JICA Research Institute

JICA-RI Working Paper

Research on Declining Fertility in East Asia

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No. 165

March 2018

JICA Research Institute

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Inverse J-Shaped Relationship between Fertility and Gender Equality: Different Relationships of the Two Variables According to Income Levels

Yoko Nakagaki*

Abstract

The fertility decline, which started first in developed countries, has been observed among most developing countries since the latter half of the 20th century. On the other hand, among developed countries, the long-lasting decline of fertility seems to have stopped in recent decades, and a modest recovery of fertility has been observed in most countries.

A large number of studies focusing on the relationship between fertility and gender equality have been conducted. However, gender equality is composed of various aspects, and the relationship between fertility and gender equality could be different at different levels of economic development. This study aims to empirically examine the relationship between fertility and gender equality according to countries' different income levels, using the integrated framework for both the fertility decline in developing countries and the fertility recovery in developed countries. This study employs the panel dataset including fertility and the GGGI (Global Gender Gap Index) published annually by the World Economic Forum. The main findings of this study are as follows: First, this study observes the inverse J-shaped ( ) relationship between fertility and the progress of overall gender equality measured by the GGGI. This means that progress toward gender equality has a negative relationship with fertility until a certain level of development is achieved, at which point the relationship becomes positive. The inverse J-relationship is also found between fertility and the progress toward gender equality in the economy. Second, in the "low-income and modest decline of fertility" country group, where the average total fertility rate was still over 5 in 2015, the progress in overall gender equality and in gender equality in the economy do not have a particular relationship with fertility. In contrast, female life expectancy is positively correlated to fertility. Third, the progress in gender equality in literacy is important for lowering fertility regardless of income level. In middle-income countries, progress in gender equality in school enrolment is negatively correlated with fertility in all education levels.

Keywords: fertility; gender equality, Global Gender Gap Index, income level

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This paper has been prepared as part of a JICA Research Institute project entitled "Research on Declining Fertility in East Asia". The author thanks Hisakazu Kato, Koki Hirota, Naohiro Kitano, and anonymous reviewers for their valuable comments. Also, the author thanks Hiroyuki Taguchi, Kitti Limskul, Kyoko Tanaka, and Hiroaki Sakurai for their encouraging advice. All views expressed in this paper are those of the author and not those of the JICA-RI.

1. Introduction

The fertility decline, which started first in developed countries, has been observed among most developing countries since the latter half of the 20th century. On the other hand, among developed countries, the long-lasting decline of fertility seems to have stopped in recent decades, and a modest recovery of fertility has been observed in most countries.

A large number of studies focusing on the relationship between fertility and gender equality, as well as the relationship between fertility and economic development, have been conducted. However, gender equality is composed of various aspects, and the relationship between fertility and gender equality could be different at different levels of economic development.

This study aims to empirically examine the relationship between fertility and gender equality according to countries' different income levels using the integrated framework for both the fertility decline in developing countries and the fertility recovery in developed countries. Section 2 reviews related previous studies and explains the purpose of this study. Section 3 shows the dataset and the methodology. Section 4 explains the results and Section 5 concludes.

2. Literature Review and the Purpose of This Study

2.1 Literature Review

2.1.1 Reversal of the Relationship between Fertility and the Progress of Gender Equality/Equity

The literature review starts with recent studies that explained that the relationship between fertility and gender equality/equity changed from negative to positive through the progress of gender equality/equity. McDonald (2013) explained that "gender equity" was about perceptions of fairness and opportunity rather than strict equality of outcomes, while "gender equality" was a straightforward concept based on comparisons of outcomes for men and women in areas such as

education, employment, wages, participation, health, and so on. Esping-Andersen and Billari (2015) stated that, with respect to fertility, gender equity was considered more relevant than gender equality, however, gender equity was difficult to measure; in fact, measures of gender equality were often used as surrogate.[1]

McDonald (2000) explained the long-term changes in fertility through the lens of the progress of "gender equity in family-oriented institutions" and the progress of "gender equity in individual-oriented institutions." The transition from a high level of fertility to a population replacement level was mainly due to the progress of "gender equity in family-oriented institutions," which started preceding "gender equity in individual-oriented institutions." In other words, the decline in fertility was associated with women acquiring rights within the family that enabled them to reduce the number of their children. However, gender equity in this dimension progressed relatively slowly. On the other hand, the progress of "gender equity in individual-oriented institutions"[2] started in the 20th century and progressed relatively rapidly. Then finally, the level of "gender equity in individual institutions" overtook the level of "gender equity in family-oriented institutions." McDonald (2000) concluded that high levels of equity as individuals with continuing low levels of equity in the family at the end of the 20th century was regarded as the fundamental cause of the very low fertility in the region, and that very low fertility would persist unless gender equity within the family rose to much higher levels. McDonald (2013) observed that, in comparisons between countries, higher gender equity led to higher fertility. The study concluded that it was a sensible approach for governments to increase or sustain fertility through support of the combination of work and family for mothers.

[1] Other sections of this study use the term "gender equality" because both the empirical estimation in this study and previous studies which are referred to from the next section focus on the outcome variables.

[2] McDonald (2000) connected property rights, voting rights, and equitability with men in the labor market as "gender equity in individual-oriented institutions."

Both Esping-Andersen and Billari (2015) and Arpino et al. (2015) showed a "U-shaped relationship" between fertility and the progress of gender equality/equity, using the data from the large scale surveys on people's values.[3] According to Esping-Andersen and Billari (2015), a society started at the first stage with high fertility and a traditional family style with a male breadwinner and female housewife. The second stage represented the situation in which the "female revolution" was advanced. However, during that stage, the society had not yet to adapt the revolution, and so fertility decreased. The third stage encapsulated the situation where "gender egalitarianism" had achieved dominant normative status and resulted in higher fertility than the second stage, because "gender egalitarianism" became increasingly more compatible with having children.

2.1.2 Relationship between Female Labor Participation and Fertility

Studies focused on the relationship between fertility and socioeconomic development have a much longer history than studies focused on both the decline and recovery of fertility phases. Among these studies, the impact of the increase in female labor participation in accordance with the socioeconomic development has been of particular focus. Becker played a leading role in the theories on declining fertility in developed countries. Becker (1960) called the amount of cost spent on children the "quality" of children, and stressed the importance of distinguishing between the quantity and the quality of children. Becker (1965) presented a theory of the allocation of time between different activities. The heart of the theory was an assumption that households were producers as well as consumers. An increase in earnings could increase the demand for the quantity of children; however, at the same time it would work as a disincentive for time-intensive activities such as child care. Many studies have been conducted in this area.

[3] Both studies used the data responding to the question "When jobs are scarce, men should have more right to a job than women: agree, neither, or disagree?" from the World Values Surveys and the European Values Studies.

Hotz. et al (1997) summarized that the relationship between the rise in female labor force participation and the decline in fertility had been an important focus of the economic models of fertility.

Galor and Weil (1996) proposed a model combining the household's fertility choice with a growth model using the gender wage gap. The model explained the positive link between fertility decline and economic growth. At first, increases in capital per worker raised women's relative wages, because capital was more complementary to women's labor input than to men's. Increasing women's relative wages reduced fertility by raising the cost of children. And then, lower fertility raised the level of capital per worker.

In recent years, studies which focused on the reversal of the relationship between fertility and female labor participation from negative to positive at the high female labor participation level have been conducted. Feyrer et al. (2008) suggested the U-shaped relationship between fertility and female labor participation in the time series data of developed countries. According to the study, when the female labor participation rate was below 50–60 percent, there was a steep negative relationship between fertility and female labor participation, while fertility would increase modestly when female labor participation was higher than 50–60 percent. The study explained that when female labor participation began to increase to some extent without a corresponding improvement in their status in the family, disincentives to having additional children were strongest. In contrast, at the next stage when labor market opportunities began to equalize between both sexes, women's bargaining power in the family increased. In this stage, men's participation in the family increased, and disincentives for women to have children were reduced. The aforementioned McDonald (2013) also stressed the positive impact of the higher labor force participation rates on fertility in the highest income countries (see section 2.1.5).

2.1.3 Factors Affecting Fertility: Health, Female Education, and Human Capital

Studies focusing on factors affecting fertility such as health, female education, and human capital are also relevant to this study. According to the model by Easterlin and Crimmins (1986), in the beginning of socioeconomic modernization, the supply of children increased because of the increase in a couple's natural fertility and the chances of child survival, while the demand for children decreased. The situation resulted in an oversupply of children and an increasing motivation for fertility control. At the same time, the cost of regulating fertility gradually declined. After the certain point when the pressures to limit family size grew and the cost of regulating fertility fell, the real fertility started to decline with fertility control to a level corresponding to the demand for children.

Cleland and Wilson (1987), notable as the study on "diffusion"[4] theory, postulated that attitudes towards birth control were of central explanatory importance to the fertility transition. The study also stressed the link between literacy and fertility, and the link between education and fertility.

In more recent years, studies focusing on couples' decisions taking human capital and education in account have been conducted. Lagerlöf (2003) set up a model in which couples substituted quantity for quality in children, as spouses' levels of human capital became more equal and women's time became more expensive. With the fertility decline, the rates of human capital and per capita income growth rose. The rising levels of human capital lowered mortality, making population growth rise. After that, as mortality leveled out and fertility continued falling, population growth started to decline, while per capita income continued to rise. Iyigun and Walsh (2007) explained that marital bargaining power was determined according to the incomes of the spouses. The model predicted that wives invested more than was Pareto efficient in their education to increase their bargaining power.

[4] "Diffusion" referred to the spread of information, ideas, and behaviors among individuals, communities, and countries (Bongaarts 2006).

Hazan and Zoabi (2006) focused on the relationship between children's health and education. In the first phase of economic development, children's health was very poor, and all additional resources for children were used to increase population growth. In the second phase, children's health conditions improved, but not sufficiently enough to justify investing most additional resources on education. In the third phase, when children's health was good enough to justify increasing the parental investment for children, population growth decelerated.

Murphy (2015) comprehensively examined the regional fertility variations in France using département level data in the late 19th century. The study examined the OLS (Ordinary Least Squares) model and FE (Fixed Effects) model, and found that the male literacy rates and the gender gap of literacy rates were negatively correlated with fertility. The study also found the spatial dependence of fertility among départements, which suggested that diffusion of fertility played a particular role.

Hazan and Zoabi (2015) focused on the reversal of the relationship between fertility and female education from negative to positive at the high female education level. The study showed that the cross-sectional relationship between fertility and women's education in the US had become U-shaped. According to the study, highly educated women were recently able to have more children and work longer hours because of the decrease in the relative cost of childcare.

2.1.4 Relationship between Fertility and Gender Equality Measured by the Data of the GGGI (Global Gender Gap Index)

de la Croix and Donckt (2010) examined the relationship between the decline of fertility and several dimensions of gender equality. The study presented a model which was composed of two regimes called the "corner regime" and the "inner regime". The "corner regime" was characterized by fertility at its maximum, high infant mortality, and a short reproductive period for women. In the regime, women devoted all their time to child rearing, and the motive for educating daughters based on the expectation for higher labor market returns did not exist.

Therefore, reducing the social and institutional gender gap didn't impact fertility in the regime. After that, as mothers' survival was promoted and infant mortality was curbed, women started to supply their time to the labor market, and then fertility would start to decline. Changes concerning health conditions for mothers and children were the key to moving from the "corner regime" into the "inner regime," which was characterized by lower fertility, higher female labor supply, and higher economic growth. In the "inner regime," reducing the social and institutional gender gap resulted in a decline in fertility.

The study conducted empirical tests to examine the impact of the progress of gender equality on the "corner regime" and the "inner regime." The cross country data of sub-indexes of the GGGI (Global Gender Gap Index) in 2007 was used for the estimations. The GGGI was the simple average of four sub-indexes, each of which stood for different gender dimension (economy, education, health, and politics).[5] In the "corner regime" countries, the progress of gender equality in the economy, education, and politics did not relate to fertility, while in the "inner regime" countries, the progress of gender equality in those dimensions was proven to have negative impacts on fertility. In contrast, an increase in women's life expectancy had a positive relationship with fertility in the "corner regime," and a negative relationship in the "inner regime."

The GGGI was also used in Myrskylä et al. (2011). The study concluded that the positive impact of development on fertility in high development countries[6] was conditional on gender equality. The conclusion was based on a comparison of the pace of the fertility increase against the average GGGI from 2006 to 2010 for 30 countries.

[5] The details of the GGGI are explained in section 3.1.1.
[6] The positive impact was examined by Myrskylä et al. (2009), which is presented in the next section (section 2.1.5).

2.1.5 Reversal of the Relationship between Fertility and Socioeconomic Development

Most studies published until around 2000 assumed a negative relationship between fertility and the socioeconomic development. However, in recent years, another stream of studies, which focused on the reversal of the relationship between fertility and the socioeconomic development from negative to positive at the high development level, has been conducted.

Myrskylä et al. (2009) showed the inverse J-shaped relationship ( )[7] between fertility and the HDI (Human Development Index)[8] using data from over 100 countries in 2005, which meant that the relationship between fertility and development changed from negative to positive at the higher stages of development. This proposition has been reexamined by other authors. Employing the threshold regression, Furuoka (2013) argued that even in countries with relatively high HDI levels, the relationship between fertility and the HDI was either slightly negative or had a flatter slope, and Harttgen and Vollmer (2014) found very little support for simple interpretations that fertility would automatically start to increase beyond a certain level of development.

