Schooling and Cohort Size: Evidence from Vietnam, Thailand, Iran and Cambodia

by

Evangelos M. Falaris
University of Delaware

and

Thuan Q. Thai
Max Planck Institute for Demographic Research

March 2012

ABSTRACT

Schooling and Cohort Size: Evidence from Vietnam, Thailand, Iran and Cambodia.

In many developing countries the annual number of births has reached a peak in recent years and has declined since that time. We investigate how the schooling that individuals complete responds to the changes in the number of potential labor market competitors implied by changes in the annual number of births. We use census data from Vietnam, Thailand, Iran and Cambodia and document a similar pattern in all of them: holding other characteristics constant, individuals born during the upswing of the demographic cycle complete less schooling than individuals born during the downswing of the demographic cycle. This pattern is consistent with imperfect substitutability of workers with different amounts of work experience.

Introduction.

In many developing countries the annual number of births has reached a peak in recent years and has declined since that time. This phenomenon is the demographic cycle. We investigate how the schooling that individuals complete responds to the changes in the number potential labor market competitors implied by changes in the annual number of births. Of particular interest to us is the transition from a period of rising numbers of births over time to a period of falling numbers of births over time, that is the upswing to the downswing of the demographic cycle. We investigate how individuals alter their completed schooling and in particular how schooling outcomes differ for individuals who face the upswing or the downswing of the demographic cycle.

We use census data from Vietnam, Thailand, Iran and Cambodia to document a similar pattern of behavior: holding other characteristics constant, individuals born during the upswing of the demographic cycle complete less schooling than individuals born during the downswing of the demographic cycle. This pattern is consistent with imperfect substitutability of workers with different amounts of work experience.

We assume that individuals are forward-looking. In deciding how much skill to acquire they take into account the conditions that are likely to prevail in the labor market when they enter it and as their careers unfold. In particular, in deciding how much schooling to complete they use information on the number of individuals who are a few years older or a few years younger than themselves. These are their potential labor market competitors whose numbers will affect future labor market conditions. The numbers of potential labor market competitors are known while one is making schooling decisions. We measure the effects of potential labor market competitors with two relative birth cohort size variables. Past relative birth cohort is the five

year average of the ratio of the number of individuals born in the same year as oneself to those born in each of the five previous years. Future relative birth cohort size is defined as the five year average of the ratio of the number of individuals born in the same year as oneself to individuals born in each of the five subsequent years. Past and future relative birth cohort sizes indicate the position in the demographic cycle of an individual and represent the exogenous constraints imposed by the demographic cycle on individuals[1]. In other words, individuals may respond to these constraints but cannot affect the constraints by the choices they make.

Wachter and Wascher (1984) and Falaris and Peters (1992) have used past and future relative birth cohort to measure the effect of the position in the demographic cycle in individuals' schooling decisions. Both of these studies used U.S. data. These studies are part of the literature on the effect of the demographic cycle on individual outcomes in high income economies that appeared when relatively large cohorts were entering the labor markets in several high income economies. In our study we use data from Vietnam, Thailand, Iran and Cambodia. In these four developing countries the annual number of births has recently peaked. However, enough years have elapsed since the peak to have a sufficient number of people such that the downswing of the demographic cycle was ahead of them. Previous studies have not examined individual schooling responses to the demographic cycle with developing country data. Using data from several developing countries makes it possible to investigate if a common pattern of behavior applies to them.

[1] Labor market cohort size (defined by means of years of labor market experience), which has been used by some previous studies of the effects of the demographic cycle on labor market outcomes, may not be exogenous since individuals may delay or speed up their entry into the labor market in order to compete with more favorable labor market cohorts.

Data and Methods.

