

**Making the Case for Investing on Girls: Linking Family Planning Programs, Girl's  
Education, and Women's Economic Empowerment**

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## **ABSTRACT**

Much literature has explored the topic of integrating the reproductive health, educational attainment, and economic enhancement components of women empowerment; however a majority of this work has considered both economic enhancement and improved reproductive health to be a result of increased women's education level. This study sets out to test an alternative model in which improved reproductive health leads to higher educational level among women, and additional education for women results in better women's economic performance. Using cross-country population data from 1995 through 2015 derived from the UNDP and World Bank Databank, linear regression models were first used to estimate women's educational level from their reproductive health indicators. Linear regression models were then used to study the impact of women's education level on their income level, labor force participation, and unemployment, adjusting for gender inequalities and reproductive health conditions. The analyses showed that total fertility rate has a more significant impact on women's educational attainment than adolescent birth rate or maternal mortality rate, and that increases in women's education significantly improve women's income level and labor force participation only in low and upper-middle income economies while having minor effects on unemployment rates or all economic enhancement components in lower-middle income economies. This study indicates that further focus be given to reducing fertility through family planning and improving gender equality contexts in education in the developing world, and suggests that future studies examine whether the observed trends of education-labor participation and education-income associations are related to the U-shaped curve of female labor participation with economic development.

## **INTRODUCTION**

Women's empowerment is a component of both the United Nation's Millennium Development Goals (1) and the Sustainable Development Goals (2). Empowering women is an essential step to reach gender equality, as girls today are still less likely to receive education than boys, and women globally also receive fewer wages than men (3, 4). As improvements in women's reproductive health are found to improve women's economic empowerment and to increase women's agency, education, and labor force participation, increasing efforts have been made to integrate the components of reproductive health, educational attainment, and economic enhancements of women (5).

Literature has focused on how education improves reproductive health conditions through enhancing the use of contraceptive methods and reducing fertility (6, 7), and how reduced fertility was found to increase female's labor output during their fertile years (8). This literature suggests a model that emphasizes the importance of investing on education, as education improves reproductive health which leads to economic enhancement. However Joshi and Schultz (2007) (9) also demonstrated that improved reproductive health through family planning (FP) programs leads to higher women's earnings and more schooling for the women's children, and a study by Cohen et al. (2011) (10) suggested that the causality of childbearing to reduced education is stronger than the causality of reduced education to childbearing. This evidence suggests an alternative model to integrate the components of women's empowerment, where improved reproductive health leads to higher educational level among women, and additional education for women results in better women's economic performance.

This study aims to understand whether the associations identified by these alternative approaches are reasonable and significant. Using data derived from the United Nation

Development Programme and the World Bank, the first section of this study will analyze the independent effects of reproductive health components, including teenage childbearing, maternal mortality, and fertility, on women's education when adjusted for each other. The second section of this study will then focus on the economic enhancement effect of women's education after adjusting for gender inequality contexts and reproductive health terms. These analyses will advance our understanding of the potential impact of improved reproductive health on women's economic empowerment around the world.

## **METHOD**

### **Data.**

Population national trend data for indicators included and analyzed in this study were derived from the United Nation Development Programme's (UNDP) Human Development Data (HDD) (11) and the World Bank Databank (12). Data derived from the HDD included adolescent birth rate (ABR) in births per 1,000 women aged 15-19, maternal mortality rate (MMR) in deaths per 100,000 live births, female mean years of schooling (FMY), male mean years of schooling (MMY), female expected years of schooling (FEXPY), male expected years of schooling (MEXPY), gender inequality index (GII), female and male estimated gross national income per capita in 2011 purchasing power parity US dollars, female and male labor force participation rate in % of the population aged 15 and older, and female to male total unemployment rate ratio (UR). The expected years of schooling data differ from the mean years of schooling data from that it is an estimation of number of years of schooling that a child of school entrance age can expect to receive if prevailing patterns of age-specific enrollment rates persist throughout the child's life made by UNESCO (11). Data downloaded from the World Bank Databank were

fertility rate (FR) in births per women. Data for all indicators between 1995 and 2015 were included in the study.

ABR, MMR, and FR were defined as the reproductive health indicators (RHIs) in this study. Studies by Joshi and Schultz (2012) (13) and Fauveau et al. (1991) (14) had shown that FP programs have significant effects on reducing these RHIs that are closely related to maternal reproductive health, and they would serve as indicators for the health outcomes associated with investing on FP programs in the analyses of this study.

Data for FMY were divided by MMY to produce adjusted mean years of schooling (AMY), and data for FEXPY were divided by MEXPY to produce adjusted expected years of schooling (AEXPY). These adjusted indicators allowed comparison in women's education levels between different times and across countries to be made by treating men's education levels as the "gold standard" to eliminate fluctuation in education levels caused by factors shared by both sexes in the same country and time, including various economic and infrastructural conditions. FMY, FEXPY, AMY, AEXPY were defined as the education level indicators (ELIs) in this study, and they represented the absolute and relative levels of education which women received.

Similar to the adjustments made in the ELIs, data for female estimated gross national income per capita and female labor force participation rate were each divided by the corresponding data of males to produce adjusted estimated gross national income per capita (AGNI) and adjusted labor force participation (ALP). The UR data were already downloaded in its adjusted female to male ratio form, thus no further adjustment were made to this data set. These adjustments allowed women's economic performances to be compared between different times and across countries while eliminating fluctuations caused by external factors that affect

both sexes, and simplifies the analyses into a gender inequality context. AGNI, ALP, and UR were defined as the economic performance indicators (EPIs) in this study.

The countries included in this study were the low income, lower-middle income, and upper-middle income economies as defined by World Bank in FY 2018 (15). R was utilized to match the country names and years of the data sets and compile them.