Luci-Greulich and Thévenon (2014) confirmed another inverse J-shaped relationship between fertility and per capita income in OECD countries. The study used panel data and focused on intra-country variations estimated through the FE model. Lacalle-Calderson et al. (2017) also found the inverse J-relationship. The study employed a conditional quantile regression. Among three per capita income level groups, the inverse J-shape was found only for the third tertile. The study found that the inverse J-shape depended on the fertility level as well. The higher the fertility, the higher the GDP per capita needed to reverse fertility decline. Both studies employed the quadratic function to estimate the inverse J-relationship.

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[7] Myrskylä et al. (2009) described the curve as "J-shape." However, the shape of the curve is like , therefore, this study uses the term "inverse J" for the curve.

[8] The HDI is published by the United Nations Development Programme.

McDonald (2013) stressed that such inverse J-shaped relationships were not the result of wealth alone but of higher labor force participation rates for women in the highest income countries.

2.1.6 Change in the Timing of Child Birth

As mentioned, the reversal of the relationship between fertility and the progress of gender equality/equity and the reversal of the relationship between fertility and the socioeconomic development could be regarded as two factors to explain the recovery of fertility in developed countries.

Furthermore, it should be noted that the change in the timing of child birth affects TFR (Total Fertility Rate), which is the most popular indicator to measure fertility.

Bongaarts and Feeney (1998) and Bongaarts and Sobotka (2012) explained that the recovery of TFR was due to the slowdown in the postponement of childbearing. During the period when postponement was occurring, fewer young women had children than previous generations did, while elder women had few children because they were already past the childbearing stage. This situation caused a lower TFR, which was the total of the age-specific fertility rates of a period (=a year) compared to the complete fertility of each cohort. The distortion was called the demographic distortion of period fertility. When the postponement slowed down, TFR recovery could be observed. Bongaarts and Sobotka (2012) concluded that the decrease and recent upswing of fertility rates were weaker when using “tempo (and/ or parity) adjusted TFR” which limited the variations of fertility rates due to changes in the timing of child birth.

The aforementioned Luci-Greulich and Thévenon (2014) used not only TFR but also tempo adjusted TFR as the explained variable for the estimations of limited countries where tempo adjusted TFR was available. The study concluded that the reversal of the relationship

between fertility and per capita income was not only a mechanical consequence of the process of birth postponement coming to its end.

2.2 Purpose of This Study and Expected Results

This study aims to empirically examine the relationship between fertility and gender equality according to different income levels of the country, using the integrated framework for both the fertility decline in developing countries and the fertility recovery in developed countries.

This study employs the 10 year panel dataset of the GGGI itself, its sub-indexes (on economy, education, health, and politics), and gender gap indicators. This study uses the panel dataset including fertility and the GGGI, while de la Croix and Donckt (2010) used the cross-country data of sub-indexes of the GGGI in 2007 and Myrskylä et al. (2011) used the average of GGGI from 2006 to 2010.

This study estimates pooled OLS (Ordinary Least Squares) models and FE (Fixed Effects) models following Murphy (2015). However, this study focuses on the phases of both decline and recovery of fertility, while Murphy (2015) focused only on the declining fertility phase. For the estimation of the fertility recovery phase, this study assumes the quadratic functions as previous studies did.

This study conducts estimations by income level (low-income, middle-income and high-income) with reference to Furuoka (2013) and Lacalle-Calderson et al. (2017). In the estimations, this study divides the low-income group into two sub-groups: countries with a relatively moderate decline in fertility and those with a relatively rapid decline in fertility. The introduction of two sub-groups in the low-income country group is expected to enable us to clearly examine the changes in the relationship between fertility and gender equality at the initial stage of the fertility transition, on which de la Croix and Donckt (2010) focused. According to the study, at the very beginning of the fertility transition (in other words, in the “corner regime”),

the decline of fertility was small, the progress of gender equality did not correlate to fertility, and female life expectancy was positively correlated to fertility.

The hypotheses in this study are as follows:

- There might be an inverse J-shaped (ʃ) relationship[9] between fertility and the progress of overall gender equality, which is measured by the GGGI. Also there might be an inverse J-shaped relationship between fertility and the sub-index on economy.
- In countries with "low-income and a moderate decline in fertility," the GGGI sub-indexes on the economy, education, and politics might not have a particular impact on fertility, while the sub-index on health might have a positive impact on fertility.
- In other income groups, the GGGI and its sub-indexes on the economy and education might be correlated to fertility. In particular, the relationship between fertility and the GGGI, and the relationship between fertility and its sub-index on the economy might be inverse J-shaped.

3 Data and Methodology

3.1 Data

3.1.1 Structure of the Dataset

This study mainly uses the GGGI (Global Gender Gap Index), its four sub-indexes, and gender gap indicators which are used to calculate the four sub-indexes. Those data are published annually in the Global Gender Gap Report from the World Economic Forum. The report was first published in 2006 with the GGGI for 115 countries. In 2015 the report included the GGGI for 145 countries. The GGGI is the simple average of the four indexes: economy, education, health, and politics. To calculate the sub-indexes, the Global Gender Gap Report uses 14 gender

[9] Esping-Andersen and Billari (2015) and Arpino et al. (2015) called their curves concerning the relationship between fertility and gender equality/equity "U-shape." However, the fertility recovery up to now is quite moderate, therefore, the term "inverse J-shape" is used for the estimation of this study.

gap indicators, all of which are female/male ratios of outcome variables. Each of those indicators is published data available at the time of calculation of the GGGI. For instance, gender gap indicators mainly from 2013 to 2015 were used to calculate the GGGI in 2015. For the GGGI and its sub-indexes, 1 refers to perfect gender equality, while 0 refers to inequality.[10] Therefore, indices below 1 mean that the female position in those areas are below the male.

This study also uses TFR (Total Fertility Rate, the number of children a woman is expected to have in a year), GDP per capita (constant 2011 international $), and female life expectancy at birth, all of which come from the World Bank World Development Indicators. Concerning the use of TFR, it should be noted again that TFR might have been affected by the change in the timing of child birth as explained in section 2.1.6.[11] With those data, this study

[10] Construction of the GGGI (Global Gender Gap Index) from the World Economic Forum Global Gender Gap Report

- The GGGI is calculated as the simple average of sub-indexes on economic participation and opportunity, educational attainment, health and survival, and political empowerment.
- For the GGGI and its four sub-indexes, 1 means perfect gender equality, while 0 means gender inequality.
- Each sub-index is calculated from several global gender gap indicators in each area. When composing those indicators into the sub-index, a weight is assigned for each indicator. The weight is calculated according to the standard deviation per 1 percent point change of the indicator.
- All 14 indicators are expressed as female/male ratios. The female/male ratios could be over 1, if the females' performance is better than males'. When calculating sub-indexes, the Global Gender Gap Report truncates indicators at the "equality benchmark." The indicators used for the calculation are as follows:

  [Sub-index on economic participation and opportunity]
  - Ratio: female labor force participation over male values
  - Wage equality between women and men for similar work (converted to female over male ratio)
  - Ratio: female estimated earned income over male value
  - Ratio: female legislators, senior officials, and managers over male value
  - Ratio: female professional and technical workers over male value

  [Sub-index on educational attainment]
  - Ratio: female literacy rate over male values
  - Ratio: female net primary enrolment rate over male value
  - Ratio: female net secondary enrolment rate over male value
  - Ratio: female gross tertiary enrolment rate over male value

  [Sub-index on health and survival]
  - Sex ratio at birth
  - Ratio: female healthy life expectancy over male value.

  [Sub-index on political empowerment]
  - Ratio: females with seats in parliament over male value
  - Ratio: females at ministerial level over male value
  - Ratio: number of years of a female head of state over male value.

[11] As mentioned in section 2.1.6, Luci-Greulich and Thévenon (2014) examined the estimations using

constructs the panel data set for 10 years (2006–2015) of 147 countries (the number of countries for which the GGGI was calculated at least once during the 10 years).[12]

In addition, the dataset includes data on the countries' policy stances on fertility in 2015 from the United Nations World Population Policies Database. The data includes five possible policies toward fertility: raise, maintain, lower, no intervention, and no official policy.

This study uses nine region groups: East Asia and the Pacific, South Asia, Latin America and the Caribbean, Middle East and North Africa, North America, Eastern Europe, Western Europe, Sub-Saharan Africa, and Central Asia.

This study also uses three income groups: low-income, middle-income, and high-income. The three groups were according to the World Bank Analytical Classifications based on GNI per capita in US$ (Atlas methodology) using the data in 2015. The per capita incomes in 2015 of low-income countries are $1,025 or less. The incomes of middle-income countries are between $1,026 and $12,475. The incomes of high-income countries are over $12,475. In addition, this study divides the low-income group into two sub-groups by the ratio of changes in fertility from 2006 to 2015. These two sub-groups are identified as the "low-income and modest decline of fertility" country group, and the "low-income and rapid decline of fertility" country group. The "low-income and moderate decline of fertility" group is introduced to examine the situation at the very beginning of the fertility transition, which corresponds to the concept of the "corner regime" countries characterized by fertility at their maximum in de la Croix and Donckt (2010). The fertility transition is expected to start with the "low-income and modest decline of fertility" phase, then move into the "low-income and rapid decline of fertility" phase.

"tempo adjusted TFR." However, this study does not employ the measure, because the measure is available for limited countries.

[12] Among 147 countries in the dataset, Syria and Cuba do not have the GDP per capita data.

Table 1 shows the summary of the dataset which includes totally 147 countries. However, out of the 147 countries, only 108 countries have the complete 10 year data of the GGGI. Therefore this study also considers the dataset which is composed of only 108 countries (Appendix 3.1 is the summary of the 108 country dataset), and even conducts several estimations for the 108 country dataset, too. All the countries in the dataset are shown in Appendix 1.

Out of 18 low-income countries, 9 countries are included in the "low-income and moderate decline of fertility" group, while the remaining 9 are included in the "low-income and rapid decline of fertility" group. There are 80 countries in the middle-income country group, and 49 countries in the high-income country group.[13]

3.1.2 Levels and Changes of TFR and the GGGI

3.1.2.1 TFR

According to Table 1, TFR declined from 2006 to 2015 in the world overall, and in the low- and middle-income groups. However, in these areas, levels of TFR in 2015 were still higher than the population replacement level (around 2.1): 2.6 in the world overall, 4.9 in the low-income group, and 2.6 in the middle-income group. Of note, TFR in the "low-income and moderate decline of fertility" group was still 5.2 in 2015, much higher than TFR in the "low-income and rapid decline of fertility" group (4.5). In contrast, TFR in the high-income group increased slightly from 1.7 in 2006 to 1.8 in 2010, then declined to 1.7 in 2015; in other words, TFR in the group was far below the population replacement level throughout the period.

Regionally, TFR in 2015 was higher than 4 in Sub-Saharan Africa , and over 3 in Central Asia. TFRs in the Middle East and North Africa, South Asia, Latin America and the Caribbean,

[13] Out of 20 "inner regime" countries in de la Croix and Donckt (2010), 15 "inner regime" countries are included in the dataset of this study. Among them, five countries are included in the "low-income and moderate decline of fertility" group. Four countries are included in the "low-income and rapid decline of fertility" group, and six countries belong to the middle-income group.

and East Asia and the Pacific were between 2 and 3. TFRs in Eastern Europe, Western Europe, and North America were far below the population replacement level.

According to Figure 1, the cross country data of TFR in 2015 and GDP per capita in 2014 is inverse J-shaped. Figure 1 also shows that lower income and higher TFR countries tend to aim to lower their fertility (red dots), while higher income and lower TFR countries tend to aim to raise their fertility (blue dots).[14]

3.1.2.2 GGGI

According to Table 1, the GGGI and its sub-indexes basically increased in the estimation period, except the health sub-index which was already close to 1 in 2006. In other words, the total gender equality measured by the GGGI and the gender equality in economy, education, and politics measured by the corresponding sub-indexes progressed during the estimation period.

The level of the GGGI was higher in the high-income group than the middle-income group, and lower in the low-income group than the middle-income group. However, in the "low-income and modest decline of fertility" group, the GGGI level was higher than the "low-income and rapid decline of fertility" group.

Regionally, the GGGI was higher than the world overall in Western Europe, North America, Eastern Europe, Latin America and the Caribbean, East Asia and the Pacific, and Central Asia, while it was lower than the world overall in the Middle East and North Africa, South Asia, and Sub-Saharan Africa.

[14] It should be also noted that most countries aiming to raise their fertility (blue dots in Figure 1) are situated below the red line which stands for the estimation result of the simple OLS regression of the samples.

3.1.2.3 Correlation Coefficients between Explanatory Variables

The explanatory variables in this study, such as the GGGI, its sub-indexes, and GDP per capita could be correlated with each other. Therefore, this study checks the correlation coefficients between them. Appendix 2 shows the results. Obviously, the GGGI is well correlated with its economy sub-index in any income level. In contrast, the health sub-index does not correlate to the GGGI much. The correlation coefficient for GDP per capita with the GGGI is 0.336 for all samples.

3.2 Methodology

Using the dataset, this study conducts estimations to analyze the relationship between TFR and the GGGI and its sub-indexes.