a. The four data sets

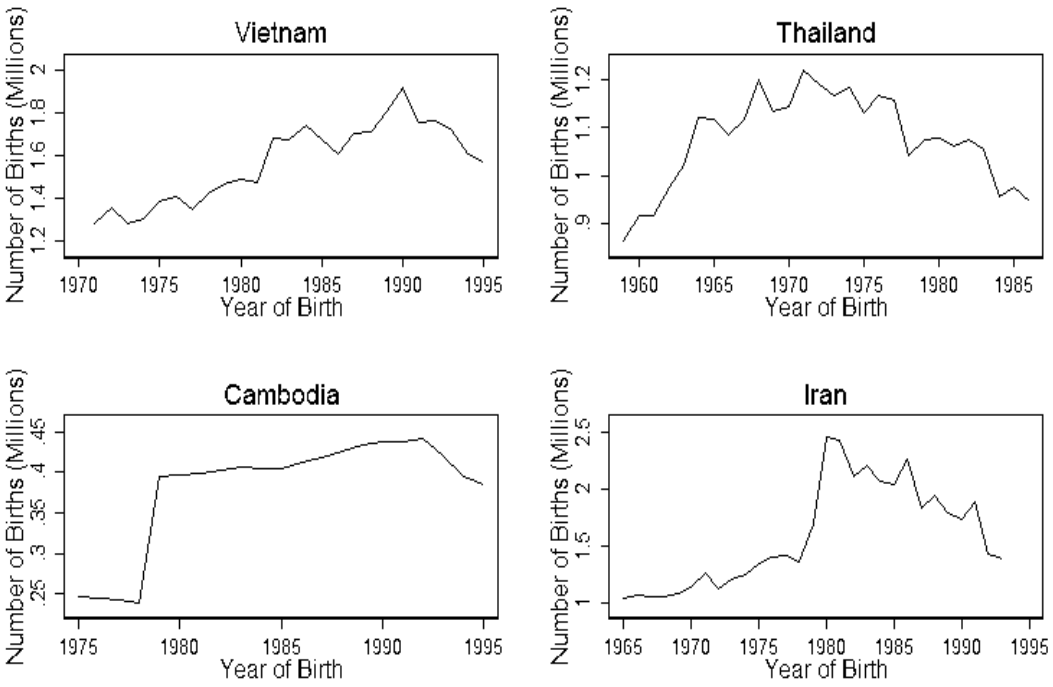
We used census data for four countries with several objectives in mind. First we wanted to investigate if the same empirical pattern applies in several countries. We also wanted to study countries in which the peak of the demographic cycle took place long enough ago for there to be a sufficient number of people who were born in years such that they faced the downswing of the demographic cycle. We also selected countries for which recent census data were available to us making our results relevant to the present-day economic and social conditions in the four countries. We used public use samples of the 2009 census of Vietnam, 2000 census of Thailand, 2006 census of Iran and 2008 census of Cambodia[2]. As Figure 1 shows, the peak of the demographic cycle took place in Vietnam in 1990, in Thailand in 1971, in Iran in 1980 and in Cambodia in 1992. In all four cases the peak is 16-29 years before the census year, therefore there are several birth cohorts facing the downswing of the demographic cycle.

For Vietnam we estimate statistical models with a sample of individuals born between 1976 and 1990 who were between 18 and 34 years old in 2009. This is Vietnam's postwar generation. Economic reform in Vietnam started in 1986 and the postwar generation faced a market economy when they were making schooling choices and when entering the labor force. Those individuals would be expected to respond to market forces in making schooling decisions. In contrast, individuals born in earlier periods faced wartime disruptions and many completed

[2] Source of the data: http:/www.ipums.org. The data are the 15 percent public use sample for Vietnam, one percent public use sample for Thailand, two percent public use sample for Iran and 10 percent public use sample for Cambodia. We arbitrarily list the four countries in reverse alphabetical order.

their schooling and entered the labor force in a command economy. We do not examine the behavior of the prewar generation. We note that cohorts born in the late 1980s and up to 1990

Figure 1: Number of Live Births in the four countries



Source: Vietnamese data come from the 2009 Census: data for Cambodia are from the U.S. Census Bureau: data for Thailand and Iran are obtained from the United Nations Demographic Yearbooks.

faced the downswing of the demographic cycle while earlier cohorts faced the upswing of the demographic cycle. We would like to study cohorts born in both phases of the demographic cycle but younger people are more likely to be in school when the census was carried out. Since schooling for these individuals will be right censored, we estimate censored regression models. Selecting 1990 as the final cohort in our study rather than a more recent year moderates the incidence of right censoring of schooling since most individuals completing secondary education or less would have completed their studies by the 2009 census date. At the same time, selecting

1990 as the final cohort preserves a big enough sample of individuals facing the downswing of the demographic cycle. Relative birth cohort size is calculated using the numbers of people of the same age as an individual as of April 1, 2009, or a specified number of years of age younger or older (up to five in each direction). Cohort size information is obtained from published census tabulations of Vietnam's population by single years of age.

