Joshua Chestnut

Alan Griffith

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Examining the Relationship Between Education and Fertility Rate

To simply say that the average fertility rate has declined over time would be a gross understatement, as the average rate has fallen by more than fifty percent in the last sixty years (Roser). The decline of fertility rates across the world remains of particular interest to scientists, economists, and policymakers since it is a multifaceted subject that seems to possess strong correlational ties to both social and economic development. This decline in the average fertility rate of 4.7 children per woman to 2.5 children per woman "is one of the most fundamental social changes that [has] happened in human history. It is therefore especially surprising how very rapidly this transition can indeed happen" (Roser). A major contributor to this change is the increase in female education. Education and fertility rates are negatively correlated, as "educated women are more physically capable of giving birth, provide better care at home, thus increasing the value of their children's human capital and reducing the need for more children, and adopt modern birth control methods more often than uneducated women" (Kim). In addition to this decline, in terms of birth rates, there has been a strong convergence between developed and less developed countries. To examine this idea further, countries that "already had low fertility rates in the 1950s only slightly decreased fertility rates further, while many of the countries that had the highest fertility back then saw a rapid reduction of the number of children per woman" (Roser). Understanding these broad ideas, I felt that it would be of particular interest to analyze the difference in the correlation of female educational attainment on fertility rates in Sub-

Saharan Africa when compared to that of Canada; as, an analysis of these two countries, underdeveloped and developed, respectively, may also lend a hand into the comprehension of the convergence in fertility rates.

Prior to jumping into an investigational analysis of the varying studies, appreciating the many correlating variables that correspond with fertility rate, it is important to lay the groundwork as to why the evaluation of female educational attainment is of utmost importance when it comes to fertility rate. Simply put, “the higher the level of a woman’s educational attainment, the fewer children she is likely to bear” (Pradhan). It seems that female educational attainment is the center of the web that connects multiple variables that are negatively correlated with fertility rates. Put differently, “female education affects many variables that have been proposed to bear on direct influence on fertility” (Kasarda) (Figure 1-1). In a general sense, female educational attainment is a sign of societal and economic development. The greater female educational attainment a country possesses, on average, the country is further developed when compared to other countries. This increasing development results in an entire host of other factors that are negatively correlated with fertility rate, but are positively linked with female educational attainment—access to contraception, increasing gross domestic product, ability to receive quality health-care, and improvements in female labor force participation. Additionally, female educational attainment delays the age of marriage, leads to higher wages, and reduces fertility due to age. In the end, considering that children are usually more time-intensive than working in the labor market, women may feel that raising children is more expensive compared to the income forgone. Distinguishing the fact that female educational attainment seems to be the centerpiece to the network of components that are correlated to the decline in fertility rate, in a narrowly focused paper such as this, it makes the most sense to examine this particular relationship.

The foundation of the concept of a trade-off between education and childbearing was first introduced by Gary Becker and H. Gregg Lewis in the Quantity and Quality of Children Model. Fundamentally, the basis of the theory is that as there is an increase in the quality of children, those children, per unit, become more expensive. Therefore, the increase in the quantity of higher-quality children is more expensive. This theory accounts for both the income and price effect of having children. Since "[q]uantity and quality are closely related, because the shadow price of quality depends on the quantity and the shadow price of quantity depends on quality[,]" as female educational attainment increases there is a positive effect on the quality of children and a negative effect on the quantity of children (Becker).

In beginning with the analysis, the first study that I examined was "Women's education and fertility transition in sub-Saharan Africa," which was written by David Shapiro, and was published in the Austrian Academy of Sciences Press. The reason for focusing in on sub-Saharan Africa is because of its contrasting high fertility rates and low female educational attainment. Additionally, "sub-Saharan African was the last major part of the developing world to experience fertility decline, and fertility in the region remains high compared to fertility in Asia and Latin America" (Shapiro). Understandably, in relation to this delayed decline, sub-Saharan Africa possesses significantly slower falling fertility rates when compared to other developing regions in the world—even with steady growth in female educational attainment. To dissect this phenomenon to the deepest level, this study "examines the contribution of increasing women's education to the ongoing fertility transition in sub-Saharan African, utilizing multiple approaches [,]" and borrows certain theoretical frameworks from the Easterlin fertility analysis. (Shapiro).

As a side note, similar approaches were conducted in a study completed by the National Academy of Sciences in 1983. The data for this analysis was collected from the Demographic and Health Surveys, and is evaluated on three separate levels for each country with at least two DHS surveys (Shapiro). The three separate levels include national, urban-rural, and regional. Lastly, this study scrutinizes the evolution of fertility rates and educational attainment in sub-Saharan Africa through the implementation of three distinct substantive sections.

The first section essentially is a *starting point*, as it provides a broad brushstroke for the analysis to come. It examines and compares the projections of “total fertility rates (TFRs) for sub-Saharan Africa, Northern Africa, Asia, and Latin America and the Caribbean, for the period from 1950-2050” (Shapiro). As evident from the data, it can be seen that sub-Saharan Africa, as of 2010, possesses a fertility rate of just below five, while all of the other comparable regions possess a fertility rate between two and three (Figure 2-1). The study goes on to examine this concept further by breaking Africa into five distinct regions: sub-Saharan Africa, Eastern Africa, Middle Africa, Southern Africa, and Western Africa. This is important to recognize, as it displays, even within Africa, sub-Saharan Africa has experienced a delayed decline in fertility rates and experiences higher fertility rates than other regions within Africa (Figure 2-2). The second part of the first substantive section is an overall evaluation of female educational attainment in sub-Saharan Africa. Demonstrating the distinct polarity, it was found that forty percent of African women have no schooling at all, 20 percent of women in Asia have no schooling at all, and just over 10 percent of women in Latin American/Caribbean have no schooling at all (Figure 2-3). Similar to before, even within Africa there is significant variation in both fertility and women’s education, as the “average TFR is just under 5.3, with a range from 3.3 (Lesotho) to 7.0 (Niger), and the average number of years of schooling of women of reproductive age equals 4.6, with…a range from just under 1 (Niger) to 8.4 (Namibia)" (Shapiro). With this data, the study constructed a simple linear regression of total fertility rate on the average number of years of schooling, which yielded a negative coefficient of -0.3. Furthermore, with an absolute value of 0.7, "this variable alone accounts for just over half of the TFR variation across countries" (Shapiro).

