IMPACT OF GENDER INEQUALITY ON THE REPUBLIC OF KOREA'S LONG-TERM ECONOMIC GROWTH: AN APPLICATION OF THE THEORETICAL MODEL OF GENDER INEQUALITY AND ECONOMIC GROWTH

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ABSTRACT

This paper presents a theoretical model that can analyze the impact of gender inequality on long-term economic growth. The model is calibrated to fit to Korean data. We find that gender equality policies that lower discrimination in the labor market or that increase the time spent by a father on child-rearing can contribute positively to female labor market participation and per capita income growth. The simulation results show that when the disparities between men and women at home and in the labor market are completely removed, the female labor force participation rate increases from 54.4% to 67.5%, and the growth rate in per capita income rises from 3.6% to 4.1% on average over a generation.

Keywords: economic growth, female labor market participation, gender inequality, human capital accumulation, Republic of Korea

JEL codes: E24, J13, J71, O53

I. INTRODUCTION

The Republic of Korea has made significant economic progress in the past 50 years, as demonstrated by the increase in its per capita income from just $80 in 1960 to over $24,000 in 2013. A critical factor for the Republic of Korea's economic success has been its fast-growing, well-educated labor force. From 1960 to 2010, the share of adults who had completed secondary schooling or higher soared from 20% to an impressive 87% in 2010 (Barro and Lee 2013). This abundance of well-educated workers has brought about higher levels of labor productivity and higher returns on investment and has developed capabilities for facilitating technological adoption and innovation. Low-cost and good-quality labor thus became the foundation for the Republic of Korea's successful export-oriented development strategy.

During its period of rapid industrialization and development, the Republic of Korea made substantial strides toward gender equality in education and employment opportunities. The gender gap has become negligible in the secondary school enrollment rates and in the advancement rates to higher education. More noticeable than ever before is the presence of women in such elite professions as law, medicine, and high-level civil service.

There is still a significant gender gap in labor market participation, however. According to Organisation for Economic Co-operation and Development (OECD) data, only 55% of Korean women from ages 15 to 64 are in the labor force compared to 65% for OECD countries on average. The Republic of Korea's female labor force participation rate (LFPR) substantially lags behind the male participation rate of about 77%, which is close to the OECD average of 79%.

The LFPR of Korean women shows an M-shaped pattern over the life cycle. Due to career interruption after marriage or child birth, that rate drops significantly in their late 20s and early 30s. More Korean women are likely to be eventually attracted to the labor market but child-rearing remains a major obstacle for highly educated and capable female workers who want to continue their careers. Korean mothers remain primarily responsible for raising children, and inflexible work environments along with a lack of affordable, good-quality childcare facilities make it challenging for them to balance work and home.

Korean women generally have a strong perception that there is gender inequality in various parts of society. According to the 2002 Social Survey by Statistics Korea, 72.4% of women have that perception. This finding was also borne out by the Global Gender Gap Report of the World Economic Forum, which ranked the Republic of Korea 111th in gender equality in 2013 (Table 1). The World Economic Forum index takes into account women's general standing in (i) economic participation and opportunity, (ii) educational attainment, (iii) health, and (iv) political empowerment.

The Korean government aims to change this. In a 3-year plan for economic innovation announced in February 2014, it set the major goal of increasing the female employment rate from the current 54% to 62% by 2017. This goal will be pursued by encouraging female workers to remain in the workforce through such measures as providing affordable, good-quality childcare facilities, and expanding paid parental leave.

Given this background, the objective of this paper is to assess the output cost of gender inequality and the impacts of gender-based policies on female labor force participation and on the Republic of Korea's long-term economic growth. In particular, we will examine which gender-based

policy is most effective in enhancing the growth rate of per capita income. We will also examine how high the female LFPR can rise if gender bias is eliminated.

Table 1: The Global Gender Gap Index Ranking in 2013

Country	Overall	Economic Participation and Opportunity	Educational Attainment	Health and Survival	Political Empowerment
Iceland	1	22	1	97	1
Finland	2	19	1	1	2
Norway	3	1	1	93	3
Sweden	4	14	38	69	4
Philippines	5	16	1	1	10
Germany	14	46	86	49	15
United States	23	6	1	33	60
Sri Lanka	55	109	48	1	30
Singapore	58	12	105	85	90
Thailand	65	50	78	1	89
People's Republic of China	69	62	81	133	59
Viet Nam	73	52	95	132	80
Bangladesh	75	121	115	124	7
Indonesia	95	103	101	107	75
India	101	124	120	135	9
Malaysia	102	100	73	75	121
Japan	105	104	91	34	118
Republic of Korea	111	118	100	75	86
Pakistan	135	135	129	124	64

Source: Bekhouch, Y., R. Hausmann, L. D. Tyson, and S. Zahidi, S. 2013. *The Global Gender Gap Report 2013*. Geneva: World Economic Forum.

A key source of the gap in the labor force participation of women and men is how Korean women allocate their time. At all levels of incomes, they tend to do the majority of housework and childcare, correspondingly having less time for work in the labor market. Moreover, there is still significant gender discrimination in the labor market.

The model we are presenting, built on a model presented in a separate paper accompanying this study (Kim, Lee, and Shin 2015), accounts endogenously for women's time allocation between home production, child-rearing, and market work, and then analyzes how gender inequality at home and in the labor market affects female labor force participation and economic growth. We calibrated the model to fit its steady-state values to the observed values from the Republic of Korea and conducted simulations to quantitatively measure the opportunity cost of gender inequality in terms of foregone output as well as the impacts of gender-based policies on women's labor market participation and economic growth.

There is an increasing body of literature on gender equality and growth.[1] Existing theoretical literature emphasizes three channels through which gender equality influences growth— female labor market participation, average human capital stock, and fertility. A considerable number of empirical papers have investigated the impact of gender inequality in education and employment on economic growth and the majority of these studies have found that gender inequality indeed adversely affects economic growth.

Gender inequality having lately become a pressing issue in Korean society, many Korean researchers have studied various aspects of female labor supply and household work, mostly using microeconomic perspectives. Kim and Sung (2007), Woo (2008), Cho (2009), and Choi (2011) have estimated the labor supply function of Korean women empirically or by model calibration in their investigation of the effects of various government policies like subsidies for childcare and earned income tax credits. Kim and Cho (2003), and Kim (2012) have studied the determinants of labor market reentry by married women after childbirth or childcare leave, including several gender-related policies. Heo (2008) has examined the factors for time spent on household production by men and women.

To the best of our knowledge, no academic research using macroeconomic perspectives has yet been undertaken to assess the effects of gender inequality on economic growth in the context of the Korean economy. This paper, which is an effort to fill this gap, proceeds as follows after this introductory section. Section II provides an overview of gender issues in the Republic of Korea. In section III, which introduces the formal model, we calibrate it and derive the benchmark steady state that is characterized by a balanced growth path. In section IV, we experiment on the effects of gender equality policies and estimate the output cost of gender inequality. Section V provides concluding observations.

II. GENDER INEQUALITY IN THE REPUBLIC OF KOREA

The modern Korean woman faces various dimensions of inequality—social, cultural, and economic. From a historical perspective, the gender inequality problem has been improving greatly since the takeoff of the Korean economy in the 1970s. However, Korean women still have many hurdles to overcome to get equal treatment from the various sectors of society.

On a positive note, the educational attainment of women in the Republic of Korea has improved substantially in the last half century. In 1990, the average years of schooling for Korean women in their 30s was 10.4 while the average years for men was 11.8. By 2010, those averages had risen to 13.9 for women and to 14.1 for men. However, if we consider only women in their 20s, their average schooling years actually reached 14.3 in 2010, even higher than the 13.9 years of their male counterparts (Social Indicators in Korea, Statistics Korea).

The general improvement in gender equality in the Republic of Korea was also manifest in the change in sex ratio at birth. In 1990, at the peak of its rise, the sex ratio at birth—measured by the number of boys born per 100 girls—reached 116.5; by 2007, that ratio fell down to the normal level of 106. It is widely believed that the high sex ratio at birth in the past was mainly due to gender inequality

[1] See Kim, Lee, and Shin (2015) for a succinct survey of recent papers.

in Korean society. That the sex ratio has gone down to the normal level could be an indicator that Korean parents no longer perceive any disadvantage in having daughters instead of sons.

Even with these indications of improvement in gender equality, however, significant inequality between men and women still persists in various forms in the Republic of Korea.