### **Predicting and regressing women's education with components of reproductive health.**

This part of the study analyzed the effects of the different components of women's reproductive health on women's education level. STATA was utilized to conduct correlation tests between the RHIs, between the ELIs, and between the RHIs and the ELIs. The correlation tests were conducted in both the whole data including all the countries of interest and in subsets of data categorized by the country income groups to study whether overall country income level will affect the outcomes of the correlation tests. The results were reported in the form of Pearson's correlation coefficient (r coefficient) and its corresponding significance test p-value.

Multiple linear regressions were conducted with STATA and R to assess the magnitudes of association of women's reproductive health with their education level. Each ELI of the four ELIs was predicted by a regression model including the three RHIs. One regression model was created for each combination of country income group-ELI, resulting in a total of 12 models. The regression models were reported in the form of regression association coefficient and its corresponding significance test p-value.

### **Regressing women's income with women's education level.**

The second part of the study analyzed how the increase in women's education level influence their economic performances in terms of the income level of those actively

participating in the labor market (AGNI), labor participation level (ALP), and unemployment level (UR).

Correlation tests were conducted between the ELIs and EPIs for each subset of country income group data. Based on the correlation test results, the ELI with the highest level of correlation (largest absolute value of  $r$  coefficient) and the lowest correlation test  $p$ -value for each pair of country income group-EPI was selected to represent women's education level in the corresponding linear regression models for the following regression analyses.

For each pair of country income group-EPI, the EPI was predicted by three regression models. The first model predicts the EPI with the selected ELI without any other adjusting factors. This model assesses whether the relationship between EPI and ELI follows a reasonable and expected trend. GII was added into the first model to produce the second model, and it adjusts for the effects of gender inequality in the social and cultural value contexts for each country and time point on the EPIs. The second model studies whether the effect of women's education level on their economic performance still exists and remains reasonable after adjusting for the gender inequality contexts. Finally the third model was created by adding the RHIs into the second model, and it studies the effect of women's education level on their economic performance after adjusting for the gender inequality contexts and removing the economic performance enhancements brought by improved reproductive health.

## **RESULTS**

A total of 130 countries or economies were included in the study, which consists of 31 low income economies, 49 lower-middle income economies, and 50 upper-middle income economies. The descriptive statistics of the major variables included in this study from years of 1995, 2005, and 2015 are shown in Table 1.

**All RHIs are generally predictive of ELIs.**

Correlation test results within the ELIs show high levels of correlation ( $p < 0.00005$ ) between all possible pairs of ELIs, indicating that the ELIs are highly predictive of each other, which validates the use of adjusted ELIs in the rest part of the study. Correlation test results within the RHIs also show high levels of correlation ( $p < 0.00005$ ) between all possible pairs of RHIs, suggesting that the components of women reproductive health are highly associated with each other. Significance of all the correlation tests within the ELIs and within the RHIs remains when tested in subsets of data categorized by country income groups.

Correlation tests between ELIs and RHIs show that FR is generally most predictive of the ELIs, with MMR following behind, while ABR usually is the least predictive of the ELIs among the three RHIs. Table 2 shows the correlation test results between ELIs and RHIs, categorized by country income groups, in  $r$  coefficient and its corresponding  $p$ -value. Cells of Table 2 that are not painted indicate significant correlation between the corresponding ELI and RHI, while those that are painted red indicate nonsignificant correlation. In low and lower-middle income economies, all RHIs are significantly correlated with and highly predictive of all ELIs. This observation remains true in upper-middle income countries, with the exception of between AMY and MMR ( $r = -0.0975$ ,  $p = 0.0515$ ) and between AEXPY and ABR ( $r = -0.0729$ ,  $p = 0.1484$ ).

**FR has the most significant effect on education level for all country income groups and ELIs.**

Multiple linear regression models predicting ELIs with the RHIs adjusting for each other show that only FR is consistently significantly associated with the ELIs across all country income groups. For the countries included in this study from 1995 to 2015, ABR decreased by 26.7 births per 1,000 women aged 15-19 from 75.14 to 48.44, MMR decreased by 143.1 deaths

per 100,000 live births from 315.9 to 172.8, and FR decreased by 0.836 birth per women from 3.663 to 2.827. Thus to present the effects of improvement in women's reproductive health on their education level over the past 20 years, Table 3 shows the changes in years for FMY and FEXPY and changes in value for AMY and AEXPY when ABR is reduced by 25, MMR by 150, and FR by 1, adjusted for each other. The p-values of the significance tests of these changes are reported in the parentheses. Cells in Table 3 painted red indicates nonsignificant association, yellow indicates a p-value larger than 0.005, and green indicates a p-value smaller than 0.005.

Only the decrease in FR has significant positive impact on all ELIs in all country income groups. Decrease in MMR also significantly increased the absolute amount of education years that women received (FMY and FEXPY), however the association varies according to country income group when it comes to the adjusted ELIs (AMY and AEXPY). In most cases, decrease in ABR has no significant influence on women's education level when adjusted for MMR and FR. However note that in lower-middle (coeff. = -0.037,  $p < 0.005$ ) and upper-middle income economies (coeff. = -0.040,  $p < 0.005$ ), a decrease in ABR significantly decreases the value of AMY.

**Education significantly increases income and labor participation level, but not unemployment rate.**

The correlations among the ELIs and the EPIs varied widely and are shown in Table 4. In low and lower-middle income economies, AMY was chosen as the ELI term to be included in the regression models for AGNI, ALP, and UR. In upper-middle income economies, AEXPY was chosen as the ELI term for the AGNI regression model, while FMY was chosen as the ELI term for the ALP and UR regression models.

The regression coefficients and their corresponding p-values of the regression models predicting EPIs with ELIs were shown in Table 5. Three intriguing trends were observed from the regression model analyses. First, in low and upper-middle income economies, AGNI and ALP were significantly associated with their corresponding ELIs when not adjusted for other factors, adjusted for GII, and adjusted for both GII and RHIs. This indicates that increasing the education level of women in lower and upper-middle income economies has positive effects on the income level of women participating in the formal labor market and the overall female labor participation level even when excluding the effects of gender inequality and reproductive health.