The second substantive section of the study uses the data from the Demographic and Health Surveys and uses consecutive surveys to evaluate the relationship between fertility rate and female educational attainment in sub-Saharan Africa. The method of econometrics within this section is a regression in the declines of fertility rates from one DHS survey to the next "on changes in the educational attainment of women, in the infant and child mortality rate, in real GDP per capita and in use of modern contraception, as well as on a time trend" (Shapiro). This regression is followed by the use of the first differences between pairs of consecutive cross-sectional data points from surveys, which will eliminate the time-constant effects from the estimated model (Shapiro). Additionally, the study uses Generalized Estimating Equations in order to account for the absence of independence between the observations within the model. From the regression results, it can be determined that at each level—national, urban/rural, and regional—there is a statistically significant negative correlation between the increase in the percentage of women with no schooling and fertility rates. Expanding on this idea, countries where there are large decreases in the percentage of women with no schooling, experience more rapid declines in fertility rates. Secondly, in correspondence with the results of regression, and accounting for the statistically significant positive correlation between the increase in the percentage of women with at least secondary education, "countries with more rapid growth in women's schooling at the upper end of the schooling distribution experience larger declines in their total fertility rate" (Shapiro) (Figure 2-5). Furthermore, essential to the regression analysis of the impact of female educational attainment to fertility rate:

> If a country were able to realize a decline in the percentage of women with no schooling that is one standard deviation bigger than the average decrease (representing a decline of 9.8 percentage points rather than 5.1), this would reduce the TFR by almost 0.16, other things equal. Correspondingly, if secondary and higher education were to increase by one standard deviation above the mean (i.e., by 11.6 percentage points rather than 5.0 points), the implied additional decline in the TFR would exceed 0.09, other things equal. The two changes together imply an additional reduction in the TFR of essentially 0.25, representing more than 70 percent of the observed average TFR decline between surveys. Clearly, then, these results suggest that more rapid increases in women's education have the potential to substantially accelerate fertility transition in the region. (Shapiro)

Moreover, as evident from the table, diminishing fertility rates occur at a swifter pace in urban areas when compared to that of rural areas. Lastly, as somewhat of an engrossing component to the analysis of this section, extrapolating from the regression, declines in the fertility rate in sub-Saharan Africa is slower when economic growth—annual percentage growth in GDP—is more rapid. This postulation remains consistent with the literature of Lesthaeghe, National Research Council, and Eloundou-Enyegue that suggest that a downturn in fertility rates is the result of an economic crisis; applicable to the economic crises that currently exist in sub-Saharan Africa.

The final substantive section of this study is the narrow examination of individual-level data in order to "assess the patterns and magnitudes of fertility differentials by education, using a more detailed classification of educational attainment than is customary" (Shapiro). When evaluating educational attainment and fertility rates in a not broad, but definite, manner there seem to be two schools of thought on this relationship pattern. This first school of thought was best articulated by John Cleland in his paper, "Education and Future Fertility Trends, with Special Reference to Mid-Transitional Countries." He states, "[a]s reproductive decline takes root, fertility differentials by schooling initially tend to widen…Childbearing declines first among the best educated and last among the least well educated. In the later phase of fertility transition, these differentials begin to narrow until convergence is reached at the end of transition" (Cleland). The second school of thought, popularized by John Bongaarts, believes that, while there is a steady decline in fertility rates, "educational differentials in fertility remain substantial in the late and post-transitional stages" (Bongaarts). In terms of the econometrics, this section uses independent ordinary least squares equations for each country, and female educational attainment is split into five variables: 1-6 years, 7-8 years, 9-10 years, 11-12 years, and 13+ years. The first component of the empirical analysis is a regression of the number of children born on the women's age, age squared, and five the variables of schooling. With this particular regression, the study finds a distinct pattern with an increase in education level, as coefficients of educational attainment become more negative (Figure 2-6). The pronounced pattern of the impact of increasing education level reveals that "the implied fertility differences between adjacent groups widen as the educational level increases" (Shapiro). One interesting appendage to this empirical analysis is what occurs when "urban area" is controlled for in the regression. Although it follows the same pattern, the impact of the negative coefficients is much less. This is due to the fact that "[f]amilies in urban places confront a higher net cost of children than families in rural areas, and fertility in urban places is typically lower than in rural places"

(Shapiro). The final element of the empirical analysis is a comparison of the fertility differentials by educational attainment of each country at the different stages of fertility transition; essentially providing a disaggregation of the previous results to highlight the "magnitudes of the estimated fertility differentials by education in relation to the overall national level of fertility" (Shapiro) (Figure 2-7). An evaluation of the results demonstrates that as the fertility transition is progressing a definite narrowing of the fertility differentials between university-educated women and women with no schooling occurs.

Moving on from sub-Saharan Africa, I decided to evaluate the impact of education on fertility rates in Canada. To accomplish this task, I analyzed a study titled, "The Effect of Education on Overall Fertility," which was completed by Philip DeCicca and Harry Krashinsky. This study was completed in 2016 and was published in the National Bureau of Economic Research. The reason I decided to focus on Canada, rather than the United States, was because the studies available about Canada seemed to have more comprehensive data and analysis. Additionally, in terms of schooling, the "historical development in Canada and the United States is quite similar" (Decicca et al.). In both countries, the educational system is the functioning of the state government and is delivered by the local governments. Furthermore, I chose Canada because I felt that it would be interesting to compare a study of the effects of educational attainment on fertility rates in a developing region, sub-Saharan Africa, and a developed region, Canada.

The data for this study was accumulated from the 1981 and 1991 decennial Canadian Censuses and focuses on the responses of women between the ages of 40 and 65 in order to account for women who have most likely completed their childbearing. The variables included in the empirical analysis cover both essential and correlated variables: age, currently married, ever married, number of children, percent with any children, income, and weeks worked. The seven variables are regressed in respect to the following variables: grade 6 education or less, between grade 7 and 8 education, between grade 9 and 11 education, and at lead high school education (Figure 3-1). As well, later in the study, variables to account for the quality of schooling will be included. These variables specifically are the average per-capita number of teachers in a province, annual per-capita spending on education by the provincial government, the annual per-capita spending on education by the provincial government, and the annual per-capita number of schools in a province.

