Microeconometric Evidence on the Role of Human Capital in the Growth Process

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1. Most popular wage function (Mincer wage function). For country j:

$$W(S_i)_j = W(0)_j e^{\beta(j)S(i)}$$

Based on arbitrage model (Adam Smith) and time-discounting:

A. Define lifetime income y for infinite-lived agent with schooling S_i

$$y(S_i) = \int_S W(S_i)_j e^{-r(j)t} dt$$

where r(j) = discount rate in j

assuming W=0 when schooling is being acquired

B. In equilibrium, lifetime incomes for all persons at any schooling level must be equal (arbitrage assumption):

$y(S'_i) = y(S_i)$ for any S, S', including S=0

therefore $\beta_j = r_j$

What is most important in accounting for differences in the productivity of schooling across countries?

Marginal product of worker of given schooling S in country *j*:

$$\partial Q_j/\partial L_j = w_j = w(0)_j e^{\beta(j)S}$$

Addition to marginal product from increasing schooling by one unit:

$$\partial^2 Q_j/\partial L_j \partial S = [w(0)_j e^{\beta(j)S}]\beta(j)$$

Appendix B: 52-country sample of Mincer regression coefficients

COUNTRY	EXP	EXP^2	S	YEAR	#OBS	REFERENCE
Argentina	.052	-.00070	.107	1989	2965	P
Australia	.064	-.00090	.064	1982	8227	P
Austria	.039	-.00067	.039	1987	229	P
Bolivia	.046	-.00060	.073	1989	3823	P
Botswana	.070	-.00087	.126	1979	492	P
Brazil	.073	-.00100	.154	1989	69773	P
Britain	.091	-.00150	.097	1972	6873	P
Canada	.025	-.00046	.042	1981	4642	P
Chile	.048	-.00050	.121	1989	26823	P
China	.019	-.00000	.045	1985	145	P
Colombia	.059	-.00060	.145	1989	16272	P
Costa Rica	.042	-.00050	.105	1989	6400	P
Cote d'Ivoire	.053	-.00008	.207	1985	1600	P
Cyprus	.092	-.00140	.098	1984	3178	P
Denmark	.033	-.00057	.047	1990	5289	R&S
Dominican Republic	.055	-.00080	.078	1989	436	P
Ecuador	.054	-.00080	.098	1987	5604	P
El Salvador	.041	-.00050	.096	1990	4094	P
Greece	.039	-.00088	.027	1985	124	P
Guatemala	.044	-.00060	.142	1989	8476	P
Honduras	.058	-.00070	.172	1989	6575	P
Hungary	.034	-.00059	.039	1987	775	P
India	.041	-.00050	.062	1981	507	P
Indonesia	.094	-.00100	.170	1981	1564	P
Ireland	.061	-.00100	.079	1987	531	C&R
Israel	.029	-.00046	.057	1979	1132	P
Italy	.010	-.00027	.028	1987	197	P
Jamaica	.083	-.00110	.280	1989	1172	P
Kenya	.044	-.00200	.085	1980	1600	A&S
South Korea	.082	-.00140	.106	1986	4800	P
Malaysia	.013	-.00004	.094	1979	605	P
Mexico	.084	-.00100	.141	1984	3425	P
Morocco	.068	-.00070	.095	1970	2422	P
Netherlands	.035	-.00049	.066	1983	1888	P
Nicaragua	.050	-.00080	.097	1978	962	P
Pakistan	.106	-.00060	.097	1979	1568	P
Panama	.066	-.00080	.126	1989	5436	P
Paraguay	.058	-.00090	.103	1989	1084	P
Peru	.053	-.00070	.085	1990	1625	P
Philippines	.023	-.00060	.119	1988	4283	P
Poland	.021	-.00036	.024	1986	5040	P
Portugal	.025	-.00040	.094	1985	21823	P
Singapore	.062	-.00100	.113	1974	1247	P
Spain	.049	-.00060	.130	1990	635	AR&S
Sweden	.049	-.00000	.026	1981	2996	A
Switzerland	.056	-.00069	.072	1987	304	P
Tanzania	.041	-.00100	.067	1980	1522	A&S
Thailand	.071	-.00088	.091	1971	3151	C
Uruguay	.051	-.00070	.090	1989	6567	P
USA	.032	-.00048	.093	1989	8118	K&P
Venezuela	.031	-.00030	.084	1989	1340	P
West Germany	.045	-.00077	.077	1988	2496	K&P

What is the cross-country variation in base wages?

Estimate Mincer equation for workers from around the world:

Taking logs:

$$\mathrm{Ln}W_{ij} = \ln W(0)_j + \beta_j S_{ij}$$

With workers' wages and schooling from different countries, country dummy variable identify the country-specific $\ln W(0)_j$

Estimates for 131 countries from home-country work histories for over 3,400 respondents in the New Immigrant Survey

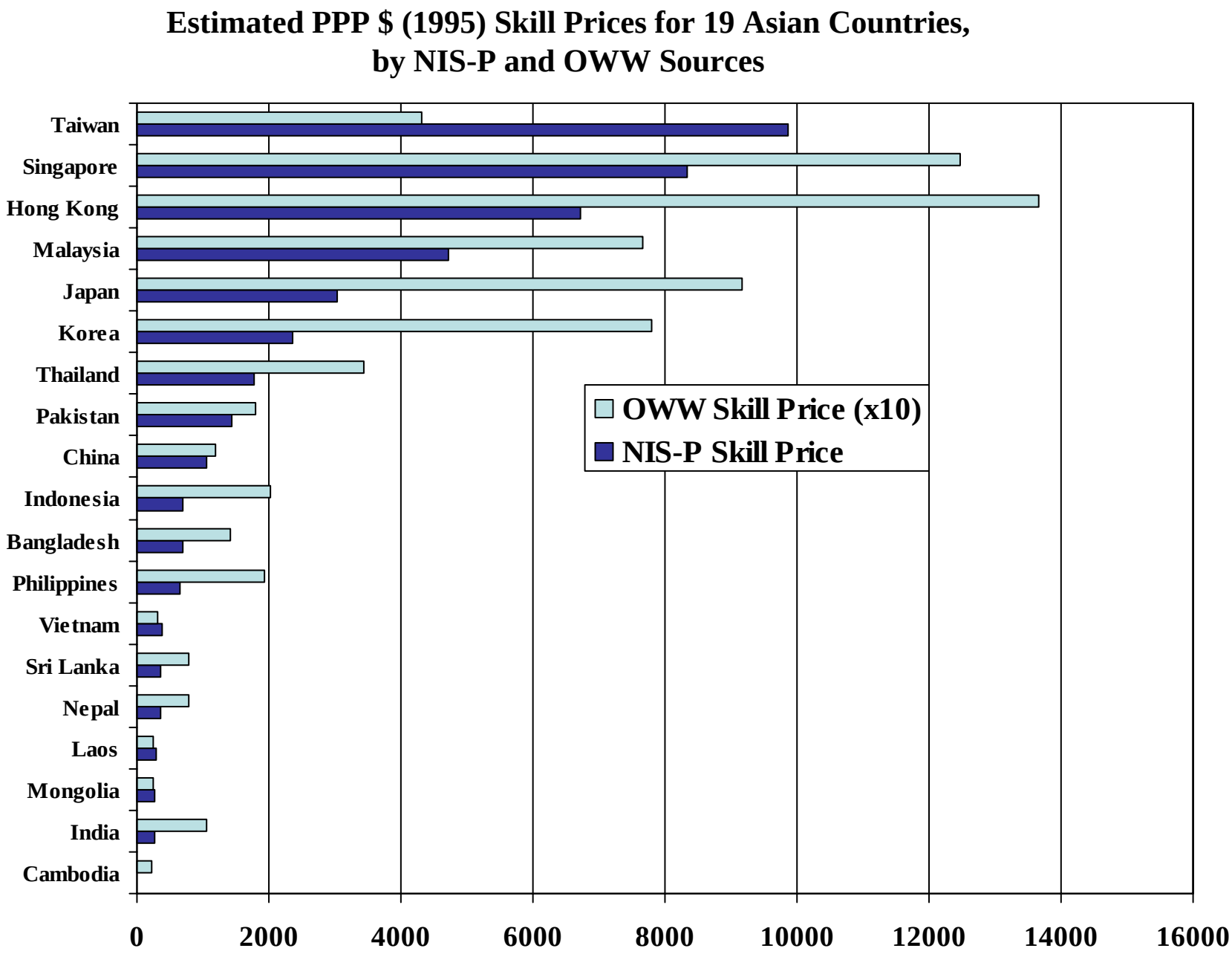
No statistically significant difference in the β_j's

Large and significant differences in the base wages

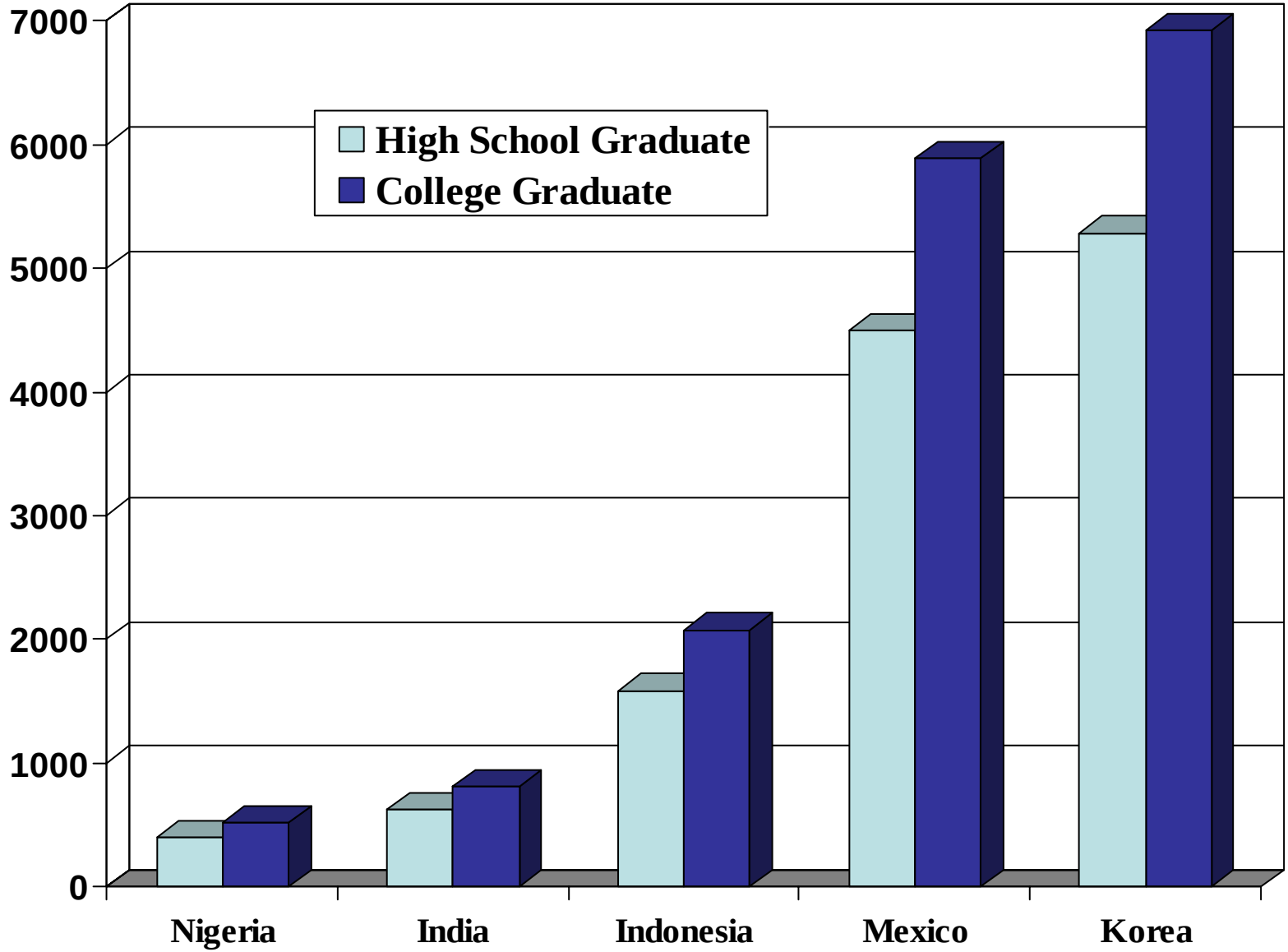
Marginal additions to output per worker from increasing schooling differ substantially: bigger impact in high base-wage countries, not poor countries

Table 4
FE-Country Log Wage Regression Coefficients:
Log Hourly Wage at the Last Job Before Coming to the United States (Mincer Test)

Sample	All Immigrants		College Grad	No College
Origin-country variable	(1)	(2)	(3)	(4)
Years of schooling completed	.0968 (12.04)	.0882 (7.79)	.0250 (0.22)	.0533 (0.98)
Years of schooling*any ranked universities in country	--	.149 (2.19)	.448 (1.97)	.0396 (0.27)
Years of schooling*mean rank of universities in country	--	-.00127 (1.98)	-.00428 (2.20)	-.00026 (0.19)
Age at last job	.123 (7.10	.125 (7.21)	.0717 (2.71)	.0459 (1.84)
Age at last job squared	-.00142 (7.00)	-.00144 (7.08)	-.0010 (3.06)	-.00065 (2.27)
R^2	.222	.223	.224	.244
Number of workers	3,364	3,364	1,605	1,739
Number of sending countries	131	131	116	114


Estimated PPP $ (1995) Skill Prices for 19 Asian Countries,
by NIS-P and OWW Sources
Taiwan
Singapore
Hong Kong
Malaysia
Japan
Korea
Thailand
Pakistan
China
Indonesia
Bangladesh
Philippines
Vietnam
Sri Lanka
Nepal
Laos
Mongolia
India
Cambodia
OWW Skill Price (x10)
NIS-P Skill Price
0
2000
4000
6000
8000
10000
12000
14000
16000

Estimated (Purchasing-Power Adjusted 1996) Earnings of High School and College Graduates, Across Selected Countries Around the World (r=.07)



Estimates of base wages or of the β_j's are not informative about the role of schooling in growth

Tests also reject the Mincer model: school quality has a direct effect on wages

What is an alternative approach to estimating wage functions?

Roy model:

Contributions of schooling to output are activity/occupation specific

Changes in occupation mix affect the "return" to (average productivity) of schooling

But these effects are transition effects - occupation distribution could stabilize, and then so will the return to schooling

What is the role of schooling and health in fostering growth? Theory

1. Exogenous growth models: growth determined by technological change

    A. Nelson and Phelps (1966): more rapid adoption of new technology facilitates growth

        Does schooling facilitate new technology adoption? Why?

2. Endogenous growth models

    A. Romer: central point is that there are learning externalities

        Accumulation of ideas, knowledge embodied in capital stock; *new* knowledge embedded in investments in new machines by individual firms spillover

        Is there learning? Is there learning from others?

        Does schooling facilitate learning?

B. Lucas: non-diminishing returns to human capital

Additions to human capital are greater the higher the level of human capital

Higher growth from greater productivity of human capital in producing human capital (also individual returns greater the higher the aggregate level of HC)

Presumes human capital is productive in general, not just in producing more human capital

Is schooling always productive?

Does a higher level of schooling facilitate the production of schooling?

No direct role for health in fostering steady-state growth models

Health determines the level of income only, unless affects learning, HC production:

What is the role of health in producing skill?

