

Does Economic Growth Reduce Fertility?
Rural India 1971-1999

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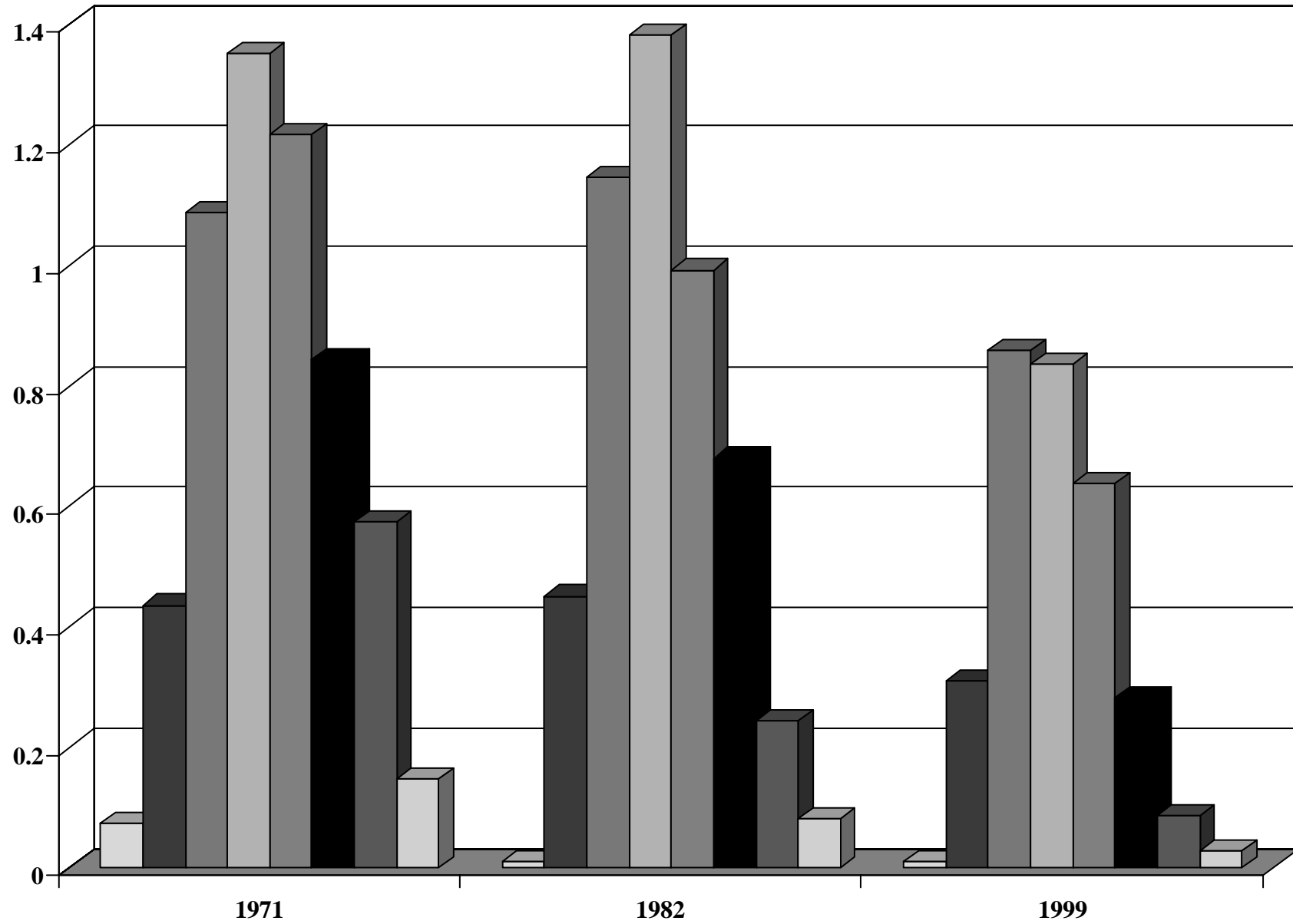
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1. Reducing fertility seen as important means to sustainable economic development
 - a. Direct policies introduced to reduce fertility
 - b. Some skepticism that economic growth will reduce fertility
 - i. Surprising given more developed countries have lower fertility
 - ii. And fertility decline has usually accompanied economic growth
 - iii. But there are significant anomalies and timing of transition doesn't quite fit.
 - iv. General view—mechanical response to lower mortality or cultural transition largely independent of economic circumstance.
 - c. Nonetheless important evidence supporting mechanisms showing how economic growth can raise costs of children.
 - i. Quality-quantity model
 - ii. Cost of time model
 - d. But what has been missing is a micro-level data set of sufficient temporal and geographical scale to assess the role of these mechanisms in explaining a sustained fertility decline

- e. Rural India is a good case study
 - i. Limited fertility declines through 1980s, substantial declines subsequently.
 - ii. Substantial regional variation in levels and changes in fertility
 - iii. Variation in changes in economic conditions due to agro-climatic conditions and state policies affecting non-farm growth

Figure 1: Period 5-year Rural Fertility Rate, 1971-1999, by Maternal Age and Year



iv. General perspective

- (1) In my view the ongoing state-level fertility declines will continue during the medium term future largely independently of trends in conventional socio-economic variables like per capita incomes and urbanisation. In other words, to a considerable extent these TFR declines now have a ‘life of their own’.” Dyson (2000)
- (2) “...fertility is declining in India primarily because of its decline among illiterate women, and they are doing so because of the diffusion of a *new reproductive idea* of having only a few children but investing more on their future.” (Italics added) Bhat (2002)
- (3) Brookins and Brookins (2002) indicate that “economic factors” explain 70% of the state level variation in fertility but female autonomy measures (considered separately) explain 84% of the state-level variation.

v. But economic factors are broad measures of economic circumstance that are poorly related to economic mechanisms and work often cross-sectional and thus reflective of cultural heterogeneity and thus not well-suited to analysis of fertility change.

