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Three Essays on Gender Gap in Parental Investment and Labor Market Outcome: Evidence from Korea

성별에 따른 노동시장 성과 및
부모의 투자 차이에 관한 연구

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Three Essays on Gender Gap in Parental Investment and Labor Market Outcome: Evidence from Korea

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Abstract

Korea has experienced drastic economic growth and improvement in women's socioeconomic status. Despite these changes, however, there are still significant gender differences in terms of labor market outcomes. This study explores the remaining son-preference in Korea and the consequent differential investment by parents. These differential investments can lead to differences in human capital in the long term. We also directly discuss the gender gap in the labor market outcome considering workplace flexibility and technological change.

Chapter 1 investigates the differential investments in the healthcare of children in the context of gender discrimination and son-preference remaining in Korea. Despite the change in social perception of gender norms and improvement in women's

socioeconomic status, there is plenty of evidence that son-preference still exists in Korea. We aim to examine the impact of son-preference on the parents' healthcare investments for their children. This study measure the son-preference using the average sex ratio at birth for 20 years after the parent's birth year. Using the regional variation in son-preference and applying the difference-in-differences approach, we find that girls' medical expenses are lower than boys', and the gender gap is more prominent in son-preference regions. The results suggest that the culture and customs of son-preference to which parents were exposed in their childhood still influence them to make investment decisions based on their child's gender.

In Chapter 2, we note two characteristics of the Korean labor market. One is that the working hours are much longer than in other OECD counties, and the other is that Korea has the widest gender wage gap. Long working hours can be seen as evidence that the overall working environment is not flexible. Also, low workplace flexibility may be related to the fact that the gender wage gap in Korea is exceptionally high. Given these characteristics of the Korean labor market and prior literature, we investigate whether the inflexible workplace could explain much of the gender wage gap in Korea, using the KNOW data of occupational characteristics and difference-in-differences approach. In the analysis comparing flexibility and gender wage gap between occupations, it is found that the women's relative hourly wage is positively related to the flexible workplaces. These relationships are more pronounced in workers with high education levels, such as college graduates.

In the last chapter, we explore whether there has been Routine Biased Technological Change (RBTC) in Korea and identify the subsequent impacts on

women's roles and economic statuses in the labor market. From the analysis using the KNOW data, the Korean version of O*Net, we confirm that Korea has undergone an increase in abstract and a decline in routine tasks, which is the pattern of RBTC. While the non-routine manual task also decreased, the change was moderate. These task shifts occurred intensively in the 1990s, and the change in female workers was more dramatic than in men. This study also verifies that wages are high for workers engaged in abstract tasks, who face small gender wage gaps. On the other hand, routine tasks are linked to relatively low wages, and the wages of men and women who specialize in these tasks are considerably different. These findings suggest that routinization in the Korean labor market may have contributed to raising the relative wages of women and narrowing the gender wage gap.

Keywords**:** Economics of Gender, Parental Investment, Son-preference, Child Care, Gender Wage Gap, Workplace Flexibility, Technological Change, Routinization

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[*] Part of Chapter 1 is based on the results of a joint research with Sok Chul Hong, a professor of Economics at Seoul National University, and Jisu Yu, a PhD candidate at Seoul National University.

[**] Part of Chapter 3 is based on the results of a joint research with Inyoung Hwang, a PhD candidate at Seoul National University.

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1 Son-preference and Healthcare Investment of Child

1.1 Introduction

In many Asian countries, women's social status has been lower than that of men, and women have been treated differently in various ways since childhood. Women in these countries have been discriminated against from birth, resulting in a high male-to-female sex ratio at birth. Moreover, childhood discrimination has caused gender gaps in both human capital and labor market performances. However, in response to rapid economic growth and the change in social perception that emphasizes gender equality, women's socioeconomic status has improved in some of these Asian countries as well as in Western countries.

In particular, South Korea—henceforth, Korea—became the only country that reverted to the natural sex ratio at birth in Asia. Nevertheless, the rebalancing of the sex ratio at birth does not imply that gender discrimination or son-preference has completely disappeared. Korea has the widest gender wage gap among OECD countries. Also, the evidence from a recent study on Korea shows that fewer parental inputs are made to girls than to boys (Choi and Hwang, 2015).

In the Asian countries with a strong son-preference, the value of having a son was higher than that of the daughter, which led to the sex-based fertility stopping rule or sex-selective abortion (Chung and Gupta, 2007). These behaviors can be seen as expressions of childbirth discrimination. Accordingly, many previous studies interpreted the sex ratio at birth as an evidence of son-preference (Sen, 1990, 2003; Mishra and Retherford, 2004; Das Gupta, 2005; Jayachandran and Kuziemko, 2011; Bharadwaj and Lakdawala, 2013). However, the decline in the sex ratio at birth does not necessarily mean the disappearance of son-preference. Even if there were no more childbirth discrimination, the possibility of discrimination after birth would remain. In line with such a possibility, several studies explored the gender gap in parental investment under son-preference.

The gender differential investments were actively examined in developing countries in South and Southeast Asia. A study in India has confirmed that the gender gap in prenatal investment widens as the introduction of the ultrasound technology allowed the identification of the fetal sex, and similar results have been found in data from other countries like China, Bangladesh, and Pakistan (Bharadwaj and Lakdawala, 2013). Also, the duration of breastfeeding is longer for boys than girls in India and Pakistan (Jayachandran and Kuziemko, 2011; Barcellos et al., 2014; Hafeez and Quintana-Domeque, 2018). While the stronger son-preference is more prevalent in Asian countries, evidence of son-preference is also found in developed countries such as the U.S. (Dahl and Moretti, 2008). As the investment to fetuses and infants is critical and influential, these prior studies focused on sex-based discrimination in the prenatal and neonatal period of child.

On the other hand, the differential investment in childhood driven by son-preference has not been fully explored, despite the fact that healthcare in this period is also essential for human capital. According to previous research, the increase in access to medical care promotes children's health status. An increase in medical expenditure and the growing utilization of medical services due to expansion of health insurance has reduced the child mortality rate and improved health status in adulthood (Currie and Gruber, 1996; Nixon and Ulmann, 2006; Boudreaux et al., 2016). Household income has positive effects on children's health because the income may affect the use of medical care, nutritious food, and a safe environment, and the effects become cumulative and pronounced as the children age (Case et al., 2002; Cutler et al., 2008). Moreover, childhood health condition plays a significant role not only in future health but also in educational achievement, cognitive development, and socioeconomic status as an adult (Case et al., 2005; Currie, 2009).

This research also investigates discrimination after birth, namely the gender gap in parental investments caused by the son-preference that remains in Korea. Given the importance of childhood health and the role of medical care, we consider medical expenses as an investment factor that parents can decide to pursue. Therefore, this paper aims to evaluate the effect of son-preference on the gender gap in children's medical expenditure, which is determined by their parents. To identify these effects, we use the regional variation in the intensity of son-preference and apply a difference-in-differences approach. In this study, the degree of a parent's son-preference is measured by the sex ratio at birth for 20 years following the parent's birth year.

We find that the gender gap in medical expenditure is higher in the son-preference area. In the non-son-preference area, the annual medical expense for girls is 13,760 KRW lower than for boys. On the other hand, the expenditure is much lower for girls in the son-preference regions, where 71,300 KRW is additionally less spent on girls in these regions. Intensity analysis that assesses the effect of son-preference intensity also shows consistent results. One standard deviation increase in the average level of son-preference widens the gender gap in medical expenses by 26,690 KRW. Overall, our findings suggest that the culture and customs of son-preference experienced by parents in their childhood still influence them to make investment decisions based on their child's gender.

Unlike several previous studies that examine the impact of current son-preference, this paper contributes to the literature in that it analyzes the effects of past son-preference, which is measured based on the parent's childhood. Meanwhile, Korea is a representative country that underwent drastic economic growth and improvement in women's socioeconomic status, but individual gender norms evolve gradually from generation to generation (Hwang, 2016). As Korea has recently experienced these conflicts between social change and personal perception, this research adds to the literature on evidence that son-preference remains in countries undergoing a transition.

This chapter is organized as follows. Section 1.2 briefly reviews the son-preference in Korea with related literature and data. In Sections 1.3 and 1.4, we explain the data and estimation method. Section 1.5 reports our main results, and

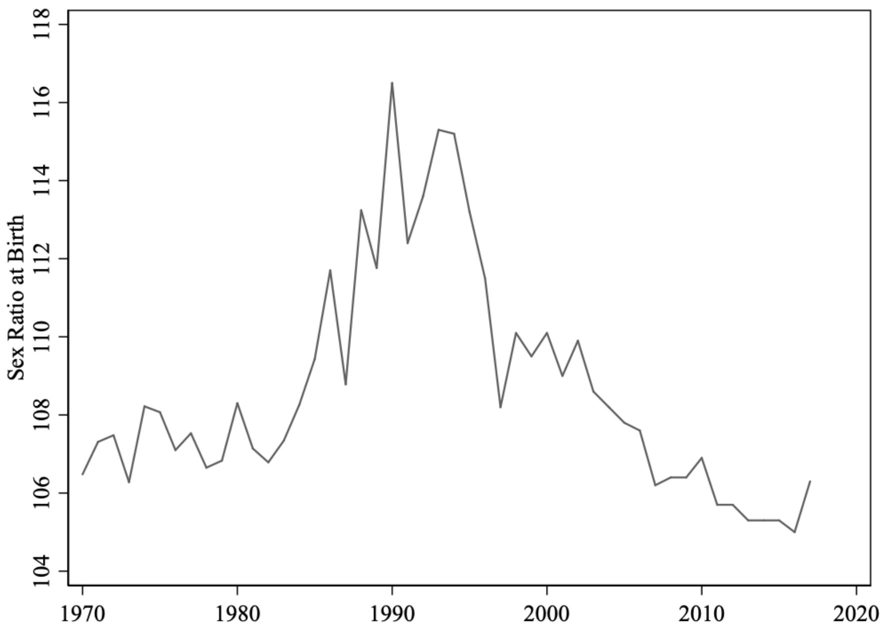
Section 1.6 describes the intensity analysis and presents its results. In Sections 1.7 and 1.8, we discuss whether the differential health investment in sons and daughters depends on the characteristics of parents and children. Section 1.9 concludes the paper.

1.2 The Son-preference in Korea

In the past, Korean families inherited Confucian culture, according to which the male heir was essential in family succession. The breadwinner–housewife household was widely spread, and the opportunity for women to participate in the labor market was limited. For these reasons, male children were preferred over girls, and with limited resources, parents decided to invest more money and time into their sons than daughters. Consequently, gender inequality in education and income became greater in Korea.