Microeconometric evidence on learning and schooling

Challenge: master how to use a new technology (Foster and Rosenzweig, 1986)

Target-input model:

$$\pi_{jt} = \lambda[\eta_j - (\theta_{jt} - \theta_{jt}^{o})^2]$$

where

π_{jt} = profits

η_j = best-use profitability of new technology

λ = operational scale parameter

θ_{jt} = input chosen at time t by farmer j

θ_{jt}^{o} = *stochastic* optimal input level at time t, normally distributed $N(\theta^*, \sigma^2_u)$

Farmers have priors over θ^*, also normally distributed with posterior variance at time t $\sigma^2_{\theta jt}$

Substituting,

$$\pi_{jt} = \lambda[\eta_j - \sigma^2_{\theta jt} - \sigma^2_u] + \varepsilon_{jt}$$

Bayesian updating implies

$$\sigma^2_{\theta jt} = 1/ (\rho_0 + \rho_l N_{jt}),$$

where

$$\rho_0 = 1/\sigma^2_0 \qquad \rho_l = 1/\sigma^2_u$$

N_{jt} = prior experience with the new technology

Implications:

1. Profits in period t depend on cumulated experience

2. Profits thus rise over time, at a diminishing rate (Bayesian)

3. Returns to learning positively related to scale and/or technology efficacy (λ)

Now, assume schooling affects the two types of precision

$\rho_0 = \rho_0(E_j), \rho_0' > 0$ [info advantage] $\rho_l = \rho_l(E_j), \rho_l' > 0$ [learning]

If schooling affects initial information *or* learning, then higher profits for the more schooled:

$$\partial\pi_{jt}/\partial E_j = \lambda[(\rho_0' + \rho_l' N_{jt})/(\rho_0 + \rho_l N_{jt})^2] > 0$$

More schooled will more likely adopt the new technology and faster, since reap higher return, and possibly from experimenting early

Can one identify the learning effect of schooling?

$$\partial\pi_{jt}/\partial E_j \partial N_{jt} = \lambda\{[-2\rho_l\rho_0' + \rho_l'(\rho_0 - \rho_l N_{jt})]/(\rho_0 + \rho_l N_{jt})^3\}$$

If $\rho_l' = 0$, no learning, then the effects of schooling diminishes with experience (schooling and experience are substitutes)

If ρ_0' small and $\rho_l' > 0$, then the effect of experience on profits is greater for the more schooled - profit trajectory steeper (faster learning)

Empirically, in increasing level of difficulty:

A. Show *no* schooling effect on productivity where nothing to learn

B. Show more schooled use more of the new technology or adopt first <u>but</u> only *if* the technology requires learning - is complex

C. Show more schooled have higher returns from new technology, <u>but</u> only *if* the technology requires learning - is complex

D. Establish learning taking place: productivity rises at a diminishing rate (Bayesian learning) with new technology

E. Show learning faster with higher level of schooling

A. There are no benefits to schooling in terms of productivity where there is nothing to learn

1. Duflo *et al.* (2011): schooling level of Kenyan farmers exhibited no effect of schooling on profitability; no reports of learning from others

Setting where no new technologies available

2. Philippine harvesters, paid with piece rate wages:

No relationship between schooling and wages

Only a relationship with height

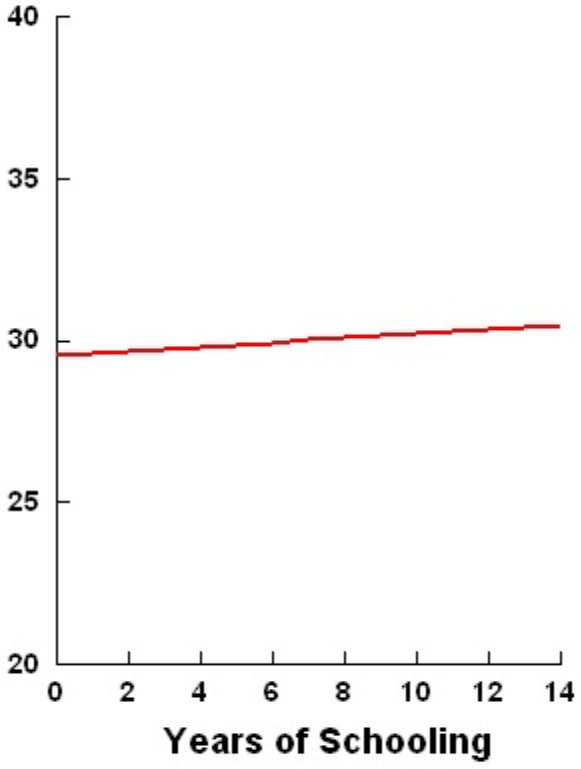
3. Adoption and use-efficacy of new contraceptive technology unrelated to schooling (Rosenzweig and Schultz, 1989)

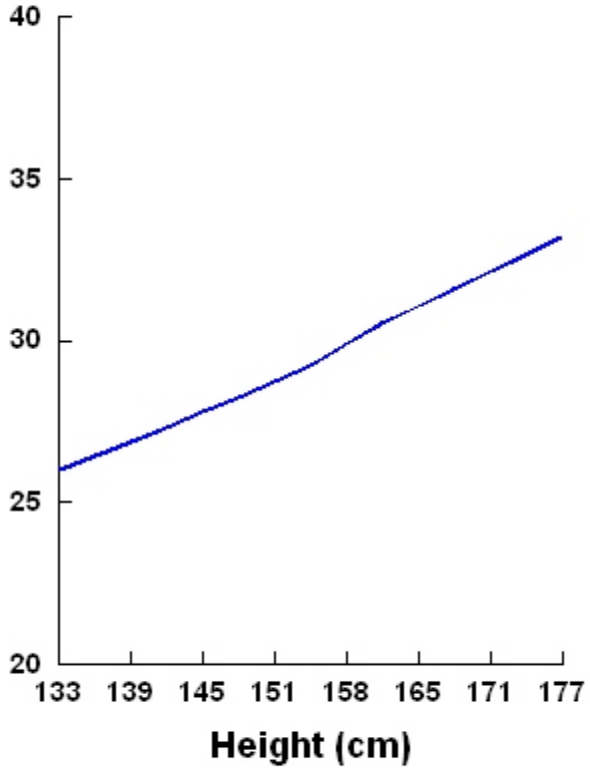
"Contraception revolution" in 1965

New technology *simplified* birth control

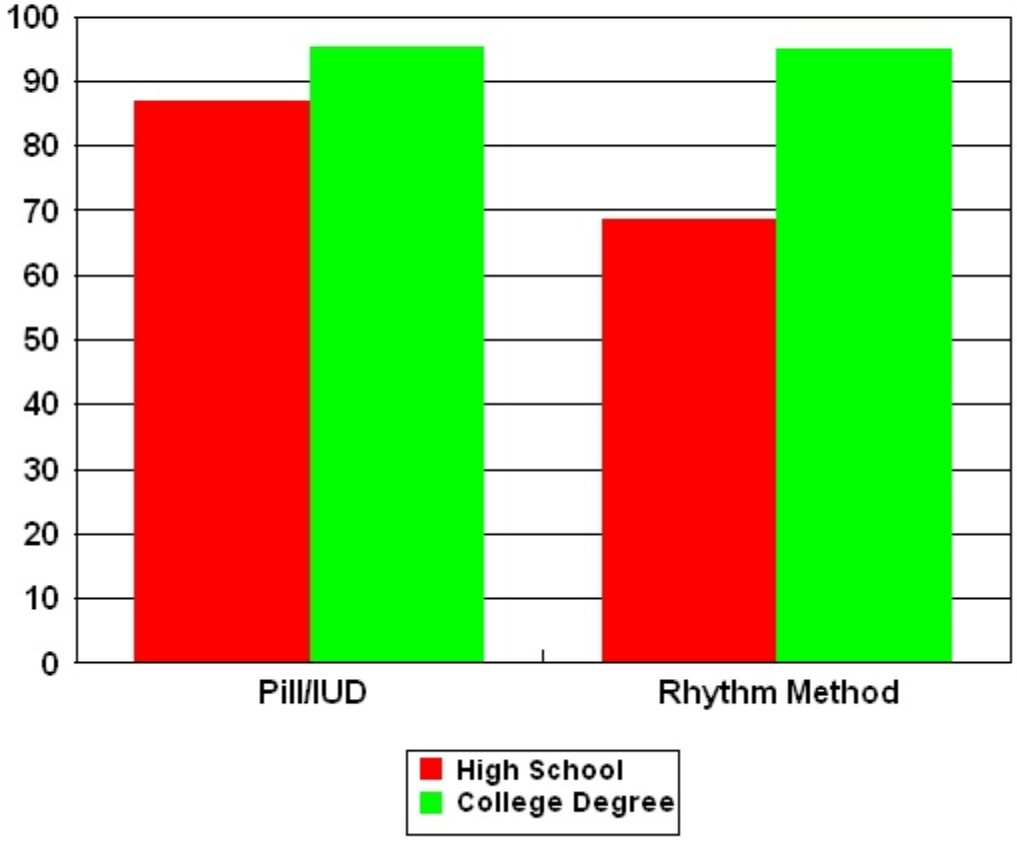
Traditional (rhythm) method was more complicated and required learning

Filippino Harvest Workers:
Effects of Schooling and Height on Piece-Rate Wages (Pesos)

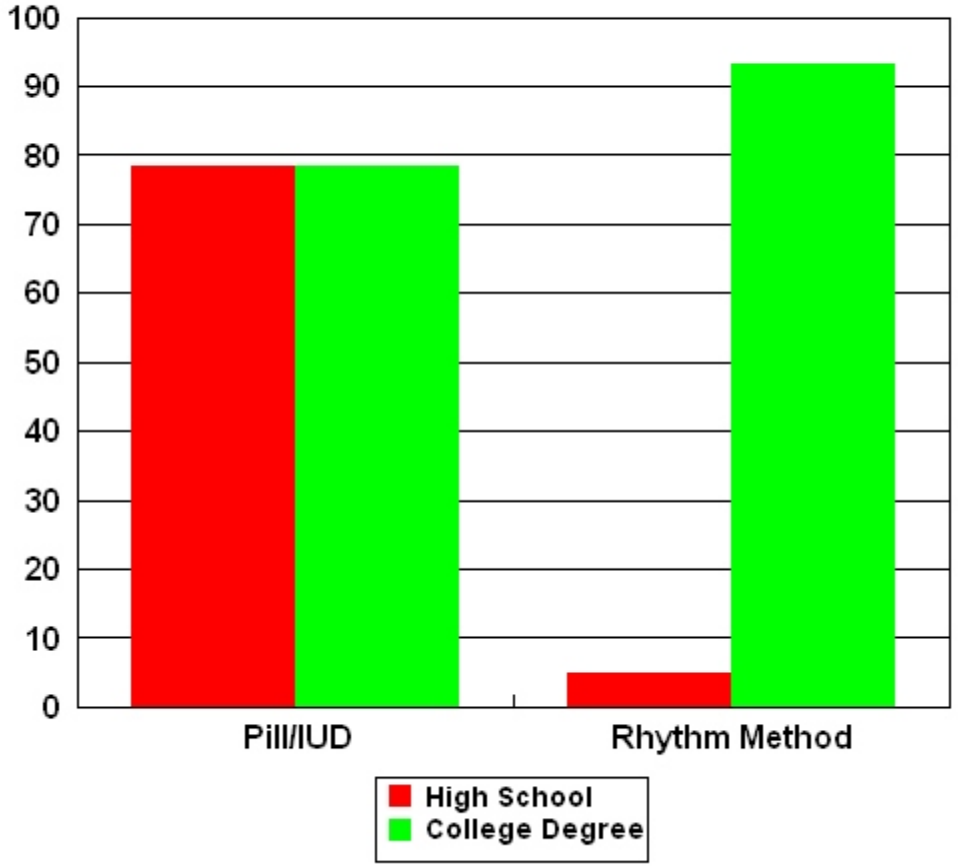




% of U.S. Women with Use-Knowledge of Contraceptives, by Contraceptive Method and Schooling



Contraceptive Use-Efficiency Among U.S. Women by Contraceptive Method and Schooling



LBD and Learning Externalities in Agriculture: Adopting and Using New HYV Seeds

1. The Indian "Green Revolution"

    1. Development of High-Yielding Varieties (HYV) of (hybrid) wheat, rice, corn outside of India in mid-1960's and *imported* to India.

        Policy example of market openness and market interference: substantial public investment - in local crop improvements

    2. Characteristics of "revolution"

        A. Continuous development of new seed varieties for original crops and new crops (e.g., sorghum, cotton). Continuing new challenges for farmers every year - whether and what to adopt, how to use.

        B. HYV seeds more sensitive to water, fertilizer than traditional seed varieties.

        C. HYV seeds only suitable to particular regions, given B.

        D. Because of the above, enormous growth in crop yields on average, but uneven across regions and across farmers.

    A second green revolution - for Africa? - GMO's, but...

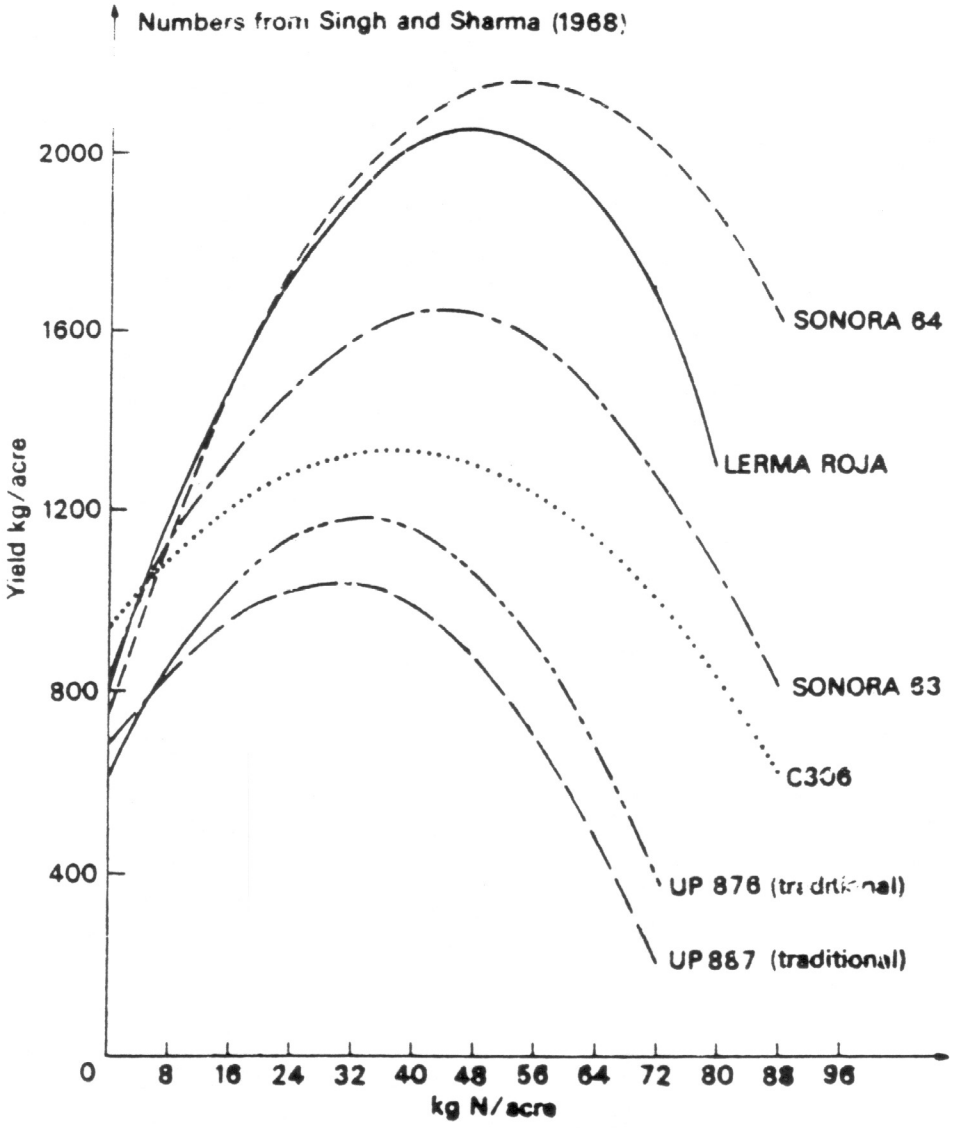


Fig. 7.1

Response of Original Mexican Varieties and Traditional (Desi) Varieties to Different Doses of Nitrogen.

