

The Effects of Education on Fertility in Colombia and Peru: Implications for Health and Family Planning Policies

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Previous studies have found that education and fertility are inversely related. However, the extant literature on the effects of education in Latin America has been limited by certain methodological problems. In particular, previous studies have used estimation methods that were prone to statistical bias, and they have frequently neglected to examine rural areas, where education is likely to have a large effect on fertility. In this paper, we attempt to improve upon our understanding of education and fertility in the region. Employing data from some of the most recent Demographic and Health Surveys (DHS) in Latin America, we test complementary hypotheses about the effects of education on fertility in Colombia and Peru. The effects of the independent variables are estimated using negative binomial regression. We also discuss the broader implications of the findings for family planning policies and regional public health governance in Latin America.

INTRODUCTION

In recent years, a number of studies have suggested that Latin America is in a state of demographic transition. Population in the region grew faster than in any other region of the world between 1920 and 1970. Subsequently, population growth rates slowed considerably in the decades of the 1980s and 1990s, falling to a regional annual mean of under 2 percent.¹ Most projections indicate that population growth in the region will continue to slow in the near future.

A number of variables are implicated in Latin America's demographic transition, but much recent scholarship attributes the decline of falling fertility rates to improvements in family planning and expanded labor market opportunities for women. In addition, many studies have emphasized the importance of education in reducing fertility rates in the region.² Indeed, early studies of the region found a strong, inverse relationship between levels of formal education and fertility.³

Although many scholars now agree that education has a negative effect on fertility, empirical research on the issue in Latin America has been subject to certain limitations. First, among the studies that have examined the effects of education on fertility in selected Latin American countries,⁴ analysts have frequently employed statistical estimation techniques – such as linear (ordinary least squares, OLS) regression – that are unsuitable for fertility data, which are based on counts.⁵ Recent studies of contraceptive use in Latin America have addressed the problem of statistical estimation,⁶ but extant research on *education and fertility* in Latin America remains based largely on older designs that were prone to statistical bias.⁷ Second, in much of the previous literature, researchers did not have access to data that would allow one to control for other

important influences on fertility in the research design. For example, more recent data sets from the Demographic and Health Survey (DHS) have incorporated new measures of household wealth; because the household wealth data are fairly new, they were not employed in the previous literature. Finally, and perhaps most important, analysts have neglected to focus on the connection between education and fertility in rural parts of Latin America.⁸ Given that the effects of education on fertility are perhaps greater in rural areas than in comparison to urban areas, the lack of focus on rural areas constitutes a major shortcoming of the existing literature.⁹ For these reasons, a reexamination of the relationship between education and fertility in Latin America is warranted.

Improving our understanding of education and fertility contributes to the literature on global health policy-making in a variety of ways. Since the mid-1990s, scholars and activists in the global health community have noted that family planning programs that focus solely on providing access to contraceptive technology neglects the underlying conditions that empower women when fertility decisions are made.¹⁰ Among the many factors that remain significant, women's access to formal education can improve their labor market bargaining power while potentially facilitating their participation in national health programs designed to depress fertility.¹¹ For this reason, health policy-makers remain interested in knowing whether investments in formal education reduce fertility and, if so, what the mechanisms are for this relationship.

In this paper, we attempt to provide a more refined investigation of education and fertility in Latin America. Focusing on Colombia and Peru, we examine the effects of differing levels of education while controlling for wealth and other important covariates. The findings of the analysis make two contributions to the literature. First, after employing appropriate estimation techniques for count data, we find that the marginal effects of higher levels of education have a strong, negative effect on fertility in rural areas, although exposure to primary education does not always have a consistent effect across both countries. Second, controlling for the effects of education, family wealth and other determinants, the results strongly suggest that the impact of education in rural areas is associated with women's labor market potential and with their improved knowledge of the biology of reproduction, all things being equal.