As shown in Figure 1.1, son-preference in Korea led to childbirth discrimination. In the early 1980s, the introduction of ultrasound technology enabled sex-selective abortion, and the sex ratio at birth reached a peak in 1990. At that time, 116.5 boys were born per 100 girls. This imbalance in sex ratio at birth declined from the mid-1990s. After industrialization and globalization, the social welfare system was developed, where living with parents after marriage became no longer common and the average family size was significantly reduced. These changes have contributed to reducing the burdens of breadwinners to provide for their families while improving women's socioeconomic status considerably. Moreover, these rapid developments weakened the Confucian tradition in Korea and the expectation for a son to take care of his parents in their old age. In addition, the notification of fetal sex was banned in 1987 by the Medical Law. Under the influence of these changes, the sex ratio at birth began to decline from the mid-1990s and returned to the natural level of 104 to 107 in the mid-2000s.

Figure 1.1. Sex Ratio at Birth in Korea (Male Births per 100 Female Births)



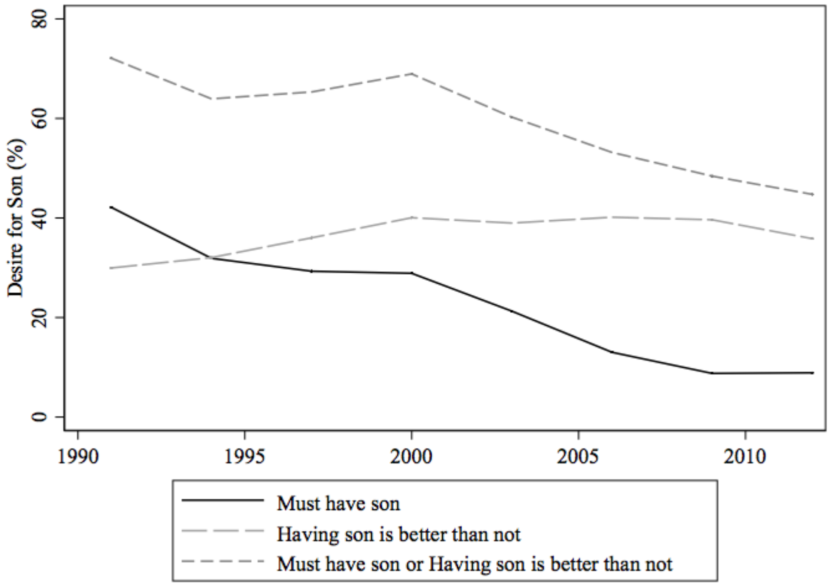
Sources: Population Statistics Based on Resident Registration, Statistics Korea

Notes: Since the sex ratio at birth is accessible from 1981, the sex ratio at birth for 1970 to 1980 is estimated with the sex ratio at age 0 to 4 from the Population Census.

The rebalancing of sex ratio at birth, however, does not indicate the disappearance of gender discrimination. Although childbirth discrimination may have disappeared, discrimination after birth could remain. To decide to abort, parents have to consider not only the monetary costs but also the physical and psychological costs of the mother's experiences. Thus, the sex-selective abortion reflects an extreme desire for sons. If parents' son-preference is not strong enough to endure those costs, parents might give birth to a daughter but invest less in her after the birth. Choi and Hwang (2015) also showed evidence of son-preference, despite the recovery to the natural sex ratio at birth. Girls in Korea spend less time with their mother and twice as much time doing house chores. The private education expenditure is also lower for girls.

Between 1991 and 2012, the National Survey on Fertility, Family Health, and Welfare (NSF) asked married women about their desire for sons. Figure 1.2 illustrates that a change in the mother's perception is in line with the decline in sex ratio at birth. The rate of women who answered to "Must have a boy" has been declining since 1991. However, the proportion of "Having a boy is better than not" has been persistent, and more than 40% of women still positively answered to it in 2012. These survey results suggest that the importance of having sons has become smaller, but the parents' mild preference for sons persists. This attitude toward the sex of one's offspring implies the possibility of sex-based discrimination after childbirth. Therefore, we aim to investigate the evidence of remaining son-preference in Korea in terms of the gender gap in medical expenditure.

Figure 1.2. Trend in Son-Preference



Sources: National Survey on Fertility, Family Health and Welfare (1991–2012)
Notes: The trend of desire for sons is measured with the proportion of women who answered to "It is necessary to have a son." The strength of desire is distinguished with those who answered to "Must have son" and to "Having son is better than not."

1.3 Data

This study uses the Korea Health Panel Survey (KHPS) data from 2008 to 2015 for analysis. From KHPS, we can obtain the records of an individual's medical expenses and the number of healthcare uses. The medical services are divided into emergency, inpatient, and outpatient services, and the expenditure data for each service is available. The drug costs are also classified into three categories of medical services.

The household characteristics such as income, family size, and composition of each household are accessible in KHPS. Moreover, the personal characteristics of children such as sex, age, and disability are also used in the analysis.

To focus on the children most affected by their parents' decision-making, we limit our analysis to the children under the age of 7. In addition, the observations with zero annual medical costs are excluded from the analysis. For reference, whether or not medical expenses were incurred did not statistically differ by region or the sex of the child, even after controlling the year and region fixed effects and characteristics of the children and household. The results can be found in Appendix Table A1.1.

Unfortunately, the KHPS data do not contain any information about where the parents were born and raised. Therefore, when using the regional sex ratio at birth, we use information of currently registered areas instead of the birthplace of parents. To supplement the shortcoming of using these registered areas, in the intensity analysis, the parents' birthplace is estimated using the Census 2010 data. We use information on the registered area in the survey year, birthplace, birth year, occupation, and education level from the Census, and estimate the sex ratio at birth of parents' places of birth.

For additional checkups, we estimate the effect of parents' gender norm using the proxy of parents' attitudes toward gender roles. The World Values Survey (WVS) in 2010 is a survey that explores people's values and beliefs. The WVS asked respondents to assess items related to their gender norm, such as "When jobs are scarce, men should have more right to a job than women," "If a woman earns more money than her husband, it's almost certain to cause problems," and "On the whole, men make better political leaders than women do." Using the WVS data, the average score of gender norm is calculated for each group of people born in the same year and living in the same area. In Section 1.6, we use the gender norm score as an indicator of son-preference for intensity analysis.

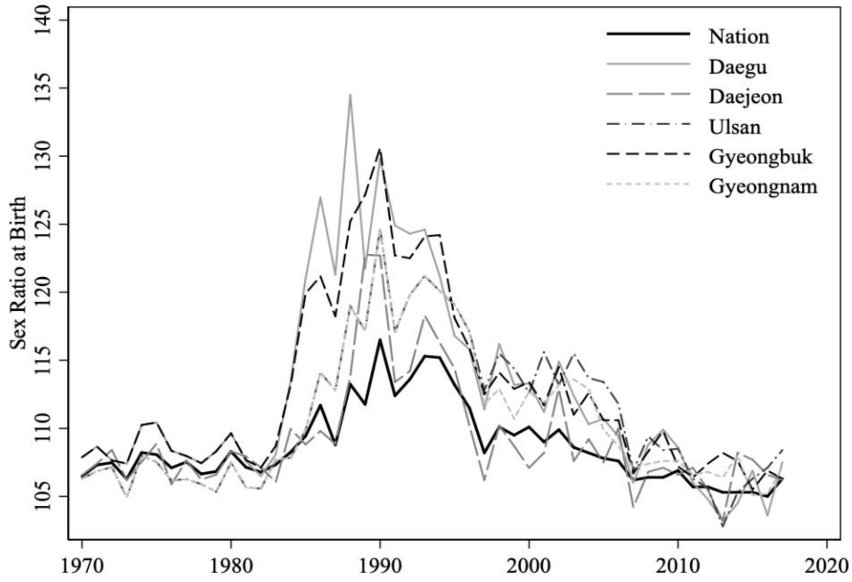
1.4 Estimation Method

In this research, we analyze the gender gap in childhood medical expenditure. According to the 2008–2015 Korea Health Panel Survey (KHPS) data, the average medical costs of boys are higher than that of girls. During the survey period, the average medical expenditures on boys and girls under the age of 7 were 336,165 and 279,507 KRW, respectively. However, this gender gap is not a result of sex discrimination as a whole. Usually, boys are more active than girls, and they are more likely to be injured or infected. Given these different characteristics between boys and girls, part of the gender gap in healthcare expenditure can be seen as a result of differences, not discrimination. Therefore, we require a careful approach to accurately estimate the impact of son-preference on the gender gap in healthcare investment.

To identify the effect of son-preference on the gender gap in medical spending, we use the fact that there is regional variation in son-preference. People of some regions have a stronger preference for sons than others, which is reflected in the sex ratio at birth. Using these regional differences, we apply the difference-in-differences (DID) approach. First, we compare the difference in medical expenditure between boys and girls. Then, we compare the differences in gender gaps between the son-preference and non-son-preference area. If the entire gender gap in medical expenses is a result of different characteristics between boys and girls, the size of the gender gap should be almost the same across regions. If the gender gap is significantly higher in the son-preference area than in the non-son-preference area, we can presume that there are more than just differences of gender characteristics. This additional gender medical expense gap in the son-preference area can be seen as the effect of son-preference—that is, sex-biased parental investment.

For the DID analysis, we use the fact that the sex ratio at birth varies by region, as shown in Figure 1.3. For reference, in the early 1990s, when sex-selective abortion was prevalent, there was a significant gap in sex ratio at birth, depending on the region. In 1990, the sex ratio at birth was 130.6 in the North Gyeongsang Province and 129.8 in Daegu, while the ratio was 111.3 in the Gyeonggi Province and 111.9 in Incheon. Depending on the region, the number of boys born for every 100 girls differed by more than 18. Considering that this regional variation reflects different degrees of son-preference, we can use the regional data on sex ratio at birth to distinguish son-preference regions in this study.

Figure 1.3. Sex Ratio at Birth by Region



Sources: National Survey on Fertility, Family Health and Welfare (1992–2012)

Notes: Since the sex ratio at birth is accessible from 1981, the sex ratio at birth between 1970 and 1980 is estimated with the sex ratio at age 0 to 4 from the Population Census.

Specifically, we calculate the 20-year average sex ratio at birth from 1975 to 1994 by region and select the top 5 regions for the son-preference areas. Our choice for the period (1975–1994) is based on the fact that the mean, median, and mode of the parents' birth year is about 1975. As we mentioned before, the culture and customs of son-preference to which parents were exposed in their childhood could be critical in the formation of parents' gender norms and sex-biased preferences toward their children. Consequently, these top 5 son-preference regions include Daegu, North Gyeongsang Province, Ulsan, South Gyeongsang Province, and Daejeon. For reference, even if we calculate the average sex ratio at birth from the recent data

(1981–2017), these top 5 regions do not change.