Prior to empirically analyzing the data, the study estimated a model to project the impact of educational attainment on the fertility rate. The model is as follows:

$$BIRTH_{bpc} = \beta EDUC_{bpc} + \gamma X_{bpc} + \alpha_p + \eta_c + \delta_t + e_{bpc}$$

Ultimately, β is the most important of the coefficients, as it represents the correlation between educational attainment and fertility rate. The subscript of *bpc* accounts for the aggregated data from individual-level Census; more specifically, *b* is each birth cohort, *p* is the particular province, and *c* is the Census of interest. The main dependent and independent variables in the model are fertility rate (*BIRTH*) and the average number of years of female educational attainment (*EDUC*), respectively.

The empirical analysis within this study evaluates fertility rates on both an intensive and extensive margin. The intensive margin analysis "presents estimates from models where the dependent variable is the number of children greater than one[;]" while the extensive margin "presents models where the dependent variable is the percent of the sample women with at least one child" (Decicca et al.). Additionally, to further inspect the correlation between educational attainment and fertility rate, the study uses methods of ordinary least squares and instrumental variables (Figure 3-2). Lastly, as somewhat of a precautionary note, all F-statistics are greater than 10 and express appropriate p-values (Figure 3-3).

Beginning with the results on an intensive margin, the study finds that "based on a sample of women with at least one child…an additional year of CSL-induced schooling reduces the lifetime number of children by roughly 0.9 of a child" (Decicca et al.). This seems significant as it represents a reduction of nearly twenty-five percent. However, even with this being said, on the intensive margin, there is an interesting phenomenon that occurs when evaluating the fraction of women who have at least two, at least four, at least six, and at least eight children. At this level of evaluation, it can be determined that there is "no systematic relationship between CSL-induced schooling and intensive margin fertility at the two children threshold[;]" yet, there seems to be a strong relationship between the four, six, and eight children thresholds (Decicca et al.). In the end, it would seem that on the intensive margin the negative correlation between educational attainment and fertility rate is most pronounced for women who have had many children—more than two.

Interestingly, there is a significant shift in the pattern on the extensive margin. The ordinary least squares estimates of the model were able to find that "an additional year of CSL-induced schooling actually *increases* the percentage of women who report having given birth to at least one child" (Decicca et al.). This is completely contrary to all of the data and empirical analysis we have previously discussed in this paper. Furthermore, the instrumental variable estimates indicate a positive correlation between educational attainment and fertility rate in a range of 0.042 and 0.057; meaning that there is a 5 to 7 percent increase in fertility rates with an additional year of schooling (Decicca et al.) (Figure 3-2). This shift in pattern occurs because as educational attainment increases the cost of child quantity rises and the cost of child quantity/investment declines. Intensively, these lead to an overall decline in the quantity of children; however, extensively, the effects seem to be ambiguous. Since there seems to be a positive correlation between educational attainment and fertility rates on the extensive margin, this must indicate that the "reduction in the cost of child quality outweighs the impact of the increase in the cost of child quantity" (Decicca et al.).

All in all, generally speaking, there seems to be a negative correlation between female educational attainment and fertility rates; however, in terms of these two studies, the details of the results make for an interesting comparison between developing and developed regions. In sub-Saharan Africa, which is currently a developing area, at each level of educational attainment, undoubtedly, there is a negative correlation between educational attainment and fertility rate. Equally, countries where there are large decreases in the percentage of women with no schooling, they experience more rapid declines in fertility rates. This same relationship holds true when examining the intensive margin of the study completed about Canada. This negative correlation switches, however, when evaluating the Canada study on the extensive margin, as "an additional year of CSL-induced schooling actually *increases* the percentage of women who report having given birth to at least one child" (Decicca et al.). Contrary to sub-Saharan Africa, the Canada study uncovers the idea that additional schooling in already developed areas "reduces the number of children a woman has over her lifetime, while also reducing childlessness" (Decicca et al.). Further education in a developed region has a "compressing" effect on lifetime fertility, which leads to contraction on the intensive margin and expansion on the extensive margin (Decicca et al.). This exemplifies the many studies that have been completed that demonstrate that the negative relationship of educational attainment on fertility rates is much greater and concentrated on women who come from poor socio-economic backgrounds and who lack high levels of achievement early in their life (Brand). In further comparison, the ultimate sustainable fertility rate is 2, as this is the replacement rate. With this being said, we are beginning to see changes in the trends, or interaction, of educational attainment and fertility rate, as developed regions, such as Canada, already possess fertility rates at, or below, 2. For example, Canada has a fertility rate of 1.60 (Statistics Canada). Additionally, in developed regions, female educational attainment, relative to both men and the world, has become quite *normal*—more normal than men in many circumstances (Figure 4-1). Not to mention, men have a positive relationship with educational attainment and fertility rate. In 2016, 40.7% of Canadian women, ages 25 to 34, obtained a bachelor's degree or higher, and more than 50% of young Canadians with an earned doctorate were women (Statistics Canada). We are able to see that female education levels have grown to a point where they are beginning to flatten out (Figure 4-2). As they flatten out further, and this normalcy becomes more abundant, the correlation between fertility rate and educational attainment is going to become more positive; which we already have begun to see in countries such as, Canada.

With all of this being said, there is one essential question that arises: is the negative relationship between female educational attainment and fertility rate one that is simply correlated, or is it causal? To answer this question, I examined a study, "Education and Fertility: Evidence from a Natural Experiment," by Karin Monstad, Carol Propper, and Kjell G. Salvanes. This study was completed in 2008 and was published in The Scandinavian Journal of Economics. In order to get at the correlation or causal inquiry, the study utilizes the "differential introduction of an extension of compulsory schooling across municipalities in Norway to identify the impact of increased education on fertility" (Monstad). The study was able to accomplish this because in 1959 the Norwegian Parliament increased the minimum number of compulsory years of schooling from seven to nine (Monstad). Norway was the prime candidate for this analysis, as "[a]ll municipalities were mandated to have implemented the reform by 1973…This implied that for more than a decade Norwegian schools were divided into two separate systems, and the system experienced by children would depend on the year of birth and municipality of residence" (Monstad). Prior to any data collection, econometrics, or empirical analysis, the study estimated the following model:

$$Y_i = \beta_0 + \beta_1 ED_i + \beta_2 COHORT_i + \beta_3 MUNICIPALITY_j + \beta_4 MUNTREND_j + \varepsilon_{ij}$$

$$ED_i = \alpha_0 + \alpha_1 REFORM_j + \alpha_2 COHORT_j + \alpha_3 MUNICIPALITY_j + \alpha_4 MUNTREND_j + \upsilon_{ij}$$