THEORETICAL APPROACH

A number of theoretical approaches have been proposed to understand the effects of education on fertility. A prominent approach, which is associated with the "New Household Economics,"¹² begins from the proposition that members of the household unit seek to maximize income.¹³ In this formulation, it is assumed that women and men respond to economic incentive structures. Accordingly, the theory predicts that once education is provided as a public good and becomes widespread for women and men, an increase in education leads to a decline in fertility, all things being equal.¹⁴ The putative mechanism for this effect is the opportunity costs associated with caring for children as education increases. As women acquire skill sets useful in the marketplace with higher levels of educational attainment, they tend to command a higher wage, increasing the

value of their time.¹⁵ To the degree that education raises women's and men's earning potential in the labor market, the theory also implies that education reduces the incentive to attempt to use fertility as a mechanism to increase family production and income.

While recognizing the micro-economic influences of education, complementary approaches suggest that the link between education and fertility is more complex.¹⁶ A theoretically eclectic framework developed by Castro Martin and Juarez¹⁷ hypothesizes that education may depress fertility rates for a number of reasons, including (1) improved literacy and cognitive skills that increase the likelihood of interaction between women and public health institutions; (2) improved knowledge of the biology of reproduction (which raises the potential efficacy of contraceptive use); and (3) changes in attitudes that raise the likelihood of using contraceptives.

Other Potential Influences

The literature of demography and comparative health also points to a number of other determinants of fertility. Bongarts, Frank and Lesthaeghe¹⁸ suggest that the potential importance of education and other economic variables will tend to be mediated by "proximate" determinants such as age, wealth, and previous and current contraceptive use. Thus, we might assume that as the income of the family increases, the demand for childhood labor to supplement family income within the family unit declines, leading to a reduction in the total fertility rate. Likewise, prior use of contraceptives before the first birth might indicate a strong preference for fertility regulation and predict current contraceptive use, with attendant consequences for fertility. Finally, women who are not married or who are not cohabiting with a partner may feel relatively less secure that there will be sufficient resources to support a child; single women, therefore, are expected to exhibit stronger interest in birth control, all things being equal.¹⁹

DATA AND METHODS

To examine the influence of education on women's fertility, we employ data from the most recent national surveys in Latin America of the Demographic and Health Surveys (DHS).²⁰ Funded by the U.S. Agency for International Development, the DHS coordinates with Macro International and developing country-institutions to administer a survey to women (ages 15 to 49) who are drawn from a national sample. The DHS instrument asks respondents to report retrospectively on fetal loss and live birth, type and duration of contraceptive use, and reasons for discontinuing contraception. Information concerning education, family nutrition and health, and other socioeconomic variables are also collected. Although the quality of the DHS data are potentially limited by problems of recall (i.e., a lapse in memory) and possible underreporting of certain types of behavior – such as abortion – due to social norms, demographers and health analysts view the data as highly reliable for use in demographic analysis.²¹ We rely on

standardized DHS coding to disaggregate the data to include observations only from individuals residing in cities and settlements classified as “rural.”

The countries included for analysis include two Latin American countries covered by the most recent DHS surveys: Colombia (2005) and Peru (2000).²² While showing variation in respondent preferences for specific types of modern contraceptive use, these two countries share a number of common institutional influences, including fairly well developed family planning services (with little restriction), sexual education in schools, and public advertising campaigns on family planning.²³ As such, these countries are suitable for inclusion in the analysis.

Dependent Variable

The measure for fertility is the number of live children ever born during the respondent’s lifetime. The fertility measure is a type of count data, and as Long has noted, “...use of the linear regression model for count data can result in inefficient, inconsistent and biased estimates.”²⁴ As an alternative, we estimate the model using Negative Binomial regression. Preliminary diagnostic tests indicated that the data are prone to overdispersion (i.e., variance of the response variable is greater than its mean). Estimation with Negative Binomial regression specifically addresses the problem of overdispersion in the data.²⁵ As with other families of statistical regression methods, negative Binomial regression estimates may be prone to bias in the face of unobserved or arbitrary heterogeneity. To address this issue, we estimate the models with Huber-White robust standard errors. Simulation studies have demonstrated that robust standard errors control successfully for heterogeneity or over-dispersion in data sets estimated with Negative Binomial or Poisson regression.²⁶

Education Covariates

To assess the effects of exposure to formal education on fertility, we created a series of dichotomous variables for the level of education completed by respondents, ranging from some or completed primary education, to some or completed secondary education, to some or completed higher education.²⁷ For the purposes of the statistical analysis, the omitted category is a respondent with no formal education. Coding the education covariates in this manner is the preferred technique employed in the recent literature.²⁸

To assess the effects of education on improved knowledge of the biology of reproduction, we include a dichotomous proxy variable, correct knowledge of the ovulation cycle (= “1” if correctly answered question when fertility is most likely in the cycle, “0” otherwise). This question and coding technique has been employed frequently in other studies that use the DHS data set.²⁹

Additional Covariates

Wealth Index. To control for the possible influence of wealth on fertility, we employ an ordinal index of household wealth, ranging from 1 through 5, with

higher levels indicating more family wealth. The index is created by DHS based upon respondent answers to various queries concerning household asset ownership and income.