This study assumes the inverse J-shaped ( ) relationship between TFR and the GGGI and the inverse J-shaped relationship between TFR and GDP per capita. With the two assumptions, pooled OLS (Ordinary Least Squares) model (1) is tested.

$$\mathrm{TFR}_{it} = \alpha_0 + (\alpha_1 \mathrm{GGGI}_{it}^2) + \alpha_2\ \mathrm{GGGI}_{it} + \left(\alpha_3 \mathrm{lagGDPPC}_{it}{}^2\right) + \alpha_4 \mathrm{lagGDPPC}_{it} + \delta_r + \epsilon_{it} \qquad (1)$$

where TFR_{it} stands for the TFR of country i in year t, GGGI stands for the Global Gender Gap Index, lagGDPPC stands for GDP per capita (1 year lag), δ_r stands for region dummies (East Asia and the Pacific, South Asia, Latin America and the Caribbean, Middle East and North Africa, North America, Eastern Europe, Western Europe, North America, and Central Asia). All the data of the GGGI, its four sub-indexes, and the gender gap indicators which are the sources of the four sub-indexes are the values of around a year or two prior, as explained in section 3.1.1.

Then, this study tests the FE (Fixed Effects) model (2) to examine the relationship between TFR and the GGGI.

$$TFR_{it} = \alpha_0 + (\alpha_1 GGGI_{it}^2) + \alpha_2\, GGGI_{it} + (\alpha_3 lagGDPPC_{it}{}^2) + \alpha_4 lagGDPPC_{it} + Z_i + year_t + \epsilon_{it} \quad (2)$$

where Z_i means the specific effect for the country i and $year_t$ means year dummies.

For equation (1) and (2), the expected signs of the coefficients are positive for $GGGI_{it}^2$ and $lagGDPPC_{it}{}^2$, and negative for $GGGI_{it}$ and $lagGDPPC_{it}$. If those conditions are not satisfied, this study estimates equations without squared terms, in other words, drops terms in ( ).

As the next step, this study tests the FE model (3) to examine the relationship between TFR and the GGGI sub-indexes.

$$TFR_{it} = \alpha_0 + (\alpha_1 ECO_{it}^2) + \alpha_2 ECO_{it} + \alpha_3 EDU + \alpha_4 POL + \alpha_5 HEA + (\alpha_6 lagGDPPC_{it}{}^2) + \alpha_7 lagGDPPC_{it} + Z_i + year_t + \epsilon_{it} \quad (3)$$

where ECO means the economy sub-index, EDU means the education sub-index, POL means the politics sub-index, and HEA stands for the health sub-index. Estimations with one sub-index at a time are also tested.

As is the case with the GGGI and lagGDPPC, the squared term for ECO is included in the equation with the assumption of an inverse J-shaped relationship between TFR and ECO; if the signs for the coefficients do not satisfy the expected condition (positive for ECO_{it}^2 and negative for ECO_{it}), then the squared term is deleted.

For all the estimations that employ the quadratic function, this study calculates the turning points of the functions, which correspond to the bottom of the inverse J-shape. At the turning point, the correlation between TFR and its explanatory variable is expected to change from negative to positive. If the explanatory variable is smaller than its turning point, it means that the country is still in the downward portion of the inverse J, where the increase in the explanatory variable is negatively correlated to TFR. On the contrary, if the explanatory variable

is bigger than its turning point, it means that the country is already in the upward portion of the inverse J, where the increase in the explanatory variable is positively correlated to TFR. The calculated turning points are shown in the result tables.

4. Estimation Results and Discussion

4.1 World Total

Table 2 summarizes the results for the OLS estimations with all samples.

Both the inverse J-shaped (⌞) relationship between TFR and the GGGI (estimation 2.1, 2.2), and the inverse J-shaped relationships between TFR and the GDP per capita (estimation 2.3, 2.4), are found in the result of the pooled OLS model. For both relationships, the R-sq (adjusted) is higher when introducing region dummies (estimation 2.1vs.2.2, 2.3vs.2.4). The impact of region dummies is especially obvious for the inverse J between TFR and the GGGI. Figure 2.1 visually shows the inverse J-shaped relationship between TFR and the GGGI. The green line which stands for the estimation result 2.2 (with region dummies) demonstrates the inverse J-shape more clearly than the red line which stands for the estimation result 2.1 (without region dummies).

Even if estimating those two inverse J-shaped relationships (TFR and the GGGI, TFR and GDP per capita) together, those two relationships are still observed and the R-sq (adjusted) reaches 0.8332 when introducing region dummies (estimation 2.5, 2.6). The estimated coefficients for region dummies in estimation result 2.6 suggest that the TFRs in Sub-Saharan Africa, Central Asia, Middle East and North Africa, Latin America and the Caribbean, and North America are higher than in East Asia and the Pacific for the same GGGI and income level. In contrast, the estimated coefficients for Eastern Europe and South Asia are negative.

Table 3.1, which shows the results of the FE model estimations, also supports the inverse J-shaped relationship between TFR and the GGGI (estimation 3.1.1, 3.1.3). However, as

shown in Figure 2.1, the inverse J-curve from the FE estimation (yellow line) is much flatter than the curves derived from the OLS estimations (red line and green line). In contrast, as shown in Figure 2.2, the inverse J-curve between TFR and GDP per capita estimated by the FE model (yellow line) seems much clearer than the curves from OLS estimations (red line and green line). Appendix 3.2, which shows the results of the estimations using the 108 country dataset, also supports the results.

Table 3.2 uses four sub-indexes of the GGGI as the explanatory variables instead of the GGGI itself. The result of estimation 3.2.11 shows the inverse J-shaped relationship between TFR and the economy sub-index, and the inverse J-shaped relationship between TFR and per capita income. Also, the negative relationship between TFR and the education sub-index is observed.[15] Concerning the health sub-index, no particular relationship is observed.[16] The results above are supported by other estimations in Table 3.2. Therefore, from the next section, all estimations are conducted without the health sub-index.

Figure 2.3 visually shows the inverse J-shaped relationship between TFR and the economy sub-index. The curve is flatter for the curve from the FE model (yellow line) than OLS models (red line and green line), which might affect the difference of the shapes of the inverse J between TFR and the GGGI according to the models (Figure 2.1).

4.2 Results According to Income Levels

Table 4 summarizes the results of the estimations by income level.

In the low-income group, negative relationships between TFR and the economy sub-index, and between TFR and GDP per capita, are observed (estimation 4.1, 4.6). In contrast, the GGGI does not correlate with TFR (estimation 4.1).

[15] See also Figure 2.4.
[16] See also Figure 2.6.

However, when focusing on the “low-income and modest decline of fertility” group, a negative relationship between TFR and the economy sub-index is not observed (estimation 4.7). Instead, a positive relationship between TFR and the politics sub-index, and a negative relationship between TFR and the education sub-index are observed (estimation 4.7). Based on de la Croix and Donckt (2010), this study also assumes the positive relationship between TFR and female life expectancy for the “low-income and modest decline of fertility” group. Appendix 4 shows the results of the estimations. As expected, a positive relationship is observed for the group (estimation ap.4.2), while a negative relationship is observed for the “low-income and rapid decline of fertility” group (estimation ap.4.3).

Concerning the “low-income and rapid decline of fertility” group, a negative relationship between TFR and the economy sub-index is observed (estimation 4.8).

For both the middle-income and the high-income group, the inverse J-shaped relationship between TFR and the GGGI, and the inverse J-shaped relationship between TFR and the economy sub-index are observed (estimation 4.4, 4.5, 4.9, 4.10). Also for both groups, the negative relationship between TFR and the education sub-index is observed (estimation 4.9, 4.10). The inverse J-shaped relationship is observed between TFR and GDP per capita for the middle-income country group (estimation 4.4, 4.9), and the positive relationship is observed for the high-income group (estimation 4.5, 4.10).

In conclusion, the inverse J-shaped relationship between TFR and the GGGI, and the inverse J-shaped relationship between TFR and the economy sub-index are observed in the middle- and high-income country groups from the estimations by income level. In contrast, in the “low-income and modest recovery of fertility” group, where TFR was still over 5 in 2015, the relationship between TFR and the GGGI, and the relationship between TFR and the economy sub-index are not statistically significant. Instead, female life expectancy is positively correlated to fertility.

4.3 Relationship between TFR and the Education Sub-Index

This study tests equation (4) to further examine the relationship using four gender gap indicators: literacy, enrolment in primary education, enrolment in secondary education, and enrolment in tertiary education.

$$\begin{aligned} TFR_{it} = {} & \alpha_0 + (\alpha_1 ECO_{it}^2) + \alpha_2 ECO_{it} + \alpha_3 LR + \alpha_4 PE + \alpha_5 SE + \alpha_6 TE + \alpha_7 POL_{it} \\ & + (\alpha_8 lagGDPPC_{it}{}^2) + \alpha_9 lagGDPPC_{it} + Z_i + year_t + \epsilon_{it} \end{aligned} \quad (4)$$

where LR stands for the ratio of the female literacy rate over the male values, PE stands for the ratio of the female net primary enrolment rate over the male value, SE stands for the ratio of the female net secondary enrolment rate over the male value, and TE stands for the ratio of the female gross tertiary enrolment rate over the male value. As shown in Appendix 2.2, education gender gap indicators correlate to each other. Therefore, this study tests estimations with different combinations of education gender gap indicators as well.

The results in Table 5 show that at any income level including the low-income group for which the education sub-index itself does not have a particular relationship with TFR (estimation 4.6 in Table 4), the progress in gender equality in literacy has a negative relationship with TFR (estimation 5.1,5.2, 5.3,5.7, 5.8, 5.9, 5.10, 5.11, 5.12).

For the low-income group, coefficients for primary and secondary education are not statistically significant (estimation 5.1, 5.4). However, the positive coefficients for the tertiary education are observed in estimation 5.1, 5.4 and 5.10.[17]

For the middle-income group, the coefficients for four education gender gap indicators are all negative and statistically significant in estimation 5.2, 5.5, 5.8 and 5.11.

It could be concluded that the progress of gender equality in literacy is especially important for lowering fertility regardless of income level. In middle-income countries, the

[17] Concerning the positive sign of the coefficient of tertiary education, Hazan and Zoabi (2015) found that highly educated women in the U.S. were recently able to have more children because of the

progress of gender equality in school enrolments is negatively correlated with fertility at all education levels.

5. Conclusion

This study aims to empirically examine the relationship between fertility and gender equality according to different income levels of countries, using the integrated framework for both the fertility decline in developing countries and the fertility recovery in developed countries. This is the first study which employs the panel dataset including fertility and the Global Gender Gap Index published annually by the World Economic Forum.

The main findings of this study are as follows:

First, this study observes the inverse J-shaped (⌊) relationship between fertility and the progress of overall gender equality measured by the GGGI. This means that the progress of gender equality has a negative relationship with fertility until a certain level of development is achieved, at which point the relationship becomes positive. The inverse J-relationship is also found between fertility and the progress of gender equality in the economy.

Second, in the “low-income and modest decline of fertility” country group, where the average total fertility rate was still over 5 in 2015, the progress in overall gender equality and gender equality in the economy do not have a particular relationship with fertility. In contrast, female life expectancy is positively correlated to fertility.

Third, the progress in gender equality in literacy is important for lowering fertility regardless of income level. In middle-income countries, progress in gender equality in school enrolment is negatively correlated with fertility in all education levels.

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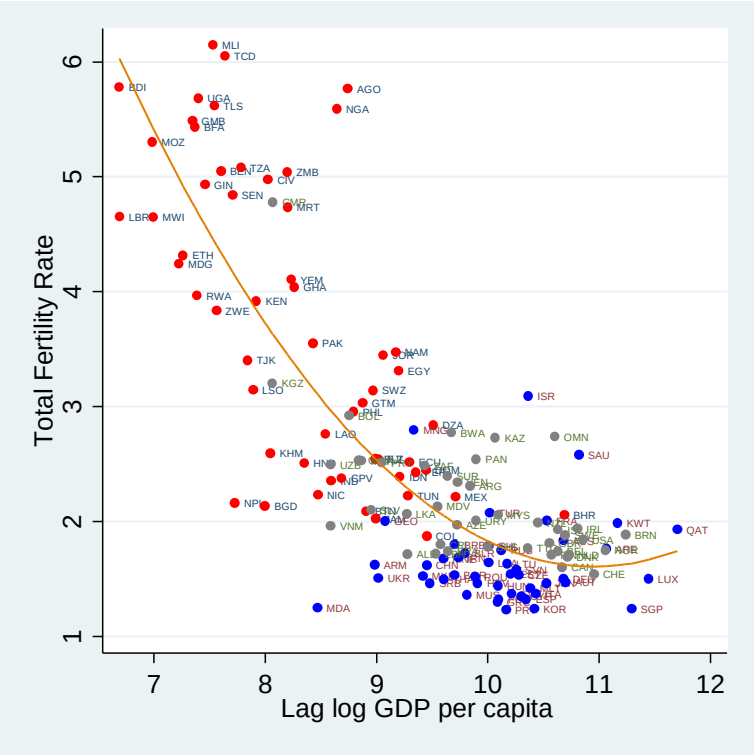
decrease in the relative cost of childcare, as mentioned in section 2.1.3.

This study could be deepened if estimations using different groupings of income levels are examined. Also, estimations by region might be insightful. Furthermore, how the policy stance on fertility affects fertility and the progress of gender equality could be examined.