After the selection of son-preference areas based on the sex ratio at birth, we use the DID approach to identify the effect of son-preference on the gender gap in medical expenditure.

$$(1.1) \quad y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 female_i + \beta_3 sonpreference_{it} + \beta_4 (female_i * sonpreference_{it}) + year_t + region_r + \epsilon_{it}$$

In this equation, y_{it} is the child i's medical expenses or number of uses in year t, and X_{it} includes control variables such as age, disability, household composition, age of parents, and household income. $year_t$ is the survey year fixed effect, and $region_r$ is the registered region fixed effect, respectively. $female_i$ is the female dummy variable, and $sonpreference_{it}$ is the son-preference area dummy variable, which is measured by region. $sonpreference_{it}$ is one if child i lives in an area with a strong son-preference in year t, or zero otherwise. In this paper, we focus on the estimate of β_4, the coefficient of the interaction term. This estimate presents the additional gender medical expense gap in the son-preference region.

Before the DID analysis, we need to check if there are any systematic differences in the demographics between men and women of the son-preference region and non-son-preference region. Table 1.1 displays descriptive statistics of dependent variables and covariates by sex and region. Medical expenditure means the annual total medical spending of an individual. This total medical spending is composed of hospital payments and drug costs. Moreover, payment and drug costs are divided into outpatient, inpatient, and emergency services. The entire sample includes children aged 0 to 6 years whose healthcare and medical costs are usually decided by their parents.

Columns (3), (4), (6), and (7) of Table 1.1 present the average values of the variables for each subgroup that are classified according to the sex and registered region. Columns (5) and (8) display the differences between boys and girls per area. Lastly, column (9) presents differences in the gender gap between the son-preference region and non-son-preference region. In other words, column (9) reports DID values without any control variables.

According to Table 1.1, there are some differences in the gender gap between the son-preference and non-son-preference region in age, disability, and the number of brothers and sisters per household. We control these demographic variables in the analysis to minimize their impact. Medical expenditure shows different results depending on the specific expenditure categories. Total medical expenses, outpatient payment at the hospital, outpatient drug cost and outpatient service use of girls are lower than those of boys and are even lower in son-preference regions. On the other hand, gender gaps in medical costs associated with emergency or inpatient services do not vary significantly depending on the region. Based on these facts, we present the results of our DID analysis in Section 1.5.

Table 1.1. Descriptive Statistics by Son-Preference Region

	Entire sample		Son-Preference Region			Non-son-preference region			Difference-in
	Mean	Std. Dev.	Female	Male	Difference	Female	Male	Difference	-difference
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Dependent Variables									
Medical Expenditure	30.864	47.600	25.307	35.352	-10.045	28.671	33.107	-4.437	-5.608**
Outpatient Payment	18.885	24.304	15.569	20.576	-5.007	18.616	19.515	-0.900	-4.107***
Inpatient Payment	6.294	34.150	4.672	8.697	-4.026	4.592	7.649	-3.057	-0.969
Emergency Payment	1.012	3.552	0.832	1.014	-0.182	0.993	1.077	-0.084	-0.098
Outpatient Drug Cost	4.654	4.241	4.221	5.031	-0.810	4.454	4.849	-0.395	-0.415*
Inpatient Drug Cost	0.004	0.076	0.003	0.003	0.000	0.002	0.006	-0.004	0.004
Emergency Drug Cost	0.009	0.089	0.005	0.010	-0.004	0.010	0.009	0.001	-0.006
Outpatient Use	24.038	17.145	21.206	24.755	-3.549	24.087	24.523	-0.436	-3.113***
Inpatient Use	0.196	1.736	0.144	0.211	-0.067	0.173	0.228	-0.055	-0.012
Emergency Use	0.271	0.679	0.223	0.282	-0.059	0.258	0.293	-0.035	-0.023
Panel B: Covariates									
Age	3.651	1.700	3.680	3.765	-0.085	3.679	3.584	0.096	-0.181*
Disability	0.005	0.067	0.006	0.013	-0.007	0.004	0.002	0.002	-0.009**
Panel C: Household Covariates									
Number of Brothers	0.996	0.781	0.575	1.469	-0.894	0.481	1.461	-0.980	0.086**
Number of Sisters	1.009	0.856	1.369	0.489	0.880	1.578	0.521	1.057	-0.177***
Number of Elderly	0.120	0.398	0.104	0.128	-0.023	0.122	0.120	0.002	-0.025
Father's Age	37.394	4.555	37.370	37.180	0.190	37.463	37.397	0.066	0.124
Mother's Age	34.573	4.130	33.871	33.975	-0.105	34.834	34.681	0.153	-0.258
Household Income	48.323	30.076	48.947	47.913	1.034	47.566	49.007	-1.441	2.475

Observations	7,665		797	894		2,927	3,047		

Notes: We checked the characteristics for each subgroup to ensure that there were no demographic differences depending on the gender and region. Columns (1) and (2) provide summary statistics for children age 0–6 from the KHPS. Columns (3), (4), (6) and (7) show the means of each subgroup distinguished by sex and region. Columns (5) and (8) present the gender gap in each region. The significance of difference between the gender gap of the son-preference region and non-son preference region is illustrated in column (9).

1.5 Main Results

Table 1.2 reports the results of the DID analysis with the total medical expenditure as a dependent variable. Column (1) displays the simple estimation results that include only females, the son-preference dummy variable, and their interaction term. In columns (2) to (4), we include the registered region and survey year fixed effect, and other control variables. Furthermore, in columns (5) and (6), initial health condition is additionally controlled, considering that medical expenses may vary depending on the health status of an individual.

Column (5) of Table 1.2 provides the result of DID regression that controls the initial health conditions by the number of emergency and inpatient services used in the previous year. In column (6), emergency and inpatient payments at hospitals are included to control the initial condition. According to the result in column (6), girls' medical expenses were 13,760 KRW lower than boys. However, in the son-preference area, the gap between boys and girls was further widened by 71,300 KRW. This additional gap can be interpreted as a result of differential investments driven by son-preference. The result of column (5) is similar to column (6). For other control variables, results consistent with common sense have been identified, such as the reduction in healthcare spending with the number of children and the elderly people in the household and the older age of a child. While the father's age has a negative impact on the child's medical expenses, the mother's age has no significant impact. Higher household income increases a child's medical expenditure.

Table 1.2. Effects of Son-Preference on Medical Expenditure

	Dependent Variable: Medical Expenditure (10,000 KRW)					
	(1)	(2)	(3)	(4)	(5)	(6)
Female	-4.437***	-4.600***	-4.557***	-3.877**	-2.222	-1.376
	(1.230)	(1.227)	(1.227)	(1.525)	(1.645)	(1.632)
Female×Son-Preference Region	-5.608**	-5.635**	-5.803**	-6.189**	-6.623**	-7.130***
	(2.621)	(2.619)	(2.618)	(2.468)	(2.703)	(2.680)
Son-Preference Region	2.245					
	(1.807)					
Age 1				7.478		
				(10.103)		
Age 2				-14.534	-12.233	-13.792
				(10.099)	(10.025)	(9.940)
Age 3				-23.959**	-23.307**	-23.982**
				(10.099)	(10.023)	(9.937)
Age 4				-25.492**	-23.054**	-23.744**
				(10.100)	(10.025)	(9.939)
Age 5				-26.981***	-25.732**	-26.550***
				(10.101)	(10.027)	(9.941)
Age 6				-26.482***	-23.687**	-24.847**
				(10.107)	(10.028)	(9.942)
Disability				139.413***	125.361***	120.381***
				(7.571)	(8.037)	(7.952)
Number of Brothers				-4.271***	-4.369***	-4.186***
				(0.897)	(0.962)	(0.953)
Number of Sisters				-4.169***	-4.551***	-4.460***
				(0.823)	(0.893)	(0.886)

Number of Elderly				-3.058**	-1.644	-1.523
				(1.324)	(1.455)	(1.442)
Father's Age				-0.470***	-0.402**	-0.300*
				(0.148)	(0.161)	(0.159)
Mother's Age				-0.082	0.196	0.202
				(0.165)	(0.178)	(0.177)
Household Income				0.032*	0.040**	0.036*
				(0.017)	(0.019)	(0.019)
Initial Condition					5.602***	0.820***
					(0.842)	(0.154)
					5.395***	0.252***
					(0.477)	(0.016)
Region FE	No	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Controls	No	No	No	Yes	Yes	Yes
Initial Condition	No	No	No	No	ER Use Inpatient Use	ER Exp. Inpatient Exp.
Observations	7,665	7,665	7,665	7,665	5,047	5,047
R-squared	0.004	0.012	0.014	0.130	0.147	0.161

Notes: We conducted equation (1.1) for the different specification of regression models. The son-preference region variable is a dummy variable that refers to whether the current registered region is a son-preference area or not. For all models, we defined Daegu, the North Gyeongsang Province, Ulsan, the South Gyeongsang Province, and Daejeon as son-preference regions. The control variables are gradually added in columns (1) to (4). From column (4) on, the specification contains the all control variables, and fixed effect of registered region and survey year. In columns (5) and (6), different initial conditions are additively included to reduce the effect of the initial health status of the child. In column (6), which is our baseline model, the emergency expenditure and inpatient expenditure are controlled as initial conditions. Parentheses indicate standard errors. A single asterisk denotes statistical significance at the 90% level of confidence, two asterisks denotes 95%, and three asterisks denotes 99%.

Given that the average medical spending of children was approximately 308,638 KRW, this additional gender gap of medical costs caused by son-preference was about 23%. For reference, the estimation results of the log-transformed dependent variable are shown in Appendix Table A1.2. According to column (6) of Table A1.2, which is the result of the same regression analysis with our baseline model, the gender gap of medical expenses was further widened by 17 percentage points in the son-preference areas.

Meanwhile, there is a reason why we control only the previous records on emergency and inpatient services for initial health conditions, except the outpatient records. If girls in son-preference regions are discriminated against in terms of healthcare, their medical service use and expenditure would be significantly lower than boys'. Consequently, the gender gap of the son-preference areas would be wider than that of the non-son-preference areas. This gender discrimination and the resulting additional gender gap in the son-preference regions may have existed in the past, too. Therefore, if the initial health condition is controlled by the total medical service use or expenditure of the last period, the discrimination effect in the son-preference region could be underestimated, as these variables are already the results of past discrimination. However, boys and girls are less likely to be discriminated against in relatively serious situations such as emergency and inpatient hospitalization. For this reason, the underestimation problem is less likely to occur when only the last year's records on emergency and inpatient services are used as the initial health condition.

These results can be found in Appendix Table A1.3. If the total medical expenses and number of medical service uses in the last year—which are supposed to be affected by son-preference—are controlled as the initial health condition, the effect of son-preference on medical spending is underestimated, as expected. The estimates of interaction term in columns (3) and (4) are less significant and have smaller absolute values than those in columns (1) and (2). We also present other regression results in Appendix Table A1.4. Only children without disabilities and children who do not belong to multicultural families are analyzed for the robustness check. According to the results, regardless of the samples, the son-preference has an additional negative effect on girls' medical expenses.