For Thailand we include in our sample individuals born during the years 1964 to 1981 who were between 18 and 36 years old at the time of the 2000 census. The ending year was chosen so that the edited data would include several cohorts who faced the downswing of the demographic cycle with a moderate degree of right censoring. The beginning year was chosen so that it would be at least five years before the peak of the demographic cycle while yielding a roughly comparable age range of the sample as in the data from Vietnam. Relative birth cohort size is derived from data on births by year from the United Nations Annual Demographic Yearbooks.

In Iran the number of births greatly increased in the late 1970s, peaked in 1980 and declined substantially after that time. Our sample includes individuals born during 1970 to 1988 who were 18-36 years old at the time of the 2006 census. The age range of the individuals in the sample is comparable to the age range of the data from Vietnam and Thailand. Our sample includes the cohorts born during the period 1980-1988, the period of the Iran-Iraq war. As Figure 1 shows, the decline in the number of births over time continued after the war ended. Thus we are measuring part of a longer-term phenomenon. Birth cohort size data for Iran are from the United Nations Demographic Yearbook[3].

[3] Some gaps in the data are filled in with information on annual births reported by the Statistical Center of Iran (http://amar.sci.org.ir/index_e.aspx), Statistical Pocketbook and Statistical Reflections (various issues).

Cambodia experienced a massive upheaval of its society and economy during the Khmer Rouge era 1975 to 1978 and its immediate aftermath in 1979. We examine data on people born during 1980-1990, i.e. born following the period of severe upheaval. The youngest individuals in our sample are 18 years old as is the case with the data from the other three countries. The oldest individuals in our sample are 28 years old. They are younger than the oldest individuals in the data from the other three countries. Cambodia's economy underwent a series of market-oriented reforms starting in 1985[4] so the individuals in the cohorts we study faced a market economy when they were making schooling decisions. Birth cohort size data for Cambodia are from the U.S. Census Bureau.

b. Variables and Methods

We measure the relative position of individuals in the demographic cycle by means of two variables: past relative birth cohort size and future relative birth cohort size. More formally $Past = \sum_{i=1}^{5}(cohort_t / cohort_{t-i})$ and $Future = \sum_{i=1}^{5}(cohort_t / cohort_{t+i})$ where $cohort_t$ is the number of individuals born in year *t*. Individuals born during the upswing of the demographic cycle will have *Past*>1 and *Future*<1 while individuals born during the downswing of the demographic cycle will have *Past* <1 and *Future*>1. If cohort sizes were identical in all years, we would have *Past*=*Future*=1.

In our empirical work we estimate reduced form regressions in which we regress years of schooling completed by an individual on relative birth cohort sizes (past and future), controls for period effects, and controls for other exogenous background characteristics that are available in the census data. The background characteristics include ethnicity (Vietnam) and language

[4] United Nations, Economic and Social Commission for Asia and the Pacific (2001).

(Cambodia). The majority ethnic group in Vietnam is Kinh and the majority language in Cambodia is Khmer. Ethnicity or language information is not available for the data from Thailand or Iran. Summary statistics of the four data sets are reported in Table 1. Our main interest is in whether the relative birth cohort size variables (past and future) have significant effects on individuals' schooling.

In selecting the samples that we used in estimating the models, we included only individuals 18 years of age or older. We selected this age cutoff in order to include in our sample younger individuals who faced the downswing of the demographic cycle but not so young that most of them would still be in school on the census date. Still there is some right censoring in the data as indicated by the proportion of individuals enrolled in school as of the census date. As reported in Table 1, the proportion enrolled ranges from 0.093 (men in Vietnam) to 0.218 (men in Cambodia). Right censoring is more severe among younger individuals in our samples. For example, the proportions enrolled among men age between 18 and 22 are 0.212 in Vietnam, 0.33 in Thailand, 0.254 in Iran and 0.353 in Cambodia. The corresponding proportions for women are 0.221, 0.365, 0.226 and 0.243. Censoring in the data does not involve a fixed censoring point. For example, an 18 year old may be enrolled in the 12^{th} grade, a 20 year old may be enrolled in the 2^{nd} year of University and we don't know how much schooling each will ultimately complete. Overall censoring is more severe with the Cambodian data, especially for men, than with the data from the other three countries owing to the narrower age range of the Cambodian data. To take account of censoring we estimate censored regressions (based on the censored normal distribution) with variable censoring points across censored observations. This is a special case of interval regression (Cameron and Trivedi, 2005, pp. 534-535). Henceforth we'll call the method interval regression. We estimate separate statistical models by gender.