Second, while AGNI and ALP remain significantly associated with the ELIs when not adjusted and when adjusted for GII in all country income groups, UR is only significantly associated with the ELIs when not adjusted and no longer has significant association after adjusted for GII in all country income groups, suggesting that the gender inequality in social and cultural values might have relatively larger role on unemployment rate compared to income level and labor participation. Also in the case of low income countries, increase in women's education level actually significantly increases their unemployment rate when not adjusted for GII or RHIs.

Third, in lower-middle economies, none of the three key variables -- AGNI, ALP, or UR -- was significantly associated with the corresponding ELIs after adjusting for GII and the RHIs. While unemployment rate, as depicted in the first trend observed, might be affected more by GII than the RHIs, increase in education seems to bring minor to no influence on the income level of women participating in the formal labor market and the overall female labor participation level.

## **DISCUSSION**

This study proposed, hypothesized, and tested the following model: that improved women's reproductive health, through reduced fertility rate, adolescent birth rate, and maternal

mortality rate, leads to higher level of education completion among women. Increased education among women then leads to better economic performances among women, including higher income levels of women actively participating in formal labor market, higher women's labor participation rate, and lower women's unemployment rate, even after adjusting for the economic effects of improved reproductive health. A visual representation of the hypothetical model tested is shown in Figure 1.

### **Constructing a model from reproductive health to educational attainment.**

The first part of this study tested the causal pathway leading from women's reproductive health to education, as there already exists a huge amount of studies and literature that analyzed and found strong associations on the reverse of the pathway tested, in other words on how parental especially maternal education leads to better reproductive health. Osili and Long (2008) (7), through their analyses focused on the universal primary education in Nigeria, observed that increasing girl's education by one year leads to a reduce in FR of 0.26 birth per woman. Breierova and Duflo (2004) (16) analyzed the effect of education on fertility and child mortality in Indonesia between 1973 and 1978, and their results showed that maternal education is an important factor on age of marriage and early fertility, while the education of both parents have strong causal effects on child mortality. Focusing on the specific topic of teenage childbearing, Silles (2011) (17) confirmed the results by Breierova and Duflo by showing that in Great Britain and Northern Ireland, increased schooling reduces incidence of teenage childbearing.

While literature focusing on the education to reproductive health pathway had shown the importance of education on reducing FR and ABR, the analyses conducted in this study reveals that for the reproductive health to education pathway, only FR but not ABR has significant effect on the absolute and relative value of women education. This finding was rather surprising, as

teenage childbearing is expected to lead to school dropout and thus lowering the overall education level that women receive. As depicted by Hofferth et al. (2001) (18), teenage mothers in the US were found to complete an average of around 2 years less of education compared to mothers that had their first birth after age of 30. However the statistical model created by Hofferth et al. included only the age of mothers at their first birth as the main independent variable and adjusted the model with only race as the control variable. The model used in this study considers the three major RHIs of mothers, and adjusting ABR by MMR and FR might be the reason for the difference in results between my study and that by Hofferth et al..

The nonsignificant associations found between ABR and the ELIs in this study were supported by a number of studies. Holmlund (2005) (19) controls for heterogeneity within families by adjusting for pre-motherhood school performance in 322 sister-pairs, and identified that the reduced educational attainment level by teenage childbearing estimated by previous studies had been overestimated. Similarly, using two cohorts of identical twin sisters in Australia, Webbink et al. (2011) (20) agree on the findings of this study that there is no difference in educational attainment between teenage mothers and their identical twins. Combining the evidence from individual based research and the results of population-based analyses in my study, it seems that the counter-intuitive trend where ABR and teenage childbearing have minor effects on women's educational attainment exists when adjusted for other personal or reproductive health factors exists.

However the conclusion that delaying marriage age and preventing teenage pregnancy is not worthwhile in terms of increasing girl's educational attainment should not be drawn from the results of this study. In the case of lower-middle and upper-middle income countries, it was found that there is a positive association between ABR and AMY when adjusted for MMR and

FR, suggesting that the effect of ABR might overlap with that of MMR and especially FR. Delayed childbearing reduces the total amount of time in a women's life to bear child, and thus the modifying effect between FR and ABR must be considered before drawing any policy implications from the lack of strong associations between ABR and ELIs. Another factor highly related to ABR but is not considered in the models of my study is early marriage, which Machio et al. (2017) (21) found to pose obstacles to women's educational attainment and labor force participation. Finally the factor of poverty must be considered, as most teen mothers come from disadvantaged backgrounds (22) and the World Bank has specifically pointed out that poverty remains the most important factor when determining a girl's access to education (23).

The regression results in the first part of this study also suggest that the reductions in FR has significant effects on increasing the absolute and relative amount of educational attainment among women. The magnitude of this effect is also relatively larger than those of MMR and ABR considering the overall trend of reproductive health improvement in the developing world, as shown in Table 3. This trend is supported by historical evidence described Frejka et al. (2010) (24) and Mason (1997) (25), who focused on fast growing economies in East Asia between 1950 and 1990, that reduced numbers of offspring allowed parents to provide more resources per child leading to higher human capital investment and educational attainment. While this historical evidence explains the associations between FR and the absolute amounts of education level (FMY and FEXPY), the associations between FR and the relative amounts of education level (AMY and AEXPY) also suggest that reduced FR affects the education level of women independent to men. While my study didn't focus on the possible factors associating FR with the adjusted ELIs, it is possible that traditional values which depreciate women receiving education

and the unequally assigned responsibility of taking care of children and siblings leads to reduced relative education level among women in economies with high FR.