Note: (i) The experiments were at U.P. Agricultural University, Pantnagar.
(ii) The curves are quadratics fitted for each case.
(iii) See § 7.1.2 for discussion.

Figure 4
HYV-Crop Productivity Growth by State:1961-81

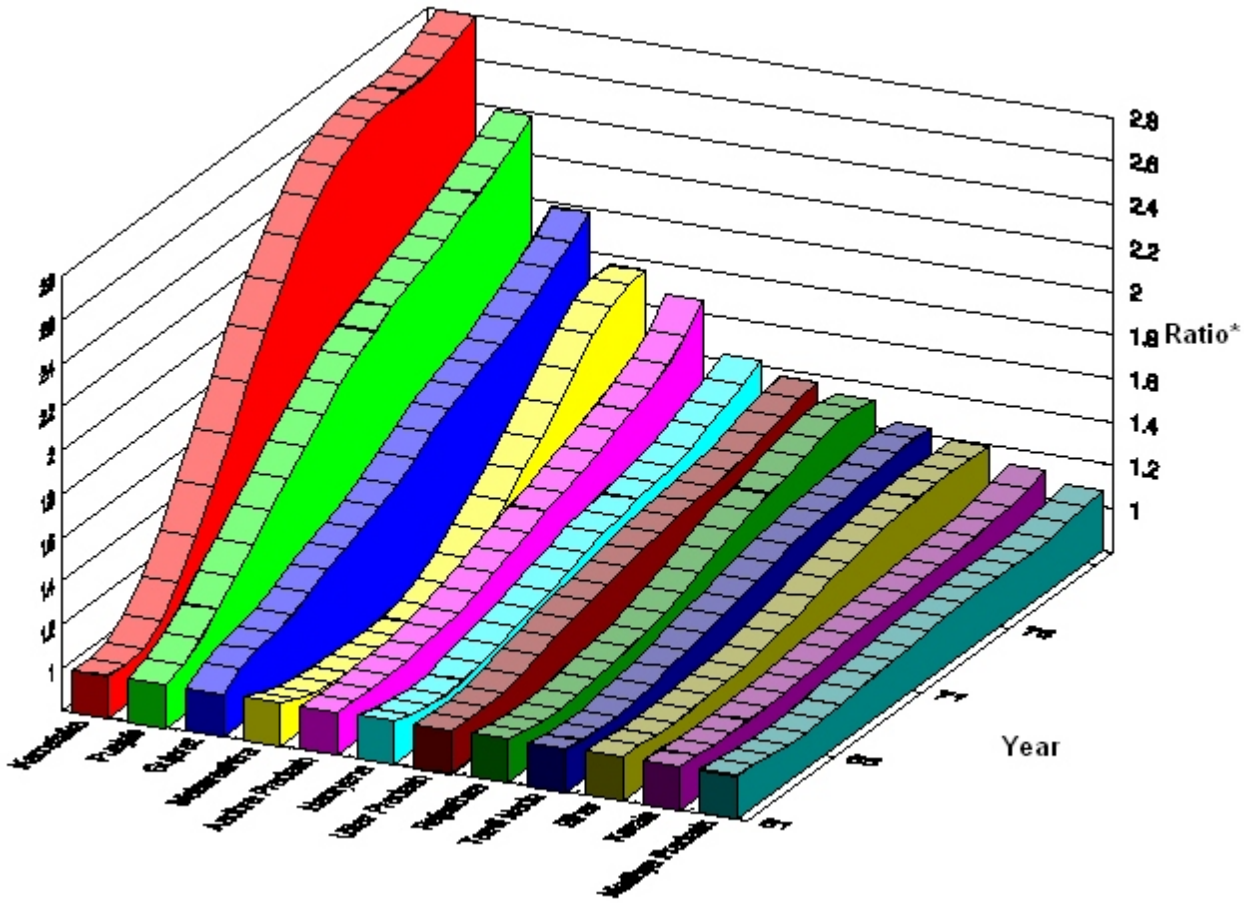


Table 1
Determinants of HYV Adoption by 1971:
Farm Households in HYV-Using Districts

Variable	Means (S.D.)	Probability Ever Adopted (Probit)
Household Schooling:		
Primary Highest	.493	.524
	(.500)	(8.55)
Secondary Highest	.213	.140
	(.410)	(1.89)
Household Owned land (acres)	10.5	.0159
	(12.5)	(6.40)
Village Agricultural Extension	.560	.162
	(.496)	(3.04)
Village Primary Highest	.955	.012
	(.207)	(0.09)
IADP	.222	.340
	(.416)	(5.29)
Constant	--	-.726
		(5.57)
N	2532	2532

[a]Absolute values of t-ratios in parentheses.

% Differential in Farm Profits Between Schooled and Unschooled Indian Farmers in 1982, for Low, Average and Highest Technical Change States

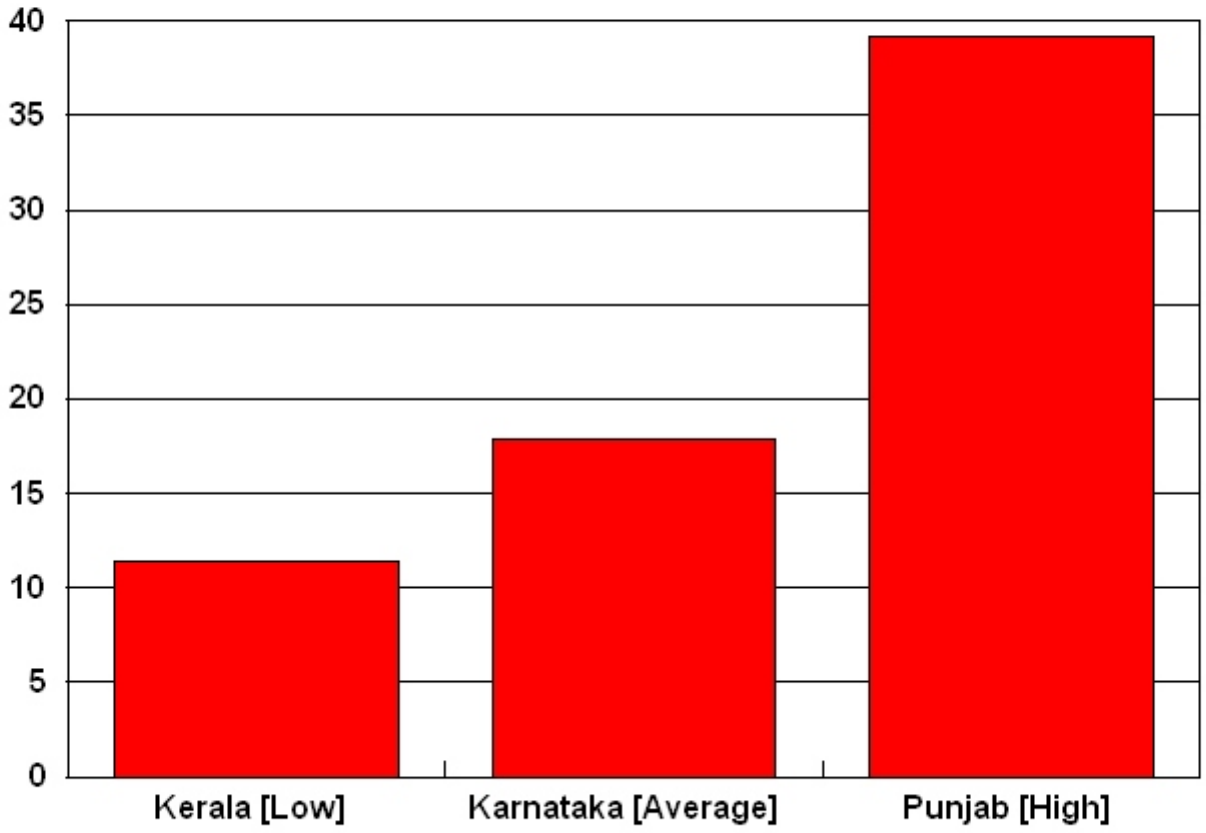


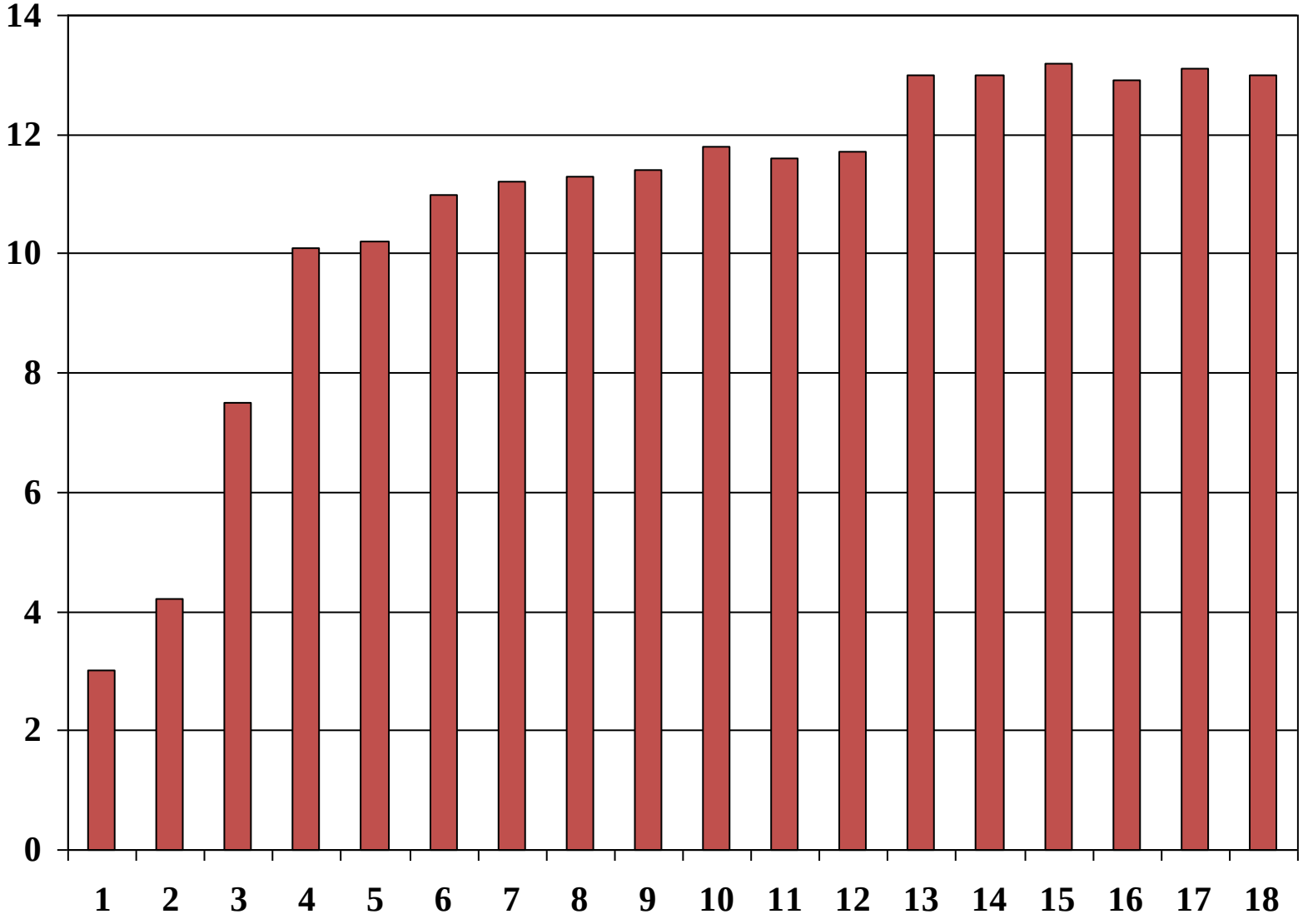
Table 2

FE-IV Estimates: Effects of HYV Adoption on Profits (10^{-3}) per Hectare by Prior Experience with HYV Seeds and Schooling, Initial Years of the Indian Green Revolution

Variable	(1)	(2)
Prior total HYV use (t=2) x HYV use	.00105	.00136
	(2.48)	(2.23)
Prior total HYV use (t=3) x HYV use	.000268	.000230
	(2.39)	(1.68)
Current HYV use	-.539	-.269
	(2.54)	(0.95)
Primary schooling x HYV use	.444	.0130
	(2.10)	(0.04)
Primary schooling x HYV use x prior total HYV use	-	.000240
		(2.21)
Number of observations	900	900
Number of farmers	450	450

Absolute values of asymptotic t-ratios in parentheses.