A. Gender Gap in Labor Force Participation Rate

Despite the Republic of Korea's rapid economic growth and its having caught up with advanced economies since the 1970s, the labor force participation of its women still lags behind that of women in other developed countries. Indeed, in 2012, the female LFPR in the Republic of Korea was at 55.2% still one of the lowest among OECD countries. In comparison, that LFPR was 12.3 percentage points lower than that of the United States.[2]

The LFPR of Korean women is significantly lower than that of males, and the gap is wider than that in most OECD countries. Based on OECD statistics, in 2011, the difference in LFPR between men and women was 23.4 percentage points in the Republic of Korea against 11 percentage points in the United States, 12.5 percentage points in the United Kingdom, and 17.5 percentage points on average in all the OECD countries. This wide gender gap in LFPR in the Republic of Korea has been quite persistent over time.

The gender difference in the Republic of Korea's LFPR becomes more pronounced when we divide the labor force participation by marital status. In 2011, the LFPR of married men in the Republic of Korea was at 82.8% and that of single men at 52.2%. On the other hand, the LFPR of married women was at 49.3% and that of single women at 50.9%. Between the Republic of Korea's married men and women, the gender gap in LFPR was thus much wider.

The falling LFPR of the Republic of Korea's married women is well documented in the so-called M curve of labor supply over life cycle. When we plot the employment rate of different cohorts in the Republic of Korea, we find a dip in the employment rate for Korean women in their 30s. In contrast, that of Korean men shows no decrease (Figure 1).

The significantly lower labor market participation by the Republic of Korea's married women is viewed as a reflection of the large burden of childcare on married women. The Korea Time Use Survey conducted in 2009 reports that time spent by a wife for childcare is, on average, more than three times longer than that by a husband—55 minutes per day versus 14 minutes.

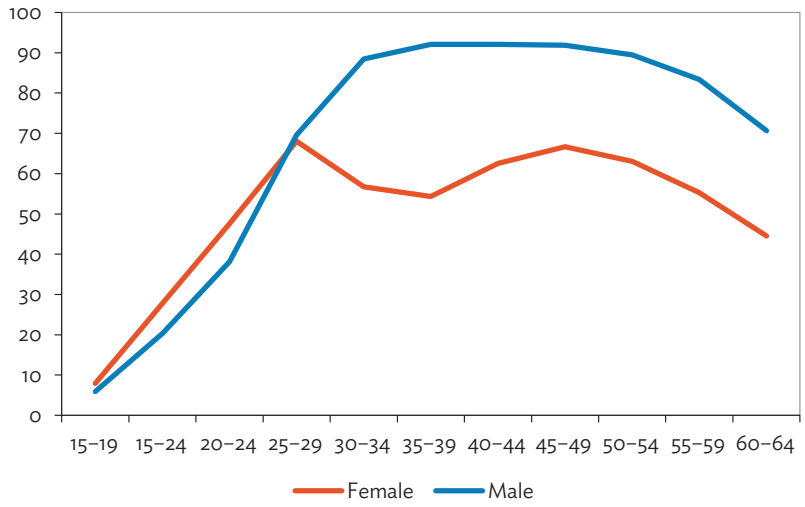
The gender gap in LFPR is even more pronounced among the highly educated. In 2011, according to the Annual Report on the Economically Active Population Survey by Statistics Korea, the LFPR of Korean men with college education or more was 88.3%, while that of their female counterparts was 62.9%. This difference is disturbing because it implies a significant misuse of human resources for the Korean economy.

[2] See OECD. http://stats.oecd.org

B. Gender Gap in Employment Rate

The female employment rate varies greatly across educational groups. According to the Statistical Yearbook of Education by the Ministry of Education, Science and Technology, the employment rate among female high school graduates in 2011 was 27.3%, higher than the employment rate of 20.2% among male high school graduates.

Figure 1: Cohort Employment Rate in 2013: Male versus Female in the Republic of Korea



Source: OECD. http://stats.oecd.org

Among the more educated, however, a reversal has been reported in the magnitude of the employment rate of men versus women. In 2011, the employment rates of men and women with a master's degree or higher were 80.6% and 59.4%, respectively. On the other hand, the employment rates of men and women with a bachelor's degree were 58.7% and 50%, respectively. This suggests that about half of female college graduates who are provided with adequate skills for the labor market are not contributing to the economy—a considerable economic loss for the Republic of Korea.

The gender gap is reported to be present not just in the quantitative dimension of employment, but also in the qualitative. Table 2 below shows the male–female difference in employment types. For example, among those employed in 2011, only 3.2% of all women owned their own businesses against 8.4% of all men owning their own businesses. Moreover, the fraction of temporary workers among women was almost twice higher than that among men, 28.7% versus 15%.

Table 2: Distribution of Workers by Employment Types

Sex	Year	Total	Employer	Own Account Workers	Unpaid Family Workers	Regular	Temporary	Daily
Female	1990	100.0	2.7	16.0	24.5	21.4	22.5	12.9
	1995	100.0	3.3	16.0	21.1	25.5	24.2	9.8
	2000	100.0	3.0	16.2	19.2	19.1	28.5	13.9
	2005	100.0	3.5	15.4	14.0	25.6	30.2	11.3
	2010	100.0	3.3	12.9	10.9	34.5	30.0	8.4
	2011	100.0	3.2	12.4	10.7	37.1	28.7	7.9
Male	1990	100.0	9.0	25.4	2.5	40.7	14.1	8.3
	1995	100.0	10.2	22.4	1.7	44.4	13.1	8.1
	2000	100.0	9.6	24.1	2.0	38.1	17.1	9.2
	2005	100.0	10.0	22.8	1.3	41.1	16.4	8.5
	2010	100.0	8.4	20.3	1.3	47.9	15.1	7.0
	2011	100.0	8.4	20.3	1.2	49.5	15.0	6.8

Source: Statistics Korea. 2011. *Annual Report on the Economically Active Population Survey*.

C. Gender Gap in Wages

Another gender gap can also be observed in the economic performance of women compared to men based on their respective wage rates in the labor market. In 2010, the average monthly wage—the total of the monthly salary and the monthly share of the annual bonus—is reported to be 2 million Korean won (W) for women against W3.2 million for men (Survey on Labor Conditions by Type of Employment 2010, Ministry of Employment and Labor). This implies that Korean women on average earn only 64% of what Korean men earn.

This wage gap has actually become narrower since the economic takeoff in the Republic of Korea, for the female–male wage ratio was only 0.47 in 1985 but had grown to 0.63 in 2000, based on the Surveys on Labor Conditions by Type of Employment. Our concern is that the gap has remained substantial, not further narrowing significantly from that level since the early 2000s.

For women with higher education, the gender gap in wage is narrower but still considerable. In 2010, women with a bachelor's degree or higher earned about 66% of what men with the same academic qualification earned in 2010.

Interestingly, the wage gap between men and women is more pronounced in occupations that require more advanced skills. In 2010, women in professional occupations such as medical doctors and lawyers earned only 61.7% of what their male counterparts earned, compared to 64% of what all Korean women earned on average against those earned by all Korean men.

D. Women's Representation in Politics and Government

Beyond the economic aspects of gender inequality, concerns have been raised about the level of Korean women's representation and participation in politics and government.

In 2008, only 41 women were elected to the 299-seat 18th National Assembly. This was a significant improvement from earlier elections; in the 14th National Assembly elections in 1992, for example, the female representation was only 1% or 3 out of 299 seats. With women constituting more

than half of the Korean population, they are thus still remarkably underrepresented in the political arena.

Compared to the political sector, women appear to be better represented in the government sector. In 2010, the percentage of female government employees at the federal government level was 41%. This share is nonetheless still significantly below the parity level of 50%.

It is also recognized that Korean women are not well represented at the administrative levels of both private and public firms. Based on a survey conducted by GMI Ratings (2013), the fraction of women in corporate boards is only 1.9% in the Republic of Korea against 11.8% in OECD countries, making the Republic of Korea rank 43rd out of the 45 countries surveyed. The survey also found that in the Republic of Korea, 19.5% of corporations with more than 100 employees have no female executive at all.

E. Government Policies on Gender Inequality

The Korean government has been pursuing various policies to improve the welfare of women in the Republic of Korea and to reduce gender inequality. A parallel objective of these policies is to encourage childbearing owing to the accelerated aging of Korean society that has been accompanied by extremely low fertility rates during the last few decades.

With these policies, the Korean government in general aims to provide women with a better environment for childbearing and child-rearing so as to encourage and enable them to return to the labor market even as they are raising children.

The policies can be categorized into three types:

(i) The first type of policies includes those aimed at helping women give birth successfully and at lowering the cost of childbearing for couples. These are:
  (a) Maternity and paternity leave (for childbirth);
  (b) Childcare leave of absence (for children ages 0–6): maximum of 1 year with pay; and
  (c) Reduced work hours during child-rearing (for children ages 0–6): maximum of 1 year combined with childcare leave of absence.

(ii) The second type of policies aims at providing parents with more reliable childcare facilities for children in grade schools. These are:
  (a) Incentives for firms to provide childcare centers at work: implemented in June 2013;
  (b) Providing public childcare centers;
  (c) Financial support for childcare; and
  (d) Encouraging private and public childcare centers with financial incentives to offer flexible hours for childcare; this was implemented starting July 2014.