Table 1.3 presents the results of the sensitivity analysis, which exploits different definitions of "son-preference area." For the baseline analysis, we define the top 5 regions with the highest sex ratio at birth as son-preference areas, which are Daegu, the North Gyeongsang Province, Ulsan, the South Gyeongsang Province, and Daejeon. Also, we analyze how the results would change if do not consider Daejeon a son-preference area, as Daejeon shows a relatively lower sex ratio at birth than the other son-preference areas. Also, some areas with relatively moderate sex ratios at birth are excluded from the analysis, to compare only regions with distinctly higher sex ratios, i.e., remarkable son-preference areas, and those with distinctly lower sex ratio, i.e., non-son-preference areas.

Table 1.3. Effects of Son-Preference on Medical Expenditure by Different Group of Son-Preference Region

	Group A	Group B	Group C	Group D
	(1)	(2)	(3)	(4)
Female	-1.376	-1.711	2.126	3.044*
	(1.632)	(1.613)	(1.773)	(1.820)
Female×Son-Preference Region	-7.130***	-6.488**	-10.157***	-10.304***
	(2.680)	(2.798)	(2.456)	(2.570)
Observations	5,047	5,047	3,301	3,066
R-squared	0.161	0.161	0.150	0.103

Notes: We conducted a sensitivity analysis for alternative definitions of "son-preference region." Column (1) shows the results for Group A, namely Daegu, the North Gyeongsang Province, Ulsan, the South Gyeongsang Province, and Daejeon, which comprise the son-preference area in our baseline model. In column (2), Group B includes four highest regions except Daejeon as a son-preference area. For columns (3) and (4), the middle regions in order of sex ratio at birth are excluded from estimation. Column (3) follows the son-preference area definition of Group A, but it only includes the highest five and lowest five regions for estimation. Column (4) includes the highest four and lowest four regions. Parentheses indicate standard errors. A single asterisk denotes statistical significance at the 90% level of confidence, two asterisks denotes 95%, and three asterisks denotes 99%.

First, the baseline analysis results, in which Daegu, the North Gyeongsang Province, Ulsan, the South Gyeongsang Province, and Daejeon were included in the son-preference area, are shown in column (1), Group A. The analysis in which Daejeon was excluded from the son-preference area can be found in column (2), Group B. For the analysis of Groups A and B, all other regions were included in the non-son-preference area. On the other hand, Group C includes five regions with the lowest sex ratio at birth—the North Jeonra Province, Gyeonggi, Incheon, Gangwon, and Gwangju—in the non-son-preference areas, and Daegu, North Gyeongsang, Ulsan, South Gyeongsang, and Daejeon in the son-preference areas, as in the baseline analysis. In this case, children who live in the North Chungcheong Province, Busan, Sejong, the South Chungcheong Province, Seoul, Jeju Island, and the South Jeonra Province, where the sex ratio at birth is between the two extreme groups, are excluded from the analysis. Lastly, Group D includes four regions with the lowest sex ratio at birth, namely the North Jeonra Province, Gyeonggi, Incheon, and Gangwon, in the non-son-preference areas, as well as Daegu, North Gyeongsang, Ulsan, and South Gyeongsang in the son-preference areas. In this case, Daejeon, the North Chungcheong Province, Busan, Sejong, the South Chungcheong Province, Seoul, Jeju Island, South Jeonra Province, and Gwangju are excluded from the analysis.

These analyses show that even with some changes in the definition of "son-preference region," the medical expenses gap between males and females in the son-preference area is significantly higher than in the non-son-preference area—a result that is common in all of the analyses. However, in the case of Groups C and D, the effect of son-preference on the gender gap in medical spending becomes larger and more significant. These results are more significant as the son-preference regions with a high sex ratio at birth and the non-son-preference regions with a low sex ratio at birth are more clearly distinguished by excluding the middle regions. For reference, all top four regions are adjacent to the Gyeongsang Province. Therefore, for the following analyses, we define the son-preference areas as the top five regions that include Daejeon to reflect geographic diversity.

Meanwhile, the impact of son-preference on healthcare spending and the number of uses may differ depending on the specific type of medical service. The medical services are classified into emergency, inpatient, and outpatient services, and each service has three detailed variables: the hospital payment, prescription drug cost, and the number of uses. Therefore, we carry out additional analyses using these specific variables of each service as a dependent variable.

The results of the analysis with the specific variables are presented in Table 1.4. According to the results of outpatient payment and the number of outpatient service uses, the gap between boys and girls in the son-preference areas is significantly higher than in the non-son-preference areas. On the other hand, the results of emergency and inpatient service-related variables show that the male–female gap is not significantly different between the son-preference regions and other regions. These results suggest that parents' son-preference may affect the use and spending of outpatient services. However, parents do not discriminate between boys and girls in serious situations requiring emergency or inpatient services.

In this section, we identified the treatment dummy effect of son-preference on the gender gap in medical spending, applying the DID approach with the son-preference dummy variable. The following section examines the treatment intensity effect of son-preference, using the sex ratio at birth itself.

Table 1.4. Effects of Son-Preference on Use of Medical Services

	Dependent Variable:									
	Expenditure	Payment at Hospital (10,000 KRW)			Drug Cost (10,000 KRW)			Num. of Uses (times)		
	Total	Outpatient	Inpatient	ER	Outpatient	Inpatient	ER	Outpatient	Inpatient	ER
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Female	-1.376	0.040	-1.244	-0.008	-0.165	0.000	0.002	0.049	-0.037	-0.030
	(1.632)	(0.838)	(1.228)	(0.151)	(0.178)	(0.001)	(0.003)	(0.654)	(0.081)	(0.026)
Female×Son-Preference Region	-7.130***	-5.329***	-1.193	-0.136	-0.460	-0.002	-0.006	-3.375***	0.064	-0.038
	(2.680)	(1.375)	(2.016)	(0.248)	(0.291)	(0.002)	(0.005)	(1.074)	(0.133)	(0.043)
Observations	5,047	5,047	5,047	5,047	5,047	5,047	5,047	5,047	5,047	5,047
R-squared	0.161	0.153	0.093	0.033	0.107	0.006	0.006	0.149	0.083	0.055

Notes: We conducted equation (1.1) for different dependent variables. For column (1), which is the result of the baseline estimation, we use the total expenditure on medical services as a dependent variable. The medical expenditure can be divided into hospital payments and drug costs. Columns (2) to (4) and (5) to (7) show the results of using the payments at hospital and expenditure on drugs as dependent variables, respectively. Finally, in columns (8) to (10), the number of visits to medical services is used as a dependent variable instead of expenditures. The expenditure and uses of medical services are also separated by outpatient, inpatient, and emergency. Columns (2), (5), and (8) is for outpatient services; columns (3), (6), and (9) is for inpatient services; and columns (4), (7), and (10) is for emergency services. Parentheses indicate standard errors. A single asterisk denotes statistical significance at the 90% level of confidence, two asterisks denotes 95%, and three asterisks denotes 99%.

1.6 Intensity Analysis

Previously, in Section 1.5, we defined the region with the highest sex ratio at birth as a son-preference region and applied the DID approach, including the son-preference region dummy variable. In this section, considering that the sex ratio at birth is a proxy for the intensity of son-preference, our analysis uses the sex ratio at birth itself instead of the son-preference dummy variable. By doing so, we want to examine how the gender gap in medical expenditure widens as the intensity of son-preference increases.

For the intensity analysis, the following equation is to be estimated:

$$(1.2)\quad y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 female_i + \beta_3 sexratio_{it} + \beta_4 (female_i * d\_sexratio_{it}) + year_t + region_r + \epsilon_{it}$$

In this equation, y_{it} is the child i's medical expenditure in year t, and X_{it} includes the control variables as before. $year_t$ and $region_r$ are the fixed effects of the survey year and the registered region, respectively. $female_i$ is the female dummy variable, and $sexratio_{it}$ is the sex ratio at birth matched to the registered region and birth year of the parents of child i.

Variable $sexratio_{it}$ is the average sex ratio at birth for 20 years after the parents' birth year, and it is based on the current residence. We also use the $d\_sexratio_{it}$ as an interaction term with $female_i$. $d\_sexratio_{it}$ is a value that deducts the national level of sex ratio at birth from the $sexratio_{it}$ for the corresponding year. Considering that the sex ratios at birth are generally a decreasing trend, the extent to which they deviate from the national level would be a better proxy to reflect the degree of son-preference. The intensity analysis result using the "average sex ratio at birth for 20 years after the parents' birth year" is shown in Panel A of Table 1.6.

The problem with the analysis so far is that the area used in this study is not the birthplace but the registered region. The reason we use the "average sex ratio at birth for 20 years after the parents' birth year" is to reflect the culture and customs of son-preference to which the parents were exposed in their childhood. However, if the place of birth differs from the place of living, it is difficult to ensure that the degree of son-preference that parents experienced in their childhood is properly measured with the sex ratio at birth of the registered region.

We use Census 2010 data to check the proportion of current residences for each birthplace. In Table 1.5, the Gyeongsang Province, Chungcheong Province, Jeonra Province, metropolitan, and the other areas are displayed roughly in the order of sex ratio at birth. As shown in the table, many people live in their native area, but the percentage of people moving to other regions is not negligible. In the case of the Gyeongsang Province, which accounts for the majority of the son-preference areas, 75% of the people born in this area are currently registered in the same region; the remaining 25% of the people moved to other regions. Thus, using registered region information instead of birthplace may cause measurement errors.

Table 1.5. Migration Rate from Birthplace to Current Registered Region

		Birthplace				
		Gyeong sang-do	Chung cheong-do	Jeonra-do	Capital Region	Others
Registered Region	Gyeong sang-do	74.8%	5.0%	5.3%	3.1%	8.5%
	Chung cheong-do	3.1%	53.2%	4.5%	4.6%	5.4%
	Jeonra-do	1.1%	1.8%	49.8%	1.7%	1.4%
	Capital Region	19.6%	38.3%	39.2%	88.9%	35.8%
	Others	1.2%	1.7%	1.2%	1.7%	48.9%
Total		100.0%	100.0%	100.0%	100.0%	100.0%

Sources: Population Census 2010
Notes: 1) Gyeongsang-do includes Busan, Daegu, Ulsan, Gyeongbuk, and Gyeongnam; 2) Chungcheong-do includes Daejeon, Sejong, Chungbuk, and Chungnam; 3) Jeonra-do includes Gwangju, Jeonbuk, and Jeonnam; 4) Capital Region includes Seoul, Incheon, and Gyeonggi; 5) Others includes Gangwon and Jeju.