Cohen et al. (2011) (10) conducted two counterfactual analyses on Norwegian women assuming that childbearing has no effect on educational attainment and education level has no effect on childbearing, and recognized that the former model contradicts existing data while the latter conforms with the data, suggesting stronger causality of FR on education level than the other way around. While Cohen's model support the rationale of building the conceptual model of improved reproductive health leads to higher educational attainment, my study and other literature suggests a more comprehensive model that describes the positive feedback loop between reproductive health and educational attainment, as shown in Figure 2. Assume that the FR in Nigeria, a lower-middle income country, can be lowered by 1 birth, then according to the model FMY would be increased by 0.827 year. One additional year of education among Nigerian women was found to reduce FR by 0.26 birth (7), therefore it could be argued that the investment of reducing FR by 1 in Nigeria generates a return of further reducing the FR by 0.215. While the analyses by Cohen et al. suggest the cross-interaction between reproductive health and education level is apparently more complicated than shown in the estimation above, this additional "dividend" for investing in women's reproductive health is definitely not to be underestimated.

### **Separating the economic effects of education from health.**

The second part of this study focused on the gain in economic empowerment, including income level, labor participation, and unemployment, among women by increasing their educational attainment. EPIs and ELIs adjustment is a unique approach this study took to conduct comparisons across countries and time and to specifically estimate the economic effect attributed to education and not other confounding factors. Women's education levels and

economic performance can be affected by a huge number of social, infrastructural, and economic factors, and including these factors in the regression model might unnecessarily complicate the analyses. Thus in the regression analyses between the ELIs and EPIs, the ELIs were first simplified into a gender inequality issue by adjusting economic performances of women by men, then the effects of gender inequality were removed by adding GII, a measurement of the level of gender inequality in a certain place and time, to the regression models. Finally by including the RHIs into the regression model, it removes the economic performance enhancement attributable to improved reproductive health, leaving those attributable only to women's education.

Adjustment to the regression models with the RHIs claims high importance as the first part of this study showed that women's education is highly correlated with their reproductive health status. Hotz and Miller (1988) (26) had shown that the efforts and time it took for a mother to take care of her children leads to negative effects on the mothers labor force participation. Similar results were identified by Chun and Oh (2002) (27) who discovered that among Korean women, having children reduces their labor force participation by 27.5%. Thus, it was necessary to separate the economic enhancement effects brought by higher education and by reproductive health before testing the linkage between education and economic empowerment among women as shown in Figure 1.

Most existing literature support the argument that women's education brings positive effects on their income level and labor participation described in this study. Previous economic models such as that introduced by Griliches and Mason (1972) (28) demonstrated the economic significance of schooling on income. More recently Heckman et al. (2016) (29) conducted a comprehensive study on the causal effects of education on earnings, and identified that education has substantial effect on income while the effect varies by the level of schooling and personal

factors. My analyses further contribute to the literature body by showing that under the specific contexts of low and upper-middle income countries, education significantly contributes to higher income for women actively participating in the formal labor market.

Similar to the associations between education and labor participation found in my study, Sackey (2005) (30) showed that for women in Ghana, post-primary education exerts significant impact on improving women's labor force participation while bringing down their fertility. Marchetta and Sahn (2016) (31) also discovered that education promotes earlier entry into the formal labor market, thus improving women's labor force participation. However Marchetta and Sahn assigned this effect to the delayed marriage and delayed first birth encouraged by increased education, which contradicts my finding that education still improves women's labor participation after removing the effects of improved reproductive health. This difference might be caused by the fact that Marchetta and Sahn focused on age of marriage and age of first birth while my model included ABR, FR, and MMR, and by that Marchetta and Sahn measures women's age of labor force entry while my model used ALP.

Li and Urmanbetova (2003) (32) did not find an association between educational attainment and women's income level in their study of China's rural industry. While this disagreement might be explained by the difference in the approaches of adjustment used or the population and context studied, it inevitably draws attention to the discrepancy that also exists in my study as described by the third trend identified in the EPIs-ELIs regression models, which is that in lower-middle income economies AGNI and ALP are insignificantly associated with the ELIs after adjusting for GII and the RHIs. A strong explanation of this trend is the theory of U-shaped female labor force function in economic development identified by Goldin (1995) (33). When a society moves from a low-income, low-education condition to that with a higher income

due to wider market or new technologies, strong social stigmas prevent women from entering these segments of labor forces, leading to the downward portion of the U-shaped curve in female labor participation. As the society further develops to even higher income and women receive more education, they start to enter the white-collar work force where less social stigmas exists, thus creating the upward portion of the U-shaped curve.

Heath and Jayachandran (2016) (34) identified evidence that low income countries are on the downward portion of the U-shaped curve, where further economic development will lead to lower female labor participation. Thus the nonsignificant associations of AGNI and ALP with the ELIs after adjusting for GII and the RHIs in lower-middle income countries might be a result of the extremely low women's labor force participation at the bottom part of the U-shaped curve. It is possible that under this specific labor market structure, additional education in women doesn't favor entering the formal labor force and doesn't improve the income level of women in the saturated traditional labor sector after adjusting for reproductive health factors. On the other hand, additional education in the low average education environment of low income economies and the high average education environment upper-middle income countries allows women to further participate and receive better wages in a non-saturated traditional labor sector or a growing white-collar industry, which leads to the significant positive association seen between AGNI and ALP with educational attainment in low and upper-middle income countries.

The U-shaped curve of female labor participation with economic development might also explain trends of association between UR and the ELIs across country income groups when unadjusted for GII. In low income economies, as women's education level increases with economic development, they find themselves in a situation where employment opportunities decrease as a result of the change in employment and labor market structure for women. This

macroeconomic trend discourages women from entering the formal labor force, leading to the nonsignificant association between ALP and ELI later seen in lower-middle income countries. Then as lower-middle income countries are moving out of the low point of the U-shaped curve, more employment opportunities are opened to women with higher education level, thus reducing the UR as seen in lower-middle income countries, This encourages women with higher education level to return to the formal labor market, which leads to the significant association between ALP and ELI later seen in upper-middle income countries. In this case, unadjusted UR-ELI relationship acts as a precursor for ALP-ELI and AGNI-ELI trends, where UR-ELI trends in low income economies lead to ALP-ELI and AGNI-ELI trends observed in lower-middle income economies, and whose UR-ELI trends then lead to ALP-ELI and AGNI-ELI trends observed in upper-middle income economies. While further investigation will be required to support this the U-shaped curve hypothesis for my analyses results, it should still be considered as a powerful explanation that describes the observed trends.