Table 1. Summary Statistics

	Men		Women	
	Mean	Std	Mean	Std
Vietnam				
Schooling	8.838	(3.534)	8.924	(3.556)
Ethnicity (1=Kinh)	0.773			0.803
Past relative birth cohort size	1.066	(0.052)	1.066	(0.052)
Future relative birth cohort size	0.970	(0.070)	0.970	(0.069)
Proportion enrolled	0.093			0.094
Sample size	1759552		1725531	
Thailand				
Schooling	8.857	(3.580)	8.845	(3.879)
Past relative birth cohort size	1.022	(0070)	1.024	(0.070)
Future relative birth cohort size	1.016	(0.045)	1.015	(0.045)
Proportion enrolled	0.109			0.110
Sample size	84642		90157	
Iran				
Schooling	9.242	(3.496)	8.828	(4.031)
Past relative birth cohort size	1.129	(0.210)	1.123	(0.213)
Future relative birth cohort size	0.985	(0.167)	0.996	(0.167)
Proportion enrolled	0.117			0.121
Sample size	228601		221516	
Cambodia				
Schooling	7.563	(3.573)	6.746	(3.362)
Language (1=Khmer)	0.976			0.978
Past relative birth cohort size	1.131	(0.160)	1.127	(0.158)
Future relative birth cohort size	0.987	(0.031)	0.987	(0.031)
Proportion enrolled	0.218			0.146
Sample size	130881		124919	

Note: Standard errors are in parentheses. Standard errors are reported only for continuous variables.

We wish to control for period effects that measure time-dependent influences on schooling. These influences include the business cycle, changes in economic policy, changes in technology, improvements in the health environment that give individuals an incentive to acquire more human capital (Bloom and Canning, 2004), or anything else that varies over time, other than relative birth cohort size, that individuals faced as they went through life. We control for period effects by means of period-specific binary variables for pairs of years (with the first two-year period as the omitted reference category)[5]. We alternatively specified the period-specific binary variables for single years of birth but this specification resulted in severe collinearity. Allowing for separate period effects for pairs of years reduces collinearity while affording greater flexibility than a single linear trend variable.

Estimates.

In Tables 2 to 5 we report maximum likelihood estimates of the interval regression schooling models for Vietnam, Thailand, Iran and Cambodia, respectively. We obtained separate estimates by gender. In the tables we report coefficient estimates of the past and future relative birth cohort sizes, the control variables, period effects and intercepts[6].

[5] For Iran we specify period variables for 1980-83 and 1984-88 (the wartime period). Measuring wartime period effects with two-year period variables resulted in severe collinearity. We measure period effects for the pre 1980 period in Iran with two-year period variables. The first two-year period (1970-71) is the omitted reference category.

[6] For all regressions we report estimates of the standard errors of the coefficients that are robust to hereroscedasticity. It is not feasible to obtain standard error estimates that are clustered by cohort because our models have too many parameters relative to the number of birth cohorts in the data. To get an idea whether estimating clustered standard errors would affect our main results we estimated the schooling models (for each country) with a specification of the period effects so that the reference category consists of more years. There are fewer period parameters in these models and we estimated models with clustered and robust standard errors and with robust standard errors only. In all cases clustered and robust standard errors are higher than robust standard errors. However, the results about statistical significance of the relative birth cohort coefficients are the same as in Tables 2 to 5.

The first columns of Tables 2 to 5 report estimates for men and the second columns report estimates for women. For Vietnam, Thailand, Iran and Cambodia the coefficients of past relative birth cohort size are negative and the coefficients of future relative birth cohort size are

Table 2. Maximum Likelihood Estimates of the Interval Regression Schooling Model for Vietnam

	Men	Women
Past relative birth cohort size	-3.824	-5.274
	(0.262)	(0.265)
Future relative birth cohort size	4.153	5.390
	(0.255)	(0.258)
Ethnicity	1.916	2.108
	(0.006)	(0.007)
Born 1978-79	0.491	0.508
	(0.018)	(0.018)
Born 1980-81	0.923	0.967
	(0.019)	(0.019)
Born 1982-83	1.219	1.368
	(0.019)	(0.019)
Born 1984-85	1.222	1.387
	(0.012)	(0.012)
Born 1986-87	1.442	1.560
	(0.013)	(0.013)
Born 1988-89	1.763	1.978
	(0.016)	(0.016)
Born 1990	1.790	2.035
	(0.033)	(0.034)
Intercept	6.533	6.644
	(0.116)	(0.117)
Log-likelihood	-4478815.7	-4393823.1
Sample Size	1759552	1725314