In the case of classical measurement error, it is known that the estimated OLS effect will be attenuated. However, in our case, the observed residence variable is not continuous but is instead a dummy variable. Besides, the residence and birthplace can be correlated with other explanatory variables, such as household income. Card (1996) discussed this kind of measurement error issue. He identified the relative wage effect of unions when there were misclassification errors in the reported union status. According to him, the addition of explanatory variables related to the true union status exacerbates the attenuation effect. In this study, misclassification errors occur by using the observed residence information instead of the true birthplace, and we can make the same argument as Card (1996). That is, the analysis results reported in this paper may include the exacerbated attenuation bias, which means that the true effect of son-preference on the gender gap in medical expenditure would be higher.

Considering that there are some differences between the place of birth and the place of living, we carry out further analysis using the sex ratio at birth in the area where the parents are assumed to have been born. We estimate the unknown birthplace from the current residence and calculate the average sex ratio at birth of the estimated birthplace. For example, a person was born in 1975, lives in Seoul, has graduated from college, and works in the legal profession. While many people have the same conditions, their birthplaces might be different. In this case, the sex ratio at birth of the estimated birthplace is calculated by a weighted average of sex ratios in different birthplaces. The share of each birthplace of the people who were born in 1975, live in Seoul, graduated from college, and work in the legal profession, is used as a weight. This is possible because Census 2010 includes not only birthplace and residence data but also information on birth year, education level, and occupation. The regression results using the sex ratio at birth of the estimated birthplace are presented in Panel B of Table 1.6.

Meanwhile, instead of using the sex ratio at birth as a measure of son-preference intensity, we also include in our analysis a more direct measure of gender norm that parents currently have. To measure the current gender norm, the survey data from the 2010 World Value Survey (WVS) is used. The WVS includes questions related to the respondent's gender norm. The questions used in our research to derive the parents' gender norm score are as follows: "When jobs are scarce, men should have more right to a job than women"; "If a woman earns more money than her husband, it's almost certain to cause problems"; "On the whole, men make better political leaders than women do"; "A university education is more important for a boy than for a girl"; and "On the whole, men make better business executives than women do." The respondents answered these questions in scales of "Agree," "Neither," and "Disagree," or "Strongly Agree," "Agree," "Disagree," and "Strongly disagree."

Using the responses to these questions, we make standardized scores to indicate the conservativeness of the respondents' gender norms. The higher the score, the more conservative the respondent's gender norm is. The average score of respondents who were born in the same year and live in the same area is calculated and then matched to the parents of each child. The results using the gender norm score as a measure of son-preference intensity are shown in Panel C of Table 1.6.

According to the analysis, the medical expenditure gap between boys and girls widens as the son-preference grows stronger. Panel A of Table 1.6 reveals that when the sex ratio at birth goes up by 1 standard deviation, the medical expenses of girls decrease by an additional 26,690 KRW, compared to boys. Columns (2) and (3) use only the sex ratio at birth of the father's or mother's birth year as a measure of son-preference, and they provide similar results. As presented in Panel B, the analysis using the estimated birthplace's sex ratio at birth also shows consistent results. The gender gap in a child's medical expense widens by 25,380 KRW as the estimated birthplace's sex ratio at birth increases by 1 standard deviation. The sex ratio at birth, calculated based on the parents' birth year, reflects the intensity of son-preference. Accordingly, our findings suggest that sex-biased parental investments become more pronounced as son-preferences become stronger.

Table 1.6. Effects of Parents' Intensity of Son-preference

Dependent Variable: Medical Exp. (10,000 KRW)	Parents' Birth year (1)	Father's Birth Year (2)	Mother's Birth Year (3)
Panel A. Registered Region's Sex Ratio (20 years Average after Birth)			
Female	-3.549**	-3.605**	-3.500**
	(1.512)	(1.515)	(1.510)
Z-score of Parents' Sex Ratio at Birth	5.067**	3.850*	4.984**
	(2.490)	(2.050)	(2.444)
Female×Z-score of Parents' Sex Ratio at Birth	-2.669***	-2.833***	-2.414***
	(0.884)	(0.937)	(0.818)
Panel B. Estimated Birthplace's Sex Ratio using Census (20 years Average after Birth)			
Female	-2.977**	-3.114**	-3.106**
	(1.504)	(1.517)	(1.518)
Z-score of Parents' Sex Ratio at Birth	6.634***	5.764***	4.653**
	(2.184)	(2.024)	(2.201)
Female×Z-score of Parents' Sex Ratio at Birth	-2.538**	-3.058***	-2.303**
	(0.996)	(1.055)	(0.938)
Panel C. Normalized Conservative Gender Norm of Parents (at Birth year)			
Female	-4.109***	-3.828**	-2.546
	(1.495)	(1.519)	(1.786)
Conservative Gender Norm	-0.668	1.143	-3.224
	(1.766)	(1.731)	(2.040)
Female×Conservative Gender Norm	-2.931	-5.582**	0.458
	(2.573)	(2.389)	(2.844)

Notes: We conducted equation (1.2) to analyze the effects of son-preference intensity on the gender medical expenses gap. To measure the intensity of the son-preference, we use the sex ratio at birth and gender norm score based on the parent's birth year. For panels A and B, the 20-year average of sex ratio at birth after the parent's birth is used. As the birthplace of the parent is not available, Panel A shows the effect of sex ratio at birth using the currently registered regions. The parent's birthplace estimated from the Census is used in Panel B. Finally, Panel C shows the impact of gender norm score calculated from the WVS data at the parent's birth year. Columns (1) to (3) represent the effect in the birth year of parent, mother, and father, respectively. Parentheses indicate standard errors. A single asterisk denotes statistical significance at the 90% level of confidence, two asterisks denotes 95%, and three asterisks denotes 99%.

Meanwhile, when the sex ratio at birth is substituted by gender norm score instead, it turns out that parents' conservative gender norms widen the gender gap in children's medical expenses, although the estimate is not significant. However, when estimating using only the father's gender norm, it is found that the conservative gender norm of the father has a significantly negative impact on the girl's medical costs and thus increases the gender gap. The mother's gender norm has no significant effect on the sex-biased healthcare spending. We also confirm the robustness of these intensity analyses in Appendix Table A1.5. The robustness check was conducted for only children without disabilities and only children who do not belong to multicultural families, and the results are consistent regardless of the samples.

In general, people's various values, including their son-preference and gender norm, have been formed since childhood. For this reason, we calculate the sex ratio at birth based on the parents' birth year to measure their son-preference. In line with this idea, the results so far suggest that the disparity in medical expenditure between boys and girls widens as their parents' son-preference increases. From this point of view, the same intensity analysis using the sex ratio at birth based on the child's birth year is close to reflecting the son-preference at the time the child was born. We verify this using either the sex ratio at birth of the child's birth year or the average sex ratio at birth from the child's birth year to the survey year. The results show that the son-preference at the time the child was born, which is measured by the sex ratio at birth based on the child's birth year, has little or no significant effect on the gender medical expenses gap. These results can be found in Appendix Table A1.6.

1.7 The Effects of the Socioeconomic Status of Parents

In this section and Section 1.8, we discuss whether the differential healthcare investment in sons and daughters depends on the characteristics of parents and children. In the case of parents, their socioeconomic status, such as income or education level, may affect decisions on their children's medical expenses. For children, we consider that their birth order or the gender composition of the siblings may affect the gender differences in the medical costs.

In this section, we identify how sex-biased parental investment changes depending on the parents' socioeconomic status. In the past, when household income levels were low, the resources available to children were limited. Under the resource constraints and preference for sons, it was common in Korea that intensive educational investments were made for boys rather than girls. We investigate whether this mechanism still works today in making investment decisions on children's healthcare. In other words, we examine whether the parents' son-preference has a stronger negative effect on girls' medical expenditure when parents have a low socioeconomic status and limited resources. For the analysis, the annual household income per capita is used as a variable to represent the parents' socioeconomic status.

$$
\begin{aligned}
(1.3) \quad y_{it} = {} & \beta_0 + \beta_1 X_{it} + \beta_2 female_i + \beta_3 sonpreference_{it} + \beta_4 income_{it} \\
& + \beta_5 (female_i * sonpreference_{it}) + \beta_6 (female_i * income_{it}) \\
& + \beta_7 (sonpreference_{it} * income_{it}) \\
& + \beta_8 (female_i * sonpreference_{it} * income_{it}) + year_t \\
& + region_r + \epsilon_{it}
\end{aligned}
$$

To identify the effect of household income, we apply the difference-in-difference-in-differences (triple difference) estimation method. In this equation, y_{it} is the child i's medical expenditure in year t, and X_{it} includes control variables such as age, disability, household composition, and age of parents. $year_t$ is the survey year fixed effect, and $region_r$ is the registered region fixed effect. $female_i$ is the female dummy variable, and $sonpreference_i$ is the son-preference area dummy variable as before.

Meanwhile, two types of household income variables are used in this analysis. First, $income_{it}$ is a high-income dummy variable that has a value of 1 if the annual household income per capita of individual i is above the median for the entire sample in survey year t, or 0 otherwise. Second, we replace $income_{it}$ with the continuous variable of household income per capita for the analysis.

In equation (1.3), the additional gender gap in medical expenditure in the son-preference region can be identified by the estimate of β_5, and the main interest in our analysis is the estimate of β_8, the coefficient of the triple interaction term. The estimate of β_8 presents the effect of household income on the gender gap in healthcare spending in the son-preference region. In other words, this estimate indicates how the differential investments driven by son-preference vary depending on the level of household income. The results are presented in Table 1.7.

Table 1.7. Effects of Household Income on Gender Gap of Medical Expenditure

Variable of Household Income:	High-Income Dummy Variable (1)	Household Income per Capita (2)
Dependent Variable: Medical Exp. (10,000 KRW)		
Female	-2.719	-2.956
	(2.060)	(2.587)
Household Income	1.663	0.125
	(1.817)	(0.111)
Female×Son-Preference Region	-10.245***	-8.364
	(3.856)	(5.501)
Female×Household Income	2.578	0.130
	(2.503)	(0.166)
Son-Preference Region×Household Income	-6.192*	-0.250
	(3.740)	(0.290)
Female×Son-Preference Region×Household Income	6.032	0.106
	(5.355)	(0.394)
Observations	5,047	5,047
R-squared	0.162	0.162

Notes: We conducted equation (1.3) to determine the effects of the socioeconomic status of parents, especially household income. The difference-in-difference-in-differences (triple difference) estimation method is applied, and two types of household income variables are used. Column (1) shows the results of using a high-income dummy variable. Column (2) uses household income per capita, which is a continuous variable. Parentheses indicate standard errors. A single asterisk denotes statistical significance at the 90% level of confidence, two asterisks denotes 95%, and three asterisks denotes 99%.