The results of the adjusted UR-ELI regression analysis suggested that after adjusting for gender inequality contexts, education exerts no effect on women's unemployment rate. A study by Campa et al. (2010) (35) on Italian data showed that the gender gap between men and women is significantly associated with their index of gender culture, suggesting high influence of cultural gender inequality context on the gender inequality of employment opportunities. This may explains why after adjusting for GII, the ELIs for all country income groups ceased to be significantly associated with UR. While my models suggest that the gender inequality context within social and cultural values of low, lower-middle income, and upper-middle income countries have overwhelming effects over education on unemployment rate, it is also essential to note that education is closely related to gender stereotypes, gender cultures, and gender

discrimination in the labor market, and thus the quality of education and the focus of gender equality in education should be focused on more than the sheer amount of education that women received.

### **The new hypothetical model and policy implications.**

Concluding from the findings of the two parts of the analyses of this study, it is possible to propose a more complete model that describes the interaction between women's reproductive health, women's educational attainment, and women's economic enhancement. Figure 2 provides a visual presentation of this new hypothetical model. Regarding the linkage between reproductive health and the educational attainment, my analyses showed that the impact of reductions in FR on educational attainment are generally greater than those of either MMR or ABR. This linkage is also a two-way process, where the additional education brought by improved reproductive health could further improve women's reproductive health status.

Regarding the linkage between educational attainment and economic enhancement, my analyses demonstrate that while additional education improves women's income level and labor participation in low and upper-middle income countries, such associations do not exist in lower-middle income countries after adjusting for reproductive health factors. These findings suggest a possible U-shaped relationship between women's labor participation and economic development, which changes the employment structure and leads to transition in women's income and labor participation levels. My analyses also revealed that gender inequality contexts with social and cultural values seem to play a larger role in the unemployment rate of women than the sheer amount of education that they received. The enhanced income level and labor force participation among women leads to further economic development, and provides opportunities to invest in human capital by allocating more resources to the reproductive health and educational sector.

This new model suggests the following policy implications. First, FP programs and investments on reproductive health should prioritize in avoiding unwanted pregnancy by providing contraception methods and educating the benefits of have fewer children, as FR has the largest impact on women's educational attainment. Second, low and lower-income countries should support the transition of women into newly developed labor markets to minimize the effects of the downward portion of the U-shaped curve in female force labor participation and maximize the economic enhancement effects offered by women's education. Finally, all developing countries should minimize the gender employment gap posed by gender culture, gender discrimination, and gender employment segregation through means of focusing on gender equality in education, as social and cultural gender inequality have overwhelming effects on women's unemployment rate.

#### **Limitations and future directions.**

There are some major limitations to this study. First is the failure to consider the effects of early marriage separated from early childbearing due to the lack of marriage age data. Also compared to MMR, percentage of birth in health facilities is generally considered a better indicator for maternal health, however since MMR provides a more complete set of historical trend cross-country data it was instead included in this study. In the second part of the study, I categorized the analyses based on country income groups based on the assumption that countries of similar income level faces similar reproductive health, educational, and economic challenges. While this categorization allowed this study to link to the U-shaped curve trend described, it ignores the geographical relationships between countries and the cultural and economic interactions that might occur beyond the country borders. The use of GII to present the cultural gender inequality context in each country in the second part of the study might also interfere with

other terms included, as women's health and economic empowerment were also included in the calculation of GII (36). Finally, this study only considers women's educational attainment in terms of amount, which fails to acknowledge the influences of the quality of study.

Future studies could overcome some of these limitations by including a more complete set of indicators, such as marriage age, births in health facilities, index of gender culture, and measurements of school performance. The topic of whether the trends in AGNI-ELI and ALP-ELI association identified in this study is a product of the U-shaped curve of women's labor participation with economic development or is merely a random trend is also worth further attention. Finally, by integrating geographic information science, the spatial patterns of the mechanism studied can be identified and can contribute to FP interventions in various regions.