(iii) The third type of policies aims at giving companies incentives to hire back women after childbirth or childcare. At present, private firms can receive tax subsidies if they employ female workers who are trying to return to the labor market after child-rearing.

These policies have been successful to some extent in promoting female labor market participation. For instance, in 2014, the female employment rate among women from age 15 and over rose above the 50% mark—50.4% to be exact—for the first time (Economically Active Population Survey 2014, Statistics Korea). However, the Republic of Korea's female employment rate is still significantly lower than that of many advanced economies like Canada (69.2%), Japan (60.7%), and Sweden (71.8%). This leaves a lot of room for the Korean government to implement better policies for encouraging women's participation in the labor market.

III. THE THEORETICAL MODEL

The theoretical model we have developed has a three-period overlapping generations (OLG) structure where various aspects of gender inequality are related to the economy's growth performance. Based on a similar model, Kim, Lee, and Shin (2015) have shown that improving gender equality can contribute significantly to economic growth by changing female time allocation and promoting accumulation of human capital.[3]

In order to apply to the Korean economy, we modified the model introduced in Kim, Lee, and Shin (2015) in the following ways:

(i) First, aside from market and home production, males allocate some of their time to child-rearing and education. This modification is essential for examining the impact of a government policy that encourages males to spend more time in child-rearing.
(ii) Second, we assume that the father's education level as well as that of the mother's determines the accumulation of human capital by their children. This change, along with the change in the first modification that males allocate time to education, will allow us to investigate the perfect gender-equality case where males and females behave exactly in the same way.
(iii) Third, we remove the parental bias in favor of sons in time allocation and in the preference for educating children because there seems to be no evidence now of that bias in favor of sons.
(iv) Fourth and finally, we assume in the benchmark model that the government revenue is not spent on any growth-enhancing activities. This will allow us to explore a possible government policy that switches spending from unproductive usage to education.

[3] The model in Kim, Lee, and Shin (2015) is built on Agénor (2012), but differs in several important dimensions. First, Kim, Lee, and Shin (2015) explicitly considers the difference between the quantity and quality of children in terms of their costs, following Becker, Murphy, and Tamura (1990), and allows the altruism in utility, as in Ehrlich and Lui (1991). Second, the model assumes the existence of a fixed cost per child and a distinct time cost in educating children. Finally, it also assumes that husbands take limited responsibility in household production, which is one aspect of the gender gap.

A. Model Structure

In the economy, every individual's lifetime has three periods: childhood, adulthood (at middle age), and retirement (at old age). There is a continuum of identical families consisting of parents born at time (*t*-1) and children born at time *t*. The family's utility function at time *t* is as follows:

$$U_t = \eta_c \frac{1}{1-\sigma} {c_t}^{1-\sigma} + \eta_q \frac{1}{1-\sigma} {q_t}^{1-\sigma} + \eta_e \left[\frac{1}{1-\sigma} \left(\left(\frac{n_t}{2} \right)^{\delta} e_{t+1}^{m} \right)^{1-\sigma} + \frac{1}{1-\sigma} \left(\left(\frac{n_t}{2} \right)^{\delta} e_{t+1}^{f} \right)^{1-\sigma} \right] + \frac{p_A}{1+\rho} \frac{1}{1-\sigma} {c_{t+1}}^{1-\sigma} \quad (1)$$

where c_t (c_{t+1}) is the family's total consumption during the parents' adulthood (parents' retirement), q_t consumption (and production) of home goods, n_t the number of children (of which half are sons and the other half are daughters), e_{t+1}^{m} (e_{t+1}^{f}) the education level of sons (daughters) that will determine the efficiency of male (female) adult workers at t+1, $\rho > 0$ the time discount rate, σ^{-1} the intertemporal elasticity of substitution, and p_A the probability of survival from adulthood to retirement. The coefficient η_c^j pertains to relative preference for today's consumption, η_q to relative preference for the home-produced good, and η_e to relative preference for children's education.

We assume that the female adult divides her time for four uses: market production, home production, child-rearing, and child education. Thus, the time constraint for the female is as follows:

$$h_t^w + h_t^q + h_t^R + h_t^e = 1 \quad (2)$$

where h_t^w is the adult female's time allocated to market production, h_t^q her time allocated to home production, h_t^R her time allocated to child-rearing, and h_t^e her time allocated to child education.

We assume that

$$h_t^{mq} = f_1 h_t^q \quad (3)$$

where h_t^{mq} is the male adult's time allocated to home production and f_1 represents the bargaining power of a wife with respect to home production. Equation 3 implies that the decision on time allocation to home production by the male and by the female is done in two steps: first, the decision on the female's time allocated to home production is made, and then second, the bargaining power of a female determines the male's proportionate time allocation to home production. The bigger the bargaining power of the women, the higher is the proportion. For simplicity, we assume that f_1 is exogenously determined and constant. Generally $f_1 < 1$ and perfect equality is obtained if $f_1 = 1$. This two-step decision allows us to focus solely on the female's decision, thus simplifying the problem. We will make the same assumption for the time allocation to other uses.

We assume that $h_t^R = (2 - f_2) v n_t$ where $2v$ is rearing time needed per child. Again the male's time allocated to child-rearing is

$$h_t^{mR} = f_2 v n_t \quad (4)$$

where f_2 represents the bargaining power of a female with respect to child-rearing. f_2 is not necessarily equal to f_1 since the comparative advantage of the male and the female in these activities are not the same. In general, the female has more comparative advantage in child-rearing particularly if child-rearing also involves breast-feeding.

Finally, the time allocated to education satisfies $h_t^e = n_t \epsilon_t^e$ where ϵ_t^e is average education time spent for each child. We assume that the female allocates her time equally between sons and daughters. The male's time allocated to child-rearing per child is determined by

$$\epsilon_t^{me} = f_3 \epsilon_t^e \tag{5}$$

where f_3 represents the bargaining power of a female with respect to child education. Hence, the total time spent on child education by the male is $h_t^{me} = f_3 n_t \epsilon_t^e$.

Then the time constraint faced by the female can be represented as follows:

$$h_t^w + h_t^q + (2 - f_2) v n_t + n_t \epsilon_t^e = 1 \tag{6}$$

The home production function is

$$q_t = \bar{q}(h_t^q + h_t^{mq})^\gamma [\left(e_t^f\right)^\chi (e_t^m)^{1-\chi_1}] = \bar{q}(1 + f_1)^\gamma (h_t^q)^\gamma [\left(e_t^f\right)^{\chi_1} (e_t^m)^{1-\chi_1}] \tag{7}$$

where e_t^f and e_t^m are the education level of mother and father, and the second equality holds because of (3). We assume that time spent by a male is perfectly substitutable with time spent by a female. However, we assume that the education of a female and a male is introduced as a Cobb-Douglas functional form where χ_1 and $1 - \chi_1$ are the output elasticity of female and male education.

The education level of children that will become productivity when they become adults is determined by three factors: the average government spending on education per (surviving) child, a mother's human capital e_t^f, and the time mothers allocate to each child, as follows:[4]

$$e_{t+1}^f = e_{t+1}^m = \bar{e}(\frac{\mu G_t}{n_t^a N_t / 2})^{\nu_1} [\left(e_t^f\right)^{\chi_1} (e_t^m)^{1-\chi_1}]^{1-\nu_1} ((1 + f_3)\epsilon_t^e)^{\nu_2} \tag{8}$$

where G_t is total government spending, μ an indicator of efficiency of government spending, N_t the number of individuals of generation t, and n_t^a the average number of children in the households. Since we assume the representative household, $n_t^a = n_t$ holds in equilibrium.

[4] The formulas for children's human capital accumulation do not include the role of private education spending. However, the mother's time can be interpreted as comprising private educational spending. The model can be extended to include the allocation of family income to education of children, though the solution of the model becomes much complicated.

The household budget constraint at t and t+1 are:[5]

$$c_t + s_t = (1-\tau)w_t^H \tag{9}$$

$$c_{t+1} = \frac{(1+r_{t+1})s_t}{p_A} \tag{10}$$

where $\tau \in (0,1)$ is the tax rate, s_t saving, r_{t+1} interest rate between t and t+1, and w_t^H total gross wage income for the household.

$$\begin{aligned} w_t^H &= e_t^m h_t^{mw} w_t^m + e_t^f h_t^w w_t^f \\ &= e_t^m (1 - f_1 h_t^q - f_2 v n_t - f_3 n_t \epsilon_t^e) w_t^m + e_t^f (1 - h_t^q - (2-f_2) v n_t - n_t \epsilon_t^e) w_t^f \end{aligned} \tag{11}$$

where $h_t^{mw} = 1 - h_t^{mq} - h_t^{mR} - h_t^{me}$ is the time allocated by the male to market production. In this expression, $e_t^m h_t^{mw}$ and $e_t^f h_t^w$ measure labor supply by male and female adults in efficiency units, and w_t^m and w_t^f are effective market wages for male and female adults, respectively.