According to the results, household income has a positive effect on girls' medical expenses and reduces the gender healthcare gap in the son-preference areas, but the effect is insignificant. As shown in column (1) of Table 1.7, the medical cost gap between boys and girls is further widened by 102,450 KRW in the son-preference areas compared to non-son-preference areas. However, for the households with a median annual income per capita or higher, the gender gap in medical expenditure driven by son-preference is reduced by 60,320 KRW. Column (2) presents the results of using the continuous household income variable in the analysis. The results suggest that the medical expenses gap between boys and girls in the son-preference region decreases slightly as household income per person increases. In both cases, household income works toward reducing the impact of son-preference on the gender gap in healthcare spending, although the income effects are insignificant. Meanwhile, education level is also a representative variable of parents' socioeconomic status. Therefore, we conduct further analysis of the triple difference in gender, son-preference area, and parents' education level, but the results are insignificant. These results can be found in Appendix Table A1.7.

Finally, we assess the effect of parents' socioeconomic status, taking into account both their education level and household income. For the analysis, children are divided into two groups by their parents' education level. If both parents are college graduates, their children are defined as high education groups. Other children are included in the low education group. Forty-seven percent of the total sample belongs to the high education group, the proportion of which is similar in the son-preference and non-son-preference areas. The triple difference analysis of household income presented in equation (1.3) is performed separately for each of these two education groups. This is equivalent to deriving a quadruple difference effect of gender, son-preference area, household income, and parents' education level.

According to the results in Table 1.8, for the high education group, the gender gap in medical expenses caused by son-preference does not change significantly with the household income. On the other hand, for the low education group, the impact of household income is large and significant. In this group, higher income has a positive effect on girls' medical expenses and reduces sex-biased parental investment in the son-preference areas. In other words, when the parents' education level is relatively low, more medical investments are concentrated on boys as household income decreases in the son-preference area. Column (2) shows that, for the low education group, the medical expenditure gap between boys and girls in the son-preference region is 132,610 KRW. However, if their parents earn more than the median income, this gender gap is significantly reduced to 10,000 KRW.

These results can be interpreted in two ways. First, the low education groups may face relatively strict resource constraints since their parents' income is generally lower than the high education group. In this case, parents with limited resources and strong son-preferences are more likely to concentrate their investments on boys, much like in past times when resources were scarce. On average, parents of the high education group earn 14.2 million KRW per capita per year. For parents of the low education group, the average annual income per capita is 9.9 million KRW.

Table 1.8. Effects of Household Income on Gender Gap of Medical Expenditure by Parents' Education Level

Parents' Education Level:	High Education (1)	Low Education (2)
Dependent Variable: Medical Exp. (10,000 KRW)		
Female	-0.099	-4.063**
	(4.315)	(1.984)
Household Income	2.264	2.282
	(3.291)	(2.058)
Female×Son-Preference Region	-13.654*	-9.198**
	(8.226)	(3.727)
Female×Household Income	0.993	1.927
	(4.558)	(2.861)
Son-Preference Region×Household Income	-8.406	-7.518*
	(7.204)	(4.253)
Female×Son-Preference Region×Household Income	6.133	12.261**
	(9.886)	(6.132)
Observations	2,389	2,658
R-squared	0.198	0.137

Notes: The triple difference analysis of equation (1.3) is performed separately for two education groups. If both parents are college graduates, their children are defined as high education group, and others are included in the low education group. Parentheses indicate standard errors. A single asterisk denotes statistical significance at the 90% level of confidence, two asterisks denotes 95%, and three asterisks denotes 99%.

Also, even if both education groups live in the son-preference areas, the parents' actual behavior could be different. Parents of low education groups are more likely to be influenced by their preference for sons, traditional gender norms, and patriarchal culture. According to the data of the National Survey on Fertility, Family Health, and Welfare from 1997 to 2012, the lower the mother's education level, the higher the proportion of respondents who answered positively to "Must have a son" or to "Having a son is better than not." On average, 70% of mothers who dropped out of high school, 55% of high school graduates, and 49% of college graduates replied positively to the question about needing a son. These results suggest that the degree of son-preference may vary by parents' education level, and that the low education group could be more strongly influenced by Confucianism and patriarchal culture.

In this section, we discussed whether the differential healthcare investments in sons and daughters depend on their parents' socioeconomic status. For parents with relatively low education levels, we find that their income has a significant impact on the gender gap in parental investment driven by son-preference. In Section 1.8, the effects of children's birth order and gender composition of siblings will be discussed.

1.8 The Effects of Birth Order and Gender Composition of Children

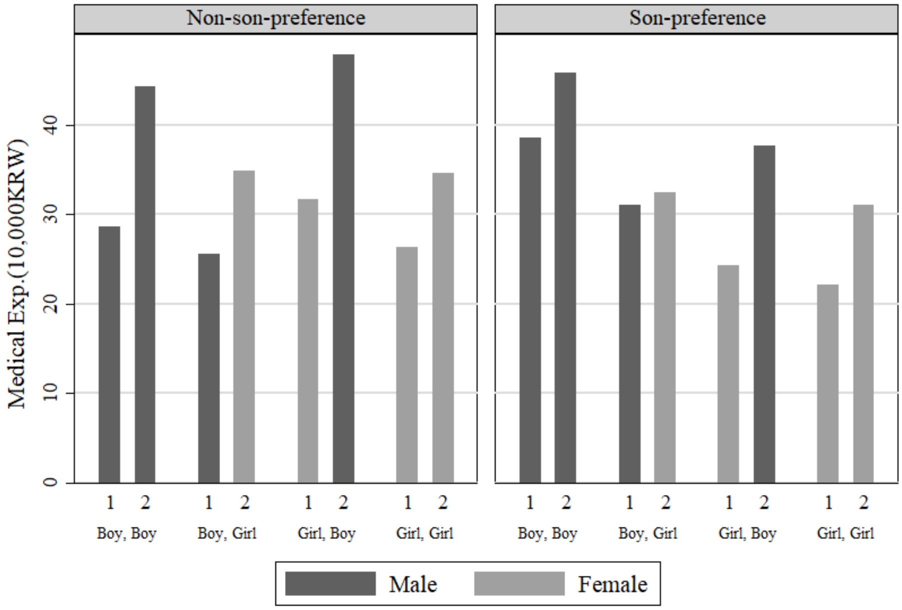
This section explores the relationship between the gender gap in healthcare spending and the preference for sons, considering the characteristics of the child. Specifically, the difference in medical expenses between boys and girls may vary depending on the children's birth order or the gender composition of siblings.

In this section, we analyze limited samples to examine the effect of children's composition. Children are included in the sample only if they have one sibling (two children in total) and both siblings are 1–7 years old. As a result, we analyze only 1,298 siblings or 2,596 children. We compare the healthcare spending of the first-born and second-born children in these limited samples. Initial health conditions, such as past medical records, are not controlled in this section. If the medical records from last year are controlled, the estimation is practically impossible because fewer than 200 samples are available for the analysis.

Figure 1.4 presents the variation in children's medical costs depending on whether they live in the son-preference area and the gender composition of their siblings. Our samples are divided into four groups according to the gender composition and birth order of the children: "first son-second son," "first son-second daughter," "first daughter-second son," and "first daughter-second daughter." Overall, the medical expenses for the second child are higher than those for the first child. However, this is because the second child is younger, and if the age is controlled, the medical costs for the first child are higher. This information can be found in Table 1.9.

Another feature shown in Figure 1.4 is that, unlike other cases, there is little difference between the first-born and second-born child in the case of a “boy–girl” composition in the son-preference region. In the non-son-preference area, the healthcare spending of the second daughter is 93,094 KRW higher than that of the first son. On the other hand, in the son-preference area, the extra medical expenses for the second daughter are only 14,239 KRW. In other cases, except for the “boy–girl” composition in the son-preference region, the medical expenses for the second-born child far exceed those for the first-born child.

Figure 1.4. Medical Expenses by Gender Composition of Siblings and Region



Notes: Children's annual medical expenses by gender, son-preference region, and sibling composition groups are depicted in this graph. The children are divided into four groups according to their birth order and the gender composition of their siblings: "first son-second son," "first son-second daughter," "first daughter-second son," and "first daughter-second daughter."

To verify that the gap between the medical expenses of the first-born and second-born child differs depending on the gender composition of the siblings and the son-preference area, we use the DID approach. The DID analysis of birth order and son-preference area in equation (1.4) is performed separately for each of the four groups.

$$(1.4) \quad y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 second_i + \beta_3 sonpreference_{it} + \beta_4 (second_i * sonpreference_{it}) + year_t + region_r + \epsilon_{it}$$

In equation (1.4), $second_i$ is the second-born child dummy variable. We include age, disability, number of elderly people in households, age of parents, and household income as control variables, like in the previous analyses. The estimate of β_4, the coefficient of the interaction term between the second-born child dummy variable and son-preference region dummy variable, indicates the effect of son-preference on the medical cost differences between first-born and second-born child.

Table 1.9 presents the results of the DID analysis. Columns (1) and (2) show that when the first-born child is a son (boy–boy or boy–girl composition), the reduction in medical expenses for the second-born child is more pronounced in the son-preference areas compared to the non-son-preference areas. These son-preferences have a large and significant effect, especially when the first-born child is a son and the second-born child is a daughter; 26,220 KRW less is spent on the latter than her older brother in the non-son-preference areas. However, the difference in medical expenses resulting from the birth order further increased by 88,310 KRW in the son-preference areas.

Meanwhile, for the girl–boy composition, unlike other cases, medical expenses for the second-born child are higher than for the first-born child even after controlling for age. The medical expenditure on the second son is 1,880 KRW higher than that on the first daughter in the non-son-preference area, and this difference is small and insignificant. In the son-preference area, healthcare spending for the second son is further increased by 13,100 KRW, but the effect of son-preference is also insignificant.

Table 1.9. Effects of Birth Order of Child

Sibling Gender Composition:	Boy–Boy	Boy–Girl	Girl–Boy	Girl–Girl
	(1)	(2)	(3)	(4)
Dependent Variable: Medical Exp. (10,000 KRW)				
Second-Born Child	-7.645	-2.622	0.188	-6.755*
	(4.830)	(3.803)	(7.832)	(4.041)
Son-Preference Region	-4.825	-8.831*	1.310	0.049
×Second-Born Child	(7.483)	(5.326)	(11.900)	(6.330)
Observations	678	702	610	606
R-squared	0.218	0.181	0.131	0.308

Notes: We analyze only 1,298 siblings, or 2,596 children, whose number of siblings is one (two children in total) and both of whom are 1–7 years old. The samples are divided into four groups according to the gender composition and birth order of the children. Applying the DID estimation method, we conducted equation (1.4) separately for the four different groups. Parentheses indicate standard errors. A single asterisk denotes statistical significance at the 90% level of confidence, two asterisks denotes 95%, and three asterisks denotes 99%.