Use of Modern Contraceptives Before First Birth. Given that prior contraceptive use before the birth of a first child might indicate knowledge and interest in regulating fertility, we include a covariate that measures use of a modern contraceptive before the birth of the first child (coded “1” if a respondent used contraceptives before the first birth, “0” otherwise).

Marital or Residence Status. Dichotomous variable, coded “1” for women who are married or who are residing with a partner, “0” otherwise. Inclusion of this variable controls for the likelihood that single women may have stronger incentives to regulate fertility, all things being equal.³⁰

Living Children. High infant mortality rates within the family may lead women to have more children.³¹ To control for this possibility, we include a covariate for the number of children still alive for a female respondent. This technique has been used in previous studies.³²

Age. We follow Mensch, Arends-Kuenning, and Jain³³ and create dichotomous variables for the respondent’s age group (e.g., ages 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49). The age group 15-19 is omitted as the comparison category.

ANALYSIS

The results of the Negative binomial regression models are presented in Tables 1a and 1b.³⁴ In what follows, we first discuss the results for the education covariates. This is followed by an analysis of the various controls in the model.

As one can see from the data, the effects of education on fertility are fairly consistent in both countries. The coefficients for secondary and higher education are all negative and statistically significant in rural Peru and Colombia. The marginal effects for each category of education in rural Peru and Colombia show that in relation to the mean fertility of the comparison category, a respondent with no education, the fertility rate declines by an increasing factor with exposure to each additional threshold of formal education. By contrast, although the coefficients (and marginal effects) for primary education are negative and statistically significant in Peru, they have no effect in Colombia.

The effects of education suggested by the regression results are possibly due to higher earnings’ potential that women experience as they acquire more years of schooling.³⁵ Employers in Latin America may use education as a proxy for skill levels and increase wages according to the level of formal education completed by women employees; in this context, as a woman acquires more education, the opportunity costs to having children may rise. Although we are unable to control for wage levels directly with the DHS data set, we can make inferences from what other studies have found about wages and education in rural Peru and Colombia. Thus, in a recent study of rural Peru, Laszlo notes that as education increases, women and men find “...better, more lucrative jobs characterized by fewer hours.³⁶” The improvement in wages in rural Peru is evident even when individuals have exposure to few years of formal education.³⁷

However, in Colombia, due to on-going problems associated with the decentralization of education,³⁸ the quality of primary education in rural areas is so low that it frequently has little effect on women's future earnings.³⁹ Instead, women in rural and urban Colombia tend to experience a large gain in real wages after completing some, or all of their secondary education.⁴⁰ In light of these findings, it is not surprising that the coefficient and marginal effects of primary education in rural Colombia failed to achieve statistical significance (Table 1a).

Table 1a Determinants of Fertility in Rural Colombia, 2005

(*N* = 8,806)

Covariate	Coefficient (Robust Stand. Error)	Marginal Effect
Primary Education	-.01 (.02)	-.14
Secondary Education	-.12*** (.02)	-.18***
Higher Education	-.35*** (.05)	-.45***
Knowledge of Ovulatory Cycle	-.003 (.01)	-.004
Wealth Index	-.01* (.005)	(ordinal measure)
Use of Modern Contraception Before First Birth	-.08*** (.01)	-.11***
Marital/Residence Status	.53*** (.03)	.72***
Living Children	.21*** (.01)	(continuous measure)
Age 20-24	1.10*** (.05)	2.53***
Age 25-29	1.37*** (.05)	3.63***
Age 30-34	1.44*** (.05)	3.98***
Age 35-39	1.46*** (.05)	4.10***
Age 40-44	1.46*** (.06)	4.23***
Age 45-49	1.47*** (.05)	4.33***

Log pseudo-likelihood = -11,519 Wald Chi-Square = 16,711***

p*<.05; ** *p*<.01; * *p*<.001

Note: Entries in column 2 are Negative Binomial regression coefficients with robust standard errors in parentheses. Entries in column 3 ("Marginal Effects") are the effects of a discrete change (from 0 to 1) for each covariate on fertility, holding all other covariates at their mean.