## REFERNCE

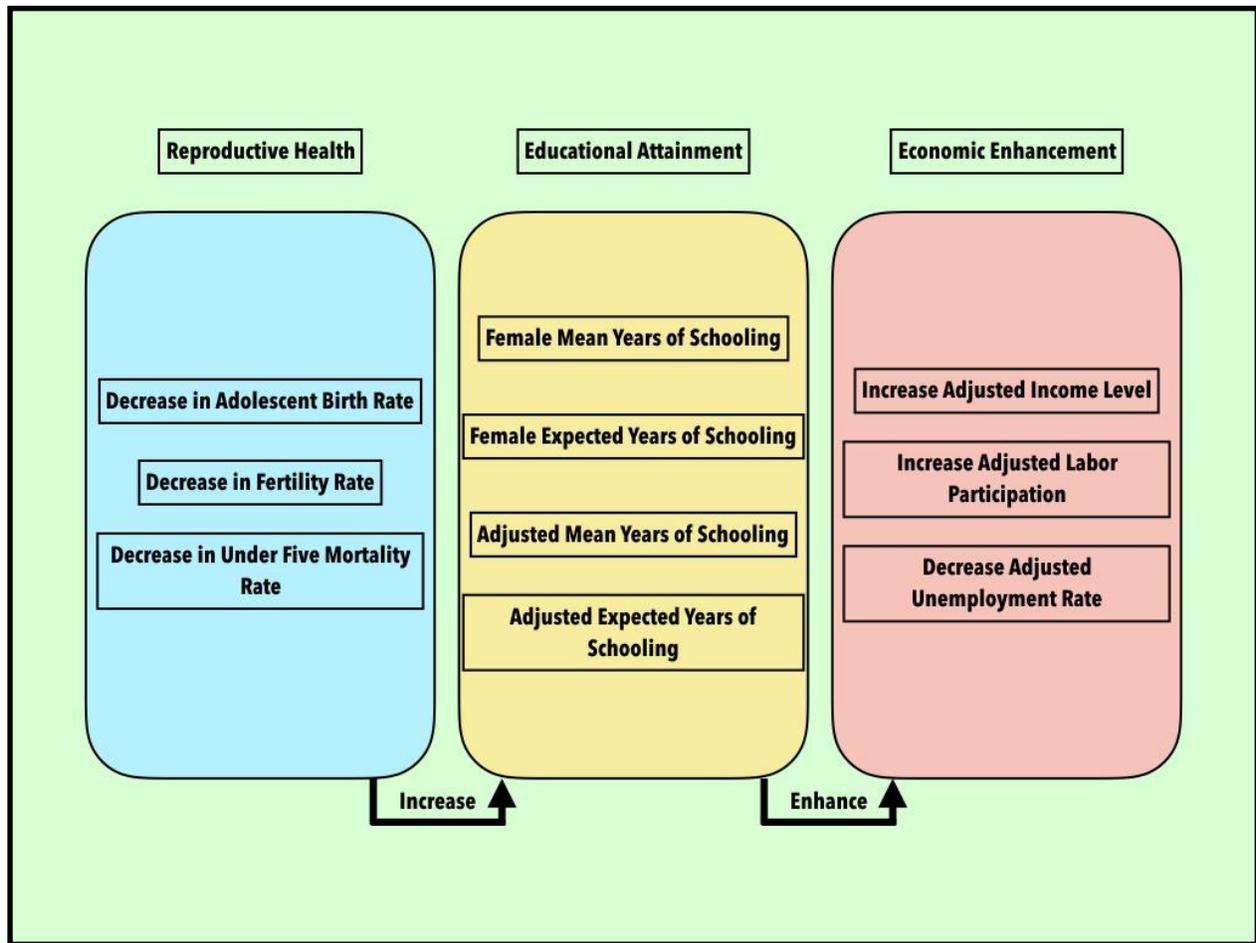
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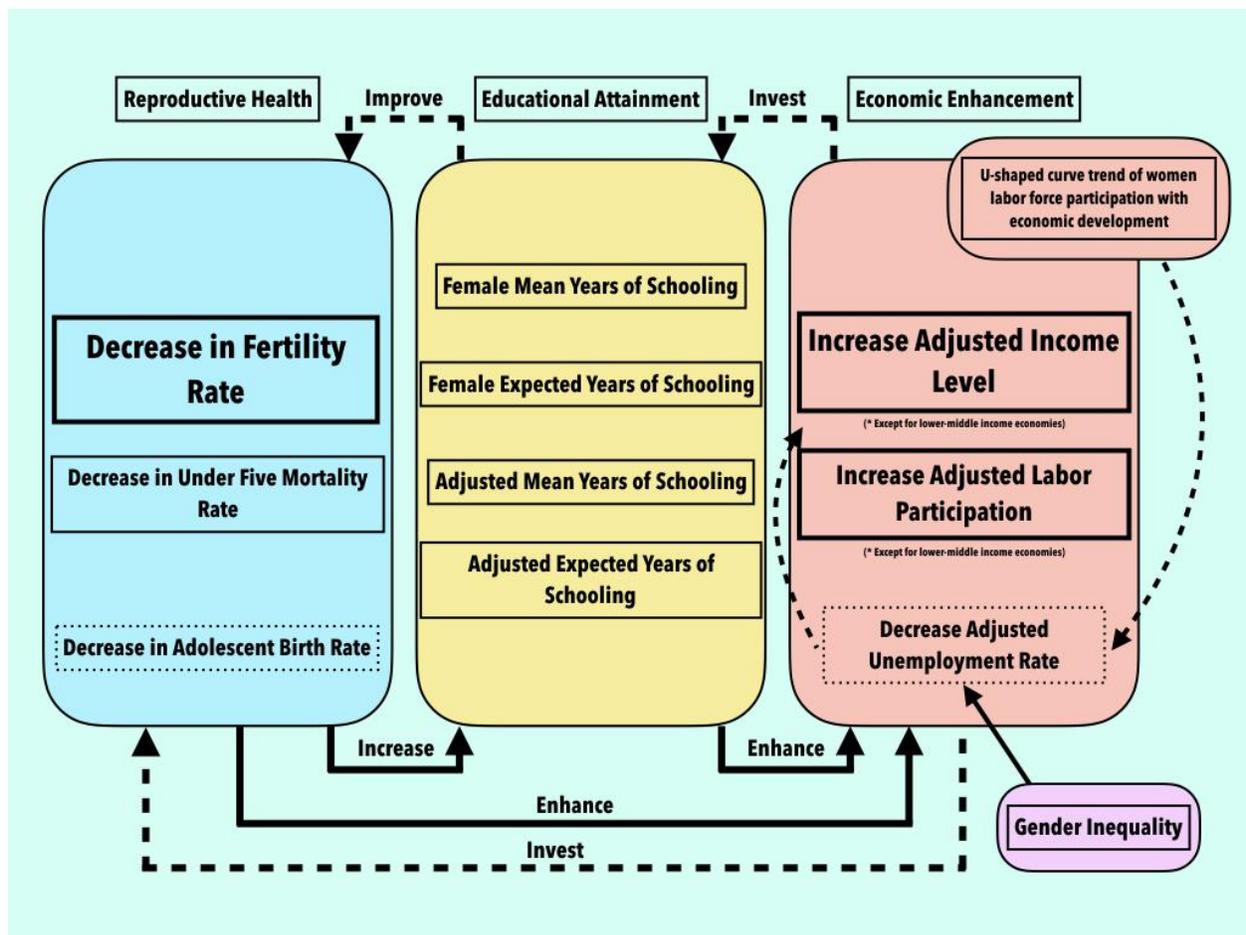
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**FIGURE**

**Figure 1.** The visual presentation of the hypothetical model tested in this study. The mechanism depicted in this model shows that the three components of reproductive health increases women’s educational attainment, and increased women’s education level enhances their economic performances in terms of higher wages, higher labor participation, and lower unemployment rate.