The household maximizes the utility (1) with respect to c_t, c_{t+1}, h_t^q, ϵ_t^e, and n_t subject to the constraints (2)–(11). The first order conditions for c_t and c_{t+1} implies that

$$\left(\frac{c_{t+1}}{c_t}\right)^\sigma = \frac{1+r_{t+1}}{\eta_c(1+\rho)} \tag{12}$$

It is useful to derive the saving rate from (12) as follows:

$$\theta_t = 1 - \frac{1}{1 + \frac{p_A}{1+r_{t+1}} \left(\frac{1+r_{t+1}}{\eta_c(1+\rho)}\right)^{1/\sigma}} \tag{13}$$

Market output is produced by identical firms whose number is normalized to unity. Each identical firm i's production function takes the following form:

$$Y_t^i = \bar{Y} (E_t^m H_t^{mw} N_t^{m,i})^\alpha (E_t^f H_t^w N_t^{f,i})^\alpha (K_t^i)^{1-2\alpha} \tag{14}$$

where $\alpha \in (0,1)$ is the elasticity of output with respect to male and female effective labor that is assumed to be the same. Since the representative firm hires labor from the labor market, it hires male and female workers with average labor productivity (education level) E_t^m and E_t^f, respectively. The average male and female adult's time allocated to market production is denoted by H_t^{mw} and H_t^w and the number of male and female workers are $N_t^{m,i}$ and $N_t^{f,i}$. Finally K_t^i is the amount of capital stock employed by firm i.

[5] As in Kim, Lee, and Shin (2015), we assume that the savings made by adults who do not survive to old age are confiscated by the government and equally distributed in lump sum to the surviving adults when they become old. Hence the return rate of saving, $\frac{(1+r_t)}{p_A}$ is higher than the actual interest rate, $1 + r_t$.

Profits of firm *i* are represented as follows:

$$\Pi_t^i = Y_t^i - \left(w_t^m E_t^m H_t^m N_t^{m,i} + w_t^f E_t^f H_t^w N_t^{f,i}\right) - r_t K_t^i \tag{15}$$

where the price of the marketed good is normalized to unity and r_t is the rental rate of capital that is identical to the rate of return to savings. The firm, taking input prices as given, maximizes profits with respect to the number of male and female workers and capital.

As in Kim, Lee, and Shin (2015), we assume that there is discrimination in the labor market against female workers: while male workers receive their marginal product, female workers receive a faction $\mathrm{d} \in (0,1)$ of their marginal product. For simplicity, we assume that firms do not distribute to households the profits accrued due to female discrimination in the labor market. Then the optimal choices of the firm for labor and capital satisfy the following equations:

$$w_t^m = \frac{\alpha Y_t^i}{E_t^m H_t^{mw} N_t^{m,i}}, w_t^f = \frac{d\alpha Y_t^i}{E_t^f H_t^w N_t^{f,i}}, r_t = (1-2\alpha)\frac{Y_t^i}{K_t^i} \tag{16}$$

In equilibrium, $N_t^{m,i} = N_t^m$, $N_t^{f,i} = N_t^f$ and $K_t^i = K_t$ for all *i* and the aggregate output is,

$$Y_t = \int_0^1 Y_t^i = \bar{Y}(E_t^m H_t^{mw} N_t^m)^\alpha (E_t^f H_t^w N_t^f)^\alpha (K_t)^{1-2\alpha} \tag{17}$$

From (14) and the equilibrium conditions, the following relation holds between w_t^m and w_t^f:

$$w_t^m E_t^{mw} H_t^m = d^{-1} w_t^f E_t^f H_t^w \tag{18}$$

In equilibrium the following equations hold: $e_t^m = E_t^m$, $e_t^f = E_t^f$, $h_t^{mw} = H_t^{mw}$ and $h_t^w = H_t^w$.

The government finances its expenditure on education, G_t and on unproductive usage, U_t by taxing the wage income.[6] We assume that the expenditure on the unproductive usage is proportional to that on education: $U_t = \emptyset G_t$. Further, we assume that the government budget is balanced every period:

$$G_t + U_t = \tau\left(E_t^m H_t^m N_t^m w_t^m + E_t^f H_t^w N_t^f w_t^f\right) \tag{19}$$

where τ is the tax rate of government expenditure. Then

$$(1+\emptyset)G_t = \tau\left(E_t^m H_t^m N_t^m w_t^m + E_t^f H_t^w N_t^f w_t^f\right) \tag{20}$$

or

$$(1+\emptyset)g_t = \tau\left(E_t^m H_t^m w_t^m + E_t^f H_t^w w_t^f\right) \tag{21}$$

where $g_t \equiv \frac{G_t}{N_t^f} = \frac{G_t}{N_t/2}$.

[6] The model can be easily extended to allow nondistortionary revenue financing public education expenditures or unproductive government spending reallocated to the education sector. This extension will produce a more positive contribution to economic growth in the form of an increase in government education spending.

In equilibrium, from (16) and (18)

$$(1+\emptyset)g_t = \tau\left(E_t^m H_t^m w_t^m + E_t^f H_t^w w_t^f\right) = \tau\left(e_t^m h_t^m w_t^m + e_t^f h_t^w w_t^f\right) = \tau(1+d^{-1})e_t^f h_t^w w_t^f$$
$$= 2\tau(1+d)\,\alpha\frac{Y_t}{N_t} \quad (22)$$

or

$$(1-\emptyset)G_t = \tau(1+d)\,\alpha Y_t \quad (23)$$

The competitive equilibrium satisfies the following three conditions:

(i) The household maximizes utility (1) with respect to $c_t, c_{t+1}, n_t, h_t^w, h_t^q, h_t^R,$ and h_t^e.
(ii) The firm maximizes profits with respect to $N_t^{m,i}, N_t^{f,i}$, and K_t^i.
(iii) Markets cleared. In particular the asset-market clearing condition requires that total savings by all households $(0.5N_t)$ in period t are equal to total capital stock at the beginning of period $(t+1)$: $0.5N_t s_t = N_t^f s_t = K_{t+1}$.

In the balanced growth path, it can be easily verifiable that $\frac{Y_t}{N_t}$ and $\frac{K_t}{N_t}$ grow at the same rate as e_t^f. Hence, the female education (that is the same as the male education) is the key to perpetual growth.

The growth rate of per capita gross domestic product in steady state is:[7]

$$1+\gamma_{Y/N} = 2\bar{Y}(1-fh^{q*}-f_2vn^*-f_3n^*\epsilon^{e*})^{\alpha}\,(1-h^{q*}-(2-f_2)vn^*-n^*\epsilon^{e*})^{\alpha}(k^*)^{-2\alpha}d\alpha\Phi\theta^*(n^*)^{-1} \quad (24)$$

where the variables with * are steady-state values and $k^{f*} = (\frac{K}{e^f N^f})^*$.

B. Calibration and Balanced Growth Path

Most parameter values are from the macroeconomics literature and Kim, Lee, and Shin (2015). Some of our parameters are derived from the calibration of our model to fit into its steady-state values, which are derived from the average values from the Republic of Korea for the period 2005–2010 as reported in the World Development Indicators by the World Bank, Bank of Korea data, and Korea Time Use Survey (2009) data. The values are as follows:

(i) Fertility: 1.17,
(ii) Annual per capita income growth rate: 3.6%,
(iii) Net private saving rate (% of disposable income): 16.1%,[8]
(iv) Female and male LFPR: 54.43% and 75.92%,
(v) Wife–husband ratio of child-rearing time: 5.1[9] (51 minutes a day by wife and 10 minutes by husband), and

[7] See the appendix for the derivation.
[8] Net saving rate is private saving rate (22.1%) minus depreciation (6%).

(vi) Wife–husband ratio of child education time: 3.25 (26 minutes a day by wife and 8 minutes by husband).

f_2 is derived from $(2 - f_2)/f_2$ = 5.1. f_3 is derived from $1/f_3$ = 3.25. Since the male LFPR in our model is $(1 - f_1 h_t^q - f_2 v n_t - f_3 n_t \epsilon_t^e)$, parameter f_1 can be estimated from the equation:

$$f_1 h_t^q = 1 - 0.7592 - f_2 v n_t - f_3 n_t \epsilon_t^e,$$

where h_t^q, n_t, and ϵ_t^e are endogenously determined in our model. From the calibration with other average values, we are able to pin down the following parameter values:

f_1 = 0.5897,
f_2 = 0.3279,
f_3 = 0.3077,
v = 2.8099,
ρ = 0.5982,
$\bar{e}$ = 4.2797, and
$\bar{q}$ = 23.6313.