As previously explained, we analyze only the limited samples in this section. Therefore, the number of samples decreased considerably compared to prior analyses. Nevertheless, when the first-born child is a son, the parents not only spend more on the first son's healthcare than the younger child's, but the difference is further widened in the son-preference area. In particular, in the composition of first son and second daughter, the medical expenditure reduction pattern for the second-born child significantly increases in the son-preference area. These results suggest that there are cultural influences favoring the first-born son in Korea.

Korea's traditional family system is based on the immediate family system, and son-preference has also emerged from this background. The immediate family system values family succession through the first son. For this reason, in the past, the first son lived with his parents even after marriage, held ancestral rites, and was given preferential treatment in the property inheritance. Therefore, in the areas with a strong son-preference, parents not only prefer sons but particularly favor their first son over other sons and daughters. In this context, we can understand our estimation results that when the first-born child is a son, the differential healthcare investment between the first-born and second-born child increased in the son-preference area, which is especially significant in the composition of first son and second daughter.

In this section, we discussed whether the differential healthcare investments in sons and daughters depend on the children's birth order and gender composition of their siblings. Our findings indicate that the birth order and gender composition may also affect the gender gap in healthcare spending. When the first-born child is a son and the second-born child is a daughter, the decline in medical expenditure for the second-born child is significantly pronounced in the son-preference area compared to the non-son-preference area. From the results, we suggest that the cultural influences favoring the first-born son remain in Korea.

1.9 Conclusion

In this chapter, we examine the impact of son-preference on the parents' healthcare investment for their children, using the pooled data from the 2008–2015 Korea Health Panel Survey (KHPS). From the KHPS, we obtained the records of children's medical expenditure and the number of uses of medical services. To identify the effect of son-preference on the gender gap in healthcare investment, we use the variation of son-preference across regions of Korea. We define the regions with the highest sex ratio at birth as the son-preference areas and apply the difference-in-differences estimation method.

According to the result, the gender gap in medical expenditure and uses are greater in the son-preference region. In the non-son-preference areas, girls' annual medical expenses are 13,760 KRW lower than boys'. The gap between boys and girls is further widened by 71,300 KRW in the son-preference areas. This additional gap can be interpreted as a result of differential investments driven by son-preference. According to the analysis with the log-transformed dependent variable, the gender gap of medical expenses is additionally increased by 17 percentage points in the son-preference region.

Furthermore, we examine the effect of son-preference intensity on the gender gap in healthcare investments. The sex ratio at birth measured for the 20 years following the parent's birth year is directly used for the analysis. The intensity analysis also shows consistent results. One standard deviation increase in the average level of son-preference widens the gender gap in medical expenses by 26,690 KRW. We also confirm a similar result in the analysis with the gender norm score using the WVS data. Our findings suggest that the culture and customs of son-preference in the parent's childhood still influence them to make investment decisions based on their child's gender.

Lastly, we discussed whether the differential healthcare investment in sons and daughters depends on the characteristics of parents and children. Our results show that for parents with relatively low education levels, their income has a significant impact on the sex-biased healthcare investment decision. Also, the children's birth order and the gender composition of their siblings may affect the gender gap in healthcare spending.

Korea has experienced drastic economic growth and improvement in women's socioeconomic status. Despite these changes, there is still plenty of evidence for significant gender differences in terms of labor market outcome. In this research, we suggest evidence of the remaining son-preference in Korea and the consequent differential investment by parents. Given that such differential investments can lead to differences in human capital in the long term, this study is expected to help deepen the understanding of gender gaps in the labor market today, as well as non-labor discrimination. The next two chapters directly address the gender wage gap that remains in the Korean labor market.

Appendix

Table A1.1.Effects of Son-Preference on Medical Expenditure Status

	Dependent Variable: Medical Expenditure Status (Dummy Variable)					
	(1)	(2)	(3)	(4)	(5)	(6)
Female	-0.001	-0.001	-0.001	0.003	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Female×Son-Preference Region	0.002	0.002	0.002	0.001	-0.004	-0.004
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Son-Preference Region	-0.004					
	(0.003)					
Age 1				-0.010		
				(0.020)		
Age 2				-0.010	-0.004	-0.004
				(0.020)	(0.019)	(0.019)
Age 3				-0.019	-0.013	-0.012
				(0.020)	(0.019)	(0.019)
Age 4				-0.016	-0.003	-0.003
				(0.020)	(0.019)	(0.019)
Age 5				-0.017	-0.006	-0.006
				(0.020)	(0.019)	(0.019)
Age 6				-0.025	-0.011	-0.011
				(0.020)	(0.019)	(0.019)
Disability				0.014	0.005	0.004
				(0.015)	(0.015)	(0.015)

Number of Brothers				0.003	0.004**	0.004**
				(0.002)	(0.002)	(0.002)
Number of Sisters				-0.001	0.004**	0.004**
				(0.002)	(0.002)	(0.002)
Number of Elderly				0.002	0.002	0.002
				(0.003)	(0.003)	(0.003)
Father's Age				-0.001**	-0.001*	-0.000
				(0.000)	(0.000)	(0.000)
Mother's Age				0.001	0.000	0.000
				(0.000)	(0.000)	(0.000)
Household Income				-0.000	0.000	0.000
				(0.000)	(0.000)	(0.000)
Initial Condition					0.003	0.000
					(0.002)	(0.000)
					0.000	0.000
					(0.001)	(0.000)
Region FE	No	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Controls	No	No	No	Yes	Yes	Yes
Initial Condition	No	No	No	No	ER Use	ER Exp.
					Inpatient Use	Inpatient Exp.
Observations	7,727	7,727	7,727	7,727	5,104	5,104
R-squared	0.000	0.004	0.009	0.013	0.010	0.009

Table A1.2. Effects of Son-Preference on Medical Expenditure (Log Transformation)

	Dependent Variable: ln(Medical Expenditure) (10,000 KRW)					
	(1)	(2)	(3)	(4)	(5)	(6)
Female	-0.091***	-0.095***	-0.093***	-0.076**	-0.089**	-0.078*
	(0.029)	(0.029)	(0.029)	(0.035)	(0.041)	(0.041)
Female×Son-Preference Region	-0.150**	-0.141**	-0.148**	-0.190***	-0.178***	-0.183***
	(0.062)	(0.062)	(0.062)	(0.057)	(0.068)	(0.068)
Son-Preference Region	0.011					
	(0.043)					
Age 1				-0.124		
				(0.232)		
Age 2				-0.706***	-0.636**	-0.629**
				(0.232)	(0.252)	(0.251)
Age 3				-0.997***	-0.959***	-0.937***
				(0.232)	(0.252)	(0.251)
Age 4				-1.100***	-1.025***	-1.004***
				(0.232)	(0.252)	(0.251)
Age 5				-1.204***	-1.159***	-1.131***
				(0.232)	(0.252)	(0.251)
Age 6				-1.191***	-1.102***	-1.073***
				(0.232)	(0.252)	(0.251)
Disability				1.847***	1.538***	1.671***
				(0.174)	(0.202)	(0.197)

Number of Brothers				-0.163***	-0.184***	-0.179***
				(0.021)	(0.024)	(0.024)
Number of Sisters				-0.147***	-0.154***	-0.154***
				(0.019)	(0.022)	(0.022)
Number of Elderly				-0.111***	-0.080**	-0.078**
				(0.030)	(0.037)	(0.037)
Father's Age				-0.010***	-0.008**	-0.008**
				(0.003)	(0.004)	(0.004)
Mother's Age				0.001	0.005	0.004
				(0.004)	(0.005)	(0.004)
Household Income				0.183***	0.187***	0.188***
				(0.024)	(0.029)	(0.029)
Initial Condition					0.136***	0.014***
					(0.021)	(0.003)
					0.063***	0.025***
					(0.012)	(0.003)
Region FE	No	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Controls	No	No	No	Yes	Yes	Yes
Initial Condition	No	No	No	No	ER Use	ER Exp.
					Inpatient Use	Inpatient Exp.
Observations	7,665	7,665	7,665	7,665	5,047	5,047
R-squared	0.004	0.026	0.033	0.184	0.129	0.133

Table A1.3. Effects of Son-Preference on Medical Expenditure (Various Initial Condition Variables)

	Dependent Variable: Medical Expenditure (10,000 KRW)			
	(1)	(2)	(3)	(4)
Female	-2.222	-1.376	-2.600	-1.299
	(1.645)	(1.632)	(1.641)	(1.603)
Female ×Son-Preference Region	-6.623**	-7.130***	-5.246*	-5.806**
	(2.703)	(2.680)	(2.698)	(2.633)
Age 2	-12.233	-13.792	-11.172	-13.988
	(10.025)	(9.940)	(9.996)	(9.764)
Age 3	-23.307**	-23.982**	-20.246**	-18.902*
	(10.023)	(9.937)	(9.995)	(9.762)
Age 4	-23.054**	-23.744**	-19.524*	-17.590*
	(10.025)	(9.939)	(10.000)	(9.767)
Age 5	-25.732**	-26.550***	-20.822**	-20.289**
	(10.027)	(9.941)	(10.005)	(9.769)
Age 6	-23.687**	-24.847**	-17.476*	-18.231*
	(10.028)	(9.942)	(10.010)	(9.770)
Disability	125.361***	120.381***	123.060***	93.891***
	(8.037)	(7.952)	(8.005)	(8.039)
Number of Brothers	-4.369***	-4.186***	-5.192***	-3.576***
	(0.962)	(0.953)	(0.959)	(0.938)
Number of Sisters	-4.551***	-4.460***	-5.054***	-3.703***
	(0.893)	(0.886)	(0.890)	(0.871)
Number of Elderly	-1.644	-1.523	-1.669	-1.165
	(1.455)	(1.442)	(1.450)	(1.417)
Father's Age	-0.402**	-0.300*	-0.242	-0.217
	(0.161)	(0.159)	(0.160)	(0.156)
Mother's Age	0.196	0.202	-0.097	0.098
	(0.178)	(0.177)	(0.178)	(0.173)
Household Income	0.040**	0.036*	0.049***	0.030
	(0.019)	(0.019)	(0.019)	(0.018)
Initial Condition	5.602***	0.820***	0.525***	0.262***
	(0.842)	(0.154)	(0.034)	(0.012)
	5.395***	0.252***		
	(0.477)	(0.016)		
Initial Condition	ER Use Inpatient Use	ER Exp. Inpatient Exp.	Medical Use	Medical Exp.
Observations	5,047	5,047	5,047	5,047
R-squared	0.147	0.161	0.151	0.190

Table A1.4. Effects of Son-Preference on Medical Expenditure (Robustness Check)