[Figure 1] Total Fertlity Rate (2015) and GDP Per Capita (2014)



Notes:

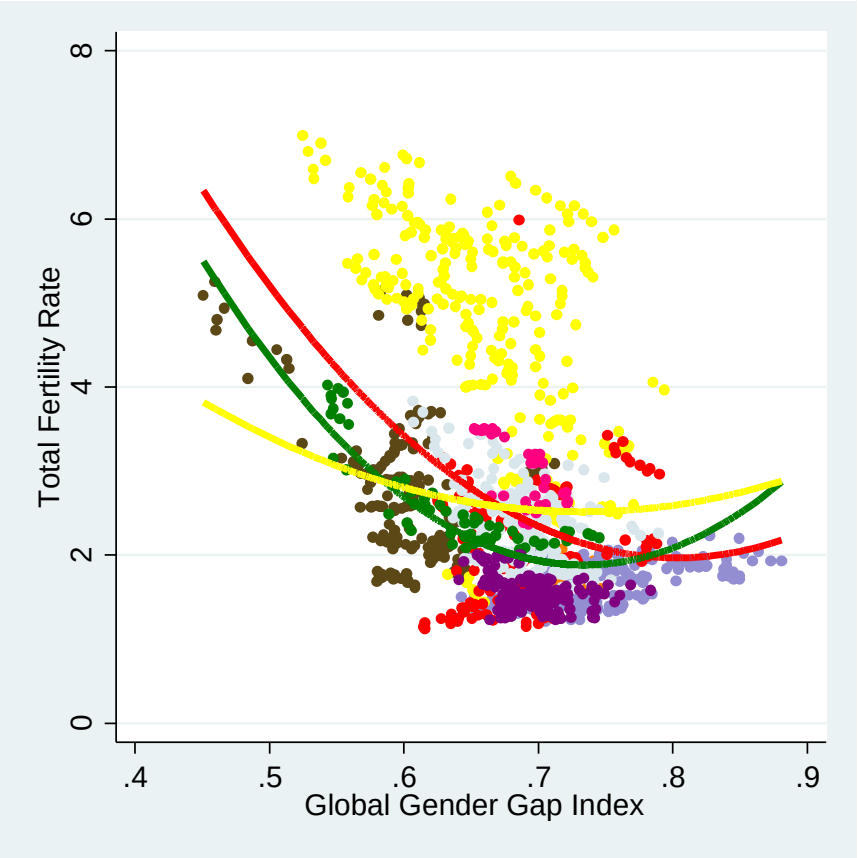
- This figure includes 145 countries that have GGGI (Global Gender Gap Index) data in 2015.
  The GGGI data is from the World Economic Forum Global Gender Gap Report 2015.
- Total fertlity rate data and lag log GDP per capita data are from the World Bank World Developent Indicators.
  Lag log GDP per capita stands for the 1 year lagged figure of the natural logarithm of GDP per capita (constant 2011 international $).
  For total fertility rate, data in 2015 is used. Lag log GDP per capita stands for per capita income in 2014.
- The colors of the dots stand for the policy stance on fertlity in 2015.
  The data of policy stance on fertlity is from the United Nations World Population Policies Database.
  Red dots stand for countries where the governments aim to lower their fertility.
  Blue dots stand for countries where the governments aim to raise their feritility.
  Gray dots stand for countries where the governments seek to maintain their fertility, have a policy not to intervene, or have no official policy on fertility.
  Each country's policy stance is shown in Appendix 1.
- Country names corresponding to country codes are shown in Appendix 1.
- The red line stands for the equation below.

TFR= 0.243lagGDPPC^2 -5.324*lagGDPPC + 30.768

(-5.69) (-6.79) (8.65) ( ):t value

Adj R-sq=0.6735

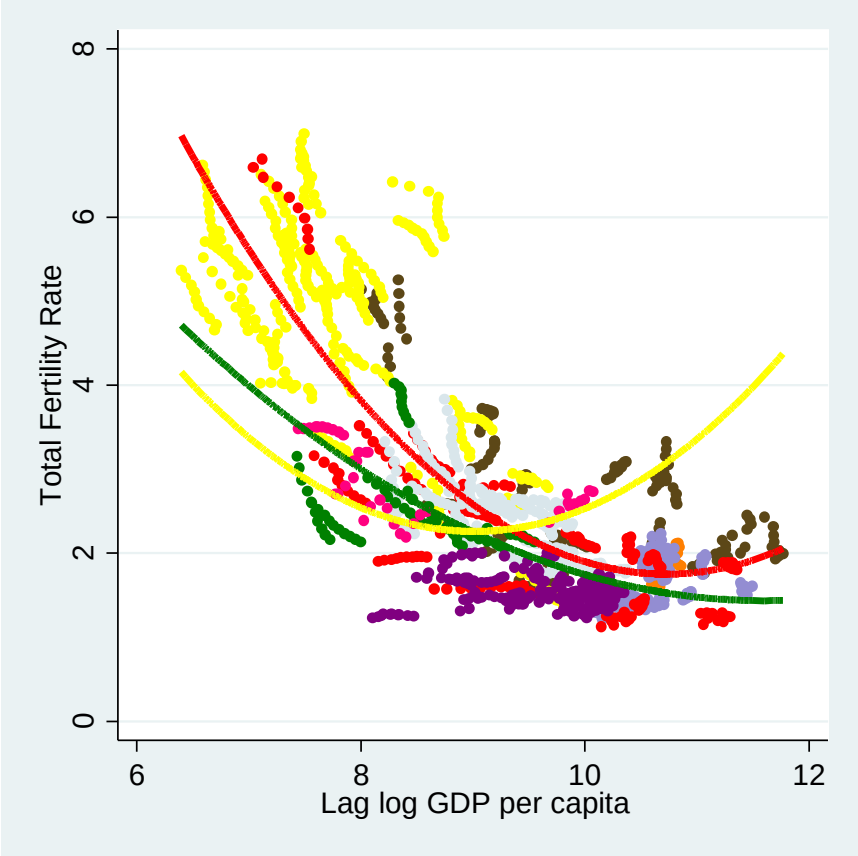
[Figure 2.1] Total Fertility Rate and the GGGI (2006-2015)



Notes:

- This figure includes all the samples that have the Global Gender Gap Index from 2006 to 2015.
- Total fertility rate data is from the World Bank World Developemt Indicators.
- Global Gender Gap Index-related data is from the World Economic Forum Global Gender Gap Report.
- The colors of the dots stands for region groups.
  Countries included in each group are shown in Appendix 1.
  Red dots: East Asia and the Pacific
  Green dots: South Asia
  Bluishgray dots: Latin America and the Caribbean
  Olive dots: Middle East and North Africa
  Orange dots: North America
  Purple dots: Eastern Europe
  Lavender dots: Western Europe
  Yellow dots: Sab-Saharan Africa
  Pink dots: Central Asia
- The red line stands for the estimation result of 2.1 in Table 2. (OLS model without region dummies)
  The green line stands for the estimation result of 2.2 in Table 2. (OLS model with region dummies)
  The yellow line stands for the estimation result of 3.1.1 in Table 3.1. (Fixed effects model)

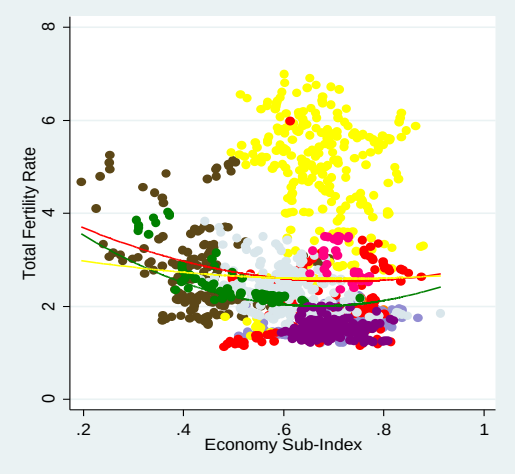
[Figure 2.2] Total Fertility Rate and GDP Per Capita (2006-2015)



Notes:

- This figure includes all the samples that have the Global Gender Gap Index from 2006 to 2015.
- Total fertlity rate data and lag log GDP per capita data are from the World Bank World Develompent Indicators.
  Lag log GDP per capita stands for the 1 year lagged figure of the natural logarithm of GDP per capita (constant 2011 international $).
- The colors of the dots stand for region groups. For further information, see Notes for Figure 2.1.
- The red line stands for the estimation result of 2.3 in Table 2. (OLS model without region dummies)
  The green line stands for the estimation result of 2.4 in Table 2. (OLS model with region dummies)
  The yellow line stands for the estimation result of 3.1.2 in Table 3.1. (Fixed effects model)

[Figure 2.3] Total Fertility Rate and the Economy Sub-index



Notes:

-For information on data sourses and colors of the dots, see Notes for Figure 2.1.

-The red line stands for the result of the estimation below. (OLS model without region dummies)

TFR=4.283*ECO^2 -6.155*ECO +4.747

(2.25) (-2.71) (7.15)

Adj R-sq=0.0118 ( ): t value

-The green line stands for the result of the estimation below. (OLS model with region dummies)

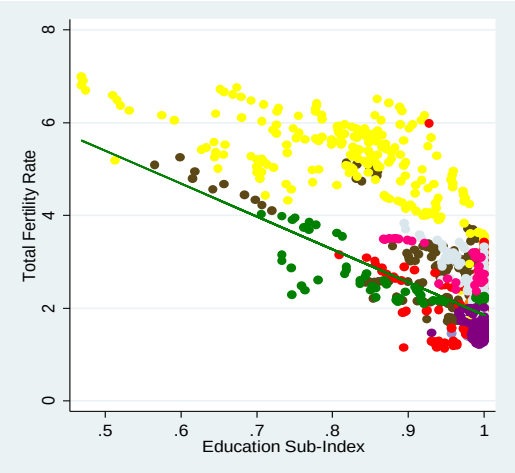
TFR=6.923*ECO^2 -9.259*ECO +5.103+Region dummies

(5.94) (-6.32) (10.96)

Adj R-sq=0.7044 ( ): t value

-The yellow line stands for the estimation result of 3.2.1 in Table3.2. (Fixed effects model)

[Figure 2.4] Total Fertility Rate and the Education Sub-Index



Notes:

- For information on data sourses and colors of the dots, see Notes for Figure 2.1.

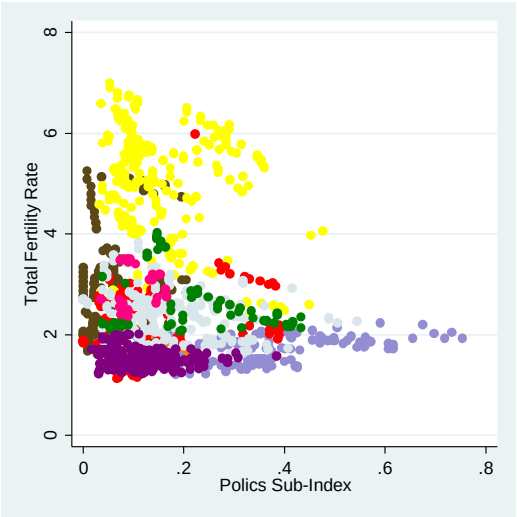
- Green line stands for the equation below. (OLS model with region dummies)

TFR= -7.078*EDU +8.930+ Region dummies

(-31.03) (39.56)

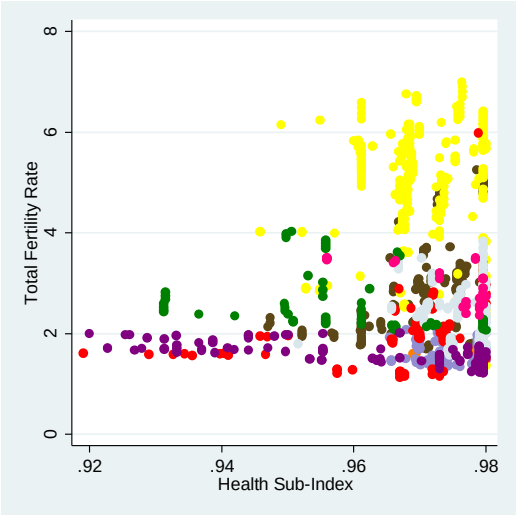
Adj R-sq=0.8234 ( ): t value

[Figure 2.5] Total FertilityRate and the Politics Sub-index



Notes:
- For information on data sources and colors of the dots, see Notes for Figure 2.1.

[Figure 2.6] Total Fertility Rate and the Health Sub-Index



Notes:
- For information on data sources and colors of the dots, see Notes for Figure 2.1.