Table 1b Determinants of Fertility in Rural Peru, 2000
(*N* = 8,713)

Covariate	Coefficient (Robust Stand. Error)	Marginal Effect
Primary Education	-.05*** (.01)	-.12***
Secondary Education	-.18*** (.01)	-.44***
Higher Education	-.39*** (.03)	-.88***
Knowledge of Ovulatory Cycle	-.02** (.008)	-.06**
Wealth Index	-.03*** (.005)	(ordinal measure)
Use of Modern Contraception Before First Birth	-.20*** (.02)	-.50***
Marital/Residence Status	.46*** (.03)	1.05***
Living Children	.19*** (.003)	(continuous measure)
Age 20-24	.93*** (.05)	3.55***
Age 25-29	1.24*** (.05)	5.29***
Age 30-34	1.37*** (.05)	6.13***
Age 35-39	1.41*** (.05)	6.62***
Age 40-44	1.43*** (.05)	7.03***
Age 45-49	1.46*** (.05)	7.48***

Log pseudo-likelihood = -13,805.3

Wald Chi-Square = 27,144***

p* < .05; ** *p* < .01; * *p* < .001

Note: Entries in column 2 are Negative Binomial regression coefficients with robust standard errors in parentheses. Entries in column 3 ("Marginal Effects") are the effects of a discrete change (from 0 to 1) for each dichotomous covariate on fertility, holding all other covariates at their mean.

Nevertheless, as Castro Martin,⁴¹ and Castro Martin and Juarez⁴² have argued, the causal pathways through which education influences fertility may be more complex than the mechanisms postulated by microeconomic approaches. Indeed, it is possible that education improves women's literacy and leads to

better understanding of the biology of reproduction, thereby increasing the efficacy of family planning and contraceptive use methods. To assess this possibility, we estimated the full model with a variable for “knowledge of the ovulatory cycle.” In Peru, the coefficient and marginal effects for knowledge of ovulatory cycle is, as expected, negative and statistically significant. These results are partially suggestive that after adequate controls have been introduced into the model, the effect of education on knowledge of the biology of reproduction has an influence on fertility, as suggested in previous studies.⁴³ In Colombia, however, we found that the coefficient and marginal effect of this covariate was not significant. Quite possibly, this difference between Peru and Colombia is due to the variation in the degree of coverage in sexual education in schools. Although both countries moved to make sexual education in schools compulsory during the 1990s, available data suggest that the percentage of schools incorporating sexual education into the curriculum is far higher in Peru (80 percent of secondary schools; 22 percent of primary schools, 2000) in comparison to Colombia, where sexual education is more fragmented.⁴⁴

The effects for the remaining covariates in the models are fairly straightforward. As expected, the coefficient for the wealth index suggests that as wealth increases, fertility declines in rural Colombia and Peru.⁴⁵ This finding complements the argument that one reason that education depresses fertility is due to the wage effects of higher education. Likewise, in both countries, women who used modern contraceptives prior to the birth of their first child are more likely to have fewer children. As in other countries, marriage and couples who are cohabitating are more likely to have children. The number of living children is positively associated with fertility; consistent with Valente and Saba,⁴⁶ mortality among children does not appear to influence fertility decisions in rural parts of Colombia and Peru. Finally, the coefficients and marginal effects for age also have the expected effect. Relative to the comparison category, women aged 15 to 19, cumulative fertility increases as women become older.

CONCLUSION

This paper has examined the effects of education on fertility in rural areas of two Latin American countries. Employing improved estimation techniques and new covariates, the study demonstrates that education and fertility remain inversely related in rural Colombia and Peru – a finding that is possibly due to the relationship between education and wage levels for rural women. At the same time, our results suggest that education may depress fertility for reasons that go beyond micro-economic factors. As noted, women who correctly identified when conception is most likely during the ovulatory cycle had fewer children in Peru. This probably reflects the influence of women’s exposure to sexual education in the public education system.