Figure A. Learning Curve for US Lawrence Company Loom Workers, 1842-55: Yards per Hour By Months on the Job (Bessen, 2003)



Microeconometric evidence on learning from others

A. Early stages of Indian green revolution

Foster and Rosenzweig (1986)

Profits rose faster the more adoption by neighboring (same village) farmers

Neighbor experience/profit trajectory same shape as own experience, consistent with learning from others

Simulations based on structural estimates indicate spillover effects are significant in affecting the trajectories of profits and HYV adoption

Evidence of strategic behavior - externalities not internalized; scope for policy intervention

Munshi (2004)

Evidence of more learning among wheat than rice farmers as information more generalizable for the former

Figure 1: Predicted Effects of Learning on Per-HectareProfitability under Various Assumptions about Adoption and Learning

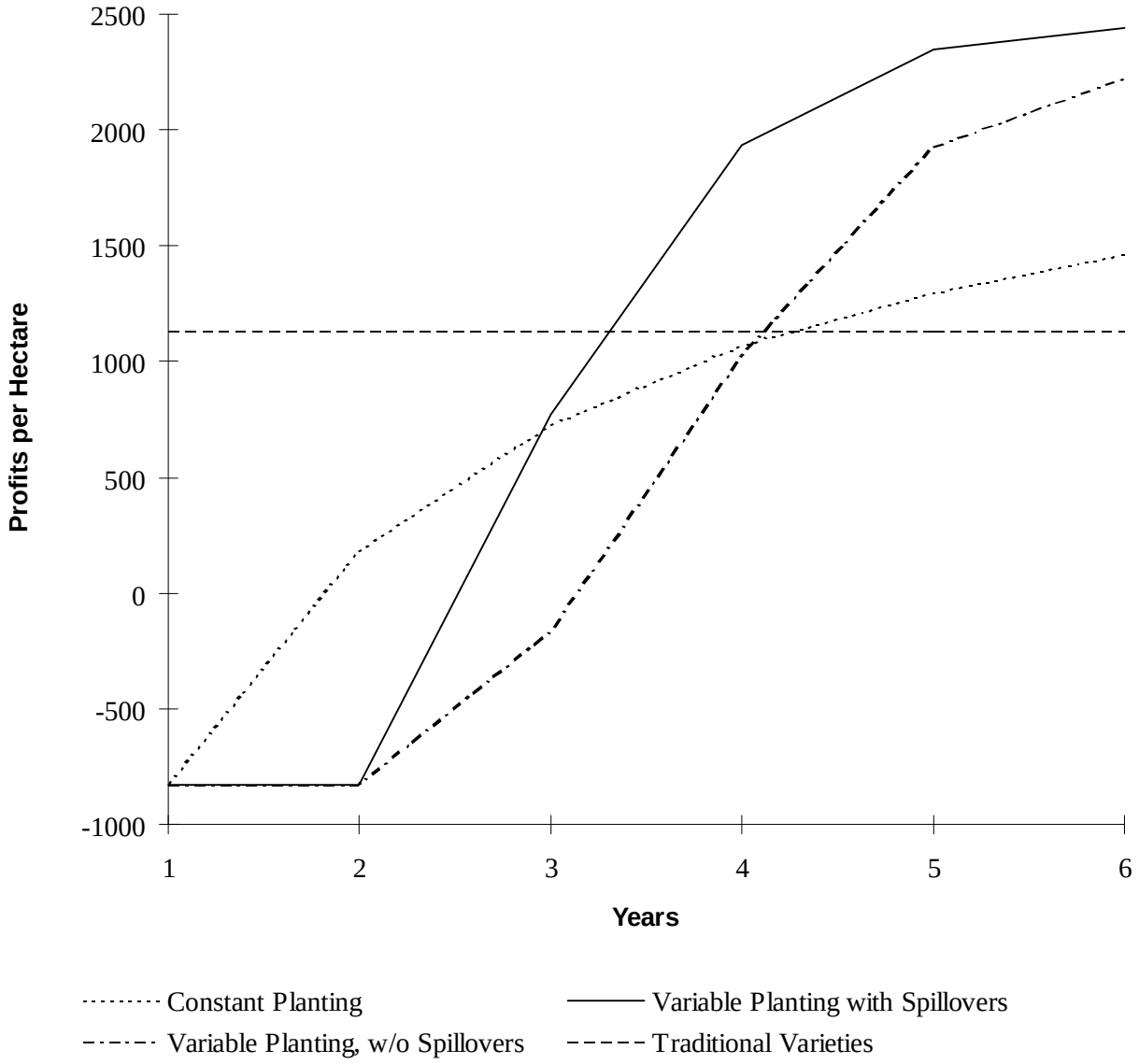
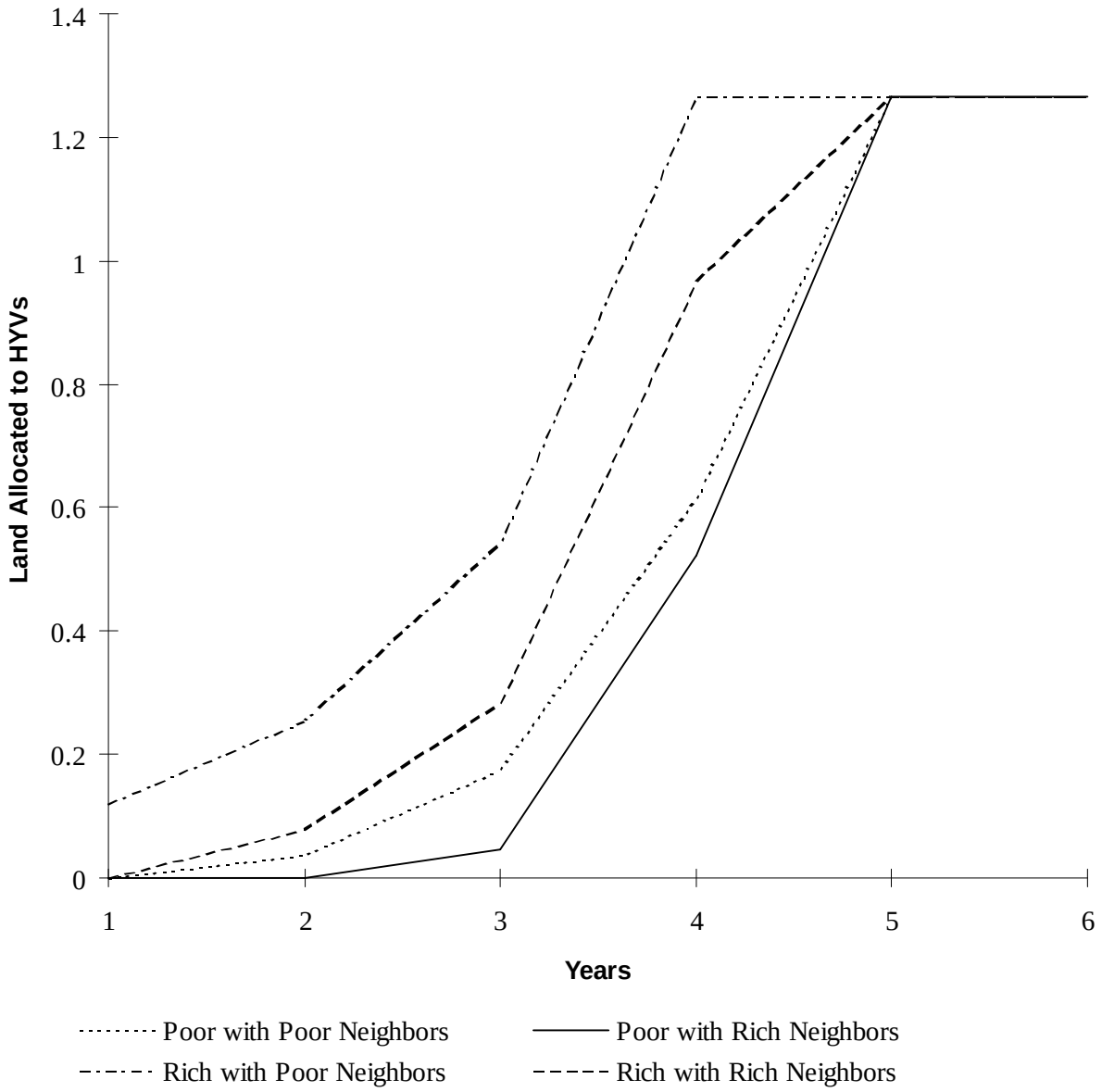


Figure 2: Predicted HYV Adoption under Various Assumptions about the Initial Assets Held by a Farmer and His Neighbors.



B. Sunflower seed adoption (Bandeira and Rasul, 2006)

Faster adoption by the more schooled

Indirect evidence of learning from others from observed strategic behavior: Adoption was slower if more within the community adopted

C. Field experiment on bednet adoption (Dupas, 2010)

The more educated are more likely to adopt

Learning inferred: subjects more likely to adopt if someone in her group received a randomized subsidy (despite health externality, which should lower adoption)

D. Field experiment on menstrual cup adoption (Oster and Thornton, 2011)

Adoption higher if more peers offered device due to learning about best use

Subjects are students, so no schooling effects estimated

E. Fertilizer use (no new technology), Ghana farmers (Conley and Udry, 2011)

An important issue:

to what extent does the schooling/productivity/learning relationships merely reflect pre-existing ability

Indirect evidence: schooling investment responds to changes in returns

1. Indian Green revolution: in areas with higher productivity growth due to new HYV seeds, increased school enrollments (Foster and Rosenzweig, 1995)

Only by cultivator households - decision makers

2. Indian reforms opening up the economy

A. Munshi and Rosenzweig (2006): in Mumbai increase in earnings returns to knowing English in post-reform years

Dramatic rise in enrollments in expensive, English-medium schools

Across all caste, income groups, especially low-caste women

Change in HYV-Crop Productivity and School Enrollment in Sample Districts: 1971-82

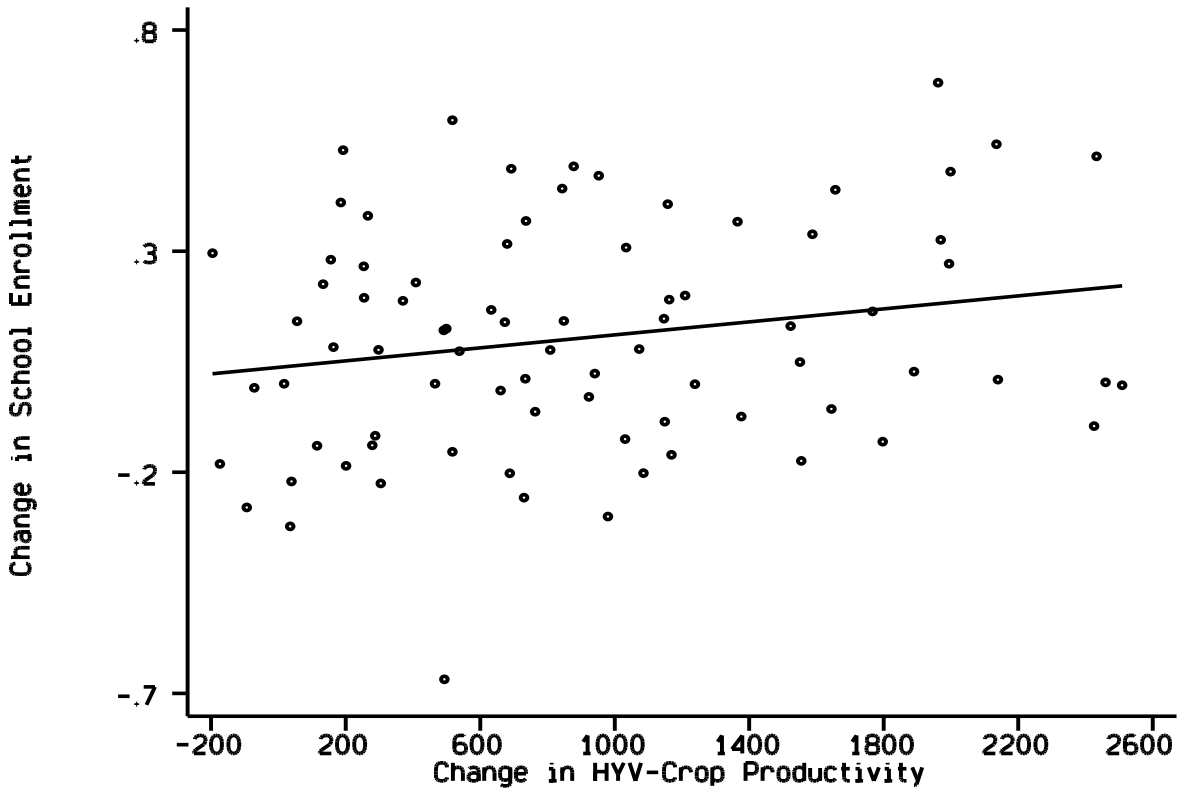


Figure 7: Rates of Return to English-medium Schooling and Years of Schooling for Men in Dadar, Bombay,by Decade, 1980-2000

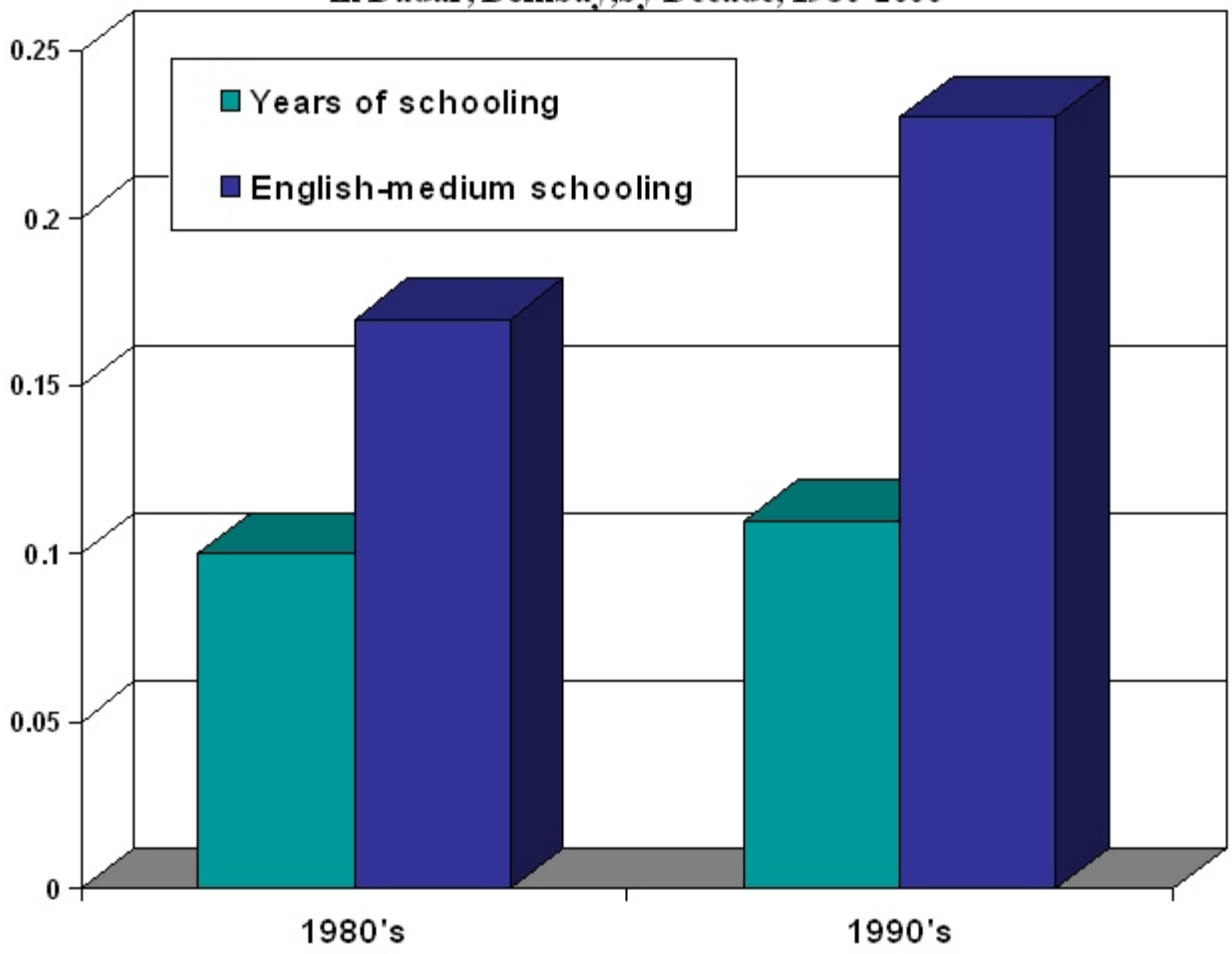


Figure 8: Rates of Return to English-medium Schooling and Years of Schooling for Women in Dadar, Bombay, by Decade, 1980-2000