Table 3 reports the parameter values used for the calibration, and Table 4 presents the steady-state values of key variables in the model economy.

Table 3: Calibrated Parameters

Parameter	Value	Description
Households		
ρ	0.5982	Annual discount rate
σ	0.8	Inverse of elasticity of substitution
P_A	0.987	Survival probability
δ	1.05	Preference parameter for number of children
η_e	0.2	Preference parameters for children's education
η_q	12	Family preference parameter for home production output
η_c	3.5	Preference parameter for consumption
v	2.8099	
Home output		
γ	0.122	Curvature of production function
f_1	0.5897	Bargaining power of a female in home production
f_2	0.3279	Bargaining power of a female in child-rearing
f_3	0.3077	Bargaining power of a female in child-rearing
$\bar{q}$	23.6313	
χ	0.8	
Market output		
α	0.4	Elasticity w.r.t. labor input
d	0.6	Gender bias in the workplace
$\bar{Y}$	1	

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[9] Child-rearing time includes time spent on washing, feeding, sending off to school, putting in bed, and transporting of children. Child education time includes time spent on helping homework, teaching, and reading.

Table 3 continued

Parameter	Value	Description
Human capital		
υ_1	0.4	Elasticity w.r.t. public spending in education
υ_2	0.3	Elasticity w.r.t. public–private ratio
$\bar{e}$	4.2797	
Government		
τ	0.163	Tax rate on marketed output
μ	0.39	Education spending efficiency parameter
Ø	3	Factor of unproductive, exogenous government expenditure to educational expenditure

w.r.t. = with respect to.
Source: Authors' calculations.

Table 4: Steady-State Solutions

Variables	Value	Description
$p_c n$	1.17	Fertility rate (n = 1.17)
h^m	0.7592	Labor force participation rate of males
h^w	0.5443	Labor force participation rate of females
θ	0.1610	Net private savings rate
$\gamma_{Y/N}$	1.889	Per capita growth rate (= 1.0360^{30} – 1)

Source: Authors' calculations.

IV. ESTIMATION OF THE ECONOMIC EFFECTS OF GENDER INEQUALITY IN THE REPUBLIC OF KOREA

A. Output Costs of Gender Inequality

We can measure the output costs of gender inequality by comparing the performances of the benchmark case with those of a hypothetical Korean economy with no gender inequality. In the hypothetical gender-equal case, males and females have the same opportunities and power at home, in education, and in the labor markets.

Table 5 illustrates the alternative steady state of the economy with complete gender equality ($d = 1$, and $f_1 = f_2 = f_3 = 1$). The table shows the values of fertility rate, female labor participation rate, and per capita output growth rate in the new steady state.

According to the simulation results, with complete gender equality, the female labor market participation rate increases from 54.4 to 67.5. Note that in our framework, the LFPRs for males and females are equal with no gender bias at home and labor market. Per capita output growth rate in the new steady state increases to a higher value. The results show that by eliminating the gender inequality, the annual growth rates of per capita income can be enhanced by approximately 0.5 percentage point, by increasing from the current level of 3.6% to 4.1%.

Table 5: Steady-State Values for the Hypothetical Cases with Gender Equality

	Fertility	Female Labor Force Participation Rate (%)	Per Capita Output Growth Rate
Current level	*1.17*	*54.43*	*0.0360*
New steady states			
Complete gender equality			
$d = 1, f_1 = f_2 = f_3 = 1$	0.98	67.51	0.0406
Gender equality by category			
$d = 1$	0.97	59.30	0.0434
$f_1 = 1$	1.29	62.24	0.0346
$f_2 = 1$	1.10	56.50	0.0378
$f_3 = 1$	1.08	55.43	0.0345
$d = 1, f_1 = 1$	1.04	64.84	0.0420

Note: See Table 1 for the definition of the parameters, d, f_1, f_2, and f_3.
Source: Authors' calculations.

According to the simulation results, in the hypothetical gender-equal economy, the fertility rate becomes 0.98, lower than the current value, 1.17.

The table also presents the new steady-state values that would be reached by the Korean economy if one of the four inequalities or the inequalities both in home production and labor market are eliminated for a comparison with the case of complete gender equality. The result in column 3, for example, shows that with the complete elimination of the gender discrimination in labor market alone (i.e., d = 1), the female labor market participation rate increases from 54.4% to 59.3%, and per capita income growth increases from 3.6% to 4.3% on average over a generation.

Interestingly, removing only the gender inequality in home production ($f_1 = 1$) or education ($f_3 = 1$) lowers the growth rate of per capita income. The decrease in per capita output growth rate is mainly due to a decrease in male labor supply. As husbands increase the time they allocate to home production, child-rearing, and education with perfect gender equality in home production or in education, they will spend less time in the labor market. Another reason for the lower income growth rate per person in the case of perfect gender equality in home production ($f_1 = 1$) c is an increase in fertility and thus, also in the population growth rate.

B. Gender-Based Policies

We consider the following three policies to promote gender equality:

(i) Lower discrimination in the labor market: $d \uparrow$
(ii) Increase the time spent by a male on child-rearing: $f_2 \uparrow$
(iii) Lower time cost for child-rearing: $v \downarrow$

In Figure 2, we illustrate the change in three key variables of the most interest—fertility rate, female labor market participation rate, and per capita income growth—when the three policies are implemented.

Lowering the discrimination in the labor market by changing the value of d from 0.6 to 0.7 increases the growth rate of per capita output by about 0.2 percentage point. When the distortion in the labor market is reduced, the female's time allocated to market production significantly increases, contributing to the increase in per capita output growth. In this case, the fertility is lowered as females allocate more time to market production.

If males increase time for child-rearing, i.e., raising f_2 (from 0.328 to 0.667), both female labor market participation and growth rate of per capita output increase. In this case, the fertility rate decreases.

Contrastingly, when the rearing time needed per child v is lowered from 2.810 to 2.5, the growth rate of per capita output decreases. Since a decrease in v implies that the cost involved with increasing the quantity of children is lowered, the optimal decision is to increase the fertility. In this case, the increase in the fertility rate dominates the increase in aggregate output, eventually lowering the growth rate of the per capita output.