One implication of our findings has to do with how public health and family planning policies are conceptualized and implemented in Latin America. Frequently, the formulation of health and family planning policies at the national and intra-regional level in Latin America has neglected the broader social context that influences fertility decisions. Instead, as many analysts have noted,

governments and NGOs throughout the region have continued to focus narrowly on the provision of modern contraception and the targeting of health advertising to young women and men.⁴⁷ A complementary approach, which is supported by the findings of this study, emphasizes the importance of improving access to education as a means of empowering women and creating a more comprehensive health and family planning framework. Our results suggest that such an approach is likely to result in improved regulation of fertility, particularly in rural areas, where the effects of education are strong.

A related policy implication of the paper has to do with public funding for education in the region. With the onset of neoliberal adjustment programs in Latin America, governments have often been compelled to reduce the growth rate in real spending on education, while simultaneously introducing decentralization and other structural reforms to education.⁴⁸ Spending cuts, the expansion of enrollment “fees” charged to parents, and the shifting of the financial burden for education to local areas has exacerbated educational inequalities and worsened educational access in many rural parts of Latin America. The impact of these reforms on women’s schooling in rural areas is now highly visible. For example, between 1995 and 1999, school enrollment ratios among rural girls and young women in Colombia declined for *every* age group between the ages 7 and 24.⁴⁹ School enrollment ratios among rural girls also declined between 1994 and 2003 in Peru.⁵⁰ To the extent that education has a strong negative influence on fertility, our findings suggest that government adjustment programs that reduce investment in education do so at the risk of undermining the reduction of fertility seen in the past twenty years in Latin America.

The findings of the paper also give rise to implications for how future research on fertility in Latin America might be refined and extended. First, our results are limited because of the paucity of measures within the DHS data set that adequately capture the possible connections between education and women’s confidence and feelings of self worth. Self-confidence is hypothesized to have some interaction with education, making a woman’s experience with family planning and medical professionals more successful. The lack of measures therefore limits the results. In addition, the statistical results are limited by a lack of data on religious attitudes among respondents in both samples. Data on religious orientations and intensity of beliefs is missing throughout much of the DHS data in Latin America; as a result, we are unable to control for the effects of religious beliefs in the models. Although the Catholic Church’s resistance to family planning varies throughout Latin America,⁵¹ its influence remains strong in the rural areas of some countries. We remain hopeful that future researchers will make some progress in addressing these limitations and issues.

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¹ Sylvia Chant and Nikki Craske, *Gender in Latin America* (New Brunswick: Rutgers University Press, 2003): 71.

² Teresa Castro Martin, "Women's Education and Fertility: Results from 26 Demographic and Health Surveys," *Studies in Family Planning* 26, no. 4 (July-August 1995): 187-202. See also Teresa Castro Martin and Fatima Juarez, "The Impact of Women's education on Fertility in Latin America," *International Family Planning Perspective* 21, no. 2 (June 1995): 52-57, 80.

³ Castro Martin and Juarez, "The Impact of Women's education on Fertility in Latin America," and Chant and Craske, *Gender in Latin America*.

⁴ Castro Martin and Juarez (1995) used OLS estimation. See Castro Martin and Juarez, "The Impact of Women's education on Fertility in Latin America."

⁵ Scott J. Long, *Regression Models for Categorical and Limited Dependent Variables* (Thousand Oaks, CA: Sage Press, 1997): 217.

⁶ Barbara Mensch, Mary Arends-Kuenning, and Anrudh Jain, "The Impact of the Quality of Family Planning Services and Contraceptive use in Peru," *Studies in Family Planning*, 27, no. 2 (March-April 1996): 59-75. Also see Mohamed M. Ali, John Cleland, and Iqbal H. Shah, "Trends in Reproductive Behavior Among Young Single Women in Colombia and Peru: 1985-1999," *Demography* 40, no. 4 (November 2003): 659-673.

⁷ Castro Martin and Juarez, "The Impact of Women's education on Fertility in Latin America." See also T.B. Heaton and R. Forste, "Education as Policy: The Impact of Education on Marriage, Contraception, and Fertility in Colombia, Peru, and Bolivia," *Social Biology* 45, no. 3-4 (Fall-Winter 1999): 194-213.