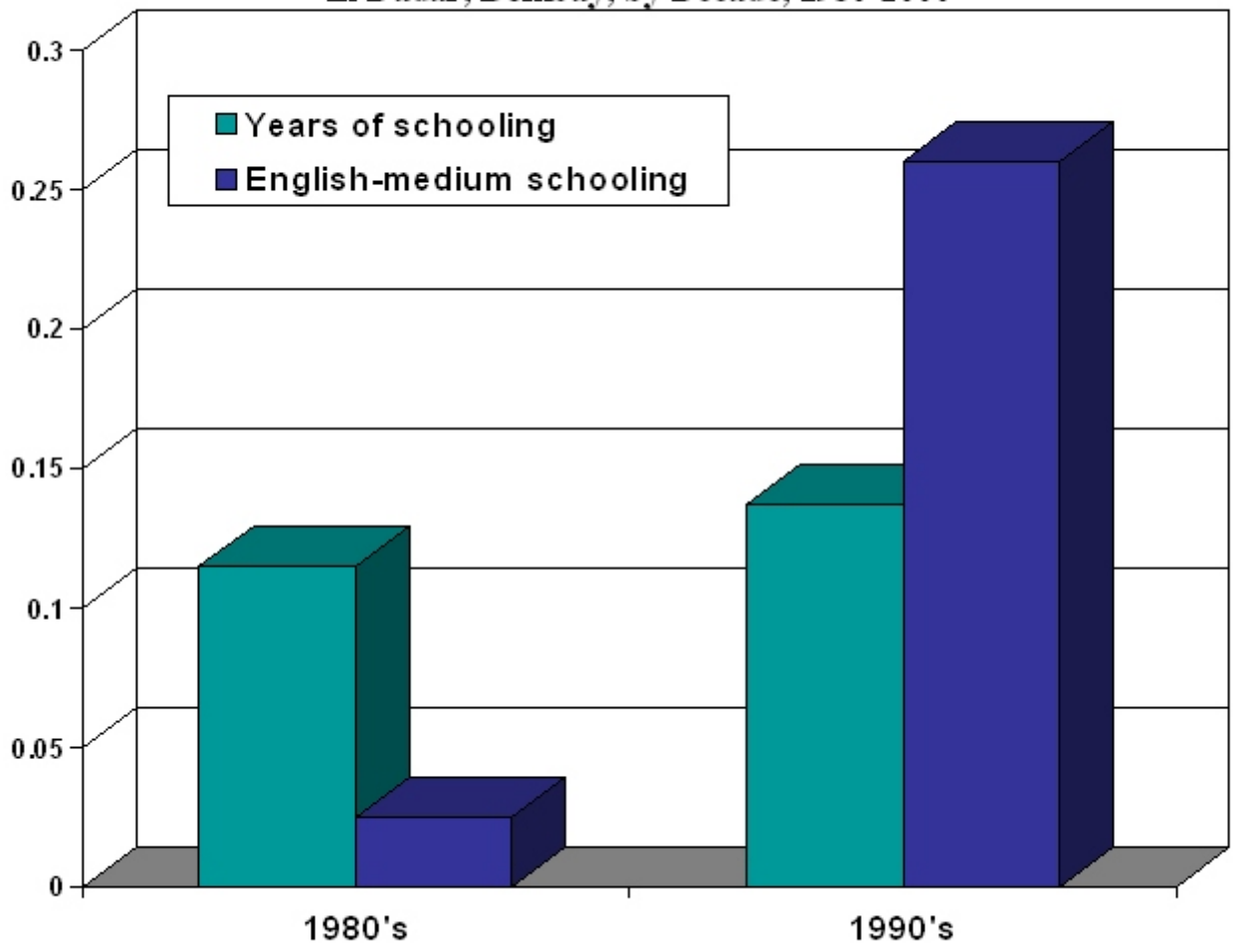


Figure 9: Fraction of Female Students Enrolling in English-medium Schools in Dadar, Bombay, by Caste and Year, 1982-2000

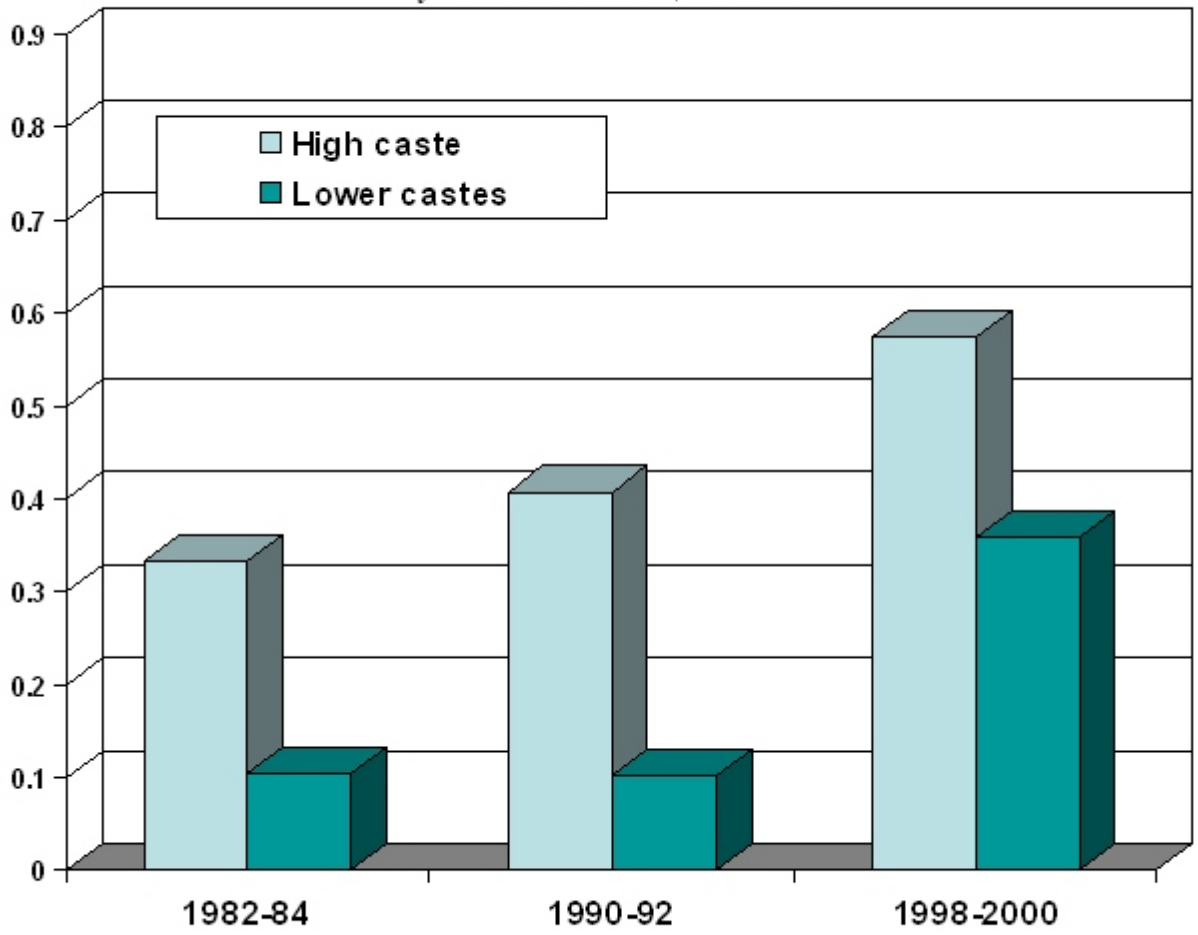
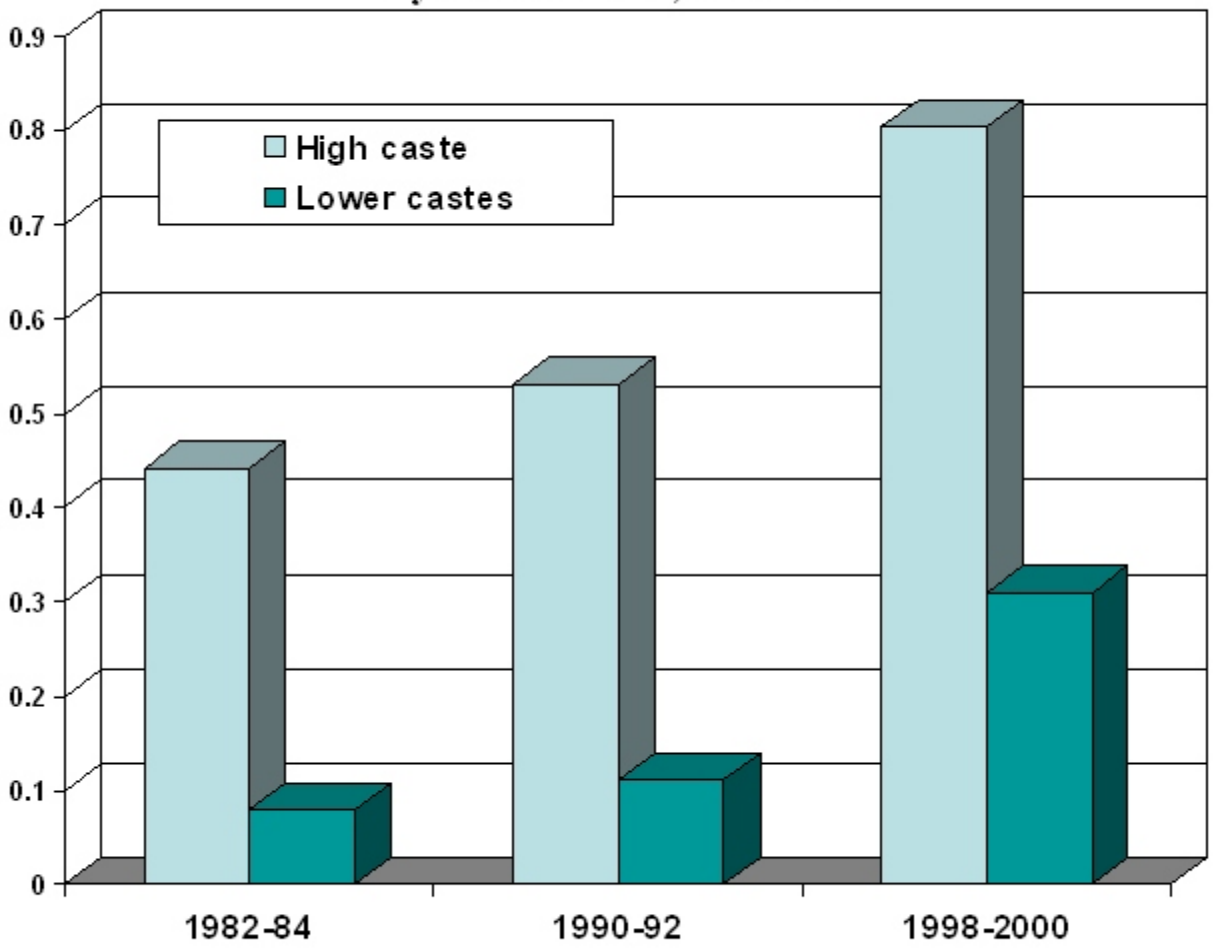


Figure 10: Fraction of Male Students Enrolling in English-medium Schools in Dadar, Bombay, by Caste and Year, 1982-2000



B. Oster and Millet (2011): local effects of initiation of ITES call centers

15% increase in enrollments in English-medium schools

These effects of changes in returns to schooling are larger than those estimated for programs pushing the supply of schools in non-dynamic areas

A. Mexico *Progresa* (Schultz, 2004): increase on .66 years of schooling

Conditional (on enrollment) cash transfer program

B. Indonesia INPRES (Duflo, 2002): increase of .31 years of schooling

Largest school building program in the history of the world

Estimated return to schooling: 3.2 percent

There is thus substantial, rigorous micro-econometric evidence on the mechanisms of the endogenous growth models:

learning, learning externalities, and the importance of schooling in fostering learning *when there are new ideas, technologies*

What about the evidence on increasing returns to human capital (Lucas)?

$$\Delta h = \Phi(h)$$

Pervasive cross-sectional evidence showing a positive correlation between parental schooling levels and child schooling investments

But many reasons why these associations may be spurious:

intergenerational preference linkages, genetics, etc.

Recent micro-econometric work designed to identify causal effect of parental schooling on children's human capital

Reviewed by Holmlund, Lindahl and Plug (2011)

Methods used to identify intergenerational schooling effects:

Twins (parents who are genetically identical)

Adoptions (parents who are not genetically linked to children)

IV (e.g., intergenerational changes in school-leaving laws)

Conclusions:

$\Phi = 0.1$ a "very small" effect, much smaller than c-s

Mother's schooling no more important than father's

Problem:

All studies from developed countries: US, France, England, Scandinavia

Negative relationship between mother's schooling and home time

Pervasive use of mother substitutes: day care, nursery schools

What about low-income countries?

Behrman *et al.* (1999):

evidence from rural India showing strong Lucas relationship:

literacy of mothers efficacious in producing children's schooling

exploits the green revolution changing returns to schooling for men (decision-makers) in Foster and Rosenzweig

Model incorporating the Lucas relationship, bargaining power and marriage-market selection

Setting in rural Indian in 1970's and 1980's:

Schooled women did *not* participate more in the paid labor market

Women's schooling, unlike mens', had no effect on farm profits as a consequence of the new seed technologies

Women were not making managerial decisions

But, demand for literate wives went up significantly in high technological change areas (dowries lowered too)

Within households having two or more mothers, children of literate mother's spent more time studying and had higher school attendance

More literate mothers did not spend more on children's clothing: not a bargaining power

So importance of the Lucas human capital production function as a mechanism driving growth in low-income countries still an open question

Health and Growth

Pervasive evidence that improving health, nutrition raise productivity, incomes where incomes are low

Recent examples:

Kremer and Miguel (2004): randomized de-worming

25% increases in wages of wage workers (25% of the sample)

Bleakley (2010): malaria eradication in historical Americas

50% increases in earnings from shifting from malaria-infected state to malaria-free state

But, unlike the mechanism highlighted in growth models:

The returns to health investments have *diminishing* returns or

One-off improvements - no *sustained* change in growth rate

Pioneering IV study of calorie consumption on farm profits in Sierra Leone (Strauss, 1986)

Quadratic relationship fit best: decreasing effects as calories rose

Compare actual effect of the green revolution on wage growth in India (1970-2004) with simulated effects of the de-worming and malaria eradication health improvements

See sustained growth from adopting new stream of technologies only

Thus, health improvements marginally affect income levels not growth rates

But, health can affect human capital (skill) production and thus contribute to learning effects (still diminishing returns)

Augment the Lucas function with health, nutrition:

$\Delta h = \Phi(h, n)$ where h = school time n = nutrition

and $\Phi_{h,}\ \Phi_{n}, \Phi_{nh} > 0$

Embodies complementarity between health and learning in school

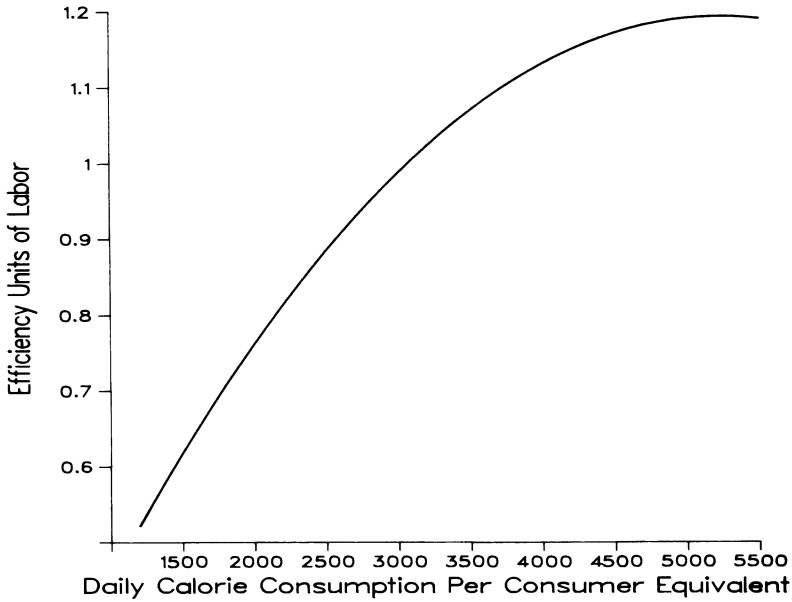


FIG. 2.—Estimated efficiency labor function

sumption per consumer equivalent $h(\cdot)$ rises much more steeply. At an intake of 1,500 calories the calorie elasticity is .75. The level of $h(\cdot)$ is roughly .6, implying that the hourly efficiency of family labor is on the order of 60 percent of the efficiency of a family worker from a representative family.