The data for this study is comprised of all women between the years of 1947 and 1958 and was collected from both administrative registers and census data of Statistics Norway. All women were matched to the data provided in the 1960, 1970, and 1980 censuses in order to account for the municipality in 1960, background, age, education, fertility, and marital status. For the empirical analysis, the study ran a simple regression to calculate the ordinary least squares estimates to test the correlation between educational attainment and fertility rate. It is important to recognize that each coefficient "is derived from a separate regression, each of which controls for municipality and year of birth" (Monstad). Similar to all of the previous results, there is a strong negative correlation between female educational attainment and fertility rate. For women, additional education results in three main outcomes: they have fewer children, there is an increased probability of remaining childless, and there is a significant decrease in the probability that a woman will have a child before the age of twenty-five (Figure 5-1). Understanding this, however, does not get at the question of causality. For this, the study uses the method of two-stage least squares. The results of this analysis are as follows (Figure 5-1):

> The results show that the impact of education is to reduce the probability of a teen birth and delay first births into the 20s and late 30s, but it has no effect on completed family size. Therefore, the effect of schooling is essentially to delay childbearing. In contrast, with the raw association with education, when controlling for possible selection into education, there is no significant relationship between the length of education and the number of children born to a woman or the probability of never having children. (Monstad)

Essentially, this study finds that an increase in female educational attainment delays childbearing; however, there seems to be no causal link to women having fewer children.

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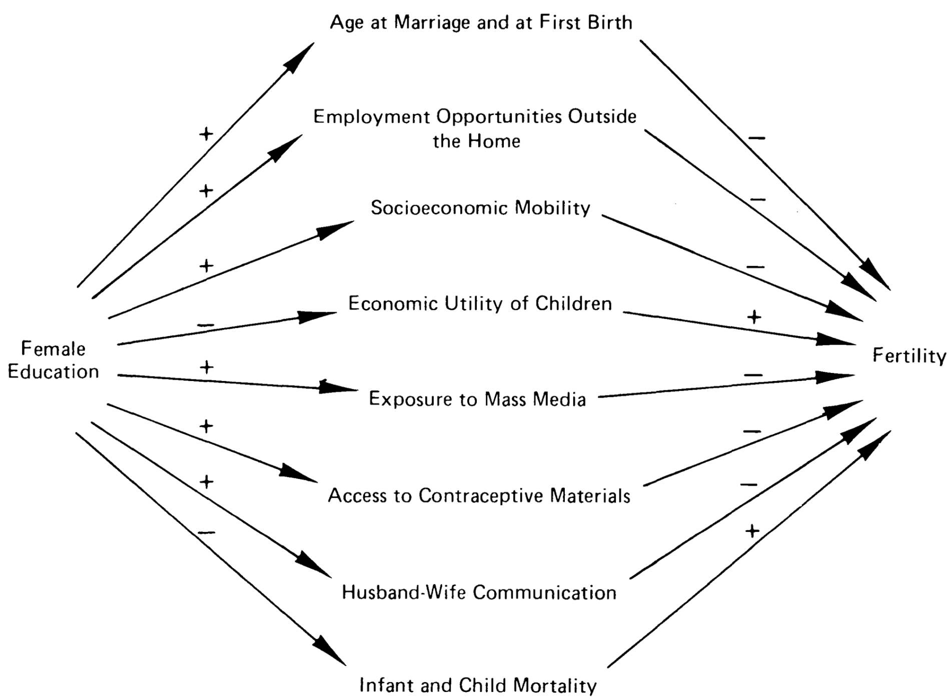
Appendix

Figure 1-1

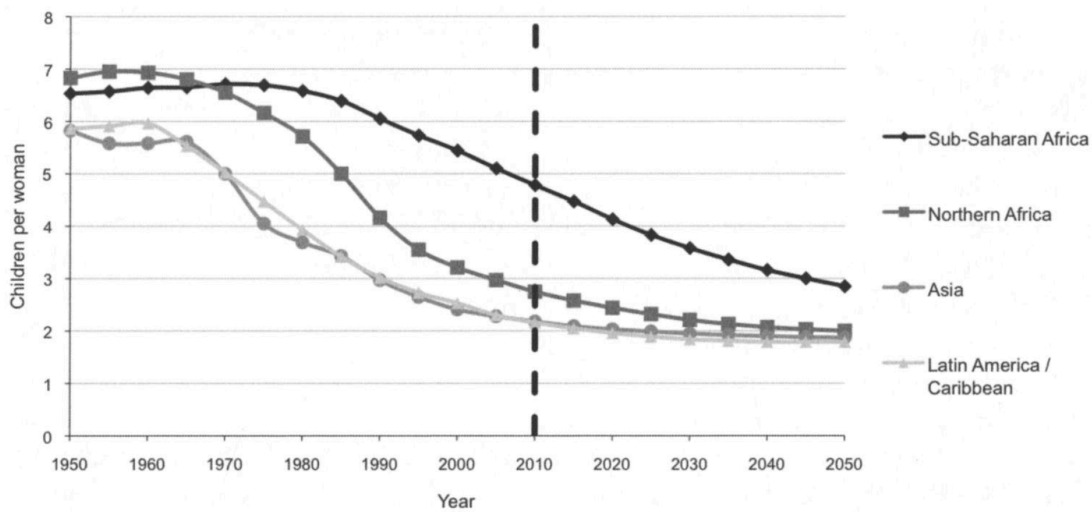
SUMMARY DIAGRAM SPECIFYING INDIRECT CAUSAL LINKAGES OF FEMALE EDUCATION TO FERTILITY



Source: Kasarda, John D. "HOW FEMALE EDUCATION REDUCES FERTILITY: MODELS AND NEEDED RESEARCH." *Mid-American Review of Sociology*, vol. 4, no. 1, 1979, pp. 1–22. *JSTOR*, www.jstor.org/stable/23252607.