⁸ Castro and Juarez, "The Impact of Women's education on Fertility in Latin America;" and Heaton and Forste, "Education as Policy."

⁹ On this point, see Thomas W. Valente and Walter P. Saba, "Campaign Exposure and Interpersonal Communication as Factors in Contraceptive Use in Bolivia," *Journal of Health Communication* 6, no. 4 (October-December 2001): 303-322. See also Sonia Laszlo, "Education, Labour Supply and Market Development in Rural Peru," Working Paper, McGill University, (2003). Available at <<http://129.3.20.41/eps/dev/papers/0312/0312005.pdf>> (accessed October 30, 2007).

¹⁰ Chant and Craske, *Gender in Latin America*.

¹¹ Maureen Rand Oakley and Emilio A. Rodriguez, "Family Planning Policy in Latin America: Rights, Development and Values," *Policy Studies*, 26, 2 (June 2005): 211-227.

¹² Gary S. Becker, *The Economic Approach to Human Behavior* (Chicago: University of Chicago Press, 1976); Gary S. Becker, *Treatise on the Family* (Cambridge: Harvard University Press, 1981);

Gary S. Becker, "The Economic Way of Looking at Life," Nobel Lecture, Department of Economics, University of Chicago, 1992.

¹³ Feminist economists have suggested that neoclassical theory tends to ignore patriarchal power relations within the household unit in Latin America (see Chant and Craske, *Gender in Latin America*, 164-168). Feminist scholars point to the increasing role conflict experienced by women as household and child labor remains women's primary responsibility in spite of their increased labor force participation (which rose during the crisis of the 1980s). They also draw attention to the structural conditions under which choices are made, see Drucilla K. Barker and Susan F. Feiner, *Liberating Economics: Feminist Perspectives on Families, Work and Globalization* (Ann Arbor: University of Michigan Press, 2004): 15-18. We acknowledge the importance of these points and agree that approaches that rely exclusively on voluntarism are theoretically naïve. Household inequality, gender processes, and structural constraints should be addressed in research on the family unit. Still, even if one agrees that economic orientations are constructed and reproduced through larger, complex social processes (that involve social class and gender), it is still possible to investigate how education mediates one's choices and orientations – even under structural constraints; a structural perspective, after all, does not deny that workers or women may respond to incentives when they have been socialized to do so under capitalism; see Jeffrey A. Frieden, *Debt, Development and Democracy: Modern Political Economy and Latin America, 1965-1985* (Princeton: Princeton University Press, 1991). Moreover, as women acquire more education and improve their earnings' potential, they gain more leverage and are in a stronger position to negotiate fertility decisions with partners; see Chant and Craske, *Gender in Latin America*.

¹⁴ See Susan H. Cochrane, *Fertility and Education: What Do We Really Know?* (Baltimore: Johns Hopkins University Press, 1979), for a discussion of the intellectual history of economic explanations of education and fertility.

¹⁵ Becker, "The Economic Way of Looking at Life," 45. Of course, this assumes that society and the "market" tend to place little economic value on the care of children and household labor; see Barker and Feiner, *Liberating Economics*, 38. This assumption would appear to describe prevailing attitudes and economic practice in much of Latin America, see Chant and Craske, *Gender in Latin America*. Acknowledgment of this point should not be conflated with condoning, or normalizing, the undervaluing of child rearing and domestic work. Certainly, we would agree that arrangements and policies that valorize household work and child-care have existed empirically (e.g., Sweden) and are theoretically possible; see Barker and Feiner, *Liberating Economics*.

¹⁶ Castro Martin and Juarez, "The Impact of Women's education on Fertility in Latin America," 53.

¹⁷ Castro Martin and Juarez, "The Impact of Women's education on Fertility in Latin America."

¹⁸ J. Bongaarts, O. Frank, and R. Lesthaeghe, "The Proximate Determinants of Fertility in Sub-Saharan Africa," *Population and Development Review* 10, no. 3 (September 1984): 511-537.

¹⁹ Castro Martin, "Women's Education and Fertility."