A different effect may be seen by looking at the first-order condition for food consumption (see n. 14). An increase in caloric intake per consumer equivalent is equivalent to a proportionate reduction in the effective price of food. Taking rice, the staple food in Sierra Leone, and ignoring the effect of higher caloric intake on clock hour wages or on total non–sick time available to the household, these results suggest that at the sample mean a percentage increase in rice consumption will reduce the effective price of rice by 42 percent.[32] Again those percentages vary by level of caloric intake, being in the range of 90 percent for an intake of 1,500 daily calories per consumer equivalent and 15 percent at 4,500 calories. Now clearly these figures are large, especially for the poorer households, although other specifications of $h(\cdot)$ result in somewhat smaller magnitudes.[33] How-

[32] This is calculated assuming a conversion of 3,743 calories per kg of rice, converting this annual figure to a daily per consumer equivalent and multiplying by the marginal product of family calories from table 3.

[33] The log-reciprocal specification of $h(\cdot)$ results in a percentage decline of 22 percent, which still seems large.

Real Agricultural Wage Growth in India, 1970-2004 (Source: Bhalla and Das, 2006) and Simulated Wage Growth from Malaria Eradiation Only Based on Bleakley (2010) and From De-Worming only (Miguel and Kremer (2011)

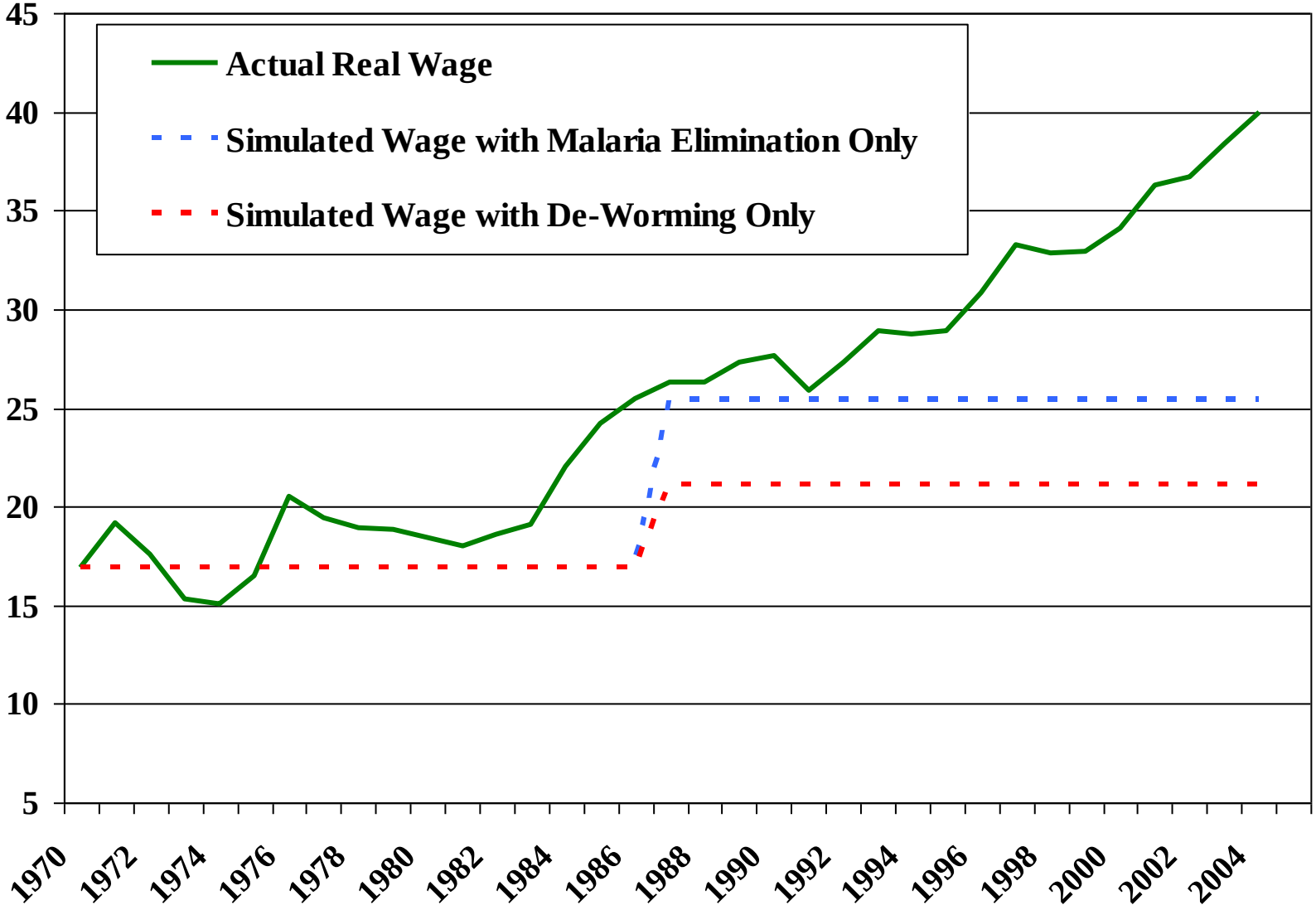
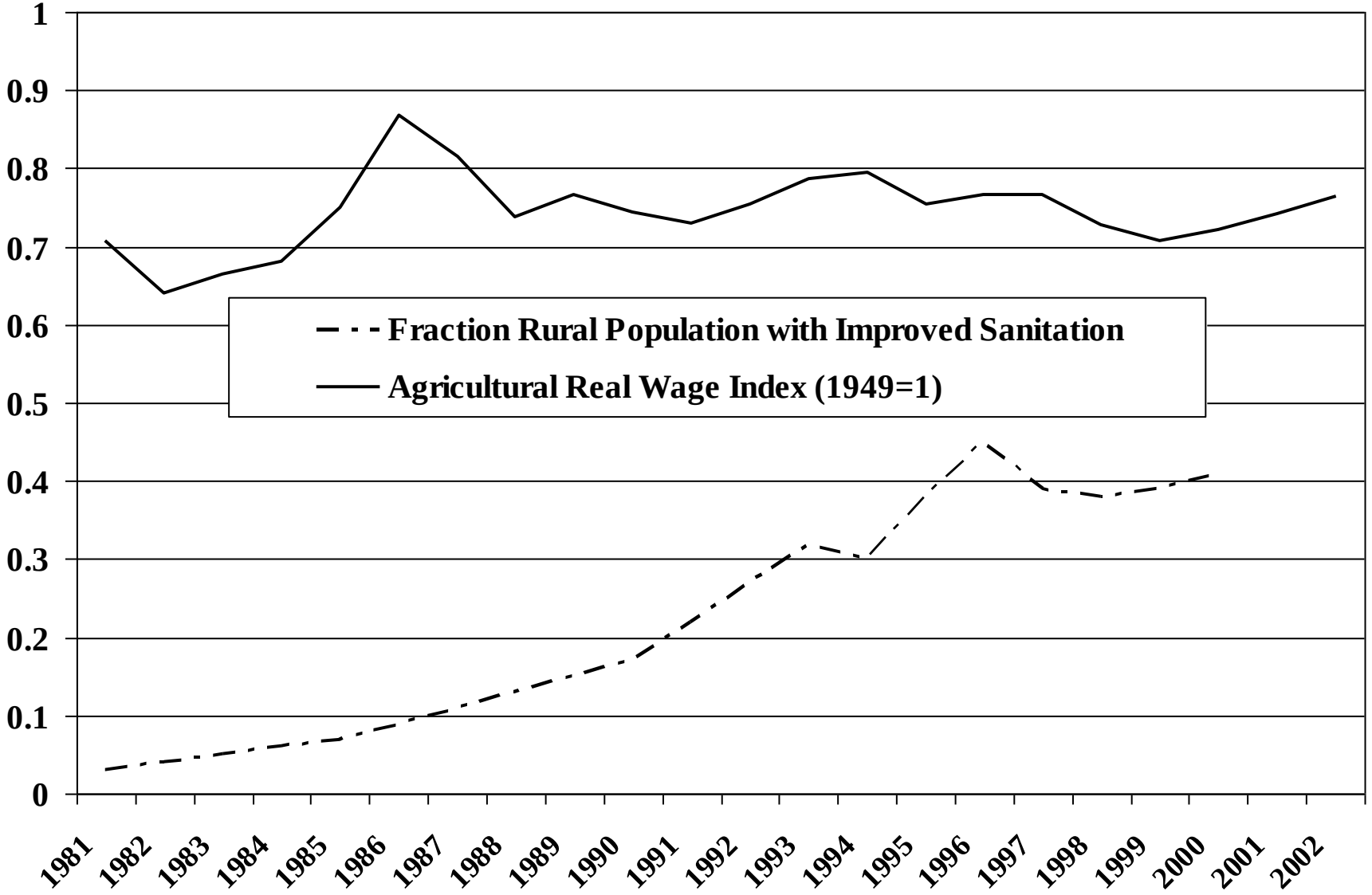
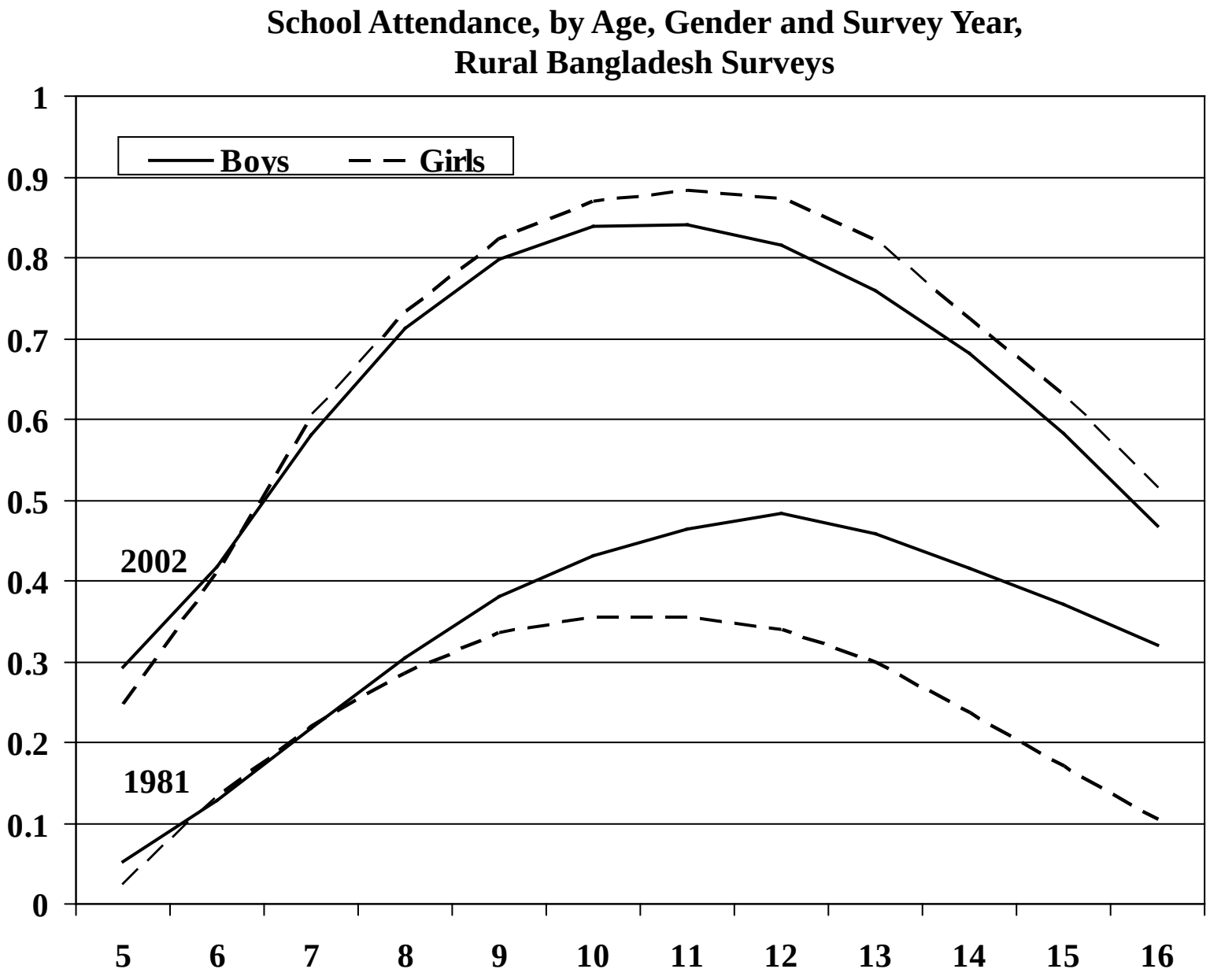
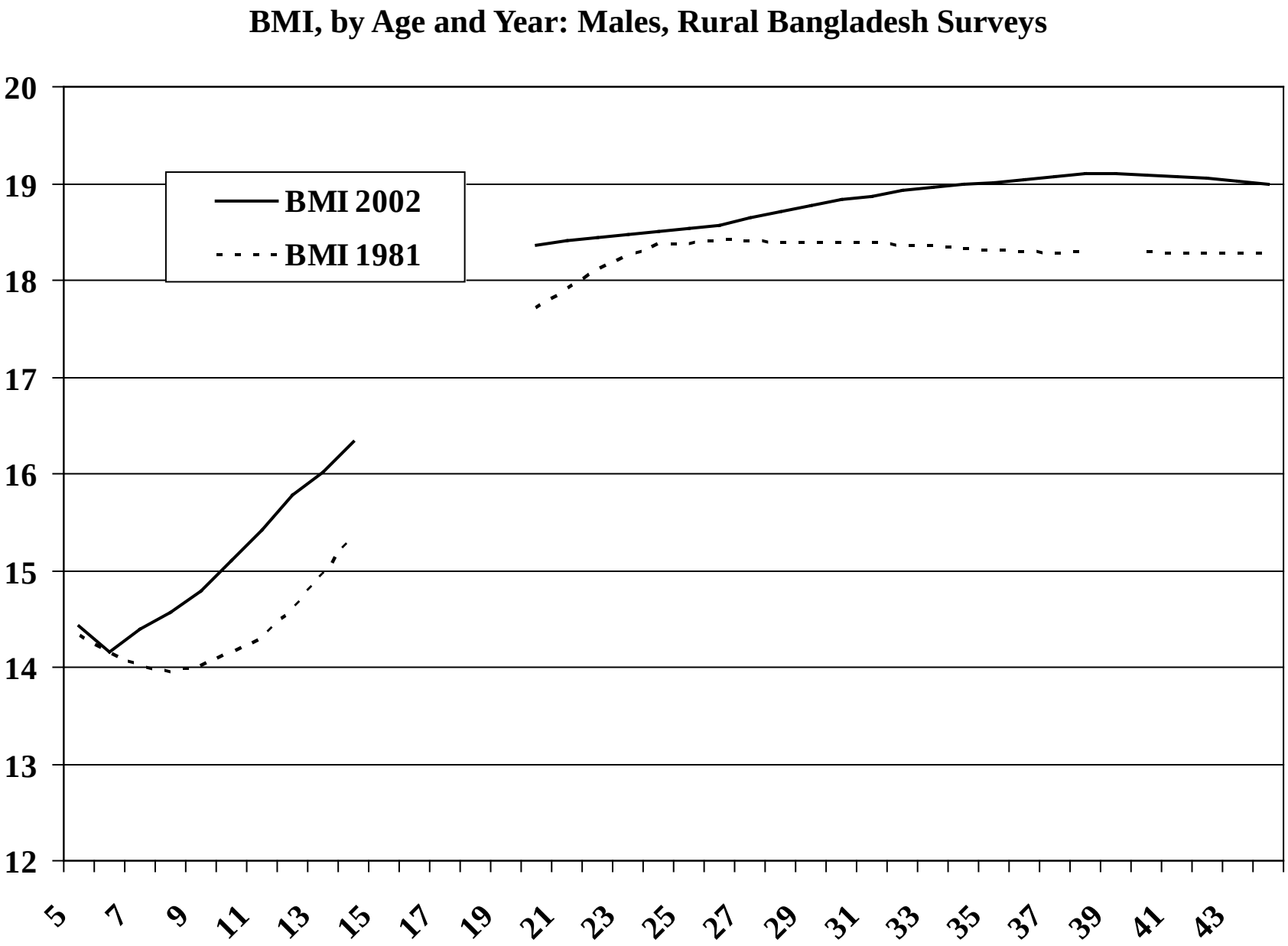