- f. This paper—newly available panel data set
 - i. Panel of households rural India 1971-1999
 - ii. Simple dynamic model incorporating main economic mechanisms
 - iii. Replicate standard results in cross-section
 - iv. But after controlling for “dynasty” fixed-effects
 - (1) value of female wages, explain 39% of the decline in fertility over the 1982-1999 period
 - (2) changes in agricultural productivity and agricultural wage rates explain fully 80% of the decline
 - (3) Health centers significant effect but only explain 3.4% of the fall.
 - v. Results suggest that the process of economic growth has had a major impact on fertility in India over the last two decades.

2. Theory

- a. Maximize expected discounted utility subject to human capital production function, farm profit equation, time budget constraints for children and parents, and intertemporal budget constraint with borrowing constraint.

$$\begin{aligned}
 u_{ijxt} &= E_t \sum_{s=t}^{t+\omega-x} \beta^{s-t} u(c_{ijs}, n_{ijs}, h_{ijs}, N_{ijs-1}; v_{ijs}) \\
 &+ \sum_{s=t-x+\alpha}^{t+\omega-x} n_{ijs} (\theta_{ijs}^b r(\phi_{ijt+\omega-x}, h_{ijs}^b) + \theta_{ijs}^g r(\phi_{ijt+\omega-x}, h_{ijs}^g)) \\
 h_{ijt}^k &= h^k(t_{ijt}^{bk}, t_{ijt}^{gk}, t_{ijt}^{mhk}, t_{ijt}^{phk}, e_{ijt}^k, h_{ij}^m, h_{ij}^p) \\
 y_{ijt} &= \phi_{ijt} f(n_{ijt} \theta_{ijt}^b t_{ijt}^{bf} + t_{ijt}^{br}, n_{ijt} \theta_{ijt}^g t_{ijt}^{gf} + t_{ijt}^{gr}, t_{ijt}^{mf} + t_{ijt}^{mr}, t_{ijt}^{pf} + t_{ijt}^{pr}, A_{ijt}, h_{ij}^m, h_{ij}^p) \\
 &+ w_{ijt}^b (n_{ijt} \theta_{ijt}^b t_{ijt}^{bo} - t_{ijt}^{br}) + w_{ijt}^g (n_{ijt} \theta_{ijt}^g t_{ijt}^{go} - t_{ijt}^{gr}) + w_{ijt}^{mo} (t_{ijt}^{mo} - t_{ijt}^{mr}) + w_{ijt}^{po} (t_{ijt}^{po} - t_{ijt}^{pr}), \\
 t_{ijt}^{gg} &+ t_{ijt}^{gb} \frac{\theta_b}{\theta_g} + t_{ijt}^{gf} + t_{ijt}^{go} = T \\
 n_{ijt} \theta_{ijt}^b t_{ijt}^{mhb} &+ n_{ijt} \theta_{ijt}^g t_{ijt}^{mhg} + t_{ijt}^{mf} + t_{ijt}^{mo} = T \\
 c_{ijt} &+ p_t^e n_{ijt} (\theta_{ijt}^b e_{ijt}^b + \theta_{ijt}^g e_{ijt}^g) + s_{ijt} = y_{ijt}, \\
 A_{it} &+ s_{it} = A_{it+1}
 \end{aligned}$$

- a. Decision rules for fertility and human capital

$$n_{ijt} = n(x, A_{ijt}, N_{ijt}, h_{ij}^m, h_{ij}^p, w_{ijt}^b, w_{ijt}^g, w_{ijt}^m, w_{ijt}^f, \phi_{ijt}, v_{ijt}).$$

$$h_{ijt} = \theta_{ijt}^b h_{ijt}^b + \theta_{ijt}^g h_{ijt}^g = h(x, \theta_{ijt}^b A_{ijt}, N_{ijt}, h_{ij}^m, h_{ij}^p, w_{ijt}^b, w_{ijt}^g, w_{ijt}^m, w_{ijt}^f, \phi_{ijt}, v_{ijt}).$$