²⁰ Measure DHS, Marco International, Demographic and Health Surveys, *Peru 2000*, Standard DHS data set (2000). Available at

<http://www.measuredhs.com/countries/country_main.cfm?ctry_id=33>; Measure DHS, Macro International, Demographic and Health Surveys, *Colombia 2005*. Standard DHS data set (2005).

<http://www.measuredhs.com/countries/country_main.cfm?ctry_id=6>

²¹ Ali, Cleland, and Shah, "Trends in Reproductive Behavior Among Young Single Women in Colombia and Peru," 663.

²² Measure DHS (2000, 2005), on the Peru and Colombia datasets.

²³ Ali, Cleland and Shah, "Trends in Reproductive Behavior Among Young Single Women in Colombia and Peru," 660-661. See also, Mohamed M. Ali and John Cleland, "Sexual and Reproductive Behaviour Among Single Women aged 15-24 in Eight Latin American Countries: A Comparative Analysis," *Social Science & Medicine* 60, no. 6 (March 2005): 1175-1185. Also see, Valente and Saba, "Campaign Exposure and Interpersonal Communication as Factors in Contraceptive Use in Bolivia," 303-304; Javier Rodríguez Morales, "Adolescentes: diagnóstico de la educación sexual en la ciudad de Sucre," Report, Family Health International <www.fhi.org>.

Historically, governments and individuals in Peru and Colombia opposed family planning on the grounds of nationalism and due to the influence of socially conservative values; for example, see J. Mayone Stycos, "Opposition to Family Planning in Latin America: Conservative Nationalism," *Demography* 5, no. 2 (1968): 846-854. See also, J.P. and S.R., "The Population Policy of Peru," *Population and Development Review* 2, no. 3-4 (September-December 1976): 506-507; Gisele Maynard Tucker, "Barriers to Modern Contraceptive Use in Rural Peru," *Studies in Family Planning* 17, no. 6 (November-December 1986): 308-316; and Oakley and Rodriguez, "Family Planning Policy in Latin America." By the 1990s, most of this resistance had diminished.

²⁴ Long, *Regression Models for Categorical and Limited Dependent Variables*, 217.

²⁵ Long, *Regression Models for Categorical and Limited Dependent Variables*, 217.

²⁶ J. Boher and R.J. Cook, "Implications of Misspecification Among Robust Tests for Recurrent Events." Working Paper, Department of Statistics and Actuarial Science, University of Waterloo, (2004), 17-18, 23.

²⁷ In the interests of presenting a parsimonious model, we do not distinguish between partial versus completed levels of primary, secondary or higher education. It is important, however, to note that alternative specifications (i.e., partial primary versus completed primary, and so forth; or each year of formal education completed) produce results that are completely consistent.

²⁸ Ali, Cleland, and Shah, "Trends in Reproductive Behavior Among Young Single Women in Colombia and Peru"; see also, Mensch, Arends-Kuenning, and Jain, "The Impact of the Quality of Family Planning Services and Contraceptive use in Peru."

²⁹ Castro Martin and Juarez, "The Impact of Women's education on Fertility in Latin America."

³⁰ Castro Martin and Juarez, "The Impact of Women's education on Fertility in Latin America."

³¹ Valente and Saba, "Campaign Exposure and Interpersonal Communication as Factors in Contraceptive Use in Bolivia."

³² Valente and Saba, "Campaign Exposure and Interpersonal Communication as Factors in Contraceptive Use in Bolivia," 309.

³³ Mensch, Arends-Kuenning, and Jain, "The Impact of the Quality of Family Planning Services and Contraceptive use in Peru."

³⁴ Analyses of VIF scores suggested that all covariates in both models were well within tolerance levels. As a result, we remain confident that the results are not distorted by multicollinearity.

³⁵ Of course, both Peru and Colombia have a history of labor market segmentation that has resulted in large differences in the mean of women's wages as a percentage of men's. Perhaps more important, we are *not* suggesting that increases in education automatically translate into a reduction in poverty among rural or urban women (a conclusion that might be taken from an uncritical reading of human capital theory; see Barker and Feiner, *Liberating Economics*). Indeed, even if rural women with more formal education enjoy relatively higher earnings, structural and institutional factors may result in (a) the persistence of a wage gap (domestically, between the rural and urban areas; and internationally, between wealthy and poor countries), and in (b) real wage stagnation that is associated with the persistence of poverty. For an overview of these issues, see John P. Tuman, "Labor Markets and Economic Reform in Latin America: A Review of Recent Research." *Latin American Research Review* 35, 3 (2000): 173-187, and Barker and Feiner, *Liberating Economics*. While recognizing the need to clarify the implications of the findings, we note only that the data point to some *relative* gains in women's earnings' potential with higher education in comparison to women with fewer, or no years of formal education.