Figure B. Rural Bangladesh 1981-2002:
Real Agricultural Wage Index and Fraction of Rural Population with Improved Sanitation




School Attendance, by Age, Gender and Survey Year,
Rural Bangladesh Surveys
Boys
Girls
2002
1981
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5
6
7
8
9
10
11
12
13
14
15
16


BMI, by Age and Year: Males, Rural Bangladesh Surveys
BMI 2002
BMI 1981
20
19
18
17
16
15
14
13
12
5
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41
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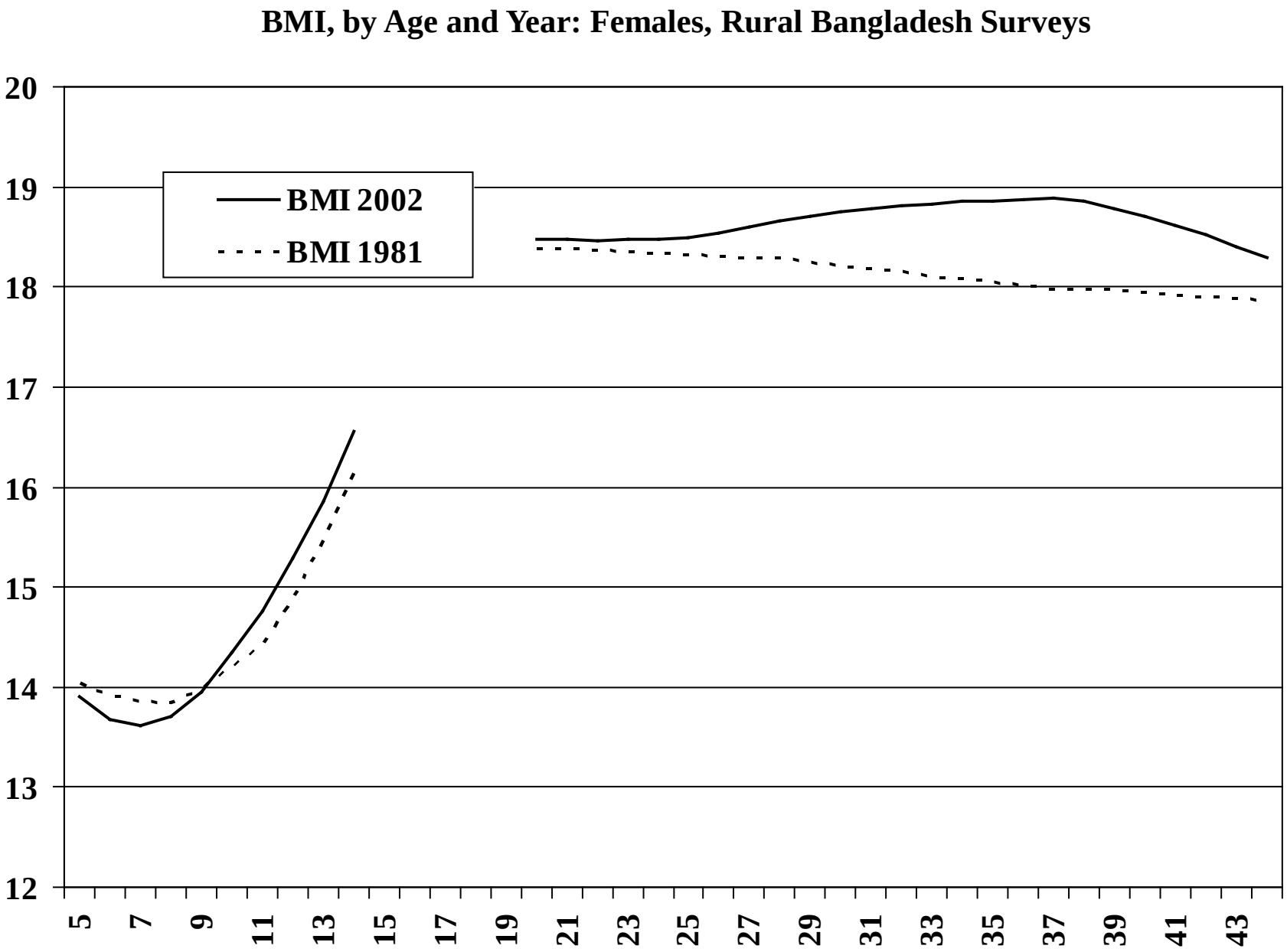
BMI, by Age and Year: Females, Rural Bangladesh Surveys
BMI 2002
BMI 1981
20
19
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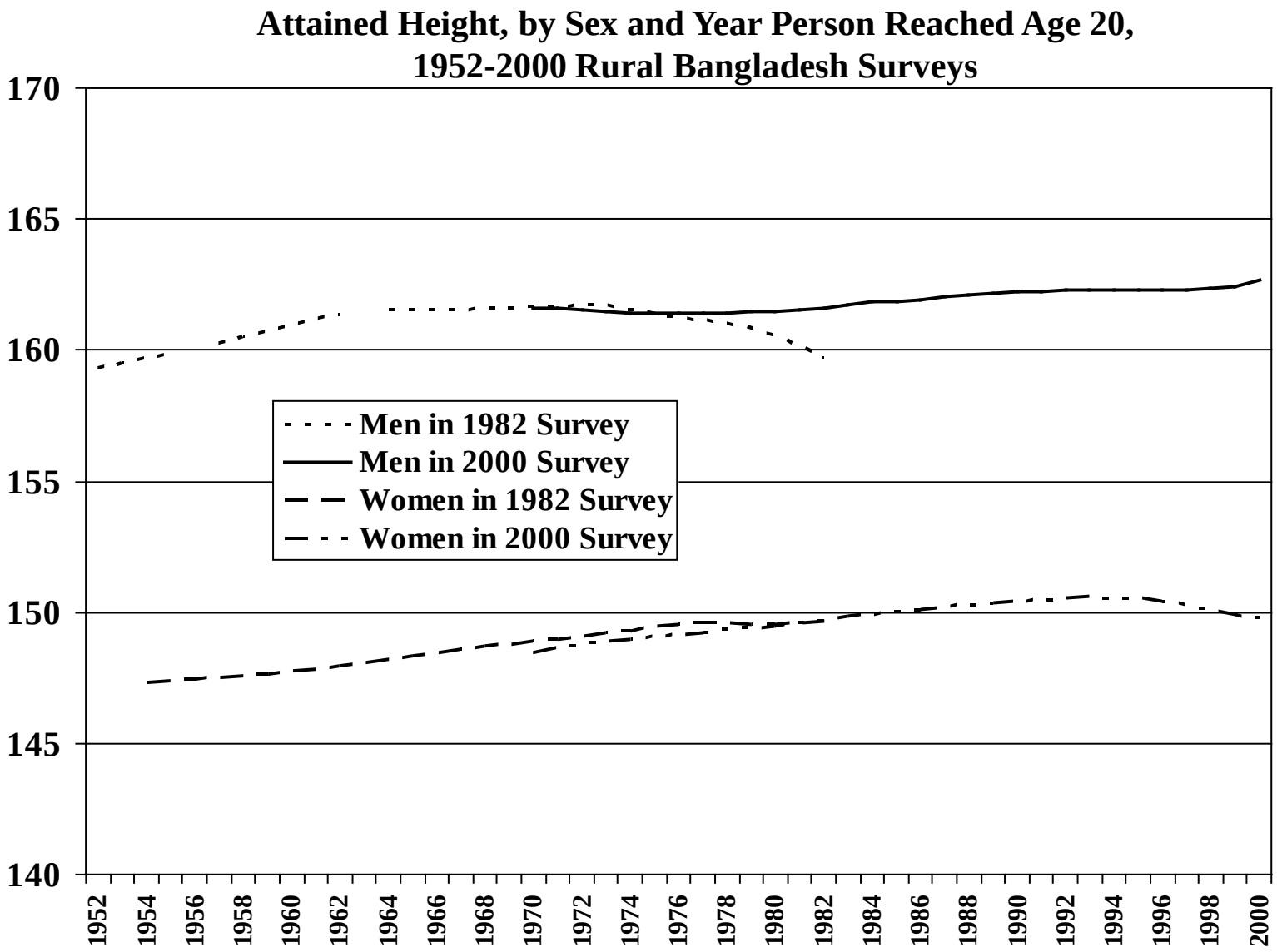
Attained Height, by Sex and Year Person Reached Age 20,
1952-2000 Rural Bangladesh Surveys
170
165
160
155
150
145
140
Men in 1982 Survey
Men in 2000 Survey
Women in 1982 Survey
Women in 2000 Survey
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
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1994
1996
1998
2000

Recent RCT evidence on health interventions on school attendance, attainment

Miguel and Kremer (2004), Maluccio *et al.* (2009), Bobonis *et al.* (2006), Field *et al.* (2009), Martorell *et al.* (2007)

(De-worming, early childhood nutritional supplementation, iodine supplementation)

Common finding: effects on schooling for girls much stronger; in many cases no effect for boys

Bleakley's study of malaria eradication: no effect on schooling

Why weak effects and effects that differ by gender?

Not estimates of the production function: do not identify Φ_{nh}

Estimates of reduced-form effects of a model not specified

Ignore that reductions in morbidity also directly affect productivity outside the classroom and thus the opportunity cost of schooling

Improvements in nutrition increase strength so increase the opportunity cost of schooling not just the productivity of schooling in producing knowledge

Implications:

A. In settings where strength is important - manual labor prevalent - effects of improving health on schooling will be weaker for boys

B. Because biologically, nutrition increases strength more for boys than for girls, the effect of improved nutrition on schooling will be more positive for girls: opportunity cost of schooling is higher for boys

Evidence:

Pitt, Rosenzweig and Hassan (forthcoming):

Formulate a model incorporating a Roy labor market in which workers are bundles of skill and strength (brawn), workers sort by comparative advantage and males have a comparative advantage in brawn

Find for rural Bangladesh (1982-2007):

A. Exogenously healthier (larger) boys receive *less* schooling and go into more energy-intensive occupations

B. Exogenously healthier girls receive marginally more schooling and sort into more skill-intensive activities

Also evidence that in most activities engaged in by men in rural Bangladesh brawn but not schooling is productive

Obtain occupation-specific estimates of productivity of schooling from structural estimation of the Roy activity production function (Cobb-Douglas):

$$W(i)_j = \pi(i) H_j^{\alpha(i)} B_j^{(1 - \alpha(i))} \xi_j,$$

where i indexes occupation, H = skill, B = brawn

Challenges: Skill (produced by schooling) is endogenous, the coefficients are functions of endogenous occupation.

IV methods employed

Table 9
Occupation-Specific Wage Function Estimates, by Gender: Adults Aged 20-49 in 2001-2

Gender	Male			Female		
Estimation procedure	GLS[a]	GLLAM[a]	GLLAM-IV[b]	GLS[a]	GLLAM[a]	GLLAM-IV[b]
Schooling	.0409 (11.6)	.0417 (10.1)	.334 (2.75)	.0487 (2.38)	.0467 (2.41)	1.14 (2.05)
Schooling x occupation energy expenditure	-	-	-.00256 (2.87)	-	-	-.007 (2.03)
Endowment	-	.0765 (0.84)	-1.46 (2.34)	-	.0895 (0.22)	-4.53 (1.28)
Endowment x occupation energy expenditure	-	-	.0115 (2.85)	-	-	.0254 (1.52)
Age x occupation energy expenditure	-	-	.000401 (1.16)	-	-	.00204 (1.09)
δ	-	-	-3.36 (1.67)	-	-	-4.37 (0.44)
λ	-	-	-	11.7 (1.46)	12.7 (1.49)	10.3 (0.78)

Wage function estimates indicate that:

1. The returns to schooling are lower in energy-intensive occupations; the returns to schooling in less energy-intensive occupations.

In particular, the effect of increased body-mass (nutrition) on the wage is positive for activities engaged in by 64% of male workers.