- b. Shadow price of children with human capital h and corresponding input demands

$$\pi^{k*}(h^k, p_e, w^k, w^k, w^m, w^p),$$

$$t^{mkh*}(h^k, p_e, w^b, w^g, w^m, w^p)$$

- c. First order conditions

$$0 = \frac{\partial u}{\partial n_{ijt}} + \frac{\partial V}{\partial n_{ijt}} + \theta_{ijt}^b r^b(\phi_{ijt+\omega-x}, h_{ijs}^b) + \theta_{ijt}^g r^g(\phi_{ijt+\omega-x}, h_{ijs}^g) - \lambda(\theta_{ijt}^b \pi_{ijt}^b + \theta_{ijt}^g \pi_{ijt}^g)$$

$$u_{ijxt} = \frac{\partial u}{\partial h_{ijt}} + n_{ijt} \left(\theta_{ijt}^b \frac{\partial r^b}{\partial h_{ijt}^b} + \theta_{ijt}^g \frac{\partial r^g}{\partial h_{ijt}^g} \right) - \lambda n_{ijt} \left(\theta_{ijt}^b \frac{\partial \pi^b}{\partial h_{ijt}^b} + \theta_{ijt}^g \frac{\partial \pi^g}{\partial h_{ijt}^g} \right)$$

d. Key results

- i. Female wage raises costs of children

$$\frac{d\pi^{k*}}{dw^f} = t^{mkh*} > 0$$

- ii. Girl wage raises cost of boy children

$$\frac{d\pi^{b*}}{dw^g} = t^{bg*} > 0$$

- iii. Boy wage lowers cost of boy children

$$\frac{d\pi^{b*}}{dw^b} = t^{bb*} - T < 0$$

- iv. If different roles girl and boy wage may have opposite effects on fertility
- v. Land values raise cost of human capital if imperfect labor market
- vi. Technology raises returns to human capital. Thus, given finding that technology increases schooling, finding of a negative effect of technology on quality-quantity as source of fertility decline.

1. Data–
 - a. NCAER ARIS-REDS 1971-1999
 - i. Comprehensive village and panel survey
 - ii. Demography, economic characteristics and village environment
 - iii. 240 village total over 1971-1999 (71, 82, 99)
 - (1) 1971 (the Additional Rural Income Survey (ARIS)), includes 4,527 households in 259 villages
 - (2) 1982 round (Rural Economic Development Survey (REDS)), 250 of the original 259 villages were revisited (households intact plus new sample of split offs)
 - (3) 1999 round (REDS 1999), all of the 1971 villages were surveyed includes 7474 households
 - iv. all split-off households residing in the same villages, plus a small random sample of new households.

- b. Variables characterizing fertility and child investments are taken from information provided by all married women aged 15-59 residing in the surveyed households in each of the survey rounds.
 - i. 5405 married women in 1971,
 - ii. 5503 married women in 1982,
 - iii. 10,019 married women in 1999.
 - iv. School enrollment available at child level for 1982 and 1999 but not 1971 so household level analysis 5-14 standardizing for age using 1971 weights (Figure 2)

c. Economic variables

i. Agricultural productivity

- (1) Laspeyres-weighted index for four HYV crops - corn, rice, sorghum and wheat - of output per acre on irrigated lands.
- (2) “best” or maximal yields that villagers could obtain using the new seeds. (Figure 3)
- (3) Predict best yields based on IADP, crop variables account for over 38% of the variation across villages and time. Table A.

- ii. Wage by gender and age (adult/child)
 - (1) 1982 and 1999, wages by crop (and by task in 1999) were collected at the village level. Crop-area (crop and task) weighted average wages by age and gender were then constructed for these two years.
 - (2) In 1971 earnings by sector and time worked were reported on an individual basis. These individual reported wage data were averaged for the different demographic groups and then aggregated at the village level (Figure 4)
 - (3) Land wealth. Total value of landholdings, in 1982 rupees, for each household in each of the three survey rounds.