Figure 2-1

Figure 1:
Total fertility, by region, 1950–2050

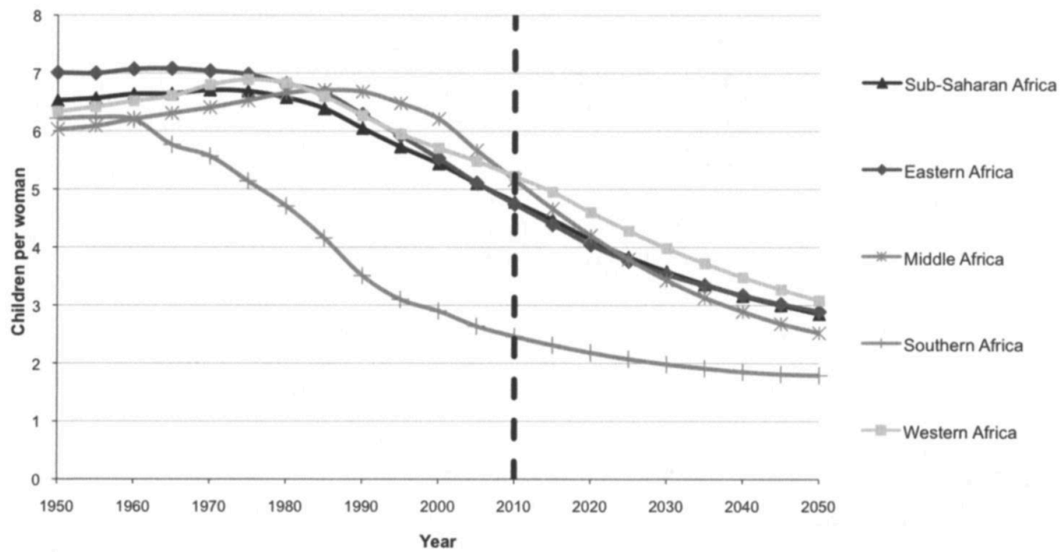


Source: Population Division of the Department of Economics and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2010 Revision, http//esa.un.org/unpd/wpp/index.htm

Source: Shapiro, David. "Women's Education and Fertility Transition in Sub-Saharan Africa." *Vienna Yearbook of Population Research*, vol. 10, 2012, pp. 9–30. *JSTOR*, www.jstor.org/stable/41940995.

Figure 2-2

Figure 2:
Total fertility, sub-Saharan Africa and its sub-regions, 1950–2050

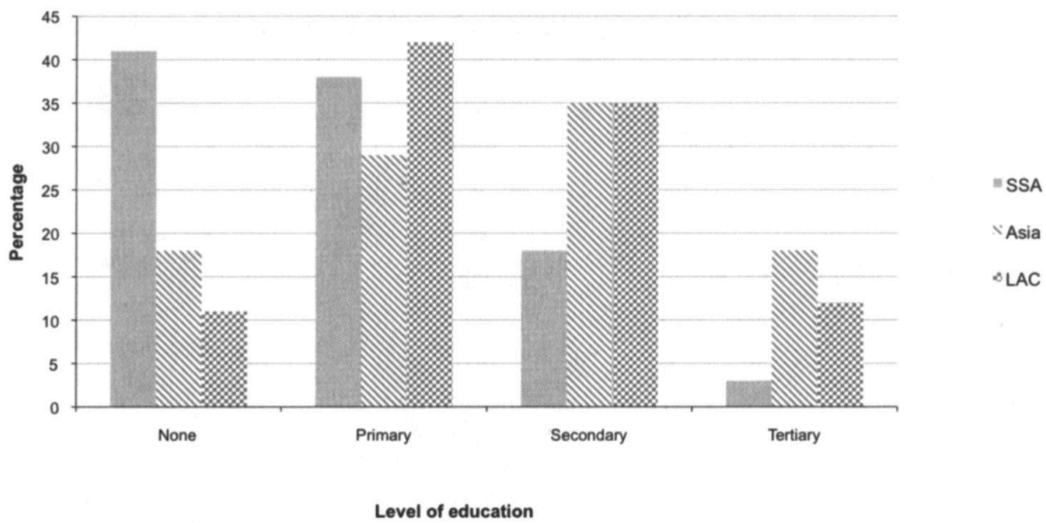


Source: Population Division of the Department of Economics and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2010 Revision, http//esa.un.org/unpd/wpp/index.htm

Source: Shapiro, David. "Women's Education and Fertility Transition in Sub-Saharan Africa." *Vienna Yearbook of Population Research*, vol. 10, 2012, pp. 9–30. *JSTOR*, www.jstor.org/stable/41940995.

Figure 2-3

Figure 3:
Highest level of education attained, by region, women aged 25+ (percentages)

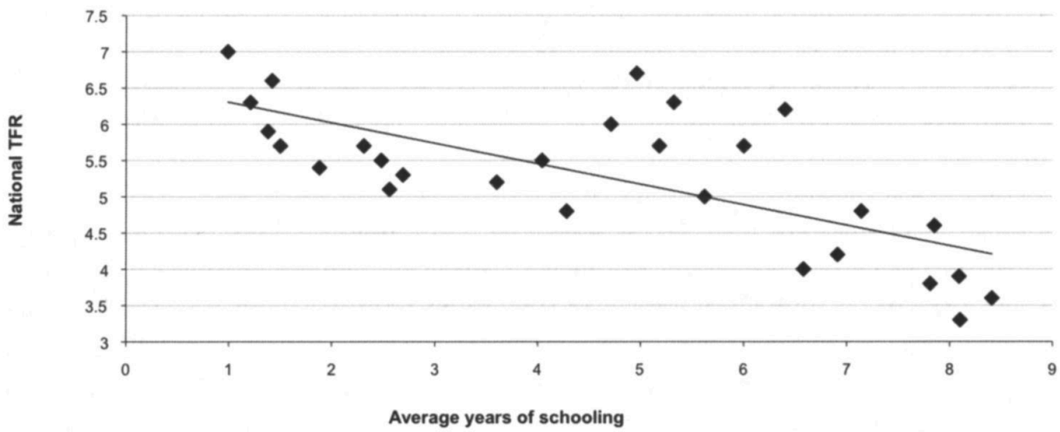


Source: United Nations 2010: Figure 3.6.