[Table 1] Summary of the Dataset

		GGGI (Global Gender Gap Index)														
					Economy			Education			Politics			Health		
		2006	2010	2015	2006	2010	2015	2006	2010	2015	2006	2010	2015	2006	2010	2015
Total		0.662	0.678	0.695	0.596	0.630	0.657	0.940	0.950	0.957	0.138	0.161	0.194	0.973	0.971	0.973
	Low-income countries	0.615	0.640	0.678	0.632	0.652	0.700	0.764	0.793	0.842	0.098	0.147	0.201	0.968	0.967	0.971
	Modest decline	0.626	0.643	0.685	0.671	0.660	0.722	0.758	0.793	0.848	0.108	0.155	0.199	0.968	0.966	0.969
Income	Rapid decline	0.605	0.636	0.672	0.592	0.642	0.678	0.770	0.793	0.836	0.088	0.138	0.202	0.969	0.970	0.972
level	Middle-income countries	0.650	0.663	0.680	0.574	0.601	0.619	0.940	0.951	0.960	0.116	0.132	0.167	0.972	0.970	0.972
	High-income countries	0.689	0.710	0.725	0.617	0.667	0.701	0.986	0.993	0.994	0.180	0.205	0.233	0.975	0.974	0.974
	East Asia and the Pacific	0.674	0.686	0.698	0.648	0.677	0.706	0.961	0.970	0.974	0.116	0.126	0.142	0.971	0.970	0.970
	South Asia	0.608	0.639	0.653	0.440	0.482	0.508	0.823	0.881	0.927	0.209	0.235	0.209	0.959	0.957	0.966
	Latin America and the Caribbean	0.664	0.691	0.708	0.560	0.626	0.648	0.980	0.991	0.993	0.137	0.169	0.213	0.978	0.977	0.979
	Middle East and North Africa	0.588	0.601	0.612	0.431	0.440	0.450	0.909	0.937	0.946	0.043	0.058	0.085	0.971	0.970	0.968
Region	North America	0.710	0.739	0.740	0.744	0.788	0.800	0.990	0.999	1.000	0.128	0.191	0.190	0.979	0.979	0.972
	Eastern Europe	0.686	0.691	0.710	0.670	0.692	0.706	0.990	0.993	0.995	0.110	0.110	0.164	0.973	0.968	0.972
	Western Europe	0.716	0.746	0.764	0.629	0.694	0.735	0.993	0.996	0.998	0.269	0.322	0.350	0.975	0.974	0.975
	Sub-Saharan Africa	0.636	0.654	0.683	0.626	0.659	0.694	0.838	0.845	0.873	0.110	0.143	0.190	0.970	0.969	0.972
	Central Asia	0.685	0.688	0.696	0.713	0.717	0.705	0.983	0.959	0.970	0.066	0.103	0.135	0.979	0.972	0.973

		GDP per capita, PPP (1 year lagged, constant 2011 international $ and its natural logarithm in italic)						TFR (Total fertility rate)			N of countries			
		2006		2010		2015		2006	2010	2015		2006	2010	2015
Total		18784	*9.264*	19562	*9.331*	19882	*9.360*	2.704	2.654	2.572	147	115	134	145
	Low-income countries	1453	*7.244*	1543	*7.307*	1636	*7.353*	5.575	5.268	4.867	18	12	14	18
	Modest decline	1630	*7.389*	1632	*7.364*	1714	*7.397*	5.658	5.446	5.218	9	6	8	9
Income	Rapid decline	1277	*7.099*	1425	*7.230*	1558	*7.309*	5.493	5.031	4.517	9	6	6	9
level	Middle-income countries	7995	*8.795*	9037	*8.924*	10394	*9.078*	2.854	2.742	2.581	80	59	71	78
	High-income countries	37978	*10.443*	39530	*10.483*	41302	*10.534*	1.719	1.779	1.715	49	44	49	49
	East Asia and the Pacific	20792	*9.503*	23695	*9.598*	25413	*9.706*	2.029	2.050	2.051	17	12	15	16
	South Asia	3467	*8.028*	5322	*8.385*	6744	*8.638*	2.991	2.637	2.354	7	5	6	7
	Latin America and the Caribbean	10576	*9.143*	12112	*9.270*	13537	*9.392*	2.565	2.358	2.226	26	20	26	26
	Middle East and North Africa	27404	*9.666*	30908	*9.864*	31293	*9.886*	2.958	2.782	2.654	18	14	18	18
Region	North America	45117	*10.712*	44241	*10.693*	47389	*10.762*	1.847	1.779	1.722	2	2	2	2
	Eastern Europe	15885	*9.532*	16825	*9.599*	18418	*9.718*	1.410	1.547	1.580	22	17	19	22
	Western Europe	41911	*10.603*	42006	*10.605*	43066	*10.621*	1.648	1.699	1.609	20	20	20	20
	Sub-Saharan Africa	3556	*7.818*	3778	*7.869*	4140	*7.939*	5.038	4.861	4.461	31	22	25	31
	Central Asia	7151	8.494	7952	8.472	9771	8.659	2.483	3.069	3.111	4	3	3	3

Notes:
- "GGGI" and its sub-indexes are from the World Economic Forum Global Gender Gap Report from 2006 to 2015.
- "GDP per capita" and "Total Fertlity Rate" data are from the World Bank World Development Indicaters.
- Countries included in each group are shown in Appendix 1. Concerning the income classification, see Notes for Appendix 1.

[Table 2] Results of Estimations - Total Fertility Rate and Gender Gaps for All Samples (Ordinary Least Squares, 2006-2015)

Explained variable	Ordinary least squares																					
Total fertility rate	All samples																					
	2.1				2.2				2.3				2.4				2.5				2.6			
Explanatory variables	coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t	
Global Gender Gap Index ^2	35.219	5.504	6.40	***	45.336	3.360	13.49	***									35.471	3.394	10.45	***	36.324	2.815	12.90	***
Global Gender Gap Index	-56.577	7.468	-7.58	***	-66.495	4.589	-14.49	***									-51.912	4.599	-11.29	***	-52.579	3.855	-13.64	***
Lag log GDP per capita ^2									0.278	0.015	18.25	***	0.121	0.014	8.80	***	0.261	0.014	18.32	***	0.124	0.013	9.81	***
Lag log GDP per capita									-5.964	0.279	-21.35	***	-2.807	0.255	-10.99	***	-5.601	0.261	-21.45	***	-2.784	0.235	-11.85	***
East Asia and the Pacific					baseline								baseline								baseline			
South Asia					0.152	0.103	1.47						-0.127	0.094	-1.34						-0.298	0.088	-3.40	***
Latin America and the Caribbean					0.350	0.069	5.06	***					0.243	0.064	3.79	***					0.319	0.059	5.40	***
Middle East and North africa					0.057	0.085	0.67						0.819	0.068	11.98	***					0.325	0.072	4.50	***
North America					-0.102	0.159	-0.64						0.224	0.145	1.54						0.247	0.134	1.84	*
Eastern Europe					-0.441	0.072	-6.10	***					-0.436	0.066	-6.64	***					-0.363	0.061	-5.99	***
Western Europe					-0.377	0.078	-4.84	***					0.053	0.070	0.76						-0.034	0.068	-0.50	
Sub-Saharan Africa					2.510	0.070	35.99	***					1.558	0.075	20.68	***					1.562	0.069	22.55	***
Central Asia					0.963	0.128	7.52	***					0.205	0.118	1.74	*					0.360	0.109	3.30	***
Const	24.689	2.528	9.77	***	26.265	1.574	16.69	***	33.738	1.268	26.60	***	17.714	1.178	15.04	***	50.609	1.807	28.01	***	36.112	1.680	21.49	***
Number of samples	1334				1334				1316				1316				1316				1316			
Adjusted R-sq	0.1821				0.7540				0.6515				0.8027				0.7034				0.8332			
Turning point																								
GGGI	0.803				0.733												0.732				0.724			
Lag log GDP per capita									10.727				11.599				10.730				11.226			

Notes:
- Data is from the World Economic Forum Global Gender Gap Reports, and the World Bank World Development Indicators.
- *significant at 10 percent level, **significant at 5 percent level, ***significant at 1 percent level.

[Table 3.1] Estimation Results - Total Fertility Rate and the GGGI (Global Gender Gap Index) for All Samples (Fixed Effects, 2006-2015)

Explained variable	Fixed effects with year dummies											
Total fertility rate	All samples											
	3.1.1				3.1.2				3.1.3			
Explanatory variables	coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t	
Global Gender Gap Index ^2	16.490	1.437	11.47	***					14.851	1.325	11.21	***
Global Gender Gap Index	-24.148	1.982	-12.19	***					-21.687	1.836	-11.81	***
Lag log GDP per capita ^2					0.277	0.016	17.41	***	0.243	0.015	16.05	***
Lag log GDP per capita					-4.991	0.291	-17.15	***	-4.350	0.278	-15.66	***
Const	11.356	0.687	16.54	***	24.742	1.343	18.42	***	29.549	1.329	22.23	***
Number of samples	1334				1316				1316			
Number of countries	147				145				145			
R-sq (within)	0.3539				0.4106				0.4828			
Turning point												
GGGI	0.732								0.730			
Lag log GDP per capita					9.009				8.951			

Notes:

- Data is from the World Economic Forum Global Gender Gap Reports, and the World Bank World Development Indicators.
- *significant at 10 percent level, **significant at 5 percent level, ***significant at 1 percent level.

[Table 3.2] Estimation Results - Total Fertility Rate and the Sub-Indexes of the GGGI (Global Gender Gap Index) (Fixed Effects, 2006-2015)

Explained variable	Fixed effects with year dummies																			
Total fertility rate	All samples																			
	3.2.1				3.2.2				3.2.3				3.2.4				3.2.5				3.2.6			
Explanatory variables	coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t	
Economic participation^2	1.525	0.342	4.46	***													1.224	0.326	3.76	***	1.207	0.325	3.71	***
Economic participation	-2.143	0.426	-5.03	***													-1.830	0.405	-4.52	***	-1.815	0.405	-4.48	***
Education attainment					-0.287	0.204	-11.23	***									-2.297	0.202	-11.35	***	-2.293	0.202	-11.33	***
Political empowerment									-0.174	0.088	-1.97	**					-0.190	0.083	-2.28	**	-0.191	0.083	-2.29	**
Health and survival													-0.504	0.807	-0.62		-0.721	0.760	-0.95					
Const	3.345	0.135	24.69	***	4.791	0.194	24.74	***	2.648	0.018	149.44	***	3.109	0.784	3.96	***	6.184	0.778	7.94	***	5.477	0.227	24.18	***
Number of samples	1334				1334				1334				1334				1334				1334			
Number of countries	147				147				147				147				147				147			
R-sq (within)	0.2737				0.3275				0.2579				0.2557				0.3477				0.3472			
Turning point																								
Economic participation	0.703																0.748				0.752			

Explained variable	Fixed effects with year dummies																			
Total fertility rate	All samples																			
	3.2.7				3.2.8				3.2.9				3.2.10				3.2.11				3.2.12			
Explanatory variables	coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t	
Economic participation^2	1.973	0.330	5.98	***													1.661	0.322	5.17	***	1.661	0.321	5.18	***
Economic participation	-2.810	0.420	-6.69	***													-2.456	0.408	-6.01	***	-2.456	0.408	-6.02	***
Education attainment					-1.769	0.189	-9.37	***									-1.721	0.187	-9.21	***	-1.721	0.187	-9.22	***
Political empowerment									-0.063	0.080	-0.78						-0.084	0.076	-1.10		-0.084	0.076	-1.10	
Health and survival													0.292	0.728	0.40		-0.028	0.693	-0.04					
Lag log GDP per capita ^2	0.272	0.016	17.49	***	0.251	0.016	16.14	***	0.275	0.016	17.25	***	0.277	0.016	17.39	***	0.247	0.015	16.01	***	0.247	0.015	16.07	***
Lag log GDP per capita	-4.927	0.285	-17.27	***	-4.497	0.286	-15.75	***	-4.969	0.292	-16.99	***	-5.001	0.292	-17.11	***	-4.431	0.283	-15.65	***	-4.432	0.282	-15.74	***
Const	25.486	1.320	19.31	***	24.066	1.297	18.55	***	24.655	1.348	18.29	***	24.513	1.460	16.79	***	24.716	1.390	17.78	***	24.694	1.282	19.27	***
Number of samples	1316				1316				1316				1316				1316				1316			
Number of countries	145				145				145				145				145				145			
R-sq (within)	0.4361				0.4521				0.4110				0.4107				0.4749				0.4749			
Turning point																								
Economic participation	0.712																0.739							
Lag log GDP per capita	9.057				8.958				9.035				9.027				8.970				8.972			

Notes:

- Data is from the World Economic Forum Global Gender Gap Reports, and the World Bank World Development Indicators.
- *significant at 10 percent level, **significant at 5 percent level, ***significant at 1 percent level.