Figure 2: Fertility and School Enrollment Rates, by Year: 1971-1999

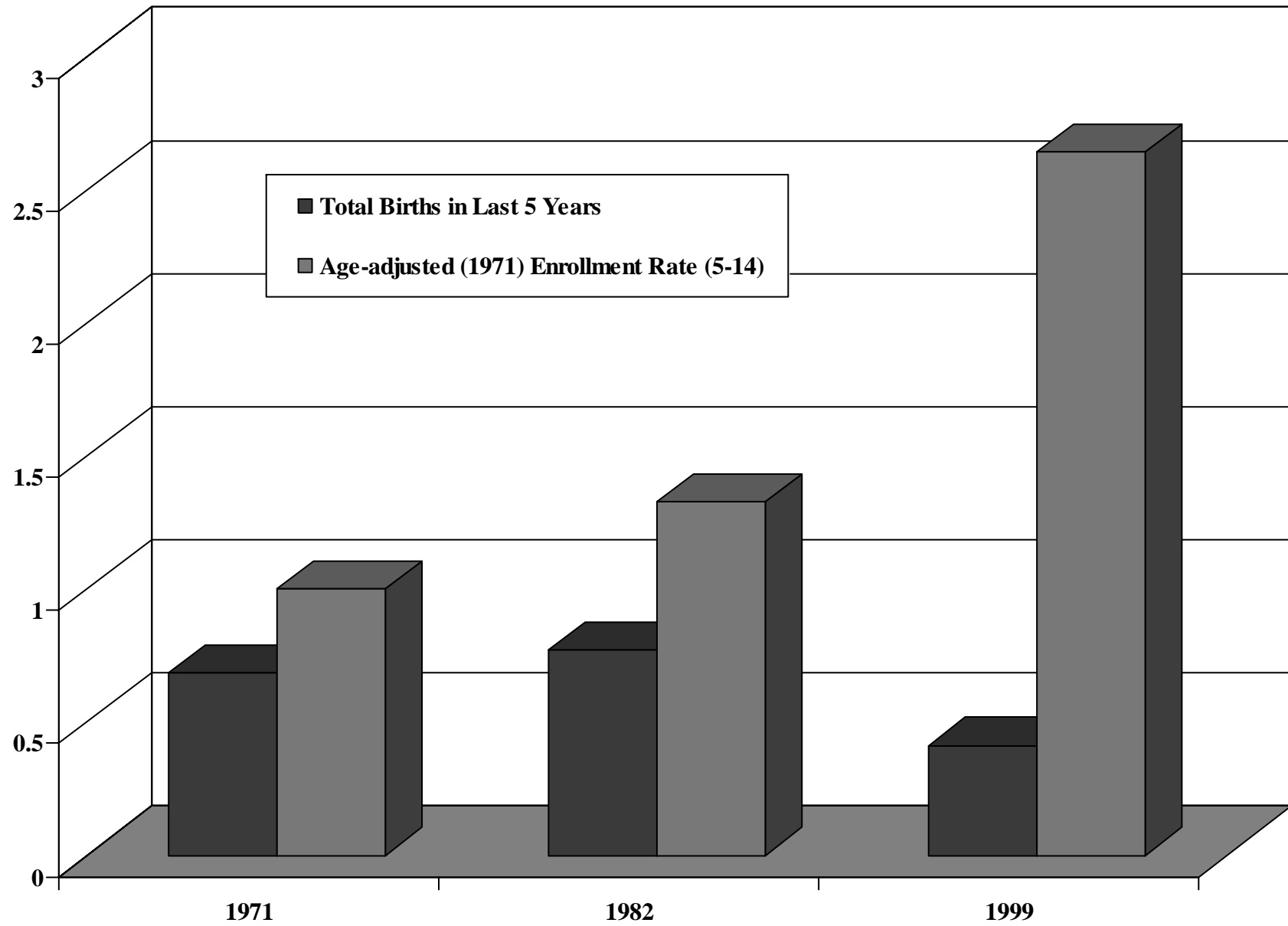


Figure 3: Average Maximum HYV Yield Index (Laspeyres-weighted HYV Crops), by Year: 1971-1999