Source: Shapiro, David. "Women's Education and Fertility Transition in Sub-Saharan Africa." *Vienna Yearbook of Population Research*, vol. 10, 2012, pp. 9–30. *JSTOR*, www.jstor.org/stable/41940995.

Figure 2-4

Figure 4:
Total fertility rates and average number of years of schooling, women aged 15–49, sub-Saharan Africa



Source: Calculated from DHS data for the 28 sub-Saharan nations that have had their most recent DHS in 2000 or later.

Source: Shapiro, David. "Women's Education and Fertility Transition in Sub-Saharan Africa." *Vienna Yearbook of Population Research*, vol. 10, 2012, pp. 9–30. *JSTOR*, www.jstor.org/stable/41940995.

Figure 2-5

Table 1:
Regression analyses of the decline in the total fertility rate between pairs of surveys, national, urban/rural and regional data

Variable	National	Urban/rural	Regional
Increase in percentage of women with no schooling	-0.0330**	-0.0379**	-0.0378**
Increase in percentage of women with at least secondary education	0.0141*	0.0125**	0.0099*
Increase in infant and child mortality[a]	-0.0059**	-0.0031+	-0.0046**
Annual percentage growth in GDP/head, last 5 years (three-year lag)	-0.0270+	-0.0196	-0.0311**
Growth in the percentage of women using modern contraception	0.0086	0.0202**	0.0031
Time trend	-0.0306**	-0.0366**	-0.0361**
Intercept	0.2949**	0.3759**	0.3892**
Wald chi-square	84.32**	105.91**	121.79**
Sample size	55	110	266

Notes: [a] For the national level, we measure the change in infant mortality with a lag of 0-14 years; for the other two levels, the lag is 0-9 years; ** Significant at the .01 level;* Significant at the .05 level; + Significant at the .10 level. Estimated via Generalized Estimating Equations (GEE) Method

Source: Shapiro, David. "Women's Education and Fertility Transition in Sub-Saharan Africa." *Vienna Yearbook of Population Research*, vol. 10, 2012, pp. 9–30. *JSTOR*, www.jstor.org/stable/41940995.

Figure 2-6

Table 2:
Fertility differentials by educational attainment*

	Controlling for:		
Educational attainment (years)	**Age, age squared**	**Age, age squared, urban dummy variable**	**Age, age squared, urban, mean cluster education**
1-6	-0.279	-0.208	-0.102
7-8	-0.649	-0.494	-0.327
9-10	-1.055	-0.860	-0.652
11-12	-1.658	-1.417	-1.178
13 and over	-2.360	-2.087	-1.771
Urban	--	-0.425	-0.216
Mean cluster education	--	--	-0.087

Notes: *Average differential in number of children ever born, relative to women with no schooling, and averages of urban dummy variable and mean cluster education. Universe: Countries with most recent survey in 2000 or later (n=28).

Source: Shapiro, David. "Women's Education and Fertility Transition in Sub-Saharan Africa." *Vienna Yearbook of Population Research*, vol. 10, 2012, pp. 9–30. *JSTOR*, www.jstor.org/stable/41940995.

Figure 2-7

Table 3:
Fertility differentials by educational attainment and by overall fertility level

a. Average differential in number of children ever born, relative to women with no schooling, controlling for age and age squared

		TFR	
Educational attainment (years)	**>=6**	**5.0-5.9**	**<5.0**
1-6	-0.123	-0.381	-0.264
7-8	-0.503	-0.688	-0.711
9-10	-0.870	-1.093	-1.147
11-12	-1.522	-1.729	-1.678
13 and over	-2.524	-2.350	-2.247
Number of countries	7	12	9

Note: Universe: Countries with most recent survey in 2000 or later (n=28).

b. Average differential in number of children ever born, relative to women with no schooling, controlling for age and age squared and urban residence

		TFR	
Educational attainment (years)	**>=6**	**5.0-5.9**	**<5.0**
1-6	-0.066	-0.268	-0.239
7-8	-0.389	-0.462	-0.618
9-10	-0.715	-0.842	-0.998
11-12	-1.336	-1.431	-1.464
13 and over	-2.318	-2.034	-1.980

c. Average differential in number of children ever born, relative to women with no schooling, controlling for age and age squared, urban residence, and mean cluster education

		TFR	
Educational attainment (years)	**>=6**	**5.0-5.9**	**<5.0**
1-6	-0.031	-0.127	-0.125
7-8	-0.325	-0.242	-0.440
9-10	-0.632	-0.568	-0.779
11-12	-1.232	-1.120	-1.206
13 and over	-2.173	-1.613	-1.668

Source: Shapiro, David. "Women's Education and Fertility Transition in Sub-Saharan Africa." *Vienna Yearbook of Population Research*, vol. 10, 2012, pp. 9–30. *JSTOR*, www.jstor.org/stable/41940995.

Figure 3-1

Table 1: Descriptive Statistics

	Grade 6 Education or Less	Between Grade 7 and 8 Education	Between Grade 9 and 11 Education	At Least HS Education
Age	54.91 (7.07)	53.56 (7.23)	51.54 (7.40)	49.97 (7.38)
Currently Married	0.661 (0.473)	0.738 (0.440)	0.765 (0.424)	0.756 (0.429)
Ever Married	0.935 (0.247)	0.964 (0.186)	0.968 (0.176)	0.952 (0.215)
Number of Children	4.221 (3.284)	3.682 (2.555)	3.100 (1.999)	2.602 (1.603)
Percent with Any Children	0.890 (0.313)	0.926 (0.262)	0.937 (0.243)	0.921 (0.269)
Income	6961 (11252)	7444 (12281)	10925 (15431)	19885 (23026)
Weeks Worked	9.15 (16.02)	9.74 (16.32)	14.37 (19.58)	21.91 (22.24)

The sample consists of women, born in one of the ten Canadian provinces. The data displayed in the first five rows are assembled from the 1981 and 1991 Canada Censuses for women between the ages 40 to 65. The data displayed in the last two rows are assembled from the 1971 and 1981 Canada Censuses for women between the ages 30 to 55. Standard deviations are listed in parentheses beneath the means within each cell.

Source: Decicca, Philip, and Harry Krashinsky. “The Effect of Education on Overall Fertility.” *The National Bureau of Economic Research*, Dec. 2016, doi:10.3386/w23003.