[Table 4] Results of Estimations - Total Fertility Rate and Gender Gaps by Income Level (2006-2015)

Explained variable	Fixed effects with year dummies															
Total fertility rate	Low-income countries									Middle-income countries				High-income countries		
				Moderate decline			Rapid decline									
	4.1			4.2			4.3			4.4				4.5		
Explanatory variables	coef.	s.e.	t	coef.	s.e.	t	coef.	s.e.	t	coef.	s.e.	t		coef.	s.e.	t	
Global Gender Gap Index ^2										14.911	2.359	6.32	***	8.159	1.442	5.66	***
Global Gender Gap Index	-0.830	0.607	-1.37	0.686	0.602	1.14	-0.828	0.518	-1.60	-21.704	3.214	-6.75	***	-12.302	2.106	-5.84	***
Lag log GDP per capita ^2										0.259	0.031	8.32	***				
Lag log GDP per capita	-0.621	0.129	-4.80	*** -0.113	0.148	-0.77	-0.567	0.097	-5.87	*** -4.202	0.554	-7.59	***	0.403	0.053	7.59	***
Const	10.290	0.983	10.47	*** 5.877	1.087	5.41	*** 9.555	0.807	11.84	*** 27.261	2.687	10.14	***	2.101	0.958	2.19	**
Number of samples	142			76			66			693				481			
Number of countries	18			9			9			78				49			
R-sq (within)	0.8703			0.8682			0.9792			0.4284				0.3151			
Turning point																	
GGGI										0.728				0.754			
Lag log GDP per capita										8.112							

Explained variable	Fixed effects with year dummies															
Total fertility rate	Low-income countries									Middle-income countries				High-income countries		
				Moderate decline			Rapid decline									
	4.6			4.7			4.8			4.9				4.10		
Explanatory variables	coef.	s.e.	t	coef.	s.e.	t	coef.	s.e.	t	coef.	s.e.	t		coef.	s.e.	t	
Economic participation ^2										2.023	0.440	4.60	***	2.285	0.354	6.47	***
Economic participation	-0.368	0.192	-1.91	* 0.124	0.154	0.80	-0.726	0.213	-3.41	*** -3.020	0.541	-5.58	***	-3.172	0.461	-6.88	***
Educational attainment	-0.204	0.306	-0.67	-0.505	0.286	-1.77	* 0.265	0.239	1.11	-1.427	0.291	-4.91	***	-1.495	0.425	-3.52	***
Political empowerment	0.126	0.284	0.44	0.490	0.257	1.91	* 0.034	0.241	0.14	-0.061	0.107	-0.57		-0.019	0.079	-0.23	
Lag log GDP per capita ^2										0.264	0.031	8.40	***				
Lag log GDP per capita	-0.646	0.129	-5.00	*** -0.114	0.141	-0.81	-0.575	0.091	-6.33	*** -4.245	0.559	-7.59	***	0.379	0.052	7.31	***
Const	10.321	0.976	10.57	*** 6.570	1.028	6.39	*** 9.330	0.717	13.01	*** 21.866	2.489	8.79	***	0.321	0.684	0.47	
Number of samples	142			76			66			693				481			
Number of countries	18			9			9			78				49			
R-sq (within)	0.8733			0.8889			0.9827			0.4376				0.3625			
Turning point																	
Economic participation										0.746				0.694			
Lag log GDP per capita										8.040							

Notes :
- Data is from the World Economic Forum Global Gender Gap Reports, and the World Bank World Development Indicators.
- *significant at 10 percent level, **significant at 5 percent level, ***significant at 1 percent level.

[Table 5] Results of Estimations - Total Fertility Rate and Gender Gaps (2006-2015)
Focusing on the Education

Explained variable	Fixed effects with year dummies																			
Total fertlity rate	Low-income countries				Middle-income countries				High-income countries				Low-income countries				Middle-income countries				High-income countries			
	5.1				5.2				5.3				5.4				5.5				5.6			
Explanatory variables	coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t	
Economic participation ^2					1.893	0.412	4.59	***	1.850	0.396	4.67	***					2.088	0.418	4.99	***	2.375	0.391	6.08	***
Economic participation	-0.408	0.225	-1.81	*	-2.775	0.508	-5.46	***	-2.636	0.512	-5.15	***	-0.309	0.225	-1.37		-3.006	0.516	-5.83	***	-3.262	0.508	-6.42	***
Literacy rate	-0.389	0.173	-2.25	**	-0.521	0.152	-3.42	***	-1.971	0.377	-5.22	***												
Primary education	-0.044	0.268	-0.17		-0.501	0.254	-1.97	**	-1.560	0.477	-3.27	***	-0.155	0.269	-0.58		-0.664	0.249	-2.59	**	-0.867	0.450	-1.92	*
Secondary education	0.018	0.156	0.12		-0.462	0.158	-2.93	***	-0.011	0.406	-0.03		0.017	0.160	0.11		-0.591	0.159	-3.72	***	0.370	0.407	0.91	
Tertialy education	0.197	0.108	1.82	*	-0.289	0.092	-3.13	***	-0.035	0.078	-0.45		0.205	0.111	1.85	*	-0.274	0.094	-2.92	***	-0.151	0.078	-1.95	*
Political empowerment	0.232	0.296	0.78		-0.156	0.110	-1.43		0.048	0.078	0.62		0.198	0.302	0.66		-0.151	0.111	-1.35		0.042	0.081	0.52	
Lag log GDP per capita ^2					0.210	0.031	6.73	***									0.220	0.032	6.94	***				
Lag log GDP per capita	-0.664	0.132	-5.02	***	-3.305	0.558	-5.92	***	0.364	0.053	6.81	***	-0.624	0.134	-4.66	***	-3.438	0.566	-6.07	***	0.405	0.055	7.39	***
Const	10.513	1.004	10.47	***	18.004	2.514	7.16	***	2.398	0.994	2.41	**	9.999	0.998	10.02	***	18.242	2.560	7.13	***	-0.761	0.844	-0.90	
Number of samples	130				628				437				130				632				441			
Number of countries	17				77				48				17				77				48			
R-sq (within)	0.8843				0.4714				0.4252				0.8783				0.4754				0.3752			

Explained variable	Fixed effects and year dummies																			
Total fertility rate	Low income countries				Middle income countries				High income countries				Low income countries				Middle income countries				High income countries			
	5.7				5.8				5.9				5.10				5.11				5.12			
Explanatory variables	coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t	
Economic participation ^2					2.099	0.441	4.76	***	1.620	0.358	4.53	***					2.176	0.431	5.05	***	1.572	0.395	3.98	***
Economic participation	-0.449	0.189	-2.38	**	-3.089	0.542	-5.70	***	-2.294	0.468	-4.90	***	-0.495	0.192	-2.58	**	-3.213	0.531	-6.05	***	-2.216	0.507	-4.37	***
Literacy rate	-0.446	0.164	-2.73	***	-0.322	0.158	-2.04	**	-2.276	0.329	-6.91	***	-0.425	0.161	-2.64	**	-0.456	0.156	-2.93	***	-2.203	0.364	-6.05	***
Primary education																								
Secondary education																								
Tertialy education													0.194	0.100	1.95	*	-0.226	0.090	-2.51	**	-0.091	0.078	-1.17	
Political empowerment	0.163	0.269	0.60		-0.033	0.108	-0.30		-0.043	0.076	-0.57		0.260	0.270	0.96		-0.067	0.113	-0.60		-0.032	0.078	-0.41	
Lag log GDP per capita ^2					0.283	0.031	9.04	***									0.260	0.031	8.29	***				
Lag log GDP per capita	-0.689	0.126	-5.46	***	-4.619	0.556	-8.31	***	0.359	0.050	7.22	***	-0.660	0.127	-5.21	***	-4.173	0.561	-7.44	***	0.362	0.054	6.68	***
Const	10.818	0.949	11.40	***	22.660	2.496	9.08	***	1.025	0.626	1.64		10.511	0.956	10.99	***	20.840	2.512	8.30	***	0.999	0.691	1.45	
Number of samples	142				689				477				139				669				457			
Number of countries	18				78				49				18				78				48			
R-sq (within)	0.8808				0.4105				0.4155				0.8866				0.4418				0.4089			

Notes:
- Data is from the World Economic Forum Global Gender Gap Reports, and the World Bank World Development Indicators.
- *significant at 10 percent level, **significant at 5 percent level, ***significant at 1 percent level.

[Appendix 1] List of Countries

Countryname	Code	Region	Total fertlity rate	Policy stance on fertlity	Income group	Complete gggi
Mali	MLI	Sub-Saharan Africa	6.1	Lower	Low-Income and Modest Decline of Fertility	1
Chad	TCD	Sub-Saharan Africa	6.1	Lower	Low-Income and Rapid Decline of Fertility	1
Burundi	BDI	Sub-Saharan Africa	5.8	Lower	Low-Income and Modest Decline of Fertility	0
Angola	AGO	Sub-Saharan Africa	5.8	Lower	Middle-Income	0
Uganda	UGA	Sub-Saharan Africa	5.7	Lower	Low-Income and Rapid Decline of Fertility	1
Timor-Leste	TLS	East Asia and the Pacific	5.6	Lower	Middle-Income	0
Nigeria	NGA	Sub-Saharan Africa	5.6	Lower	Middle-Income	1
Gambia, The	GMB	Sub-Saharan Africa	5.5	Lower	Low-Income and Modest Decline of Fertility	0
Burkina Faso	BFA	Sub-Saharan Africa	5.4	Lower	Low-Income and Modest Decline of Fertility	1
Mozambique	MOZ	Sub-Saharan Africa	5.3	Lower	Low-Income and Modest Decline of Fertility	0
Tanzania	TZA	Sub-Saharan Africa	5.1	Lower	Low-Income and Modest Decline of Fertility	1
Benin	BEN	Sub-Saharan Africa	5.0	Lower	Low-Income and Modest Decline of Fertility	0
Zambia	ZMB	Sub-Saharan Africa	5.0	Lower	Middle-Income	1
Cote d'Ivoire	CIV	Sub-Saharan Africa	5.0	Lower	Middle-Income	0
Guinea	GIN	Sub-Saharan Africa	4.9	Lower	Low-Income and Rapid Decline of Fertility	0
Senegal	SEN	Sub-Saharan Africa	4.8	Lower	Low-Income and Modest Decline of Fertility	0
Cameroon	CMR	Sub-Saharan Africa	4.8	No official policy	Middle-Income	0
Mauritania	MRT	Middle East and North Africa	4.7	Lower	Middle-Income	1
Liberia	LBR	Sub-Saharan Africa	4.7	Lower	Low-Income and Rapid Decline of Fertility	0
Malawi	MWI	Sub-Saharan Africa	4.6	Lower	Low-Income and Rapid Decline of Fertility	1
Ethiopia	ETH	Sub-Saharan Africa	4.3	Lower	Low-Income and Rapid Decline of Fertility	1
Madagascar	MDG	Sub-Saharan Africa	4.2	Lower	Low-Income and Rapid Decline of Fertility	1
Yemen, Rep.	YEM	Middle East and North Africa	4.1	Lower	Middle-Income	1
Ghana	GHA	Sub-Saharan Africa	4.0	Lower	Middle-Income	1
Rwanda	RWA	Sub-Saharan Africa	4.0	Lower	Low-Income and Rapid Decline of Fertility	0
Kenya	KEN	Sub-Saharan Africa	3.9	Lower	Middle-Income	1
Zimbabwe	ZWE	Sub-Saharan Africa	3.8	Lower	Low-Income and Modest Decline of Fertility	0
Pakistan	PAK	South Asia	3.6	Lower	Middle-Income	1
Namibia	NAM	Sub-Saharan Africa	3.5	Lower	Middle-Income	1
Jordan	JOR	Middle East and North Africa	3.4	Lower	Middle-Income	1
Tajikistan	TJK	Central Asia	3.4	Lower	Middle-Income	0
Egypt, Arab Rep.	EGY	Middle East and North Africa	3.3	Lower	Middle-Income	1
Kyrgyz Republic	KGZ	Central Asia	3.2	Maintain	Middle-Income	1
Lesotho	LSO	Sub-Saharan Africa	3.1	Lower	Middle-Income	1
Swaziland	SWZ	Sub-Saharan Africa	3.1	Lower	Middle-Income	0

Israel	ISR	Middle East and North Africa	3.1	Raise	High-Income	1
Guatemala	GTM	Latin America and the Caribbean	3.0	Lower	Middle-Income	1
Syrian Arab Republic	SYR	Middle East and North Africa	3.0	Lower	Middle-Income	0
Philippines	PHL	East Asia and the Pacific	3.0	Lower	Middle-Income	1
Bolivia	BOL	Latin America and the Caribbean	2.9	Maintain	Middle-Income	1
Algeria	DZA	Middle East and North Africa	2.8	Lower	Middle-Income	1
Mongolia	MNG	East Asia and the Pacific	2.8	Raise	Middle-Income	1
Botswana	BWA	Sub-Saharan Africa	2.8	Maintain	Middle-Income	1
Lao PDR	LAO	East Asia and the Pacific	2.8	Lower	Middle-Income	0
Oman	OMN	Middle East and North Africa	2.7	Maintain	High-Income	0
Kazakhstan	KAZ	Central Asia	2.7	Maintain	Middle-Income	1
Cambodia	KHM	East Asia and the Pacific	2.6	Lower	Middle-Income	1
Saudi Arabia	SAU	Middle East and North Africa	2.6	Raise	High-Income	1
Belize	BLZ	Latin America and the Caribbean	2.5	Lower	Middle-Income	0
Fiji	FJI	East Asia and the Pacific	2.5	Lower	Middle-Income	0
Panama	PAN	Latin America and the Caribbean	2.5	No official policy	Middle-Income	1
Guyana	GUY	Latin America and the Caribbean	2.5	No intervention	Middle-Income	0
Morocco	MAR	Middle East and North Africa	2.5	Maintain	Middle-Income	1
Ecuador	ECU	Latin America and the Caribbean	2.5	Lower	Middle-Income	1
Paraguay	PRY	Latin America and the Caribbean	2.5	Maintain	Middle-Income	1
Honduras	HND	Latin America and the Caribbean	2.5	Lower	Middle-Income	1
Uzbekistan	UZB	Central Asia	2.5	Maintain	Middle-Income	0
South Africa	ZAF	Sub-Saharan Africa	2.5	Maintain	Middle-Income	1
Dominican Republic	DOM	Latin America and the Caribbean	2.5	Lower	Middle-Income	1
Peru	PER	Latin America and the Caribbean	2.4	Lower	Middle-Income	1
Suriname	SUR	Latin America and the Caribbean	2.4	Maintain	Middle-Income	0
Indonesia	IDN	East Asia and the Pacific	2.4	Lower	Middle-Income	1
Cabo Verde	CPV	Sub-Saharan Africa	2.4	Lower	Middle-Income	0
India	IND	South Asia	2.4	Lower	Middle-Income	1
Venezuela, RB	VEN	Latin America and the Caribbean	2.3	No intervention	Middle-Income	1
Argentina	ARG	Latin America and the Caribbean	2.3	Maintain	Middle-Income	1
Nicaragua	NIC	Latin America and the Caribbean	2.2	Lower	Middle-Income	1
Tunisia	TUN	Middle East and North Africa	2.2	Lower	Middle-Income	0
Mexico	MEX	Latin America and the Caribbean	2.2	Lower	Middle-Income	1
Nepal	NPL	South Asia	2.2	Lower	Low-Income and Rapid Decline of Fertility	1
Bangladesh	BGD	South Asia	2.1	Lower	Middle-Income	1
Maldives	MDV	South Asia	2.1	Maintain	Middle-Income	0
El Salvador	SLV	Latin America and the Caribbean	2.1	No intervention	Middle-Income	1
Bhutan	BTN	South Asia	2.1	Lower	Middle-Income	0