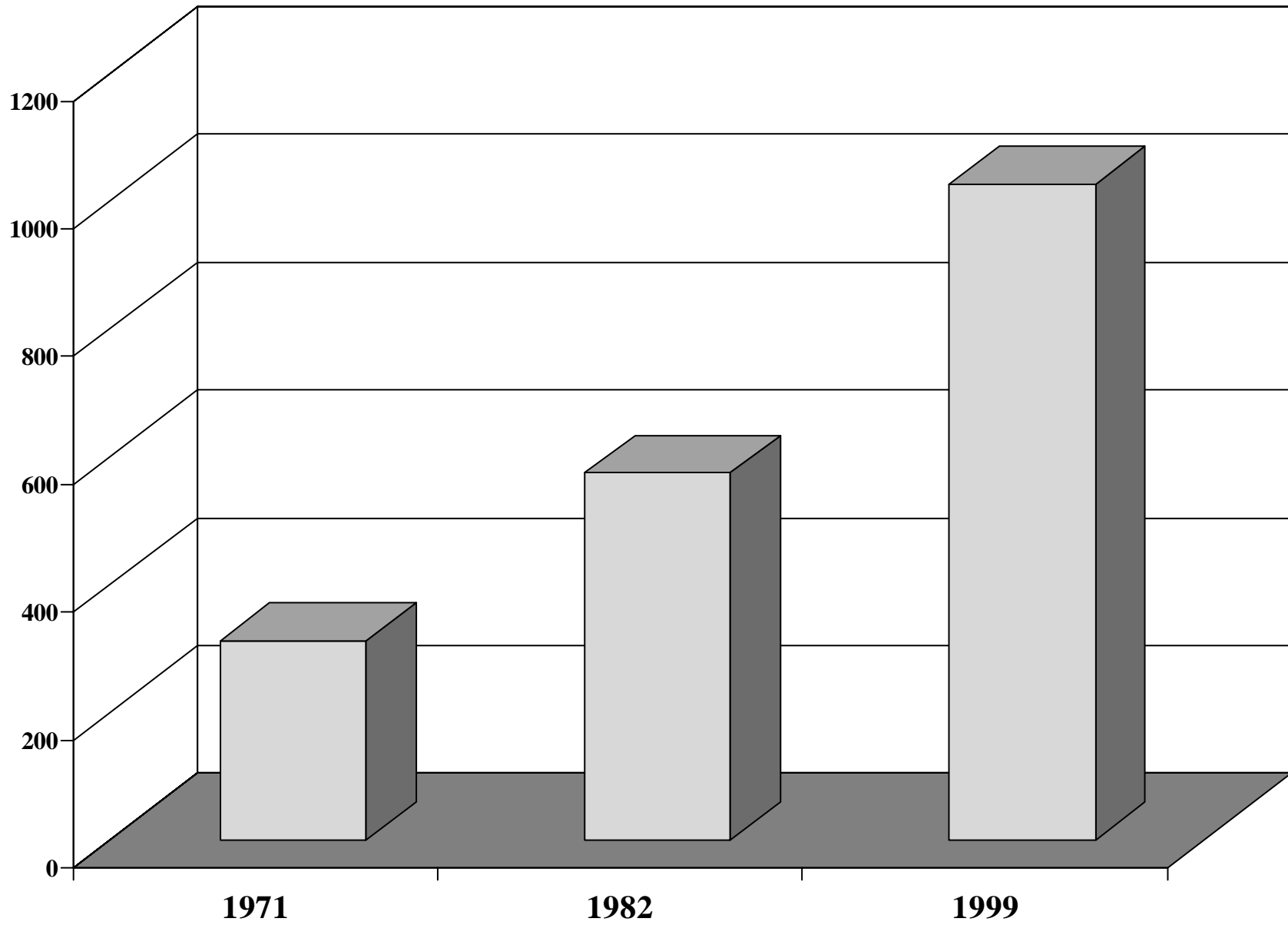


Figure 4: Real (1982 Rupees) Agricultural Wages of Adult Males and Females and Boys and Girls, by Year: 1971-1999