Figure 3-2

Table 2: The Effect of Education on the Intensive and Extensive Margins of Fertility

	Number of Children (at least one)			Percent With At least One Child		
Mean Dep. Variable		3.332 (2.049)			0.924 (0.264)	
OLS Coef. Education	-0.620 [0.002]	-0.740 [0.002]	-0.851 [0.002]	0.033 [0.014]	0.038 [<0.001]	0.041 [<0.001]
IV Education (Dropout dummies)	-0.832 [<0.001]	-0.944 [<0.001]	-1.046 [<0.001]	0.046 [<0.001]	0.055 [<0.001]	0.055 [<0.001]
IV Education (Total required years)	-1.174 [<0.001]	-1.223 [<0.001]	-1.386 [<0.001]	0.044 [<0.001]	0.047 [<0.001]	0.046 [<0.001]
IV Education (Dropout Age)	-1.171 [<0.001]	-1.221 [<0.001]	-1.349 [<0.001]	0.042 [<0.001]	0.044 [<0.001]	0.042 [<0.001]
IV Education (Entry Dummies)	-0.971 [0.004]	-0.902 [<0.001]	-0.884 [<0.001]	0.055 [<0.001]	0.057 [<0.001]	0.057 [<0.001]
IV Education (Dropout & Entry Dummies)	-0.855 [0.007]	-0.956 [<0.001]	-1.005 [<0.001]	0.047 [<0.001]	0.055 [<0.001]	0.054 [<0.001]
Quality Controls?	No	Yes	No	No	Yes	No
Trends?	No	No	Yes	No	No	Yes

The sample consists of women, aged 40 to 65, born in one of the ten Canadian provinces. The data are assembled from the 1981 and 1991 Canada Censuses. The first three columns use a dependent variable equal to the average total number of children born to woman (in each birth-year/province cohort), the next three use this same average, but compute it for women with at least one child, and the last three columns use a dependent variable equal to the percent of women (in each birth-year/province cohort) who have given birth to at least one child. The means of the dependent variables are listed in the first row of the table. The second row reports the coefficient on years of education from OLS regressions with controls that vary depending on the column. The first, fourth and seventh column's regressions include: year-of-birth dummies, province-of-birth dummies, a quartic in age, a dummy for the Census extract which produced the data, rural status, the percentage of manufacturing jobs, an aboriginal indicator, an immigrant indicator. The second, fifth and eighth column's regressions are the same as columns one and four, but also include the per capita number of schools

Source: Decicca, Philip, and Harry Krashinsky. "The Effect of Education on Overall Fertility." *The National Bureau of Economic Research*, Dec. 2016, doi:10.3386/w23003.

Figure 3-3

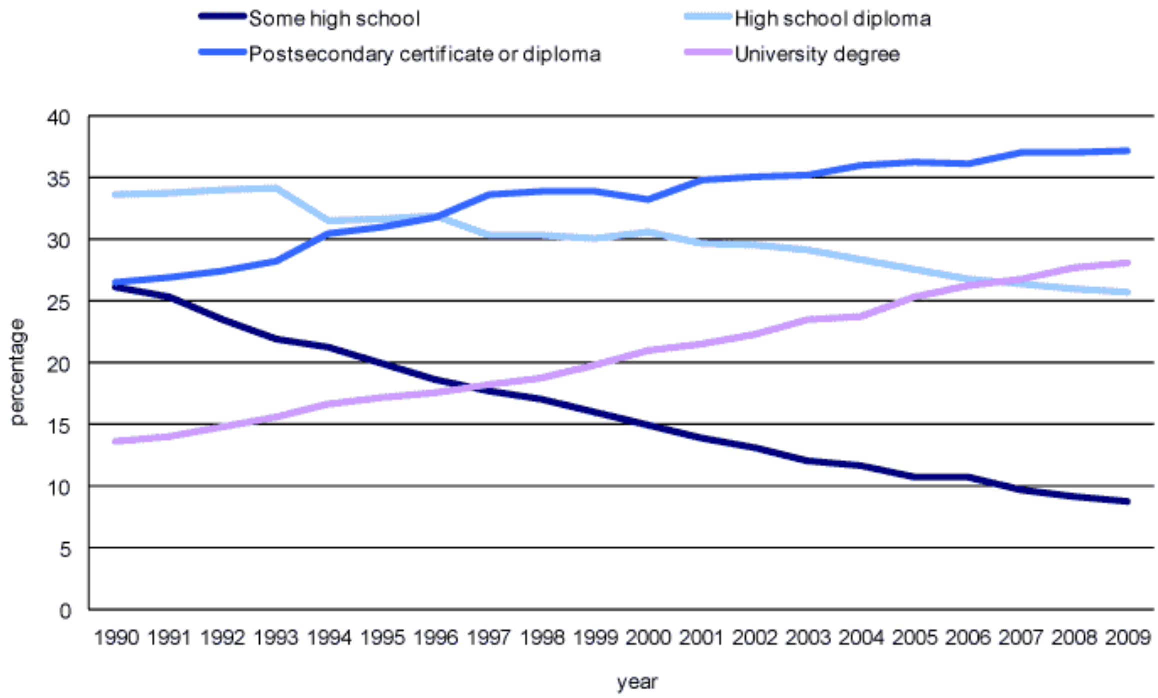
Appendix Table 4: The Effect of Various Instruments on Educational Attainment

	(1)	(2)	(3)
F-stat on Dropout Dummies (Income Sample Only)	25.14 [0.001]	32.23 [<0.001]	40.79 [0.003]
F-stat on Dropout Age	101.2 [<0.001]	111.7 [<0.001]	396.8 [<0.001]
F-stat on Total required years	87.05 [<0.001]	111.5 [<0.001]	441 [0.008]
F-stat on Dropout Dummies	73.14 [<0.001]	46.13 [0.001]	68.51 [0.002]
F-stat on Entry Dummies	59.57 [0.050]	50.56 [0.065]	288.41 [<0.001]
F-stat on Dropout & Entry Dummies	115.59 [0.081]	187.48 [0.022]	227.74 [0.003]
School Quality Controls?	No	Yes	No
Trends?	No	No	Yes