Figure 2: The Impact of Gender Equality Policies

2.1 Fertility

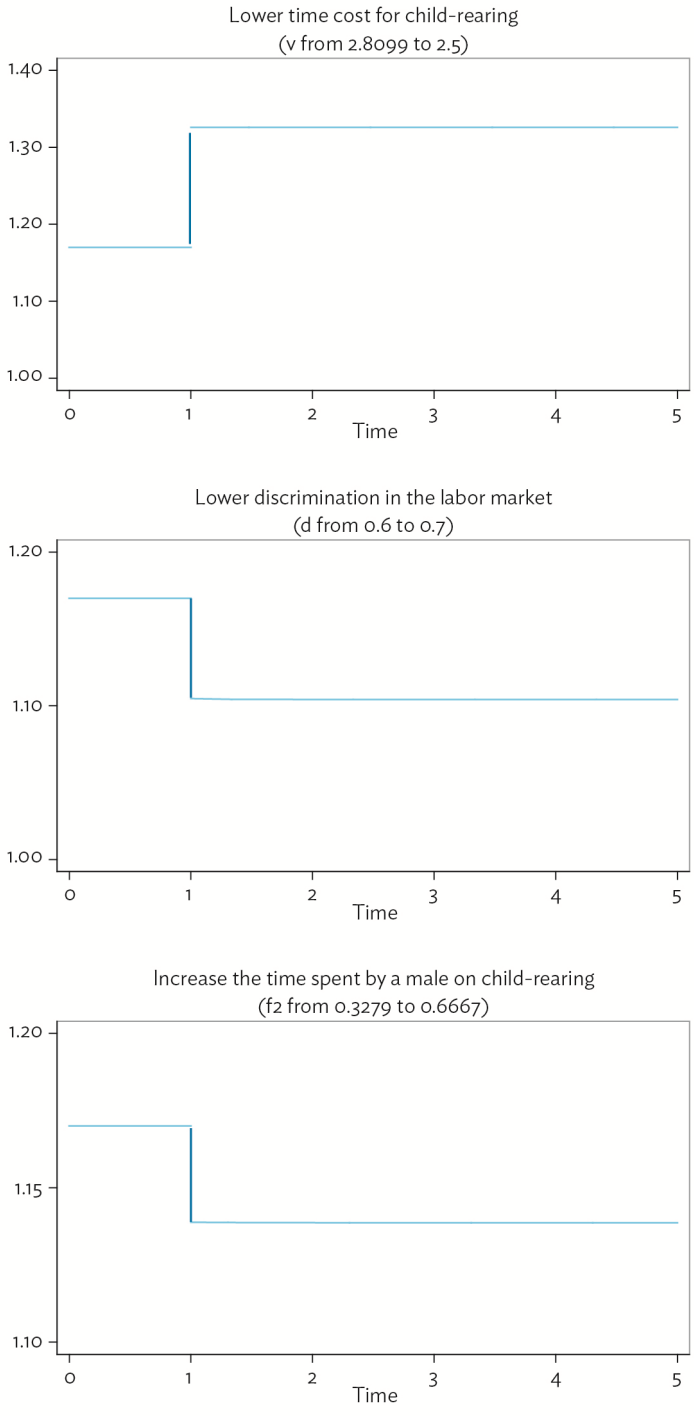

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Figure 2 continued

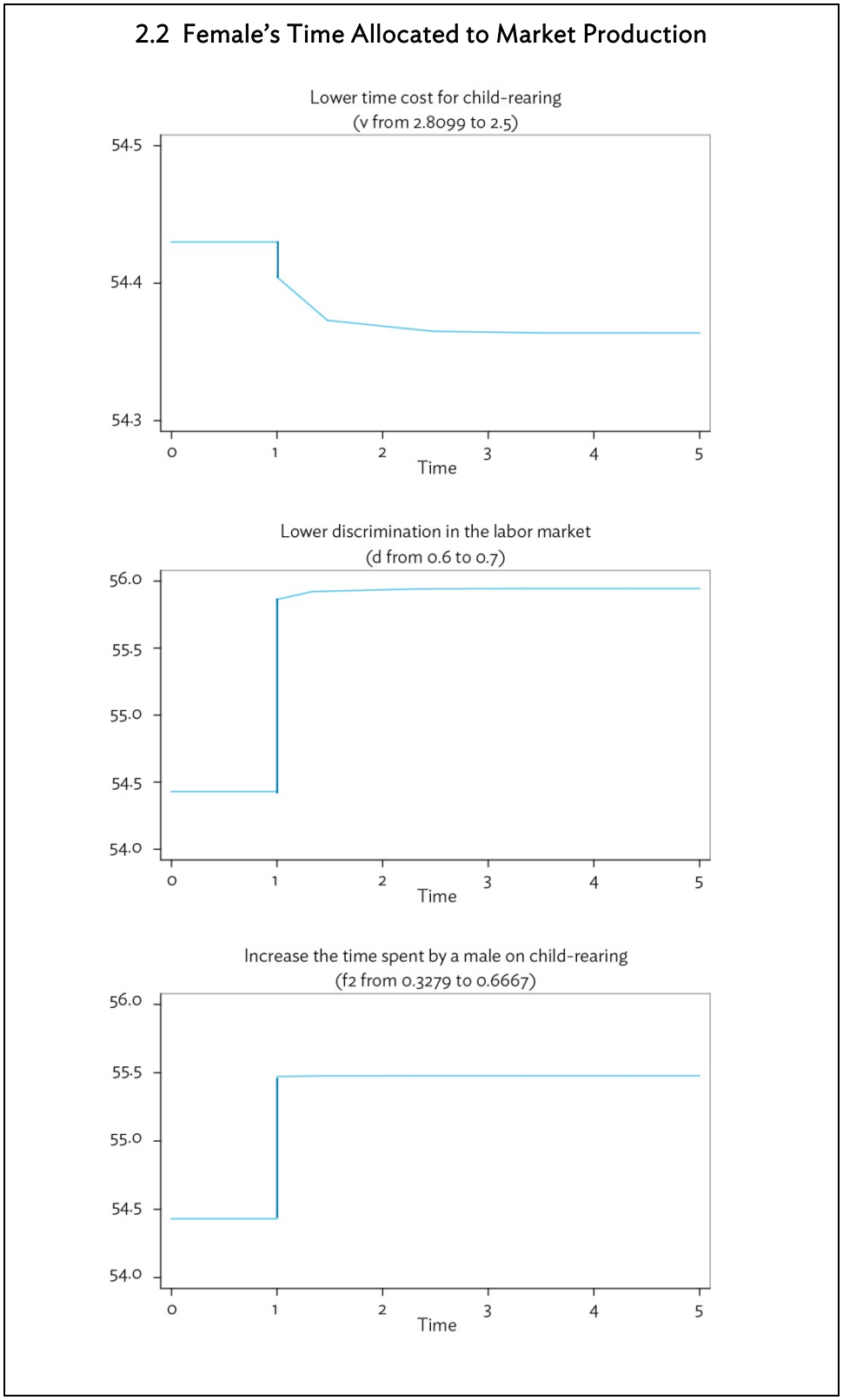

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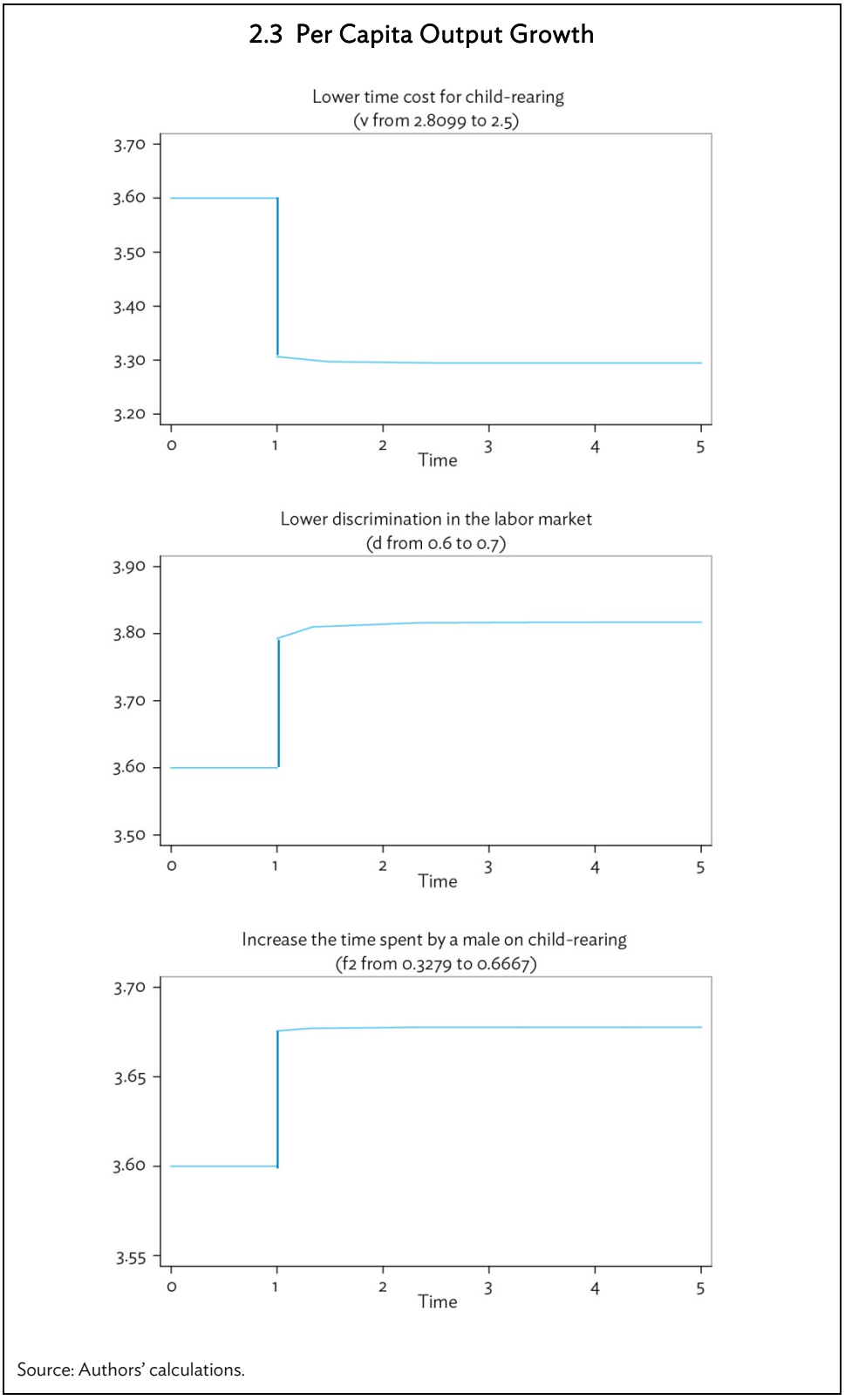
Figure 2 continued



Source: Authors' calculations.

V. CONCLUDING REMARKS

The paper provides a theoretical framework that can explain the determination of female labor market participation, human capital accumulation, and economic growth in the Korean economy. We employ this framework to quantitatively analyze the output cost of gender inequality. Our results indicate that the output cost of gender inequality is quite sizable. If the gender inequality is completely eliminated, the female LFPR increases from 54.4% to 67.5%, and the annual per capita income growth rises from 3.6% to 4.1% on average over a generation. The increase in the economic growth rate implies that with the complete elimination of gender inequality, per capita income will become approximately 15% higher over one generation. We believe that this growth-enhancing effect of gender equality is comparable to that of other types of policies contemplated in the Korean economy, such as increasing public infrastructure investment and removing unnecessary regulations.