Note: Robust standard error estimates are in parentheses

Table 3. Maximum Likelihood Estimates of the Interval Regression Schooling Model for Thailand

	Men	Women
Past relative birth cohort size	-6.080	-9.083
	(1.009)	(1.016)
Future relative birth cohort size	6.229	9.260
	(1.254)	(1.276)
Born 1966-67	0.323	0.053
	(0.086)	(0.086)
Born 1968-69	0.377	0.124
	(0.129)	(0.130)
Born 1970-71	0.593	0.484
	(0.154)	(0.155)
Born 1972-73	0.531	0.363
	(0.209)	(0.211)
Born 1974-75	0.554	0.470
	(0.254)	(0.256)
Born 1976-77	0.970	0.849
	(0.290)	(0.293)
Born 1978-79	1.442	1.684
	(0.267)	(0.269
Born 1980-81	1.969	2.374
	(0.286)	(0.289)
Intercept	8.278	8.384
	(0.633)	(0.654)
Log-likelihood	-215243.91	-233640.85
Sample Size	84642	90157

Note: Robust standard error estimates are in parentheses

Table 4. Maximum Likelihood Estimates of the Interval Regression Schooling Model for Iran

	Men	Women
Past relative birth cohort size	-0.815	-1.189
	(0.074)	(0.086)
Future relative birth cohort size	1.866	1.592
	(0.178)	(0.194)
Born 1972-73	0.462	0.445
	(0.047)	(0.054)
Born 1974-75	0.819	1.141
	(0.046)	(0.054)
Born 1976-77	1.086	1.807
	(0.054)	(0.062)
Born 1978-79	1.335	2.496
	(0.062)	(0.071)
Born 1980-83	1.031	2.931
	(0.041)	(0.047)
Born 1984-88	1.327	2.966
	(0.051)	(0.058)
Intercept	7.593	6.617
	(0.145)	(0.159)
Log-likelihood	-580302.21	-582542.11
Sample Size	228601	221516

Note: Robust standard error estimates are in parentheses

Table 5. Maximum Likelihood Estimates of the Interval Regression Schooling Model for Cambodia

	Men	Women
Past relative birth cohort size	-0.002	-1.031
	(0.326)	(0.293)
Future relative birth cohort size	7.415	8.356
	(1.461)	(1.304)
Language	1.734	1.531
	(0.072)	(0.069)
Born 1982-83	0.143	-0.075
	(0.086)	(0.078)
Born 1984-85	0.561	0.201
	(0.150)	(0.135)
Born 1986-87	0.991	0.699
	(0.145)	(0.130)
Born 1988-89	1.163	0.908
	(0.142)	(0.128)
Born 1990-91	1.272	0.938
	(0.182)	(0.163)
Intercept	-1.451	-1.917
	(1.477)	(1.318)
Log-likelihood	-315053.86	-307553.21
Sample Size	130881	124919

Note: Robust standard error estimates are in parentheses

positive[7]. This is the case for both men and for women. In most cases the absolute values of the coefficients for women are larger than those for men. All coefficient estimates are statistically significant at conventional levels except the coefficient of past relative cohort size for Cambodia. We note that for individuals born in the early 1980s in Cambodia past relative birth cohort size includes the period of upheaval in the late 1970s. The presence of this period in the data may account for the finding of no significant response of schooling to past relative birth cohort size.

[7] We also estimated interval regressions without period effects. For all four countries and for both genders we estimated negative and significant coefficients for past relative birth cohort size and positive and significant coefficients for future relative birth cohort size. These coefficients were larger in absolute value than those of the models that include period effects that are reported in Tables 2 to 5. It appears that when period effects are not explicitly controlled for, the relative birth cohort size coefficients capture both relative cohort size and period effects. We consider the estimates of the relative cohort size coefficients in Tables 2 to 5 to be more informative because they are net of period effects.

The coefficient estimates for the two relative birth cohort sizes imply that an individual born during the upswing of the demographic cycle will complete less schooling than an individual with similar characteristics born during the downswing of the demographic cycle, holding constant period and family background effects. This is a common pattern in all four countries.

We find that members of the majority ethnic group (Kinh) in Vietnam complete more schooling. We also find that speakers of the majority language (Khmer) in Cambodia complete more schooling. These results hold for both men and women.