Schooling *only* has a positive return for the minority of low-energy-intensive activities; these include clerks and tailors, in which women are over-represented

Extension to urban China where steady rise in skill-intensive occupations:

Estimates based on birthweight differences between twins

A. Schooling attainment only positively related to birthweight for girls, and more so as occupational mix becomes more skill-intensive

B. Rise in estimated "returns" to schooling due to increase in skill-intensive jobs with growth

Figure 5. Locally-weighted Within-Twin Estimated Effects of Birthweight on Attained Schooling, by Gender and the Brawn-Intensity of Occupations in Five Chinese Cities

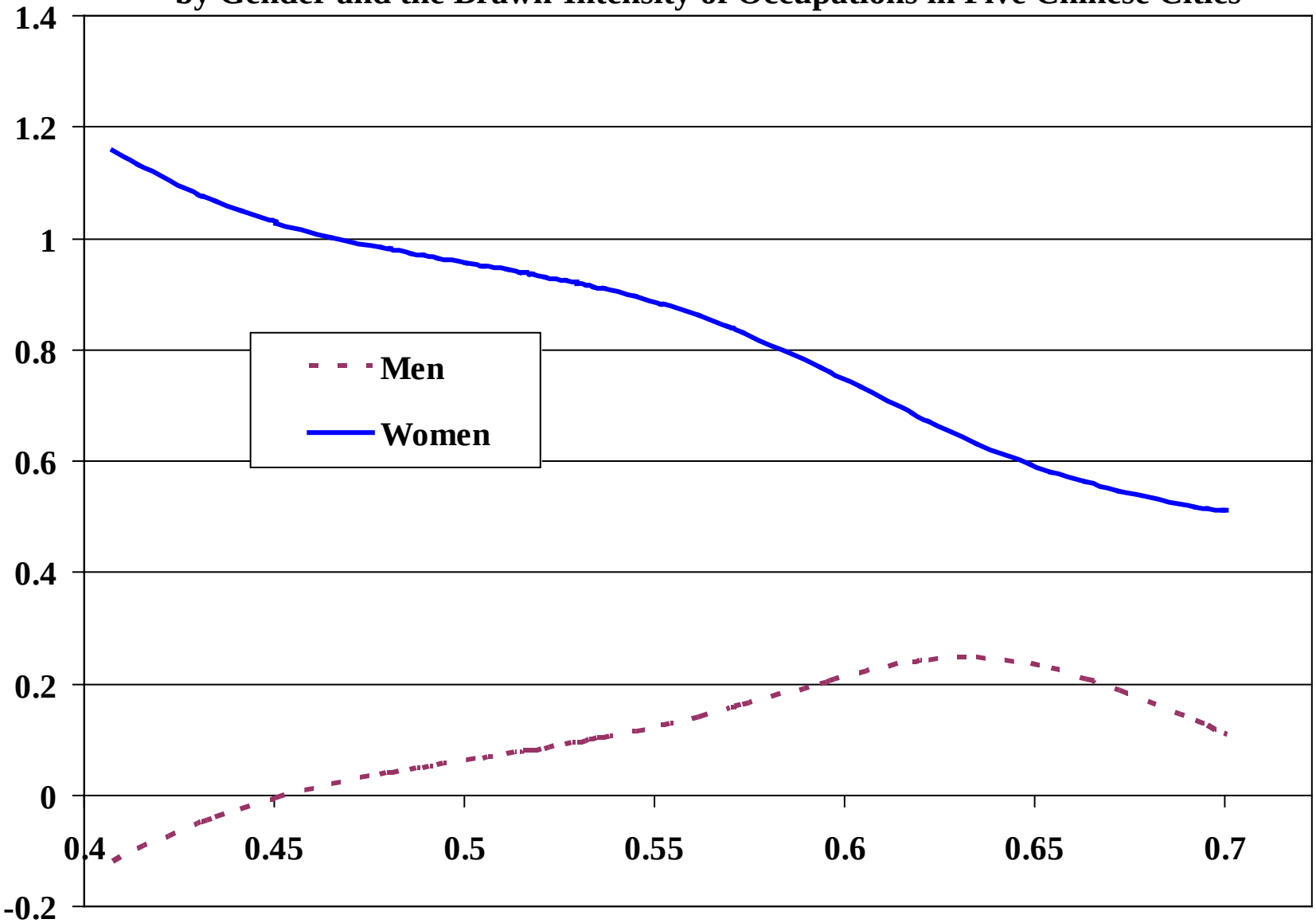


Figure 3. Proportion of Employment in in Non-Brawn Occupations, by Year, 1968-2002: in Five Chinese Cities (Source: 2002 Adult Nontwin Survey)

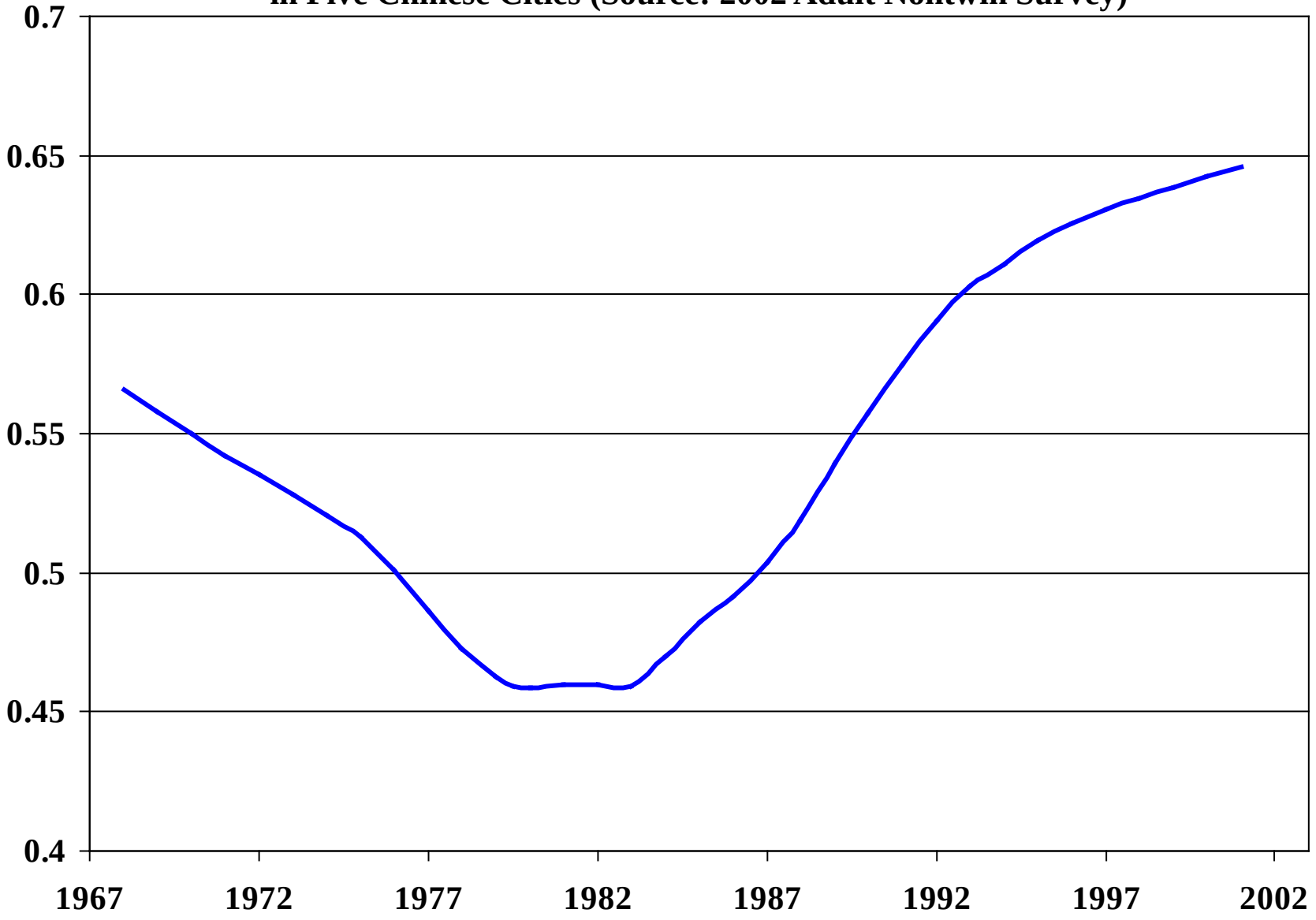


Figure 2. Estimated Rates of Return to Schooling, by Gender and Year, 1988-2001: in Five Chinese Cities (Source: Zhang *et al*., 2005)

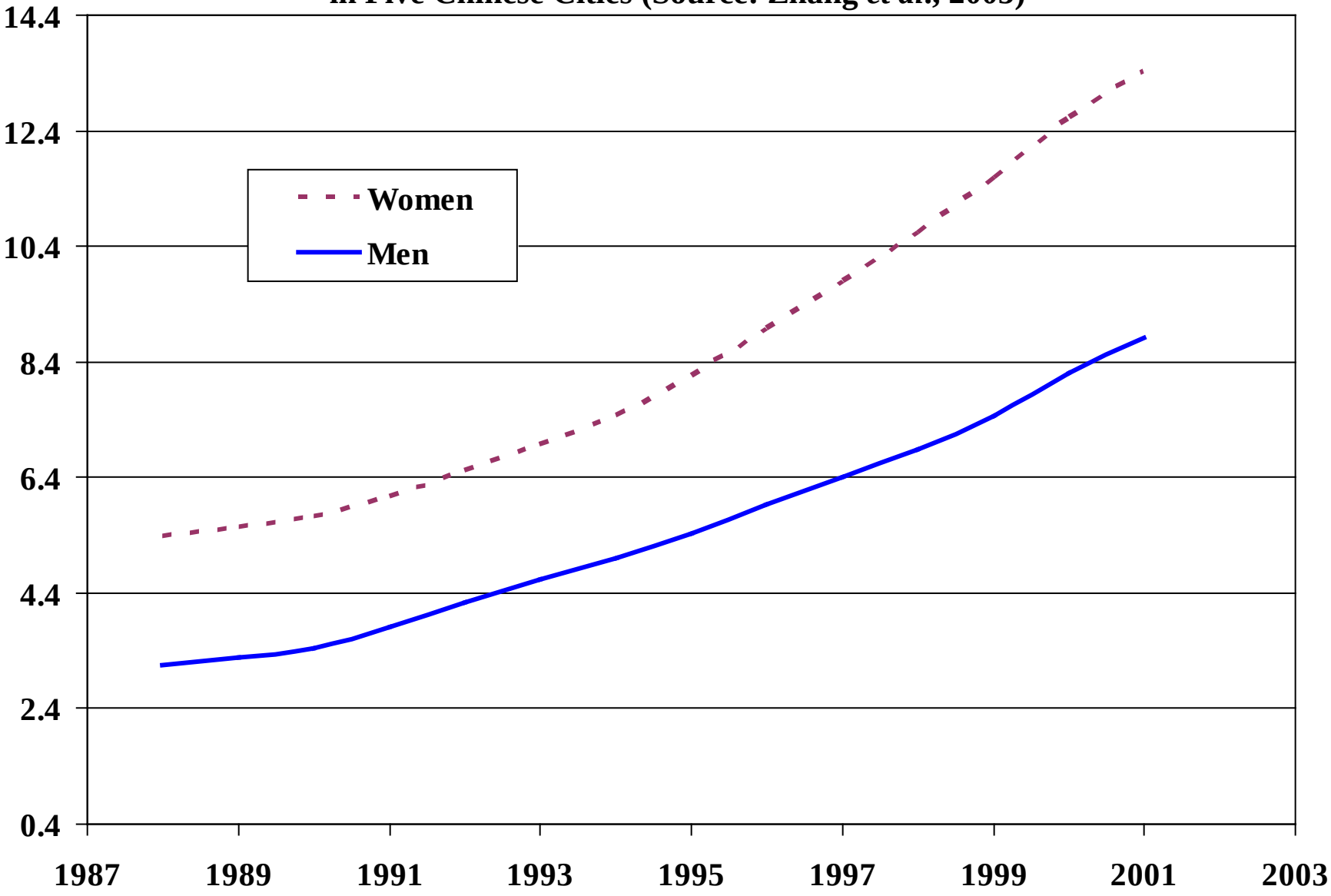
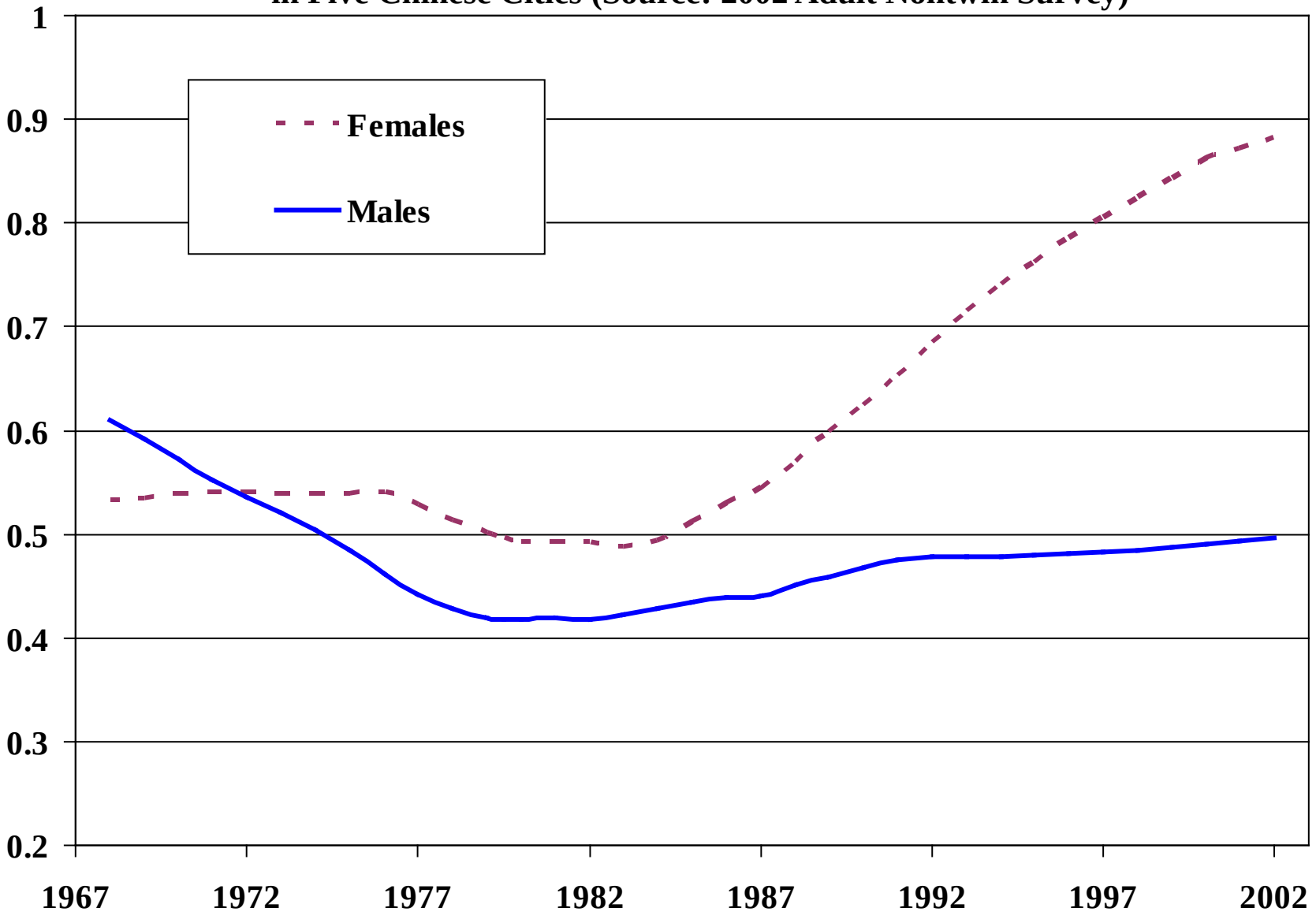


Figure 4. Proportion of Employment in in Non-Brawn Occupations, by Gender and Year, 1968-2002: in Five Chinese Cities (Source: 2002 Adult Nontwin Survey)



Growth-oriented research agenda on human capital

A. Focus on settings where change is occurring, where schooling has payoffs.

Is there too much ‘poor economics’?

Studying where there is no growth or stunted or incomplete growth - poverty areas, slums, unsuccessful schools, bad health provision, poor governance - is limiting our understanding of what really works

Elementary social science - you cannot understand how poverty is eliminated by studying only the populations that do not succeed.

B. Schooling payoffs high where new ideas, innovations, technologies are flowing - so, what is impeding these flows?

C. What kind of schooling is most relevant to state of the economy?

Cognitive versus non-cognitive skills

Does learning the names of capital cities of ME countries make for a better factory worker?

Does algebra?

Excessive focus on cognitive test scores - payoffs are known to be small

Better, direct measures of relevant productivity are needed: small proportion of workers in low-income countries work for wages

D. Where can health interventions do the most good?

E. Re-define growth to include improvements in human capital, even if such improvements do not yet augment growth?

Figure 1. Mean Years of Schooling by Gender and Urban-Rural and Year Attained Age 22, 1967-2005 (Source: 2005 Chinese Census)