**Figure 2.** The visual presentation of the new hypothetical model after integrating results from this study and existing literatures. The solid arrows connecting between boxes indicates significant causal effects found in this study, while dotted arrows represents suspected causal effects or causal relationships found in other literatures. Components under the economic enhancement and reproductive health categories that are surrounded by dotted boxes indicates nonsignificant association with women’s educational attainment level, and the thickness of the line for solid boxes surrounding the components indicates the magnitude of significant for the component’s association with educational attainment.

## TABLES

Year		ABR	MMR	FR	FMY	FEXPY	AMY	AEXPY	AGNI	ALP	UR
1995	Max	227.4	2900.0	7.725	12.700	18.800	1.263	1.265	NA	1.076	17.280
	Mean	75.1	315.9	3.663	6.120	10.206	0.801	0.934	NA	0.647	1.484
	SD	52.1	1.9	3.211	4.049	0.228	0.162	435.561	NA	0.210	1.417
	Min	1.8	4.0	1.160	0.200	1.900	0.182	0.437	NA	0.137	0.330
2005	Max	217.5	1990.0	7.608	12.900	20.600	1.234	1.162	0.834	1.051	16.670
	Mean	61.4	235.1	3.125	7.153	11.990	0.840	0.971	0.534	0.690	1.499
	SD	49.7	1.7	3.486	3.743	0.209	0.129	317.093	0.157	0.202	1.385
	Min	1.0	3.0	0.959	0.700	3.000	0.238	0.438	0.129	0.178	0.350
2015	Max	202.4	1360.0	7.290	13.400	20.900	1.321	1.226	0.916	1.094	13.270
	Mean	48.4	172.8	2.827	8.074	13.070	0.877	0.995	0.579	0.712	1.441
	SD	40.5	1.4	3.486	3.368	0.187	0.108	235.112	0.159	0.196	1.227
	Min	0.5	3.0	1.196	1.000	3.800	0.276	0.603	0.162	0.172	0.340

**Table 1.** Descriptive statistics, including the maximum values (Max), minimum values (Min), mean values (Mean), and standard deviations (SD) of the major variables included in this study from years of 1995, 2005, and 2015.

Low Income Countries	ABR	MMR	FR
<b>FMY</b>	-0.2599 (0.0001)	-0.3111 (< 0.00005)	-0.4846 (< 0.00005)
<b>FEXPY</b>	-0.4370 (< 0.00005)	-0.4982 (< 0.00005)	-0.6482 (< 0.00005)
<b>AMY</b>	-0.2985 (< 0.00005)	-0.6592 (< 0.00005)	-0.3757 (< 0.00005)
<b>AEXPY</b>	-0.3735 (< 0.00005)	-0.4349 (< 0.00005)	-0.4861 (< 0.00005)
Lower-middle Income Countries	ABR	MMR	FR
<b>FMY</b>	-0.4582 (0.0001)	-0.5556 (< 0.00005)	-0.5755 (< 0.00005)
<b>FEXPY</b>	-0.4982 (< 0.00005)	-0.6238 (< 0.00005)	-0.6459 (< 0.00005)
<b>AMY</b>	-0.2692 (< 0.00005)	-0.4147 (< 0.00005)	-0.5229 (< 0.00005)
<b>AEXPY</b>	-0.4442 (< 0.00005)	-0.5117 (< 0.00005)	-0.6512 (< 0.00005)
Upper-middle Income Countries	ABR	MMR	FR
<b>FMY</b>	-0.2815 (0.0001)	-0.4112 (< 0.00005)	-0.4519 (< 0.00005)
<b>FEXPY</b>	-0.3342 (< 0.00005)	-0.4262 (< 0.00005)	-0.4689 (< 0.00005)
<b>AMY</b>	0.1513 (0.0024)	-0.0975 (0.0515)	-0.2631 (< 0.00005)
<b>AEXPY</b>	-0.0729 (0.1484)	-0.1745 (0.0005)	-0.3741 (< 0.00005)

**Table 2.** Correlations among the RHIs and ELIs, categorized by country income groups. Results are reported in Pearson’s correlation coefficient and its associated p-value in the parenthesis.

Cells painted in red indicates nonsignificant correlations.

<b>Change in FMY in years if.....</b>	<b>ABR</b> (reduce by 25 births per 1,000 women aged 15-19)	<b>MMR</b> (decrease by 150 deaths per 100,000 live births)	<b>FR</b> (decrease by 1 birth per women)
<b>Low Income</b>	-0.052 (0.406)	0.090 (0.031)	0.660 (< 0.005)
<b>Lower-Middle Income</b>	-0.028 (0.826)	0.571 (< 0.005)	0.827 (< 0.005)
<b>Upper-Middle Income</b>	-0.029 (0.751)	0.687 (< 0.005)	0.752 (< 0.005)
<b>Change in FEXPY in years if.....</b>	<b>ABR</b> (reduce by 25 births per 1,000 women aged 15-19)	<b>MMR</b> (decrease by 150 deaths per 100,000 live births)	<b>FR</b> (decrease by 1 birth per women)
<b>Low Income</b>	-0.014 (0.873)	0.287 (< 0.005)	1.239 (< 0.005)
<b>Lower-Middle Income</b>	-0.117 (0.224)	0.582 (< 0.005)	0.870 (< 0.005)
<b>Upper-Middle Income</b>	0.124 (0.139)	0.546 (0.007)	0.663 (< 0.005)
<b>Change in AMY in value if.....</b>	<b>ABR</b> (reduce by 25 births per 1,000 women aged 15-19)	<b>MMR</b> (decrease by 150 deaths per 100,000 live births)	<b>FR</b> (decrease by 1 birth per women)
<b>Low Income</b>	0.010 (0.199)	0.010 (0.0388)	0.042 (0.001)
<b>Lower-Middle Income</b>	-0.037 (< 0.005)	0.025 (0.007)	0.087 (< 0.005)
<b>Upper-Middle Income</b>	-0.040 (< 0.005)	0.003 (0.854)	0.066 (< 0.005)
<b>Change in AEXPY in value if.....</b>	<b>ABR</b> (reduce by 25 births per 1,000 women aged 15-19)	<b>MMR</b> (decrease by 150 deaths per 100,000 live births)	<b>FR</b> (decrease by 1 birth per women)
<b>Low Income</b>	0.005 (0.398)	0.018 (< 0.005)	0.043 (< 0.005)
<b>Lower-Middle Income</b>	-0.006 (0.217)	0.007 (0.109)	0.057 (< 0.005)
<b>Upper-Middle Income</b>	-0.006 (0.055)	-0.007 (0.375)	0.034 (< 0.005)

