	-0.170***	-0.142***	-0.147***	-0.140***	-0.160***
	(-3.121)	(-2.582)	(-2.583)	(-3.000)	(-3.243)	(-3.322)	(-2.832)	(-2.982)	(-2.995)	(-3.176)
lnmwage	0.0850***	0.0828***	0.0826***	0.0848***	0.0965***	0.0946***	0.0869***	0.0805***	0.0819***	0.0917***
	(2.972)	(2.816)	(2.805)	(2.981)	(3.452)	(3.418)	(3.075)	(2.843)	(2.958)	(3.205)
st_ratio	0.110	-0.00227	0.00103	0.0802	0.177	0.147	0.0713	0.151	0.0842	-0.0197
	(0.657)	(-0.0141)	(0.00647)	(0.398)	(1.194)	(0.978)	(0.424)	(0.827)	(0.452)	(-0.122)
teachq	0.543*	0.520*	0.515*	0.637**	0.453	0.510	0.571**	0.584**	0.598**	0.544**
	(1.956)	(1.900)	(1.925)	(2.244)	(1.496)	(1.642)	(2.037)	(2.068)	(2.161)	(2.013)
lnfwage		-14.79***	-30.50							
		(-2.648)	(-0.230)							
educ			0.216							
			(0.117)							
oblast				-0.0524						
				(-1.045)						
settl_type				-0.202						
				(-1.064)						
language					-0.128**	-0.137***				
					(-2.442)	(-2.589)				
catholic						-0.00911				
						(-1.543)				
agindust							-0.0244*			
							(-1.819)			
health								-0.143	-0.129	
								(-0.941)	(-0.865)	
cost_med									-0.0531***	
									(-3.631)	
marital										0.191***
										(5.138)
Observations	401	401	401	401	401	401	401	401	401	401
dispersion	0.763	0.765	0.764	0.761	0.745	0.742	0.759	0.761	0.753	0.761
N_clust	69	69	69	69	69	69	69	69	69	69
AIC	880.0	878.1	880.1	882.7	874.9	875.6	878.8	878.7	874.5	876.8

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

z statistics in parentheses

Table 9-Late Births: Females 25-35 in Rural Settlements

	(1)	(2)
VARIABLES	Gpoisson	Probit
priorbirths	-0.330***	-1.274***
	(-6.610)	(-6.579)
year	-213.0***	-0.130***
	(-7.156)	(-6.055)
HHinc	-0.339***	-235.5***
	(-3.717)	(-4.698)
lnmwage	0.180***	0.177***
	(5.056)	(6.922)
st_ratio	-0.127	0.00749
	(-0.895)	(0.494)
teachq	0.590**	0.857**
	(2.128)	(2.242)
Constant		257.6***
		(6.049)
Observations	405	405
N_clust	100	100
AIC	827.7	

z statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10-Time Ratios from Hazard Estimates: Females 25-35 in Rural Settlements

	(1)	(2)
VARIABLES	1st marriage to 1st birth (gamma)	1st to 2nd birth (log-log)
year	1.003	1.189***
	(0.227)	(5.153)
HHinc	0.187	7.74e+92**
	(-0.0636)	(2.258)
lnmwage	1.013	0.955
	(0.942)	(-1.060)
mafb		1.260***
		(4.368)
teachq	1.395	0.156**
	(1.340)	(-2.053)
st_ratio	1.009	1.017
	(0.917)	(0.333)
Constant	0.0485	0***
	(-0.134)	(-5.122)
ln_sig	0.658***	
	(-8.118)	
kappa	0.703**	
	(-2.326)	
ln_gam		1.211***
		(3.787)
Observations	274	354

Robust *z* statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

All coefficients expressed time ratios, i.e. exponentiated form. Estimations for duration between first marriage and first birth only include marriages which occurred before first birth.

Table 11- Difference in means test for urban/rural teacher quality

	Village teachq	Urban teachq
Mean	0.79	0.89
ttest	15.6	

Difference in means test for young/old urban teacher quality

	Young teachq	Old teachq
Mean	0.89	0.898
ttest	1.28	

9. Appendix

The household maxmizes its utility U(N,Q,S),where N, is the number of children, Q is the quality of children, and S are all other commodities, subject to the budget constraint:

$F \geq NQ\Pi + p_N N + p_Q Q + p_S S$

First order conditions for a maximum: $U_N(N,Q,S) = \lambda[\Pi Q + p_N]$
$U_Q(N,Q,S) = \lambda[\Pi N + p_Q]$
$U_S(N,Q,S) = \lambda p_S$
$F \geq NQ\Pi + p_N N + p_Q Q + p_S S$

Taking a total derivative of 3-5 with respect to Π yields:

$$\begin{bmatrix} U_{NN} & U_{NQ} - \lambda\Pi & U_{NS} \\ U_{QN} - \lambda\Pi & U_{QQ} & U_{QS} \\ U_{SN} & U_{SQ} & U_{SS} \end{bmatrix} \begin{bmatrix} \frac{dN}{d\Pi} \\ \frac{dQ}{d\Pi} \\ \frac{dS}{d\Pi} \end{bmatrix} = \begin{bmatrix} \lambda Q \\ \lambda N \\ 0 \end{bmatrix}$$