The sample consists of women who are at least 40 years old, and born in one of the ten Canadian provinces. The data are assembled from the 1981 and 1991 Canada Censuses. The dependent variable is equal to the average educational attainment for women in each birth-year/province cohort. Each cell reports the F-test on the instrumental variable(s) used in the regression, as well as the p-values for these test statistics, which are listed in brackets beneath the F-statistics, and were computed with the Wild Cluster Bootstrap at the province level. The instruments differ by row: the first row involves the age at which an individual is allowed to drop out of school, the second row involves the total number of required years of education, the third row uses three dummy variables to capture the age at which a student was permitted to cease their schooling, the fourth row uses three dummy variables to capture the age at which a student was required to begin their schooling, and the fifth row involves all six dummies involved in the regressions from the third and fourth rows. The independent variables in the first column's regressions include: year-of-birth dummies, province-of-birth dummies, a quartic in age, a dummy for the Census extract which produced the data, rural status, the percentage of manufacturing jobs, an aboriginal indicator, an immigrant indicator. The second column's regressions are the same as column one, but also include the per capita number of schools in the province, the per capita number of teachers in the province, and the real per capita annual expenditures on schooling. The third column's regressions are the same as column one, but also include three trend terms to capture trends in three different regions of Canada – the Atlantic provinces (Newfoundland, PEI, Nova Scotia and New Brunswick), the central provinces (Ontario and Quebec), and the "Prairie" provinces (Manitoba, Saskatchewan and Alberta).

Source: Decicca, Philip, and Harry Krashinsky. "The Effect of Education on Overall Fertility." *The National Bureau of Economic Research*, Dec. 2016, doi:10.3386/w23003.

Figure 4-1



Source: Statistics Canada, Labour Force Survey, 1990 to 1009

Figure 4-2

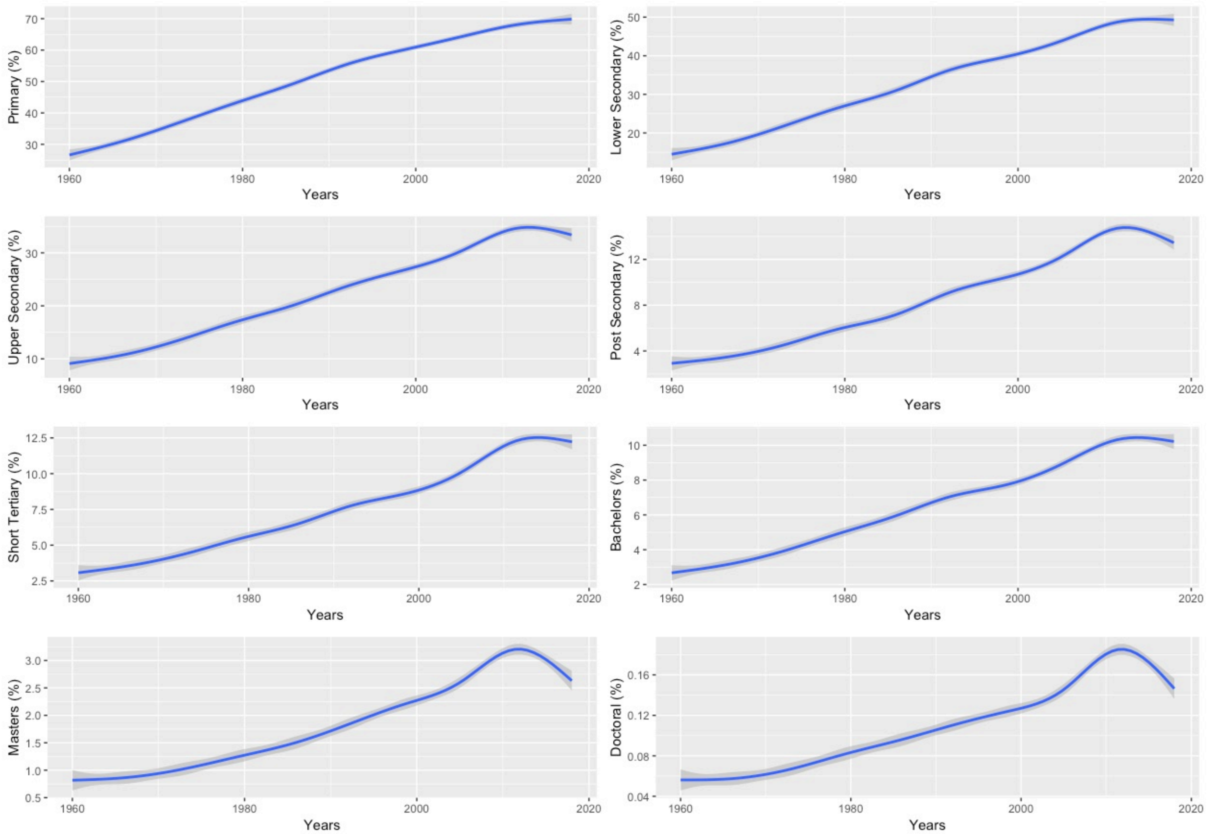

Primary (%)
Lower Secondary (%)
Upper Secondary (%)
Post Secondary (%)
Short Tertiary (%)
Bachelors (%)
Masters (%)
Doctoral (%)
Years

Figure 5-1

Table 2. *The effect of education on fertility*

Outcome	Childless	Number of children	First birth age 15–20	First birth age 20–25	First birth age 25–30	First birth age 30–35	First birth age 35–40
OLS	0.006***	–0.013***	–0.032***	–0.024***	0.030***	0.015***	0.005***
	(0.001)	(0.004)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
2SLS	0.011	–0.009	–0.080**	0.044	0.012	–0.008	0.021**
	(0.018)	(0.087)	(0.039)	(0.032)	(0.028)	(0.018)	(0.009)
N	290,596	290,604	290,604	290,604	290,604	290,591	289,057

Notes: Each column is a separate regression. Included in the specifications are municipality and year-of-birth indicators. Municipality-specific trends are excluded due to non-significance. Standard errors are adjusted for clustering at the municipality level.

*, ** and *** indicate significant coefficients at the 10%, 5% and 1% levels, respectively.

Source: Monstad, Karin, et al. “Education and Fertility: Evidence from a Natural Experiment.” *The Scandinavian Journal of Economics*, vol. 110, no. 4, 2008, pp. 827–852. *JSTOR*, www.jstor.org/stable/25195376.