Among various policy measures related with gender equality that we contemplated in our study, we find that the most effective policy in terms of enhancing the growth rate of per capita income is eliminating the discrimination in the labor market. Policies that attempt to mitigate gender inequalities by reducing women's time allocated to home production, child-rearing, and education would be helpful for enhancing growth when they are combined with the reduction of fundamental discrimination in the labor market and are designed to minimize negative influences on the male's labor market participation.

One intriguing lesson from our analysis for policy making is that, a particular policy to meet a specific goal can sometimes produce an adverse effect in terms of another goal of our concerns. One example of this point is the policy to eliminate discrimination against women in the labor market. On one hand, this policy will encourage more women to participate in the labor market and increase female labor force participation. However, it will also raise the opportunity cost of time for women, which will likely lower fertility and thus exacerbate the aging population problem. We can also show that childcare subsidies will lower the cost of child-rearing and therefore increase fertility while this policy will lower female labor market participation. Similarly, a public policy that promotes males' engagement in child-rearing can increase female labor market participation and per capita income growth, but lower fertility.

Since the early 2000s, the relationship between female labor market participation and fertility among OECD countries (based on the cross-sectional data) has been changed from a negative one to a positive one. The OECD data also show a positive relationship between the gender equality index and fertility in recent years. The results from our analysis indicate that these recent changes are not due to one particular policy but rather due to a combination of policies that are well coordinated. It would be wise for the Korean government to implement multiple public policies together in order to achieve a multiple number of goals.

Our analysis has left a number of important issues related to gender inequality unaddressed. For example, our model does not consider the glass ceiling in promotion for women in business and in the public sector, social norms against gender equality, endogenous determination of bargaining power between wives and husbands, and the like. We will pursue a more expansive model in future studies that can be used to measure the economic costs of these other aspects of gender inequality in the Republic of Korea.

APPENDIX

In this appendix, we derive equations needed to solve the steady states. Then we calculate the balanced growth rate.

The household problem is to maximize the household utility function:

$$U_t = \eta_c \frac{1}{1-\sigma} {c_t}^{1-\sigma} + \eta_q \frac{1}{1-\sigma} {q_t}^{1-\sigma}$$
$$+\eta_e \left[\frac{1}{1-\sigma} \left(\left(\frac{n_t}{2} \right)^{\delta} e_{t+1}^{m} \right)^{1-\sigma} + \frac{1}{1-\sigma} \left(\left(\frac{n_t}{2} \right)^{\delta} e_{t+1}^{f} \right)^{1-\sigma} \right] + \frac{p_A}{1+\rho} \frac{1}{1-\sigma} {c_{t+1}}^{1-\sigma} \quad \text{(A1)}$$

Subject to

$$q_t = \bar{q}(1+f_1)^{\gamma} (h_t^q)^{\gamma} e_t^f \quad \text{(A2)}$$
$$(1-\tau) e_t^m \left(1 - f_1 h_t^q - f_2 v n_t - f_3 n_t \epsilon_t^e\right) w_t^m$$
$$+(1-\tau) e_t^f \left(1 - h_t^q - (2-f_2) v n_t - n_t \epsilon_t^e\right) w_t^f - c_t - \frac{p_A c_{t+1}}{1+r_{t+1}} = 0 \quad \text{(A3)}$$

$$e_{t+1}^m = \bar{e} \left(\frac{\mu G_t}{n_t^a N_t/2} \right)^{\nu_1} [e_t^f]^{1-\nu_1} ((1+f_3)\epsilon_t^e)^{\nu_2} \quad \text{(A4)}$$

$$e_{t+1}^f = \bar{e} \left(\frac{\mu G_t}{n_t^a N_t/2} \right)^{\nu_1} [e_t^f]^{1-\nu_1} ((1+f_3)\epsilon_t^e)^{\nu_2} \quad \text{(A5)}$$

First-Order Conditions

$$(c_t) \quad \eta_c {c_t}^{-\sigma} = \lambda$$
$$(c_{t+1}) \quad \frac{p_A}{1+\rho} {c_{t+1}}^{-\sigma} = \lambda \frac{p_A}{1+r_{t+1}}$$
$$=> \left(\frac{c_{t+1}}{c_t} \right)^{\sigma} = \frac{1+r_{t+1}}{\eta_c (1+\rho)} \quad \text{(A6)}$$

$$(h_t^q) \; \eta_q \bar{q}^{1-\sigma} \gamma (1+f)^{\gamma(1-\sigma)} (h_t^q)^{(1-\sigma)\gamma-1} \left(e_t^f\right)^{1-\sigma} = \eta_c {c_t}^{-\sigma} (1-\tau)(f_1 e_t^m w_t^m + e_t^f w_t^f) \quad \text{(A7)}$$

$$(\epsilon_t^e) \quad \eta_e \left(\left(\frac{n_t}{2} \right)^{\delta} e_{t+1}^{m} \right)^{-\sigma} \left(\frac{n_t}{2} \right)^{\delta} \bar{e} \left(\frac{\mu G_t}{\frac{n_t^a N_t}{2}} \right)^{\nu_1} (e_t^f)^{1-\nu_1} (1+f_3)^{\nu_2} \nu_2 (\epsilon_t^e)^{\nu_2 - 1}$$
$$+ \eta_e \left(\left(\frac{n_t}{2} \right)^{\delta} e_{t+1}^{f} \right)^{-\sigma} \left(\frac{n_t}{2} \right)^{\delta} \bar{e} \left(\frac{\mu G_t}{\frac{n_t^a N_t}{2}} \right)^{\nu_1} (e_t^f)^{1-\nu_1} (1+f_3)^{\nu_2} \nu_2 (\epsilon_t^e)^{\nu_2 - 1}$$

$$= \eta_c {c_t}^{-\sigma} (1-\tau) [e_t^m (f_3 n_t) w_t^m + e_t^f (n_t \epsilon_t^e) w_t^f] \quad \text{(A8)}$$

$$(n_t) \quad \eta_e (e_{t+1}^m)^{1-\sigma} \left(\frac{1}{2} \right)^{\delta(1-\sigma)} \delta (n_t)^{\delta(1-\sigma)-1} + \eta_e \left(e_{t+1}^f\right)^{1-\sigma} \left(\frac{1}{2} \right)^{\delta(1-\sigma)} \delta (n_t)^{\delta(1-\sigma)-1}$$
$$= \eta_c {c_t}^{-\sigma} (1-\tau) [e_t^f w_t^f (\epsilon_t^e + (2-f_2)v) + e_t^m w_t^m (f_3 \epsilon_t^e + f_2 v)] \quad \text{(A9)}$$

Since $e_t^m = E_t^m, e_t^f = E_t^f, h_t^m = H_t^m, h_t^f = H_t^f, Y_t^i = Y_t$ and $N_t^{m,i} = N_t^{f,i} = \frac{1}{2}N_t$ hold in equilibrium,

$$w_t^f = \frac{2d\alpha}{e_t^f h_t^w}\frac{Y_t}{N_t} \tag{A10}$$

and

$$w_t^m = \frac{2\alpha Y_t}{e_t^m h_t^{mw} N_t} = \frac{2\alpha}{e_t^f (1-f_1 h_t^q - f_2 v n_t - f_3 n_t \epsilon_t^e)}\frac{Y_t}{N_t} \tag{A11}$$

Dynamics for N_t

The number of adults next period N_{t+1} is the surviving children born at time t. Since the number of households at time t is $\frac{N_t}{2}$ and each household gives birth to n_t that will survive with probability p_c, the dynamics of N_t follows:

$$N_{t+1} = n_t \frac{N_t}{2} \tag{A12}$$

Savings in Equilibrium

From (7) and (8),

$$c_t + \frac{p_A c_{t+1}}{(1+r_{t+1})} = (1-\tau)w_t^H \tag{A13}$$

Substituting (A6) into (A13) yields,

$$c_t + \frac{p_A}{1+r_{t+1}}\left(\frac{1+r_{t+1}}{\eta_c(1+\rho)}\right)^{1/\sigma} c_t = (1-\tau)w_t^H \tag{A14}$$

$$c_t = \frac{1}{1+\frac{p_A}{1+r_{t+1}}\left(\frac{1+r_{t+1}}{\eta_c(1+\rho)}\right)^{1/\sigma}}(1-\tau)w_t^H \tag{A15}$$

Hence the saving rate θ_t is

$$\theta_t = 1 - \frac{1}{1+\frac{p_A}{1+r_{t+1}}\left(\frac{1+r_{t+1}}{\eta_c(1+\rho)}\right)^{1/\sigma}} \tag{A16}$$

Since $e_t^m = E_t^m$, $e_t^f = E_t^f$, $h_t^m = H_t^m$ and $h_t^f = H_t^f$ is held in equilibrium, total gross wage income for the household becomes:

$$w_t^m e_t^m h_t^{mw} = d^{-1} w_t^f e_t^f h_t^w \tag{A17}$$

Then the budget constraint for the household becomes

$$w_t^H = e_t^m h_t^{mw} w_t^m + e_t^f h_t^w w_t^f = (1+d^{-1}) e_t^f h_t^w w_t^f \tag{A18}$$

Then savings S_t in equilibrium are

$$S_t = \theta_t(1-\tau)(1+d^{-1})e_t^f h_t^w w_t^f = \theta_t\, \Phi e_t^f \left(1 - h_t^q - (2-f_2)vn_t - n_t\epsilon_t^e\right)w_t^f \tag{A19}$$

where $\Phi = (1-\tau)\left(1+d^{-1}\right)$.