Turkey	TUR	Middle East and North Africa	2.1	Raise	Middle-Income	1
Sri Lanka	LKA	South Asia	2.1	Maintain	Middle-Income	1
Bahrain	BHR	Middle East and North Africa	2.1	Lower	High-Income	1
Malaysia	MYS	East Asia and the Pacific	2.1	Maintain	Middle-Income	1
Jamaica	JAM	Latin America and the Caribbean	2.0	Lower	Middle-Income	1
France	FRA	Western Europe	2.0	Raise	High-Income	1
Uruguay	URY	Latin America and the Caribbean	2.0	No official policy	High-Income	1
Georgia	GEO	Eastern Europe	2.0	Raise	Middle-Income	1
New Zealand	NZL	East Asia and the Pacific	2.0	Maintain	High-Income	1
Kuwait	KWT	Middle East and North Africa	2.0	Raise	High-Income	1
Azerbaijan	AZE	Eastern Europe	2.0	Maintain	Middle-Income	0
Vietnam	VNM	East Asia and the Pacific	2.0	Maintain	Middle-Income	0
Ireland	IRL	Western Europe	1.9	No official policy	High-Income	1
Iceland	ISL	Western Europe	1.9	Maintain	High-Income	1
Qatar	QAT	Middle East and North Africa	1.9	Raise	High-Income	0
Brunei Darussalam	BRN	East Asia and the Pacific	1.9	No intervention	High-Income	0
Sweden	SWE	Western Europe	1.9	No official policy	High-Income	1
Colombia	COL	Latin America and the Caribbean	1.9	Lower	Middle-Income	1
United States	USA	North America	1.8	No intervention	High-Income	1
Australia	AUS	East Asia and the Pacific	1.8	Raise	High-Income	1
United Kingdom	GBR	Western Europe	1.8	No intervention	High-Income	1
Costa Rica	CRI	Latin America and the Caribbean	1.8	Maintain	Middle-Income	1
Barbados	BRB	Latin America and the Caribbean	1.8	Raise	High-Income	0
Chile	CHL	Latin America and the Caribbean	1.8	Raise	High-Income	1
Bahamas, The	BHS	Latin America and the Caribbean	1.8	No intervention	High-Income	0
Trinidad and Tobago	TTO	Latin America and the Caribbean	1.8	Maintain	High-Income	1
United Arab Emirates	ARE	Middle East and North Africa	1.8	Raise	High-Income	1
Norway	NOR	Western Europe	1.8	No official policy	High-Income	1
Russian Federation	RUS	Eastern Europe	1.8	Raise	Middle-Income	1
Belgium	BEL	Western Europe	1.7	No official policy	High-Income	1
Brazil	BRA	Latin America and the Caribbean	1.7	No official policy	Middle-Income	1
Belarus	BLR	Eastern Europe	1.7	Raise	Middle-Income	0
Cuba	CUB	Latin America and the Caribbean	1.7	Raise	Middle-Income	0
Lebanon	LBN	Middle East and North Africa	1.7	No official policy	Middle-Income	0
Albania	ALB	Eastern Europe	1.7	Maintain	Middle-Income	1
Finland	FIN	Western Europe	1.7	No official policy	High-Income	1
Netherlands	NLD	Western Europe	1.7	No intervention	High-Income	1
Denmark	DNK	Western Europe	1.7	No official policy	High-Income	1
Iran, Islamic Rep.	IRN	Middle East and North Africa	1.7	Raise	Middle-Income	1

Montenegro	MNE	Eastern Europe	1.7	Raise	Middle-Income	0
Latvia	LVA	Eastern Europe	1.6	Raise	High-Income	1
Lithuania	LTU	Eastern Europe	1.6	Raise	High-Income	1
Armenia	ARM	Eastern Europe	1.6	Raise	Middle-Income	0
China	CHN	East Asia and the Pacific	1.6	Raise	Middle-Income	1
Canada	CAN	North America	1.6	No intervention	High-Income	1
Slovenia	SVN	Eastern Europe	1.6	Raise	High-Income	1
Estonia	EST	Eastern Europe	1.5	Raise	High-Income	1
Switzerland	CHE	Western Europe	1.5	No official policy	High-Income	1
Bulgaria	BGR	Eastern Europe	1.5	Raise	Middle-Income	1
Czech Republic	CZE	Eastern Europe	1.5	Raise	High-Income	1
Macedonia, FYR	MKD	Eastern Europe	1.5	Raise	Middle-Income	1
Romania	ROU	Eastern Europe	1.5	Raise	Middle-Income	1
Ukraine	UKR	Eastern Europe	1.5	Raise	Middle-Income	1
Germany	DEU	Western Europe	1.5	Raise	High-Income	1
Luxembourg	LUX	Western Europe	1.5	Raise	High-Income	1
Thailand	THA	East Asia and the Pacific	1.5	Raise	Middle-Income	1
Austria	AUT	Western Europe	1.5	Raise	High-Income	1
Croatia	HRV	Eastern Europe	1.5	Raise	High-Income	1
Japan	JPN	East Asia and the Pacific	1.5	Raise	High-Income	1
Serbia	SRB	Eastern Europe	1.5	Raise	Middle-Income	0
Hungary	HUN	Eastern Europe	1.4	Raise	High-Income	1
Malta	MLT	Western Europe	1.4	Raise	High-Income	1
Italy	ITA	Western Europe	1.4	Raise	High-Income	1
Slovak Republic	SVK	Eastern Europe	1.4	Raise	High-Income	1
Mauritius	MUS	Sub-Saharan Africa	1.4	Raise	Middle-Income	1
Cyprus	CYP	Western Europe	1.4	Raise	High-Income	1
Poland	POL	Eastern Europe	1.3	Raise	High-Income	1
Spain	ESP	Western Europe	1.3	Raise	High-Income	1
Greece	GRC	Western Europe	1.3	Raise	High-Income	1
Moldova	MDA	Eastern Europe	1.2	Raise	Middle-Income	1
Singapore	SGP	East Asia and the Pacific	1.2	Raise	High-Income	1
Korea, Rep.	KOR	East Asia and the Pacific	1.2	Raise	High-Income	1
Portugal	PRT	Western Europe	1.2	Raise	High-Income	1

Notes:

- "Total fertility rate" stands for total fertility rate in 2015 from the World Bank World Development indicators.
- "Policy stance on fertlity " stands for policy stance toward fertility from the United Nations World Population Policies Database in 2015.
- "Income group" is based on the World Bank Analytical Classifications based on GNI per capita in US$ (Atlas methodology) using the data in 2015.
  The income of low-income countries is $1,025 or less. The income of middle-income countries is between $1,026 and $12,475.
  The income of high-income countries is over $12,475.
  On top, this study divides the low-income country group into two sub groups according to the ratio of the change of TFR from 2006 to 2015.
- GGGI data is from the World Economic Forum Global Gender Gap Reports.
  If the " complete gggi" is 1, the country has 10-year GGGI data between 2006 and 2015, and if it is 0, the country has less than 10-year GGGI data.
- There is no GDPpc data for Cuba and Syria.

[Appendix 2] Correlation Coefficients between Variables

[Appendix 2.1] GGGI/ its Sub-Indexes / Per Capita Income

All samples (N=1316)

	GGGI	Economy	Education	Politics	Health	Laglngdppc
GGGI	1.000					
Economy	0.764	1.000				
Education	0.592	0.249	1.000			
Politics	0.756	0.332	0.177	1.000		
Health	0.231	0.137	0.163	0.114	1.000	
Laglngdppc	0.336	0.053	0.620	0.145	0.125	1.000

Low-income (n=142)

	GGGI	Economy	Education	Politics	Health	Laglngdppc
GGGI	1.000					
Economy	0.739	1.000				
Education	0.809	0.341	1.000			
Politics	0.774	0.467	0.415	1.000		
Health	0.190	0.251	0.063	0.080	1.000	
Laglngdppc	-0.321	-0.394	-0.200	-0.179	-0.022	1.000

Middle-income (n=693)

	GGGI	Economy	Education	Politics	Health	Laglngdppc
GGGI	1.000					
Economy	0.787	1.000				
Education	0.714	0.464	1.000			
Politics	0.570	0.061	0.158	1.000		
Health	0.172	0.062	0.129	0.058	1.000	
Laglngdppc	0.159	0.014	0.505	-0.081	0.117	1.000

High income (n=481)

	GGGI	Economy	Education	Politics	Health	Laglngdppc
GGGI	1.000					
Economy	0.829	1.000				
Education	0.434	0.367	1.000			
Politics	0.907	0.522	0.311	1.000		
Health	0.275	0.281	0.190	0.166	1.000	
Laglngdppc	-0.035	-0.097	-0.164	0.058	-0.624	1.000

[Appendix 2.2] Gender Gap Indicators for the Education Sub-Index

All samples (N=1195)

	Education	Literacy	Primary	Secondary	Tertiary	Economy	Politics	Health	Laglngdppc
Education	1.000								
Literacy	0.927	1.000							
Primary	0.859	0.717	1.000						
Secondary	0.944	0.819	0.819	1.000					
Tertiary	0.876	0.794	0.587	0.765	1.000				
Economy	0.252	0.327	0.242	0.209	0.129	1.000			
Politics	0.177	0.171	0.176	0.161	0.135	0.351	1.000		
Health	0.164	0.176	0.131	0.140	0.144	0.154	0.116	1.000	
Laglngdppc	0.633	0.645	0.404	0.528	0.695	0.047	0.173	0.133	1.000

Low-income (n=130)

	Education	Literacy	Primary	Secondary	Tertiary	Economy	Politics	Health	Laglngdppc
Education	1.000								
Literacy	0.856	1.000							
Primary	0.918	0.711	1.000						
Secondary	0.931	0.704	0.816	1.000					
Tertiary	0.802	0.651	0.621	0.688	1.000				
Economy	0.303	0.266	0.313	0.264	0.211	1.000			
Politics	0.389	0.258	0.398	0.408	0.257	0.460	1.000		
Health	0.064	-0.041	0.140	0.014	0.110	0.261	0.099	1.000	
Laglngdppc	-0.238	-0.171	-0.251	-0.268	-0.091	-0.453	-0.249	-0.025	1.000

Middle-income (n=628)

	Education	Literacy	Primary	Secondary	Tertiary	Economy	Politics	Health	Laglngdppc
Education	1.000								
Literacy	0.895	1.000							
Primary	0.832	0.665	1.000						
Secondary	0.932	0.783	0.770	1.000					
Tertiary	0.803	0.642	0.451	0.682	1.000				
Economy	0.465	0.589	0.366	0.419	0.229	1.000			
Politics	0.137	0.104	0.132	0.161	0.080	0.065	1.000		
Health	0.134	0.150	0.086	0.135	0.094	0.083	0.055	1.000	
Laglngdppc	0.516	0.420	0.305	0.423	0.638	0.000	-0.083	0.119	1.000

High-income (n=437)

	Education	Literacy	Primary	Secondary	Tertiary	Economy	Politics	Health	Laglngdppc
Education	1.000								
Literacy	0.545	1.000							
Primary	0.382	0.063	1.000						
Secondary	0.350	-0.061	-0.049	1.000					
Tertiary	0.833	0.170	0.111	0.215	1.000				
Economy	0.516	0.596	0.208	0.055	0.271	1.000			
Politics	0.334	0.369	0.264	-0.041	0.157	0.565	1.000		
Health	0.093	0.219	0.103	-0.073	-0.013	0.290	0.152	1.000	
Laglngdppc	-0.055	-0.136	0.024	-0.125	0.044	-0.090	0.079	-0.609	1.000

Notes :
- Calculated by the auther from the dataset of this study summarlized in Table 1.
-"GGGI":the Global Gender Gap Index, "Economy": the economy sub-index, "Education" : the education sub-index, "Politics": the politics sub-index, "Health": the health sub-index, "Laglngdppc": the per capita GDP, PPP (natural logarithm, 1year lagged, constant 2011 international $) "Literacy" : the female literacy rates over male values, "Primary" : the female net primary enrolment rates over male values, "Secondary" : the female net secondary enrolment rates over male values, and "Tertiary" : the female net tertiary enfolment rates over male values.
- Figures over 0.7 are markered in orange.