For all four countries we document non-linear period (trend) effects for both genders. These indicate generally rising schooling due to temporal factors other than relative birth cohort size. The estimated trend effects for Iran are noteworthy as they reveal the effects of the Iran-Iraq war on men. The estimate of the period effect for men for 1980-83 is smaller than that of the preceding period probably reflecting the interruption of the schooling of some men who never returned to school after wartime military service. The estimate of the period effect for 1984-88 is similar in magnitude to that of the last prewar period. In contrast the estimates of the period effects for the same era for women do not show the dip evident for men. Each period coefficient for women is greater than that of the preceding period and the last two do not differ significantly from each other.

The IPUMS data also contain information on schooling of the parents of the respondents but only for parents who live in the same household as the respondent. Parents' education measures are highly correlated with the schooling of their children. Parents' education measures may also be correlated sufficiently strongly with the other regressors (period variables, ethnicity,

language) so that their omission may cause omitted variables bias. Therefore, we wish to explore further the possible severity of such omitted variables bias.

The data sets for the four countries that report parents' schooling consist of fewer and younger individuals with higher enrollment rates and higher mean completed schooling than for the samples whose summary statistics are reported in Table 1. However, the sample that reports parents' schooling is not representative of the underlying population. We suspect there may be common unobservable factors that result in some people both completing more schooling and being more likely to live with their parents and thus be included in the sample that reports parents' schooling. Estimates of the schooling model with data that report parents' schooling may, thus, suffer from selectivity bias. We do not have suitable instruments that might be useful in obtaining selectivity-corrected estimates with the sample that reports parents' schooling. In contrast, the larger samples we used to obtain the estimates in Tables 2 to 5 that are not conditional on parents' schooling information better represent the underlying populations but models estimated with these samples may be misspecified. We re-estimated the schooling models for the four countries with the data sets that report parents' schooling and explored whether omitting parents' schooling results in omitted variable bias in the relative birth cohort size coefficients. Our evidence suggests that bias in the coefficients that are of central interest to our study from omitting parents' schooling is not serious[8].

[8] In a censored regression model omitting regressors that are correlated with the other included regressors or are not normally distributed may result in bias of the estimated parameters (Wooldridge, 2010, section 17.5.1). We can get an indication of how serious the effect of omitting parents' schooling is by estimating schooling regressions that use the same smaller samples that report parents' schooling alternatively with and without the parents' schooling regressors. We then test whether the coefficients of past and of future relative birth cohort of the former regression are equal to the point estimates of these coefficients obtained with the latter regression (i.e. without parents' schooling). These are the coefficients that are of most interest to us. In all cases, except one, the coefficients are jointly not significantly different across specifications. The exception is for the case of men in Vietnam. The relative birth cohort size coefficients obtained from the model with parents' schooling are jointly

Predictions and Discussion.

To show more clearly the implications of our findings on the effect of relative birth cohort size we calculated some predictions. We predicted years of schooling at the means of all regressors other than the two relative birth cohort size variables for each country and gender, conditional on observed schooling[9]. We constructed some hypothetical demographic cycle scenarios as follows: (a) For the hypothetical upswing we calculated the mean birth cohort size for each country. We then increased it by the difference between the peak cohort size and the mean spread equally each year over a five year period ahead. We then decreased it by the same amount spread equally each year over a five year period back. We used the resulting hypothetical cohort sizes to calculate relative past and future birth cohort sizes. (b) For the hypothetical downswing we reversed roles for the relative birth cohort size variables derived in (a). (c) Lastly we considered a flat cycle by setting both relative birth cohort variables equal to one. For a given country the hypothetical relative birth cohort size variables are the same for all predictions for that country. The means of the other regressors for a given country differ by gender.

The predictions are shown in Table 6 and for each country and gender. We show predicted observed schooling for the hypothetical upswing of the demographic cycle, downswing of the demographic cycle and no demographic (flat) cycle. Predicted schooling (both genders) is

---

different from coefficients obtained with the same sample when parents schooling measure are not included (pr = 0.04) but the coefficients are not individually significantly different across specifications. Our evidence mostly indicates that omitted variable bias arising from omission of parents' schooling is not serious in the samples that report parents' schooling. Not finding evidence of serious omitted variable bias in the smaller samples suggests that it is possible that this may also be the case for the larger samples that are not conditional on parents' schooling information.