Interest Rate

$$r_{t+1} = (1-2\alpha)\frac{Y_{t+1}}{K_{t+1}} \tag{A20}$$

Dynamics for K_t

$$\begin{aligned} K_{t+1} &= 0.5\left(N_t^m + N_t^f\right)S_t \;\; = N_t^f S_t \\ &= \Phi N_t^f \theta_t e_t^f \left(1 - h_t^q - (2-f_2)vn_t - n_t\epsilon_t^e\right)w_t^f \\ &= d\alpha\Phi\theta_t Y_t \end{aligned} \tag{A21}$$

$$\frac{K_{t+1}}{K_t} = d\alpha\Phi\theta_t \frac{Y_t}{K_t} \tag{A22}$$

$$Y_t = \bar{Y}\left(\frac{E_t^m N_t^m}{K_t}\right)^\alpha \left(\frac{E_t^f N_t^f}{K_t}\right)^\alpha (1 - f_1 h_t^q - f_2 vn_t - f_3 n_t\epsilon_t^e)^\alpha\, (1 - h_t^q - (2-f_2)vn_t - n_t\epsilon_t^e)^\alpha K_t \tag{A23}$$

$$\frac{Y_t}{K_t} = \bar{Y}\left(\frac{1}{k_t^m}\right)^\alpha \left(\frac{1}{k_t^f}\right)^\alpha (1 - f_1 h_t^q - f_2 vn_t - f_3 n_t\epsilon_t^e)^\alpha\, (1 - h_t^q - (2-f_2)vn_t - n_t\epsilon_t^e)^\alpha, \tag{A24}$$

where $k_t^m = \frac{K_t}{E_t^m N_t^m}$ and $k_t^f = \frac{K_t}{E_t^f N_t^f}$

Since $e_{t+1}^f = e_{t+1}^m\, k_t^m = k_t^f$. (A25)

$$\frac{Y_t}{K_t} = \bar{Y}\, (1 - f_1 h_t^q - f_2 vn_t - f_3 n_t\epsilon_t^e)^\alpha\, (1 - h_t^q - (2-f_2)vn_t - n_t\epsilon_t^e)^\alpha \left(\frac{1}{k_t^f}\right)^{2\alpha} \tag{A26}$$

Dynamics for Education

From (6), (17), and (18),

$$e_{t+1}^f = e_{t+1}^m = \bar{e}\left(\frac{\mu G_t}{n_t^a N_t/2}\right)^{\nu_1} (e_t^f)^{1-\nu_1}[\epsilon_t^e]^{\nu_2} = \bar{e}\left(\frac{\mu\tau(1+d)\alpha}{n_t^a/2}\right)^{\nu_1}\left(\frac{(1-\emptyset)^{-1}Y_t}{N_t}\right)^{\nu_1}(e_t^f)^{1-\nu_1}[\epsilon_t^e]^{\nu_2} \tag{A27}$$

By definition,

$$\begin{aligned} &\frac{Y_t}{0.5 e_t^f N_t} = \frac{Y_t}{K_t}\frac{K_t}{e_t^f N_t^f} = \frac{Y_t}{K_t}k_t^f \\ &= \bar{Y}\, (1 - f_1 h_t^q - f_2 vn_t - f_3 n_t\epsilon_t^e)^\alpha\, (1 - h_t^q - (2-f_2)vn_t - n_t\epsilon_t^e)^\alpha (k_t^f)^{1-2\alpha} \end{aligned} \tag{A28}$$

Dynamics for k_t^f

$$k_{t+1}^f = \frac{K_{t+1}}{E_{t+1}^f N_{t+1}^f} = \frac{K_{t+1}}{E_{t+1}^f 0.5 n_t N_t/2} = \frac{d\alpha\Phi\theta_t Y_t}{0.25 E_{t+1}^f n_t N_t}$$

$$= \frac{d\alpha\Phi\theta_t Y_t/N_t}{0.25 n_t \bar{e}\left(\frac{\mu\tau(1+d)\alpha}{n_t/2}\right)^{\nu_1}\left(\frac{Y_t}{N_t}\right)^{\nu_1}(e_t^f)^{1-\nu_1}[\epsilon_t^e]^{\nu_2}}$$

$$= \frac{d\alpha\Phi\theta_t}{[2(1-b)]^{\nu_2}\bar{e}(n_t)^{1-\nu_1}}(\mu\tau(1+d)\alpha)^{-\nu_1}\left(\frac{Y_t}{0.5 e_t^f N_t}\right)^{1-\nu_1} 2(\epsilon_t^e)^{-\nu_2}$$

$$= \Gamma\theta_t \left(\frac{Y_t}{0.5 e_t^f N_t}\right)^{1-\nu_1}(\epsilon_t^e)^{-\nu_2}$$

$$= \Gamma\theta_t\,(\bar{Y}\Gamma_1)^{1-\nu_1}\,(1-fh_t^q)^{\alpha(1-\nu_1)}\,(1-h_t^q-vn_t-n_t\epsilon_t^e)^{\alpha(1-\nu_1)}(\epsilon_t^e)^{-\nu_2}(k_t^f)^{(1-2\alpha)(1-\nu_1)} \quad \text{(A29)}$$

where $\Gamma = \frac{2d\alpha\Phi}{\bar{e}(n_t)^{1-\nu_1}}(\mu\tau(1+d)\alpha)^{-\nu_1}$

Steady-State Growth Rate

From (A11), (A21), and (A24)

$$\frac{Y_{t+1}}{N_{t+1}} = \frac{Y_{t+1}}{K_{t+1}}\frac{K_{t+1}}{N_{t+1}} = \frac{Y_{t+1}}{K_{t+1}}K_{t+1}\frac{1}{N_{t+1}}$$

$$= \bar{Y}\,(1-f_1h_t^q-f_2vn_t-f_3n_t\epsilon_t^e)^{\alpha}\,(1-h_t^q-(2-f_2)vn_t-n_t\epsilon_t^e)^{\alpha}\left(\frac{1}{k_{t+1}^f}\right)^{2\alpha} d\alpha\Phi\theta_t Y_t\frac{1}{n_t\frac{N_t}{2}}$$

$$= 2\bar{Y}\,(1-f_1h_t^q-f_2vn_t-f_3n_t\epsilon_t^e)^{\alpha}\,(1-h_t^q-(2-f_2)vn_t-n_t\epsilon_t^e)^{\alpha}\left(\frac{1}{k_{t+1}^f}\right)^{2\alpha} d\alpha\Phi\theta_t\frac{1}{n_t}\frac{Y_t}{N_t}$$

In the steady state

$$1+\gamma_{Y/N} = 2\bar{Y}(1-fh^{q*}-f_2vn^*-f_3n^*\epsilon^{e*})^{\alpha}(1-h^{q*}-(2-f_2)vn^*-n^*\epsilon^{e*})^{\alpha}(k^*)^{-2\alpha}d\alpha\Phi\theta^*(n^*)^{-1} \quad \text{(A30)}$$

where the variables with * are steady-state values and $k^{f*} = \left(\frac{K}{e^f N^f}\right)^*$.

When f increases, depending on what happens to the steady-state solutions, particularly h^q, the steady-state growth rate can either increase or not.

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Impact of Gender Inequality on the Republic of Korea's Long-Term Economic Growth: An Application of the Theoretical Model of Gender Inequality and Economic Growth

Calibrating a gender inequality growth model to fit Korean data, we find that policies that seek to reduce gender discrimination in the labor market or increase the time spent by fathers on child-rearing can contribute positively to female labor market participation and to the Republic of Korea's per capita income growth. When gender disparities at home and in the labor market are completely removed, the female labor force participation rate is shown to increase from 54.4% to 67.5%, and the per capita income growth rate from 3.6% to 4.1% on average over a generation.

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