[Appendix 3.1] Summary of the Dataset for 108 countries

		GGGI (Global Gender Gap Index)															
					Economy			Education			Politics			Health			
		2006	2010	2015	2006	2010	2015	2006	2010	2015	2006	2010	2015	2006	2010	2015	
Total		0.664	0.685	0.701	0.596	0.636	0.657	0.946	0.957	0.966	0.142	0.174	0.208	0.973	0.972	0.974	
	Low-income countries	0.613	0.631	0.661	0.630	0.631	0.671	0.755	0.784	0.839	0.098	0.141	0.165	0.969	0.969	0.971	
	Modest decline	0.630	0.622	0.656	0.704	0.608	0.678	0.726	0.767	0.827	0.119	0.147	0.154	0.969	0.969	0.965	
Income	Rapid decline	0.605	0.636	0.664	0.592	0.642	0.668	0.770	0.793	0.845	0.088	0.138	0.170	0.969	0.970	0.974	
level	Middle-income countries	0.652	0.669	0.684	0.574	0.610	0.620	0.945	0.956	0.964	0.118	0.138	0.179	0.972	0.971	0.974	
	High-income countries	0.689	0.715	0.731	0.617	0.669	0.701	0.986	0.993	0.995	0.180	0.225	0.253	0.975	0.974	0.974	
	East Asia and the Pacific	0.674	0.692	0.703	0.648	0.683	0.705	0.961	0.971	0.976	0.116	0.145	0.160	0.971	0.971	0.971	
	South Asia	0.608	0.637	0.654	0.440	0.460	0.465	0.823	0.859	0.914	0.209	0.274	0.271	0.959	0.957	0.966	
	Latin America and the Caribbean	0.664	0.690	0.707	0.560	0.618	0.638	0.980	0.989	0.991	0.137	0.175	0.222	0.978	0.977	0.979	
	Middle East and North Africa	0.585	0.599	0.613	0.427	0.442	0.450	0.906	0.924	0.938	0.038	0.062	0.096	0.971	0.970	0.968	
Region	North America	0.710	0.739	0.740	0.744	0.788	0.800	0.990	0.999	1.000	0.128	0.191	0.190	0.979	0.979	0.972	
	Eastern Europe	0.686	0.695	0.713	0.670	0.697	0.707	0.990	0.994	0.995	0.110	0.116	0.175	0.973	0.973	0.975	
	Western Europe	0.716	0.746	0.764	0.629	0.694	0.735	0.993	0.996	0.998	0.269	0.322	0.350	0.975	0.974	0.975	
	Sub-Saharan Africa	0.643	0.660	0.682	0.634	0.665	0.697	0.851	0.867	0.891	0.118	0.138	0.166	0.970	0.969	0.973	
	Central Asia	0.683	0.701	0.706	0.700	0.721	0.704	0.993	0.997	0.995	0.062	0.107	0.151	0.979	0.980	0.977	

		GDP per capita, PPP (1 year lagged, constant 2011 international $) and its natural logarithm in italic)						TFR (Total fertility rate)			N of countries				
		2006		2010		2015		2006	2010	2015		2006	2010	2015	
Total		19783	*9.350*	20198	*9.431*	21848	*9.546*	2.587	2.523	2.393	108	108	108	108	
	Low-income countries	1390	*7.191*	1534	*7.305*	1746	*7.436*	5.725	5.337	4.862	9	9	9	9	
	Modest decline	1616	*7.375*	1751	*7.456*	1950	*7.561*	6.189	5.947	5.553	3	3	3	3	
Income	Rapid decline	1277	*7.099*	1425	*7.230*	1645	*7.374*	5.493	5.031	4.516	6	6	6	6	
level	Middle-income countries	8238	*8.829*	9314	*8.956*	10830	*9.112*	2.769	2.686	2.560	55	55	55	55	
	High-income countries	37978	*10.443*	37622	*10.459*	39731	*10.521*	1.719	1.743	1.680	44	44	44	44	
	East Asia and the Pacific	20792	*9.503*	22037	*9.621*	25982	*9.825*	2.029	2.025	1.972	12	12	12	12	
	South Asia	3467	*8.028*	4119	*8.195*	5171	*8.403*	2.991	2.719	2.452	5	5	5	5	
	Latin America and the Caribbean	10576	*9.143*	11815	*9.244*	13492	*9.382*	2.565	2.407	2.255	20	20	20	20	
	Middle East and North Africa	28835	*9.711*	25904	*9.722*	26635	*9.764*	3.031	2.933	2.784	13	13	13	13	
Region	North America	45117	*10.712*	44241	*10.693*	47389	*10.762*	1.847	1.779	1.722	2	2	2	2	
	Eastern Europe	15885	*9.532*	17515	*9.644*	19685	*9.777*	1.410	1.516	1.547	17	17	17	17	
	Western Europe	41911	*10.603*	42006	*10.605*	43066	*10.621*	1.648	1.699	1.609	20	20	20	20	
	Sub-Saharan Africa	3913	*7.856*	4419	*7.978*	5194	*8.130*	4.925	4.662	4.319	17	17	17	17	
	Central Asia	9192	8.726	10917	8.901	13384	9.067	2.530	2.850	2.965	2	2	2	2	

Notes:

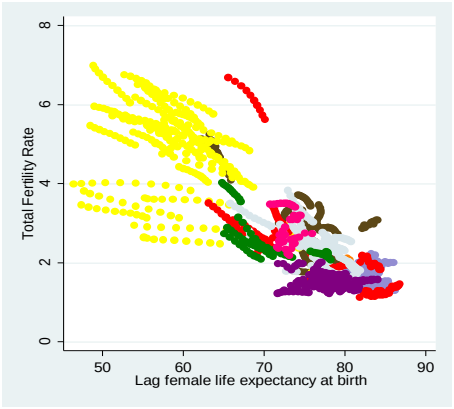
- "GGGI" and its sub-indexes are from the World Economic Forum Global Gender Gap Report from 2006 to 2015.
- "GDP per capita" and "Total Fertlity Rate" data are from the World Bank World Development Indicaters.
- 108 countries included in this figure have 10-year GGGI data between 2006 and 2015. 108 countries are shown in Appendix 1 with "comeplete gggi" =1.
- Concerning the income classification, see Notes for Appendix 1.

[Appendix 3.2] Results of Estimations - Total Fertility Rate and Gender Gaps for 108 Countries (2006-2015)

Explained variable	Ordinary least squears																																			
Total fertility rate	All samples																																				
	ap3.2.1				ap3.2.2				ap.3.2.3				ap3.2.4				ap3.2.5				ap3.2.6				Fixed effects with year dummies ap.3.2.7											
Explanatory variables	coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t									
Global Gender Gap Index ^2	36.372	5.257	6.92	***	46.125	3.441	13.40	***									33.743	3.363	10.03	***	35.194	2.801	12.57	***	14.844	1.447	10.26	***								
Global Gender Gap Index	-58.166	7.149	-8.13	***	-67.530	4.718	-14.31	***									-49.036	4.564	-10.74	***	-50.338	3.857	-13.05	***	-21.813	2.023	-10.78	***								
Lag log GDP per capita ^2									0.286	0.018	15.90	***	0.148	0.017	8.89	***	0.263	0.017	15.47	***	0.141	0.015	9.21	***	0.271	0.017	16.01	***								
Lag log GDP per capita									-6.130	0.332	-18.45	***	-3.353	0.307	-10.91	***	-5.634	0.313	-18.01	***	-3.147	0.284	-11.09	***	-4.902	0.314	-15.63	***								
Asia and the Pacific					baseline								baseline								baseline															
South Asia					0.242	0.115	2.11	**					-0.251	0.103	-2.43	**					-0.397	0.096	-4.13	***												
Latin America and the Caribbean					0.443	0.076	5.81	***					0.257	0.068	3.76	***					0.331	0.063	5.24	***												
Middle East and North Africa					0.186	0.095	1.95	*					0.917	0.073	12.59	***					0.474	0.078	6.10	***												
North America					-0.051	0.160	-0.32						0.264	0.143	1.85	*					0.269	0.132	2.04	**												
Eastern Europe					-0.409	0.079	-5.19	***					-0.420	0.069	-6.08	***					-0.354	0.064	-5.55	***												
Western Europe					-0.331	0.081	-4.06	***					0.094	0.072	1.30						-0.018	0.070	-0.26													
Sub-Saharan Africa					2.437	0.080	30.60	***					1.393	0.082	16.94	***					1.441	0.076	18.97	***												
Central Asia					0.916	0.159	5.75	***					0.317	0.140	2.26	**					0.467	0.130	3.60	***												
Const	25.101	2.426	10.34	***	26.549	1.625	16.33	***	34.518	1.516	22.76	***	20.483	1.415	14.48	***	49.581	1.916	25.87	***	37.016	1.804	20.52	***	32.165	1.494	21.52	***								
Number of samples	1080				1080				1080				1080				1080				1080				1080											
Number of countries																									108											
Adjusted R-sq	0.2149				0.7298				0.6391				0.7952				0.6902				0.8258															
R-sq (within)																									0.4981											
Turning point																																				
GGGI	0.800				0.732												0.727				0.715				0.735											
Lag log GDP per capita									10.717				11.328				10.711				11.160				9.044											

Notes:
- Data is from the World Economic Forum Global Gender Gap Reports, and the World Bank World Development Indicators.
- *significant at 10 percent level, **significant at 5 percent level, ***significant at 1 percent level.
- Estimations are conducted for 108 countries which have 10-year GGGI data between 2006 and 2015. 108 countries are shown in Appendix 1 with 1 of "complete gggi".

[Appendix 4] Fertility and Female Life Expactancy



Notes:
-This fugure includes all the samples which have the Global Gender Gap Index from 2006 to 2015.
-Total fertility rate and lag female life expectancy at birth (1 year lag) is from the World Bank World Development Indicators.
-For information on data sources and coloers of the dots, see Notes for Figure 2.1.

Explained variable	Fixed effects and year dummies																			
Total fertility rate	Low-income countries												Middle-income countries				High-income countries			
					Moderate decline				Rapid decline											
	ap.4.1				ap.4.2				ap.4.3				ap.4.4				ap.4.5			
Explanatory variables	coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t		coef.	s.e.	t	
Economic participation ^2													2.308	0.438	5.27	***	2.235	0.351	6.36	***
Economic participation	-0.396	0.193	-2.05	**	0.099	0.131	0.75		-0.262	0.199	-1.32		-3.260	0.535	-6.09	***	-3.062	0.460	-6.66	***
Educational attainment	-0.152	0.309	-0.49		-0.470	0.243	-1.94	*	-0.131	0.212	-0.62		-1.466	0.286	-5.12	***	-1.447	0.422	-3.43	***
Political empowerment	0.099	0.285	0.35		0.284	0.222	1.28		-0.015	0.198	-0.07		-0.076	0.106	-0.72		-0.009	0.079	-0.12	
Lag female life expectancy at birth	0.010	0.008	1.20		0.029	0.006	4.68	***	-0.031	0.006	-4.78	***	-0.020	0.004	-4.54	***	0.027	0.010	2.67	***
Lag log GDP per capita ^2													0.222	0.032	6.87	***				
Lag log GDP per capita	-0.712	0.140	-5.08	***	-0.314	0.127	-2.46	**	-0.371	0.086	-4.34	***	-3.480	0.575	-6.05	***	0.375	0.051	7.28	***
Const	10.177	0.982	10.37	***	6.367	0.874	7.29	***	9.764	0.593	16.46	***	19.947	2.485	8.03	***	-1.957	1.090	-1.80	*
Number of samples	142				76				66				693				481			
Number of countries	18				9				9				78				49			
R-sq (within)	0.8749				0.9214				0.9887				0.4563				0.3733			

Notes:
- Data is from the World Economic Forum Global Gender Gap Reports, and the World Bank World Development Indicators.
- *significant at 10 percent level, **significant at 5 percent level, ***significant at 1 percent level.
- TFR_it= α_0+〖(α_1 ECO_it^2)+α_2 ECO_it+α_3 EDU＋α_4 POL_it+α_5 lagFLE_it +α_6 lagGDPPC_it^2 +α_7 lagGDPPC_it+ Z_i+year_t+ϵ_it

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Abstract (in Japanese)

要約

先進国から始まった出生率の低下は、20 世紀後半には殆どの途上国に広がった。一方、先進国においては、近年、出生率の下げ止まりや緩やかな回復が見られる。
出生率とジェンダー平等については既に多くの研究が行われている。しかし、ジェンダー平等には多様な側面があり、また、出生率とジェンダー平等の関係は国の発展段階によって異なる可能性がある。このため本研究では、出生率と世界経済フォーラムが毎年発表している GGGI（グローバルジェンダーギャップ指数）を含むパネルデータを用い、途上国と先進国に共通の枠組みで出生率とジェンダー平等の関係を国の所得段階毎に実証分析した。
主な結果は以下である。第 1 に、出生率と GGGI でみたジェンダー平等全体の進展との間には逆 J 字型(L)の関係が観察される。即ち、ジェンダー平等と出生率の関係は、その進展の初期において負であるが、一定水準以上になると正に転じる。第 2 に、2015 年の出生率が 5 を上回っている低所得でかつ出生率の低下が緩やかな国では、ジェンダー平等全体や経済分野におけるジェンダー平等の進展と出生率の間に明確な関係がみられない一方、女性の平均寿命は出生率と正の関係がある。第 3 に、教育分野については、識字率に関するジェンダー平等の進展が所得水準とかかわりなく出生率と負の関係にあり、また、中所得国では初等・中等・高等教育の各段階で就学率のジェンダー平等の進展と出生率に負の関係がみられる。

キーワード：出生率、ジェンダー平等、グローバルジェンダーギャップ指数、
所得レベル