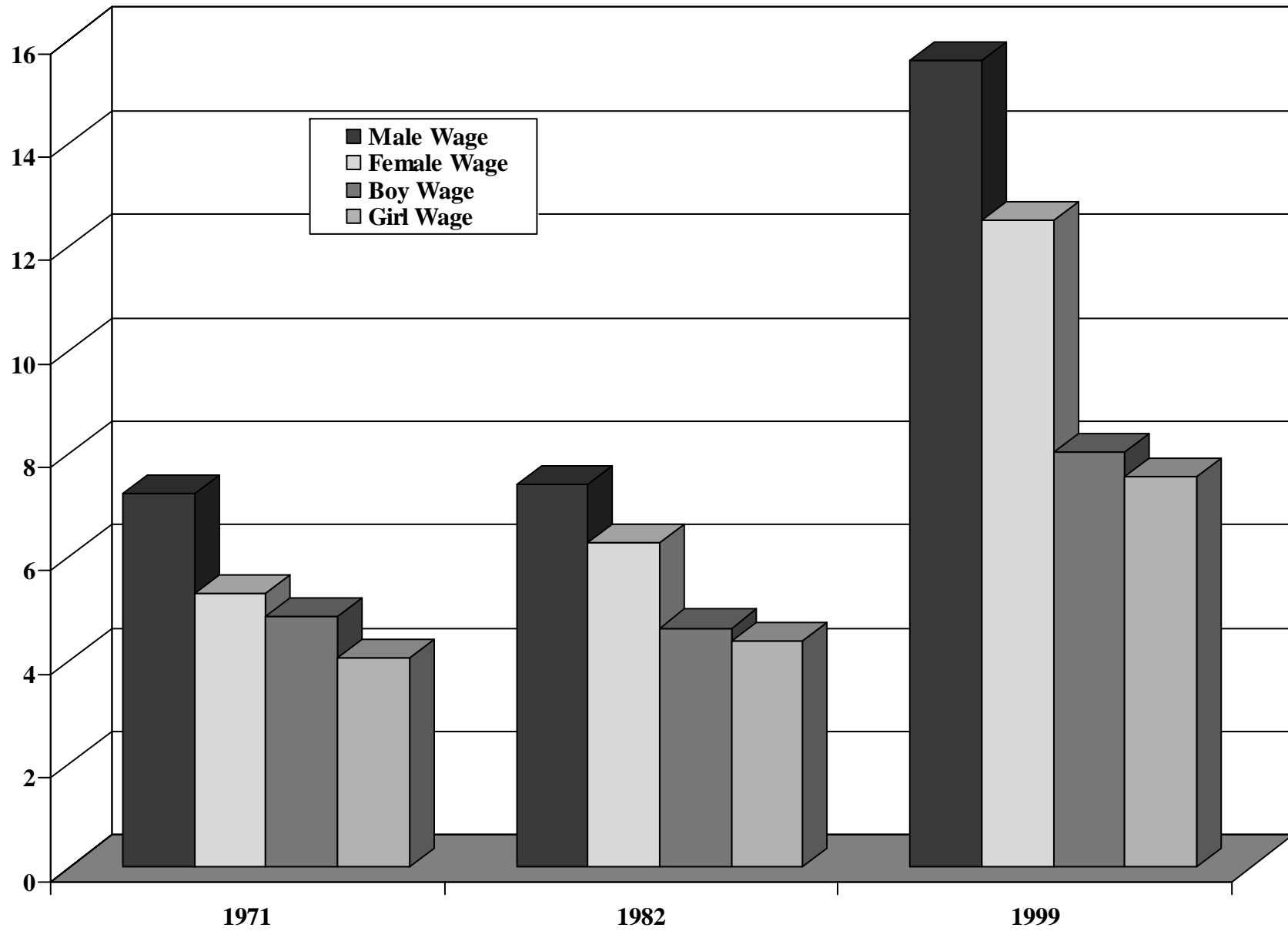


Figure 5: Parental Schooling, by Gender, Level and Year: 1971-1999

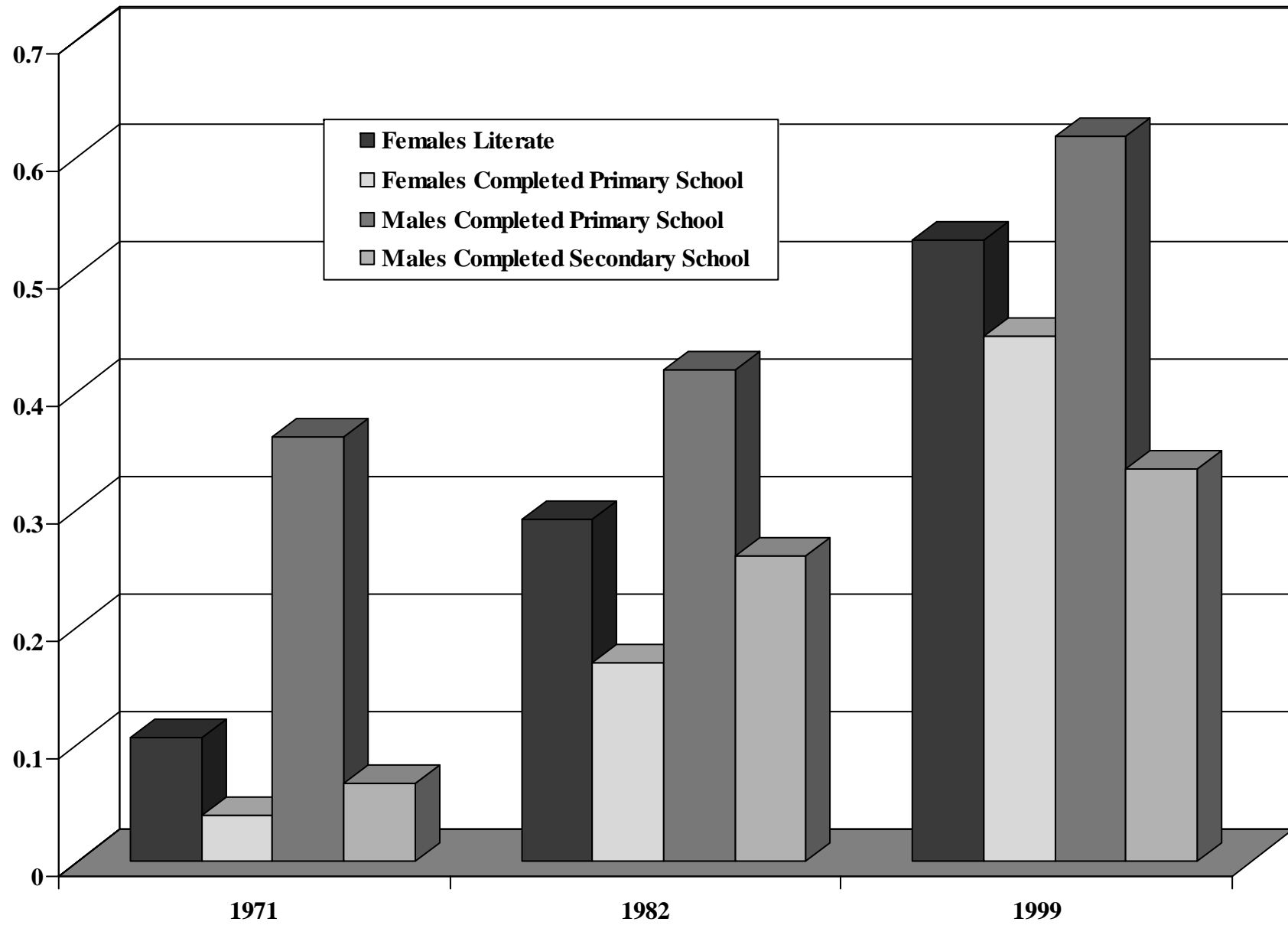


Figure 6: Proportion of Households in a Village with Family Planning and Health Facilities and Secondary Schools, by Year: 1971-1999