**Table 3.** Change in years for FMY and FEXPY and in the value of AMY and AEXPY when ABR is reduced by 25 births per 1,000 women aged 15-19, MMR is decreased by 150 deaths per 100,000 live births, and FR decreased by 1 birth per women, adjusted for each other. The p-

values of the significance tests of these changes are reported in the parentheses. Cells painted in red indicates nonsignificant association, yellow indicates a p-value larger than 0.005, and green indicates a p-value smaller than 0.05.

Low Income	FMY	FEXPY	AMY	AEXPY
AGNI	0.3535 ( $< 0.00005$ )	0.2948 ( $< 0.00005$ )	0.4346 ( $< 0.00005$ )	0.3987 ( $< 0.00005$ )
ALP	0.3564 ( $< 0.00005$ )	0.3076 ( $< 0.00005$ )	0.4125 ( $< 0.00005$ )	0.3739 ( $< 0.00005$ )
UR	0.1235 (0.0668)	-0.0119 (0.856)	0.1472 (0.0287)	0.0508 (0.4374)
Lower-Middle Income	FMY	FEXPY	AMY	AEXPY
AGNI	0.2089 (0.0001)	0.1266 (0.0146)	0.3249 ( $< 0.00005$ )	0.0666 (0.2)
ALP	0.1913 (0.0002)	0.0578 (0.2415)	0.2682 ( $< 0.00005$ )	0.0647 (0.19)
UR	-0.2527 ( $< 0.00005$ )	-0.0986 (0.0472)	-0.2864 ( $< 0.00005$ )	-0.1482 (0.0028)
Upper-Middle Income	FMY	FEXPY	AMY	AEXPY
AGNI	0.3163 ( $< 0.00005$ )	0.1976 (0.0002)	0.2637 ( $< 0.00005$ )	0.3618 ( $< 0.00005$ )
ALP	0.4323 ( $< 0.00005$ )	0.1837 (0.0002)	0.3539 ( $< 0.00005$ )	0.3278 ( $< 0.00005$ )
UR	-0.1986 (0.0001)	-0.1069 (0.034)	0.0878 (0.0785)	-0.0759 (0.1374)

**Table 4.** Correlations between the EPIs and ELIs, categorized by country income groups. Results are reported in Pearson’s correlation coefficient and its associated p-value in the parenthesis.

Cells painted in green indicates that the corresponding ELI is chosen as the education level term in the regression model for the specific pair of country income group-EPI.

Change in AGNI value when.....	Selected ELI alone (Unadjusted)	Adjusted for GII	Adjusted for GII and RHIs
<b>Low Income</b>	0.43 ( $< 0.005$ )	0.59 ( $< 0.005$ )	0.51 ( $< 0.005$ )
<b>Lower-Middle Income</b>	0.31 ( $< 0.005$ )	0.23 ( $< 0.005$ )	0.07 (0.237)
<b>Upper-Middle Income</b>	0.87 ( $< 0.005$ )	1.03 ( $< 0.005$ )	0.77 ( $< 0.005$ )
Change in ALP value when.....	Selected ELI alone (Unadjusted)	Adjusted for GII	Adjusted for GII and RHIs
<b>Low Income</b>	0.49 ( $< 0.005$ )	0.44 ( $< 0.005$ )	0.28 (0.015)
<b>Lower-Middle Income</b>	0.32 ( $< 0.005$ )	0.24 ( $< 0.005$ )	0.08 (0.265)
<b>Upper-Middle Income</b>	0.04 ( $< 0.005$ )	0.04 ( $< 0.005$ )	0.04 ( $< 0.005$ )
Change in UR value when.....	Selected ELI alone (Unadjusted)	Adjusted for GII	Adjusted for GII and RHIs
<b>Low Income</b>	0.42 (0.029)	-0.49 (0.128)	0.01 (0.982)
<b>Lower-Middle Income</b>	-0.98 ( $< 0.005$ )	-0.38 (0.086)	0.23 (0.274)
<b>Upper-Middle Income</b>	-0.05 ( $< 0.005$ )	0.002 (0.896)	0.001 (0.944)

**Table 5.** Regression coefficients between the EPIs and ELIs when not adjusted, adjusted for GII, and adjusted for GII and RHIs, separated by country income groups. The p-values of the significance tests of these regression coefficients are reported in the parentheses. The results are reported in change in AGNI, ALP, and UR values when the selected ELI increase by 1 unit. Cells painted in red indicates nonsignificant association.

## **APPENDIX**

### **Glossary of Abbreviations used in this study:**

ABR - Adolescent Birth Rate

FR - Fertility rate

MMR - Maternal mortality rate

FEXPY - Female expected years of schooling

MEXPY - Male expected years of schooling

FMY - Female mean year of schooling

MMY - Male mean year of schooling

AEXPY - Adjusted expected years of schooling (female to male)

AMY - Adjusted mean years of schooling (female to male)

GII - Gender inequality index

AGNI - Adjusted GNI per capita (female to male)

ALP - Adjusted labor participation (female to male)

UR - Unemployment rate (female to male ratio)