[9] E[y*|y<limit] where y* is the uncensored endogenous variable (schooling), y is observed schooling, and the limit is the censoring point that varies by censored observation.

lower for individuals with mean other characteristics[10] facing the hypothetical upswing than those facing a flat cycle whose predicted schooling is lower than the predicted schooling of individuals facing the hypothetical downswing. The differences in predicted schooling for men

Table 6. Predictions of schooling under hypothetical demographic cycle scenarios

Country	Men	Women
Vietnam		
Upswing	6.544	6.490
	(0.025)	(0.026)
Downswing	7.548	7.799
	(0.035)	(0.032)
Flat	7.080	7.226
	(0.011)	(0.011)
Thailand		
Upswing	6.412	6.007
	(0.097)	(0.101)
Downswing	7.369	7.422
	(0.073)	(0.069)
Flat	6.929	6.793
	(0.008)	(0.009)
Iran		
Upswing	6.935	6.192
	(0.034)	(0.040)
Downswing	7.906	7.234
	(0.045)	(0.051)
Flat	7.383	6.723
	(0.006)	(0.007)
Cambodia		
Upswing	5.440	4.651
	(0.052)	(0.049)
Downswing	6.068	5.449
	(0.075)	(0.063)
Flat	5.736	5.047
	(0.021)	(0.019)

Note: Standard error estimates are in parentheses

[10] Ethnicity (Vietnam), language (Cambodia), period effects.

with mean characteristics facing the upswing and men facing the downswing of the demographic cycle are 1.004 year (Vietnam), 0.957 (Thailand), 0.971 (Iran) and 0.628 (Cambodia). The corresponding differences for women are 1.309 (Vietnam), 1.415 (Thailand), 1.042 year (Iran) and 0.798 year (Cambodia). Women with mean characteristics respond more to a given change in relative cohort size than men do in a given country. The differences in predicted schooling between individuals facing the upswing and those facing the downswing of the demographic cycle range from 8.3 percent of the observed mean schooling for men in Cambodia to 16 percent of the observed mean for women in Thailand. These differences are economically meaningful. Previous studies have estimated the average private annual rate of return to schooling to be 4.8 percent in Vietnam, 11.5 percent in Thailand and 11.6 percent in Iran (Psacharopoulos and Patrinos, 2004)[11]. An additional year of schooling at such annual rates of return implies a considerable lifetime gain in wages. If the response of schooling to the demographic cycle in Vietnam, Thailand, Iran and Cambodia applies to other developing countries that are at earlier phases of the demographic transition, we can expect that as the demographic transition moves forward in these other countries, schooling levels will increase which could potentially boost economic growth. More concretely, the total fertility rate in Cambodia is higher than in Vietnam, Thailand or Iran[12]. If in the future Cambodia's total fertility rate were to decline to the levels of the other three countries, our estimates imply rising schooling levels in Cambodia.

We have found that individuals born during the upswing of the demographic cycle complete less schooling than individuals with the same characteristics born during the downswing of the demographic cycle in the four countries. Here's a possible simplified economic interpretation of this pattern.

[11] We have not found an estimate of the rate or return to schooling in Cambodia.
[12] Cambodia 2.80, Iran 1.77, Thailand 1.63, Vietnam 1.89 (UN data)

Suppose that workers with different schooling levels (S_1 and S_2) but no experience are closer substitutes for each other than workers with a given amount of schooling but different levels of experience. Then an increase in the relative supply of new workers with S_1 years of schooling, because of an increase in cohort size, is likely to result in a narrowing of the wage premium for workers entering the labor market with S_2 years of schooling relative to their counterparts entering with S_1 thus diminishing the incentive to continue in school. Workers with S_1 who entered the labor market S_2-S_1 periods before the increase in cohort size took place will have S_2-S_1 years of experience at the time of the increase of cohort size. An implication of the above assumption about the relative ease of substitution of different types of labor is that those more experienced workers will be relatively less affected by the increase in cohort size than the less experienced workers with either type of schooling. Then workers born during the upswing of the demographic cycle will leave school earlier and enter the labor market earlier relative to workers born during the downswing of the demographic cycle. We have no evidence on how realistic the assumption on the closer substitutability of workers with different levels of schooling than workers with different levels of experience is for the four countries we are examining.

A more complete model would incorporate how workers forecast how much schooling all other potential workers will complete. Such a model would also consider the implications of an increase in cohort size at later stages of a worker's career. This more complete model would be quite complex and is not found in the existing literature.