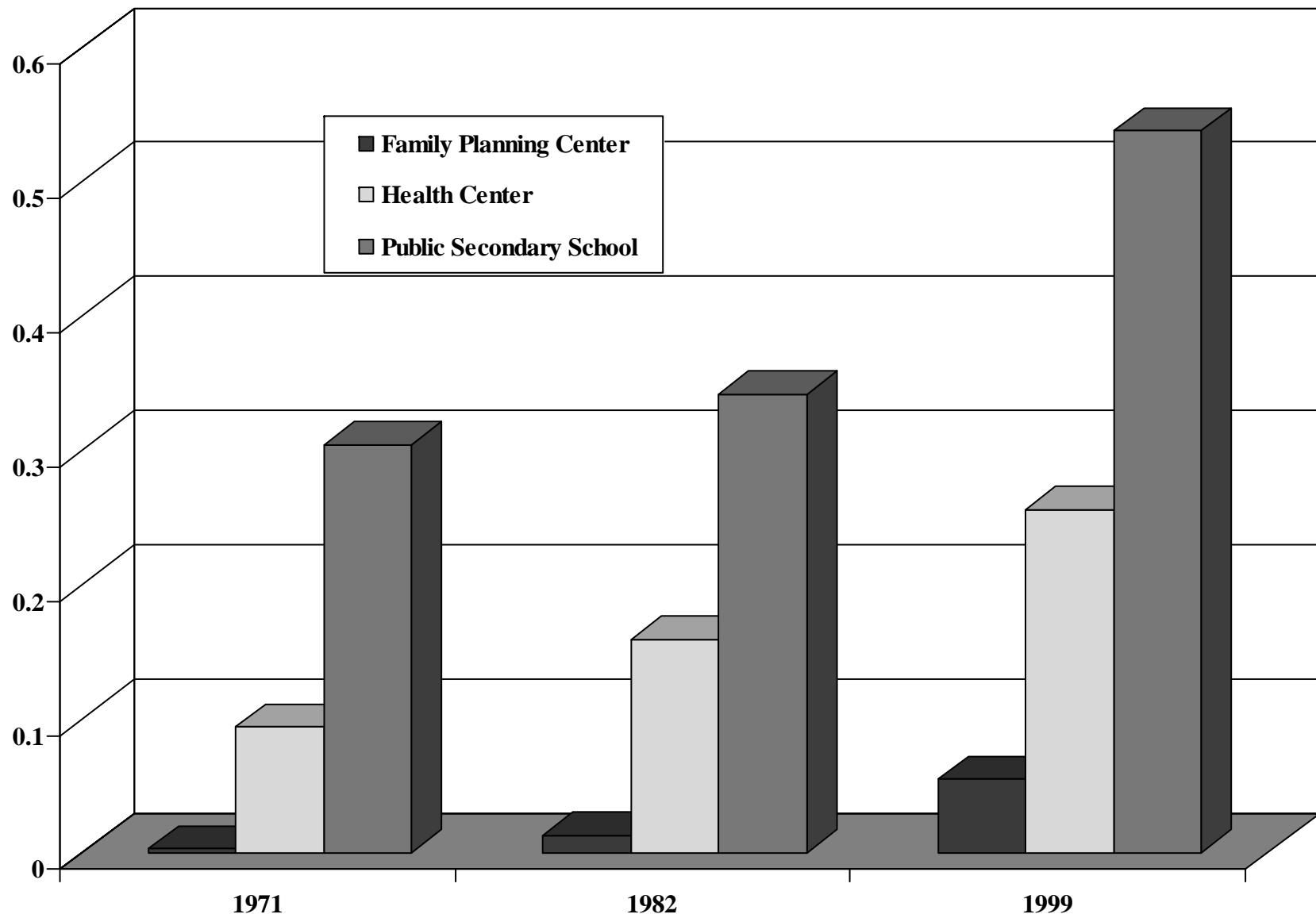


Table 1
Determinants of the Number of Live Births in Last 5 Years to Married Women Aged 15-59,
by Estimation Procedure

Variable/estimation procedure	OLS	Fixed-Effects State	Fixed-Effects Dynasty
Log maximum HYV yield in village	-.0630 (.0685)	-.116 (.0724)	-.185 (.0766)
Log male wage	-.0647 (.0662)	.0681 (.0576)	-.0390 (.0471)
Log female wage	.0185 (.0479)	-.0780 (.0382)	-.0711 (.0363)
Log male child wage	.0187 (.0210)	.0109 (.0243)	.0484 (.0256)
Log female child wage	.00637 (.0221)	-.0220 (.0171)	-.0458 (.0241)
Log value of landholdings	-.00166 (.00193)	-.00324 (.00184)	.00290 (.00236)

Mother literate	-.0578 (.0246)	-.0301 (.0257)	-.0236 (.0299)
Mother completed primary school	-.00612 (.0261)	-.00497 (.0256)	.0271 (.0301)
Father completed primary school	-.00315 (.0206)	-.00868 (.0215)	.00866 (.0229)
Father completed secondary school	-.00271 (.0175)	-.00344 (.0167)	.0105 (.0205)
Health center in village	-.0324 (.0180)	-.0413 (.0164)	-.127 (.0435)
Family planning center in village	.0251 (.0313)	.0183 (.0224)	.0923 (.0784)
Secondary school in village	.0328 (.0168)	-.116 (.0275)	.0271 (.0164)
Proportion district urban	-.189 (.0983)	-.152 (.0895)	-1.21 (.608)
Year = 1982	.192 (.0790)	.169 (.0633)	.147 (.0635)

Year = 1999	.160 (.122)	.0946 (.117)	.0273 (.107)
Number of mother-years	18,896	18,896	18,896

All specifications also include children ever born as of 5 years ago, mother's current age and mother's age squared. All estimated standard errors corrected for clustering by state and year.

d. Household linkages.

i. Households linked across time based on first entry into sample and including split-offs

ii. Controls for unobservables that are persistent over time within patrilineal descendent groups

2. Results (Table 2)

Table 2
Determinants of Age-Adjusted School Attendance Rates of Children Aged 5-14,
by Estimation Procedure

Variable/estimation procedure	OLS	Fixed-Effects State	Fixed-Effects Dynasty
Log maximum HYV yield in village	.131 (.162)	.469 (.144)	.681 (.197)
Log male wage	.388 (.165)	-.0501 (.141)	-.0282 (.149)
Log female wage	-.0659 (.146)	.196 (.121)	.111 (.0863)
Log male child wage	.0625 (.109)	.0835 (.0838)	.0504 (.0724)
Log female child wage	-.0659 (.147)	.196 (.121)	-.0509 (.0700)
Log value of landholdings	.00536 (.00399)	.00823 (.00349)	.00601 (.00552)

Mother literate	.555 (.0348)	.413 (.0485)	.302 (.0536)
Mother completed primary school	-.0350 (.0527)	-.0672 (.0392)	-.0779 (.0511)
Father completed primary school	.304 (.0471)	.330 (.0454)	.166 (.0348)
Father completed secondary school	.0935 (.0630)	.0153 (.0528)	.0230 (.0576)
Proportion of children boys	.217 (.0499)	.240 (.0506)	.269 (.0457)
Health center in village	.147 (.0416)	.114 (.0431)	-.0567 (.0874)
Family planning center in village	-.00273 (.0923)	.0145 (.0971)	-.0629 (.168)
Secondary school in village	-.00273 (.0977)	-.00568 (.0432)	.00642 (.0777)
Proportion district urban	.838 (.255)	.647 (.260)	-2.21 (1.14)

Year = 1982	.110 (.143)	-.227 (.135)	-.278 (.152)
Year = 1971	.397 (.250)	-.0119 (.222)	.140 (.267)
Number of household-years	9,158	9,158	9,158

All specifications also include children ever born, mother's current age and mother's age squared.
All estimated standard errors corrected for clustering by state and year.