The Bordered Hessian becomes:

$$\begin{bmatrix} 0 & Q\Pi + p_N & N\Pi + p_Q & p_S \\ Q\Pi + p_N & U_{NN} & U_{NQ} - \lambda\Pi & U_{NS} \\ N\Pi + p_Q & U_{QN} - \lambda\Pi & U_{QQ} & U_{QS} \\ p_S & U_{SN} & U_{SQ} & U_{SS} \end{bmatrix} \begin{bmatrix} 0 \\ \frac{dN}{d\Pi} \\ \frac{dQ}{d\Pi} \\ \frac{dS}{d\Pi} \end{bmatrix} = \begin{bmatrix} -NQ \\ \lambda Q \\ \lambda N \\ 0 \end{bmatrix}$$

Solving for $\frac{dN}{d\Pi}$ and $\frac{dQ}{d\Pi}$ by Cramer's rule, where Φ is the determinant of the bordered Hessian, and ϕ_{ij} are cofactors, we have:

(7) $\frac{dN}{d\Pi} = \frac{\lambda Q\phi_{22}}{\Phi} - \frac{\lambda N\phi_{32}}{\Phi} + NQ\frac{\phi_{12}}{\Phi}$

(8)$\frac{dQ}{d\Pi} = \frac{\lambda N\phi_{33}}{\Phi} - \frac{\lambda Q\phi_{23}}{\Phi} - NQ\frac{\phi_{13}}{\Phi}$

The first terms are constrained to be negative since own price effects from a change in the fixed costs of N and Q, p_N and p_Q, respectively are necessarily negative:
$\frac{dN}{dp_N} = \frac{\lambda\phi_{22}}{\Phi} < 0$ and $\frac{dQ}{dp_Q} = \frac{\lambda\phi_{33}}{\Phi} < 0$

Assuming that N and S, and Q and S, are complements, while N and Q are substitutes:

$\phi_{22} = [p_S^2 U_{QQ} + (N\Pi + p_Q)^2 U_{SS}] - [(N\Pi + p_Q)U_{QS}p_S + p_S U_{SQ}((N\Pi + p_Q)] < 0$
given that $U_{QQ} < 0$, $U_{SS} < 0$, and $U_{QS} > 0$.

$\phi_{32} = [p_S^2(U_{NQ} - \lambda\Pi) + U_{SS}(Q\Pi + p_N)(N\Pi + p_N)] - [p_S U_{NS}(N\Pi + p_Q) + p_S U_{SQ}(Q\Pi + p_N)] < 0$
if $U_{NQ} < 0$, $U_{SS} < 0$, $U_{NS} > 0$, and $U_{SQ} > 0$

Which implies that $\Phi > 0$

Solving for $\frac{dN}{dF}$ and $\frac{dQ}{dF}$ by taking total derivatives of 3-5 with respect to F yields the Bordered Hessian:

$$\begin{bmatrix} 0 & Q\Pi + p_N & N\Pi + p_Q & p_S \\ Q\Pi + p_N & U_{NN} & U_{NQ} - \lambda\Pi & U_{NS} \\ N\Pi + p_Q & U_{QN} - \lambda\Pi & U_{QQ} & U_{QS} \\ p_S & U_{SN} & U_{SQ} & U_{SS} \end{bmatrix} \begin{bmatrix} 0 \\ \frac{dN}{d\Pi} \\ \frac{dQ}{d\Pi} \\ \frac{dS}{d\Pi} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

$\frac{dN}{dF} = \frac{\phi_{42}}{\Phi} = \frac{-\phi_{12}}{\Phi}$ and $\frac{dQ}{dF} = \frac{\phi_{43}}{\Phi} = \frac{-\phi_{13}}{\Phi}$

where $-\phi_{12} = -[p_s U_{QQ} U_{NS} + U_{SQ} U_{QS}(Q\Pi + P_N) + U_{SS}(Q\Pi + p_N)(N\Pi + p_N)(N\Pi + p_N)]$
$+ [U_{QQ} U_{SS}(Q\Pi + p_N) + (U_{NQ} - \lambda\Pi)U_{QS}p_S + U_{NS}U_{SQ}(N\Pi + p_Q)]$ whose sign is ambiguous.

Finally, (7) and (8) become a system of partial differential equations for N and Q in terms of Π and F as in Rosenzweig (1982):

$(7)\frac{dN}{d\Pi} = \frac{\lambda Q\phi_{22}}{\Phi} - \frac{\lambda N\phi_{32}}{\Phi} - NQ\frac{dN}{dF}$

$(8)\frac{dQ}{d\Pi} = \frac{\lambda N\phi_{33}}{\Phi} - \frac{\lambda Q\phi_{23}}{\Phi} - NQ\frac{dQ}{dF}$

Disregarding the ambiguous sign on the income effect, and using that $\Phi > 0$, then

$\frac{dN}{d\Pi} < 0$ if the own price effect dominates from a change in Π

$\frac{dN}{d\Pi} > 0$ if the cross price effect dominates from a change in Π