An alternative explanation of our empirical finding can be given using the model of Dooley and Gottschalk (1984). They assume that all workers in the labor market at any point in time are perfect substitutes for each other. Wages are only affected by the total number of

workers in the labor market. Thus workers who are born into a relatively large cohort and who face a smaller cohort in the future will expect an increase in future wages which raises the rate of return to schooling. These workers are expected to invest in more schooling than workers who face a larger cohort in the future. Our estimates thus are consistent with the predictions of Dooley and Gottschalk. Berger (1983) presents evidence that US workers with different levels of schooling and experience are not perfect substitutes. Amaral et al. (2007) present evidence that workers in Brazil in different education-age categories are not perfect substitutes. To the extent that these findings are also applicable to the four countries we study, Dooley and Gottschalk's model may not be a realistic characterization of how individuals in the four countries make schooling decisions in response to the demographic cycle.

Falaris and Peters (1992) studied the effect of the demographic cycle on schooling with US data. They found that individuals facing the upswing of the demographic cycle complete more schooling than individuals facing the downswing of the demographic cycle. Their results cannot be fully explained by any of the existing theoretical models. For Vietnam, Thailand, Iran and Cambodia we find that individuals facing the upswing of the demographic cycle complete less schooling than individuals facing the downswing of the demographic cycle. We do not know which feature of these developing economies accounts for this difference in behavior in response to the demographic cycle relative to behavior of individuals in the US. It may be a difference in the degree of substitutability of factors in the production process in a high-income relative to a developing economy. We cannot explore this issue further with the data we have available. With our estimates we document an empirical pattern future research must confront.

Conclusion.

Using data from Vietnam, Thailand, Iran and Cambodia we found that individuals born during the upswing of the demographic cycle complete less schooling than individuals with similar characteristics born during the downswing of the demographic cycle. Our findings are consistent with imperfect substitutability of workers with different amounts of work experience. Our estimates imply economically meaningful responses of schooling to the demographic cycle. The additional schooling that individuals born during the downswing of the demographic cycle complete relative to those born during the upswing of the demographic cycle implies considerable lifetime private returns. If our finding for Vietnam, Thailand, Iran and Cambodia applies to other developing countries that are at earlier phases of the demographic transition, we can expect that as the demographic transition moves forward in these other countries, schooling levels will increase which could potentially boost economic growth. For Cambodia, we can expect that in the future if the birth rate declines, schooling levels will increase.

References.

Amaral, Ernesto F. L, Daniel Hamermesh, Joseph E. Potter, and Eduardo L. G. Rios-Neto, (2007), "Demographic Change and the Structure of Wages: A Demand-Theoretic Analysis for Brazil," National Bureau of Economic Research Working Paper 13533.

Berger, Mark C., (1983), "Changes in Labor Force Composition and Male Earnings: A Production Approach," *Journal of Human Resources*, 18,2: 177-196.

Bloom, David E. and David Canning, (2004), "Global Demographic Change: Dimensions and Economic Significance," in *Global Demographic Change: Economic Impacts and Policy Challenges*, Kansas City: Federal Reserve Bank of Kansas City: 9-56.

Cameron, A. Colin and Pravin K. Trivedi, (2005), *Microeconometrics: Methods and Applications*, New York: Cambridge University Press.

Dooley, Martin D. and Peter Gottschalk, (1984), "Earnings Inequality among Males in the United States: Trends and the Effect of Labor Force Growth," *Journal of Political Economy*, 92, 1: 59-89.

Falaris, Evangelos M. and H. Elizabeth Peters, (1992), Schooling Choices and Demographic Cycles," *Journal of Human Resources*, 27, 4: 551-574.

Psacharopoulos, George and Harry Anthony Patrinos, (2004), "Returns to Investment in Education: A Further Update," *Education Economics*, 12, 2: 111-134.

UN data, http://data.un.org/Data.aspx?d=PopDiv&f=variableID%3A54#PopDiv

United Nations, Economic and Social Commission for Asia and the Pacific, (2001), "The Planning Process in Cambodia," http://www.unescap.org/drpad/publication/ldc6_2174/chap2.PDF

Wachter, Michael L. and William L. Wascher, (1984), "Leveling Peaks and Troughs of the Demographic Cycle: An Application to School Enrollment Rates," *Review of Economics and Statistics*, 66, 2: 208-215.

Wooldridge, Jeffrey M., (2010), *Econometric Analysis of Cross Section and Panel Data*, Second Edition, Cambridge, MA: MIT Press.