3. Explainng change

- a. The growth in health center coverage in rural Indian villages, given its estimated effect, therefore can only account for 3.4% ($.0965 * (-.127) / .358$) of the fertility decline.
- b. Female literacy increased by 81% (Figure 5) between 1982 and 1999, but no evidence that female literacy affects fertility net of dynasty unobseables effects.
- c. Rise in agricultural wage rates accounts for 39% of the rural fertility decline between 1982 and 1999 (20% of the decline is explained by the doubling of the female wage alone).
- d. The 79% increase in HYV yields accounts for another 41% of the decline in the birth rate, net of the wage rate effects. Note that real agricultural wage rates did not increase significantly in the 1971-1982 period.

Table 3
FE-Village Estimates, 1971-1999: Determinants of Log Agricultural Wages
for Men Women, Boys and Girls

Variable/Group	Men	Women	Boys	Girls
Log maximum HYV yield in village	.332 (.0814)	.276 (.0969)	.347 (.150)	.0229 (.173)
Log population in village	-.0169 (.00465)	-.00884 (.00553)	-.0107 (.00773)	-.00606 (.00894)
Public secondary school in village	.0187 (.0311)	.0209 (.0371)	.0404 (.0539)	.105 (.0625)
Proportion district urban	.269 (2.18)	-.0652 (2.60)	-2.57 (3.53)	-1.46 (4.14)
Year = 1982	-.577 (.0619)	-.569 (.0737)	-.391 (.116)	-.546 (.129)
Year = 1971	-.342 (.117)	-.496 (3.56)	.170 (.218)	-.557 (.251)
N	717	717	668	682

Estimated coefficient standard errors in parentheses

- e. Indirect effects of HYV growth.
 - i. HYV yields pushed up wages significantly -
 - (1) the point estimates suggest that the 79% increase in HYV yields between 1982 and 1999 increased real male wages by 26%, real female wages by 22% and the real wages of boys by 27% in that period.
 - (2) Increase in HYV yields over the 1982-1999 period accounts for 47.3% of the fall in rural fertility, of which 87% of that is the direct effect net of wages.

Table 4
FE-Dynasty Estimates: Reduced-Form Determinants of Fertility (1971-99)
and Maternal Labor Supply (1982-99)

Variable	Live Births in Last 5 Years	Log Hours Worked Per Day
Log maximum HYV yield in village	-.0708 (.0343)	.441 (.141)
Health center in village	-.0997 (.0404)	-.00671 (.0224)
Family planning center in village	.0997 (.0530)	.0963 (.0377)
Secondary school in village	.0406 (.0215)	-.0299 (.0232)
Proportion district urban	-1.09 (.463)	-.263 (.300)
Year = 1999	-.245 (.0412)	-.370 (.105)
Mother's age	-.133 (.00819)	.0195 (.00583)
Mother's age squared	.00111 (.00009)	-.000178 (.00007)
Number of mother-years	16,261	10,631

All estimated standard errors corrected for clustering by state and year.

4. Conclusion

- a. Results suggest that when economic growth increases shadow price of fertility and these changes play a very important role in fertility decline
- b. Results do not say that there have not been important structural changes that impact fertility decline.
 - i. Development process importantly changes organization of economic activity
 - ii. This change in economic activity affects childbearing incentives—for example a rise in non-farm activities may have increased demand for female labor outside the home, which is evident in female wages.
 - iii. But basic nature of fertility decision making given incentives need not change importantly for substantial changes in fertility to arise.
- c. Contributions may be larger given rising returns to human capital outside of rural areas. We see large increases but have no way of robustly identifying effects as they arise outside of the village—e.g., through growth in the tradable service sector.
 - i. The importance of these effects are likely to rise over time as migration rises.
 - ii. This process of increased market integration may help to understand why identifying effects of economic growth on fertility decline can be difficult.
 - iii. Requires not only continued collection of panel data but development of new methodological approaches as well.

Table A

Random-Effects Estimates: Determinants of Log Maximum HYV Yield Index, 1971-1999

Variable	
Proportion village acreage planted in wheat in 1968* (Year = 1971)	1.48 (.302)
Wheat * (Year = 1982)	-.875 (.383)
Wheat * (Year = 1999)	-1.22 (.390)
Proportion village acreage planted in rice in 1968* (Year = 1971)	.318 (.160)
Rice * (Year = 1982)	-.113 (.204)
Rice * (Year = 1999)	-.194 (.202)
IADP * (Year = 1971)	.285 (.123)
IADP * (Year = 1982)	-.291 (.157)
IADP in 1971* (Year = 1999)	-.344 (.158)

Year = 1971	5.05 (.0844)
Year = 1982	.903 (.106)
Year = 1999	1.67 (.106)
R^2	.382
Number of villages	240
Number of observations	702

Estimated coefficient standard errors in parentheses.