³⁶ Laszlo, "Education, Labour Supply and Market Development in Rural Peru," 1.

³⁷ Laszlo, "Education, Labour Supply and Market Development in Rural Peru."

³⁸ It is beyond the scope of this paper to provide a complete analysis of education policy in Colombia. For a general overview of recent educational reforms associated with decentralization – and their failure in rural areas – see Pamela Lowden, "Education Reform in Colombia: The Elusive Quest for Effectiveness," Working Paper, Latin America Program, Woodrow Wilson International Center for Scholars, 2002

<http://www.wilsoncenter.org/topics/docs/Lowden_Paper.pdf> (Accessed April 6, 2008). One should also recognize that Colombia's civil war has undermined the effort to provide public services, including education, in some rural areas.

³⁹ World Bank, *Colombia Gender Review* (Washington: World Bank Group, 2004), 16, 18. < www.wds.worldbank.org/.../09/000090341_20070409152438/Rendered/PDF/393350CO0GenderReview0200101PUBLIC1.pdf > (Accessed October 27, 2007).

⁴⁰ World Bank, *Colombia Gender Review*, 16.

⁴¹ See Castro Martin, "Women's Education and Fertility."

⁴² Castro Martin and Juarez, "The Impact of Women's education on Fertility in Latin America."

⁴³ See Castro Martin, "Women's Education and Fertility." Education may also make it more likely that women use contraceptives. The results of a statistical analysis support this view. In separate trials, we estimated full models (with logit regression) on modern contraceptive use and found that primary, secondary and higher education had a positive and statistically significant effect on modern contraceptive use in both countries. The results of these trials are available from the authors.

⁴⁴ Ali, Cleland, and Shah, "Trends in Reproductive Behavior Among Young Single Women in Colombia and Peru," 662-663.

⁴⁵ The parameters in all three models are consistent when (1) the wealth index is omitted from the negative binomial regression estimation, and (2) when wealth is defined as an endogenous covariate and instrumented in a two-stage least squares regression (2SLS). Thus, although endogeneity between wealth and fertility is of obvious concern, the results appear to be stable nonetheless. A problem that plagues nearly all studies employing endogenous covariates, however, is finding suitable instruments that satisfy the underlying statistical assumptions of instrumental regression models; indeed, when those assumptions are violated, the results may be more prone to bias than estimation that defines the wealth covariates as being strictly exogenous. For these reasons, the results of the 2SLS should be treated with caution.

⁴⁶ Valente and Saba, "Campaign Exposure and Interpersonal Communication as Factors in Contraceptive Use in Bolivia," Table 3.

⁴⁷ Oakley and Rodriguez, "Family Planning Policy in Latin America." Also, Chant and Craske, *Gender in Latin America*.

⁴⁸ Andrew Nickson, "Education Reform in Latin America: Decentralization or Restructuring?" in Chris Abel and Colin Lewis, eds. *Exclusion and Engagement? Social Policy in Latin America* (London: Institute for Latin American Studies, University of London, 2002): 172-88.

⁴⁹ World Bank, *Colombia Gender Review*, 18-19, Table 9.

⁵⁰ World Bank, *Evaluation of the World Bank's Assistance to Primary Education in Peru: A Country Case Study* (Washington: World Bank Group 2007), Table D2.

<[http://lnweb18.worldbank.org/oed/oeddoelib.nsf/DocUNIDViewForJavaSearch/7AEB9EE607041B1A85257289007C674D/\\$file/peru_education.pdf](http://lnweb18.worldbank.org/oed/oeddoelib.nsf/DocUNIDViewForJavaSearch/7AEB9EE607041B1A85257289007C674D/$file/peru_education.pdf)> (Accessed December 20, 2007)

⁵¹ Oakley and Rodriguez, "Family Planning Policy in Latin America."