	Full Samples	Non-disabled	Non-multicultural Families
	(1)	(2)	(3)
Female	-1.376	-1.048	-1.266
	(1.632)	(1.573)	(1.665)
Female×Son-Preference Region	-7.130***	-6.159**	-8.038***
	(2.680)	(2.592)	(2.767)
Age 2	-13.792	-14.113	-13.473
	(9.940)	(9.571)	(10.019)
Age 3	-23.982**	-23.864**	-24.054**
	(9.937)	(9.569)	(10.016)
Age 4	-23.744**	-23.666**	-23.893**
	(9.939)	(9.572)	(10.019)
Age 5	-26.550***	-26.330***	-26.349***
	(9.941)	(9.573)	(10.020)
Age 6	-24.847**	-24.506**	-24.759**
	(9.942)	(9.574)	(10.022)
Disability	120.381***		119.652***
	(7.952)		(8.020)
Number of Brothers	-4.186***	-3.463***	-4.298***
	(0.953)	(0.921)	(0.975)
Number of Sisters	-4.460***	-3.997***	-4.411***
	(0.886)	(0.855)	(0.903)
Number of Elderly	-1.523	-1.528	-1.456
	(1.442)	(1.390)	(1.526)
Father's Age	-0.300*	-0.231	-0.252
	(0.159)	(0.154)	(0.198)
Mother's Age	0.202	0.117	0.159
	(0.177)	(0.171)	(0.213)
Household Income	0.036*	0.039**	0.036*
	(0.019)	(0.018)	(0.019)
Initial Condition (ER Exp.)	0.820***	0.931***	0.833***
	(0.154)	(0.152)	(0.156)
Initial Condition (Inpatient Exp.)	0.252***	0.308***	0.256***
	(0.016)	(0.018)	(0.016)
Observations	5,047	5,021	4,891
R-squared	0.161	0.110	0.164

Table A1.5. Effects of Parents' Intensity of Son-preference (Robustness Check)

	Full Samples	Non-disabled	Non-multicultural Families
Dependent Variable: Medical Exp. (10,000 KRW)	(1)	(2)	(3)
Panel A. Registered Region's Sex Ratio (20 years Average after Birth)			
Female	-3.549**	-2.898**	-3.693**
	(1.512)	(1.459)	(1.551)
Z-score of Parents' Sex Ratio at Birth	5.067**	5.511**	5.086*
	(2.490)	(2.409)	(2.599)
Female×Z-score of Parents' Sex Ratio at Birth	-2.669***	-2.315***	-2.931***
	(0.884)	(0.855)	(0.907)
Panel B. Estimated Birthplace's Sex Ratio using Census (20 years Average after Birth)			
Female	-2.977**	-2.403*	-3.006*
	(1.504)	(1.450)	(1.540)
Z-score of Parents' Sex Ratio at Birth	6.634***	6.652***	6.413***
	(2.184)	(2.108)	(2.432)
Female×Z-score of Parents' Sex Ratio at Birth	-2.538**	-2.341**	-2.792***
	(0.996)	(0.963)	(1.021)

Table A1.6. Effects of Other Intensity Measure of Son-preference

Child's Registered Region's Sex Ratio:	Child's Birth Year	Avg. from Child's Birth Year to Survey Year
	(1)	(2)
Dependent Variable: Medical Exp. (10,000 KRW)		
Female	-3.198**	-3.260**
	(1.506)	(1.524)
Z-score of Child's Sex Ratio at Birth	1.271	-2.271
	(2.072)	(1.792)
Female×Z-score of Child's Sex Ratio at Birth	-3.333*	-1.290
	(1.789)	(1.437)
Observations	5,047	5,047
R-squared	0.161	0.161

Table A1.7. Effects of Parents' Education Level on Gender Gap of Medical Expenditure

Variable of Parents' Education Level:	Father's Education (1)	Mother's Education (2)
Dependent Variable: Medical Exp. (10,000 KRW)		
Female	-5.383	-3.437
	(8.668)	(8.010)
Parents' Education Level (HSG)	-4.781	2.200
	(6.856)	(4.976)
Parents' Education Level (CLG)	-1.584	2.880
	(6.825)	(4.930)
Parents' Education Level (CLG+)	-5.170	5.151
	(7.478)	(7.413)
Female×Son-Preference Region	13.049	-10.055
	(16.759)	(13.451)
Female×Parents' Education Level (HSG)	5.355	0.231
	(8.851)	(8.194)
Female×Parents' Education Level (CLG)	2.445	3.636
	(8.753)	(8.139)
Female×Parents' Education Level (CLG+)	9.526	-0.750
	(9.799)	(11.006)
Son-Preference Region×Parents' Education Level (HSG)	19.173	-12.714
	(12.381)	(9.100)
Son-Preference Region×Parents' Education Level (CLG)	13.770	-10.023
	(12.237)	(8.971)
Son-Preference Region×Parents' Education Level (CLG+)	4.988	-20.207
	(14.289)	(13.951)
Female×Son-Preference Region ×Parents' Education Level (HSG)	-22.955	6.947
	(17.367)	(14.184)
Female×Son-Preference Region ×Parents' Education Level (CLG)	-18.903	-0.106
	(17.124)	(13.909)
Female×Son-Preference Region ×Parents' Education Level (CLG+)	-20.627	26.363
	(20.098)	(28.991)
Observations	5,047	5,047
R-squared	0.162	0.162

2 Workplace Flexibility and Gender Wage Gap

2.1 Introduction

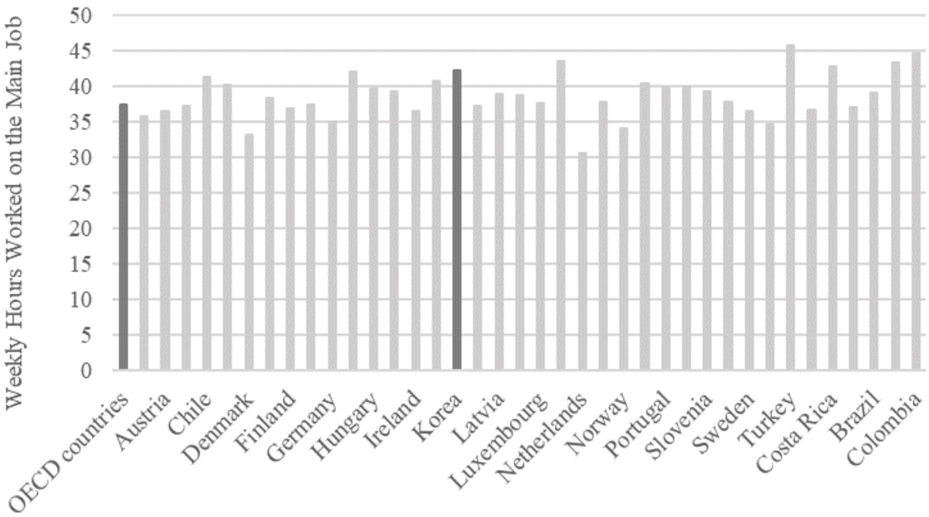
In February 2018, the South Korean National Assembly passed an amendment to the country's Labor Standards Acts. The amendment lowered the maximum weekly working hours from 68 to 52 hours. The 52-hour workweek went into effect for companies with more than 300 employees and public institutions in July 2018. From January 2020, the government expanded this legislation to workplaces with more than 50 and fewer than 300 employees. Moreover, government support for companies implementing flexible work systems was strengthened in 2017. The target of support expanded from small businesses to midsized firms, and the subsidy also increased from 3.64 million to 5.2 million KRW per year per worker using the system. Under the system, workers work 8 hours a day and 40 hours a week, but they can stagger their working hours, coordinate work hours per day within 40 hours a week, or work from home.

As such, the labor market and working culture are steadily changing in Korea to allow workers to flexibly adjust their working schedule and working conditions at their discretion. These changes reflect the value of workers seeking to improve their quality of life and balance work and family time. We analyze the impact of the flexibility of the work environment, which is emphasized today, on the gender wage gap. This paper does not address the labor market flexibility, which means how easily companies respond to changes in market conditions, including employers' ability to hire and fire employees and set wage rates. In this study, we adopt the concept of work flexibility or continuity presented in Goldin (2014), which includes the number of hours worked, the specific working hours, being around for clients or colleagues, and authority to decide own schedule.

We note two characteristics of the Korean labor market. One is long working hours. As presented in Figure 2.1, their working hours are significantly higher than the average level of OECD countries. The average number of usual weekly hours worked on a main job in Korea as of 2018 is 42.2 hours, which is the sixth-highest among OECD countries; Korean workers work 4.8 more hours a week than the OECD average (37.4 hours). Figure 2.2 shows the working hours by gender. In Korea, women work five hours less per week than men, but these differences are similar to other countries. Also, Korean men work the sixth-most hours, and Korean women the fourth-most, among OECD countries. Korean workers, regardless of gender, generally work long hours.

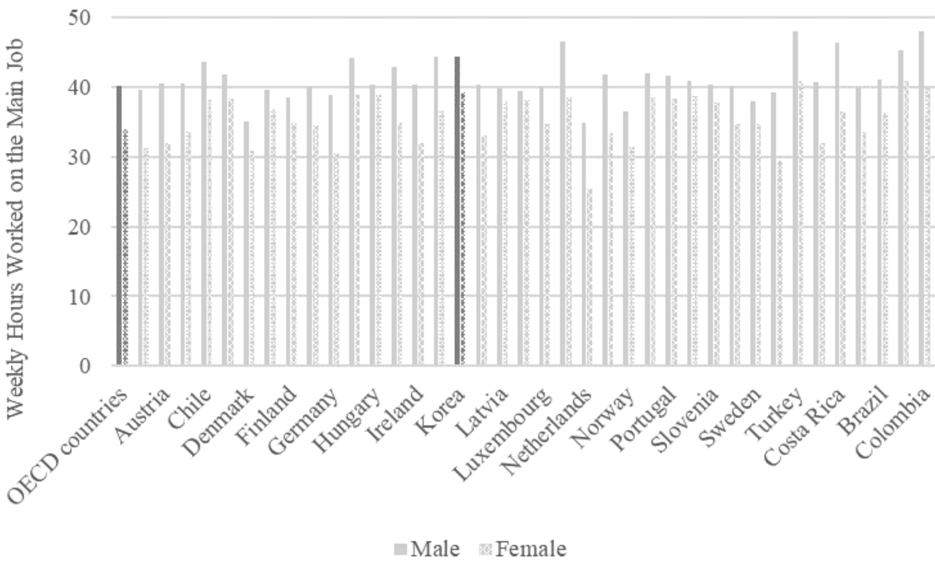
In addition to the problem that workers' quality of life decreases due to excessive work, long working hours are known to attribute to conflicts between work and family life. For this reason, long working hours becomes a barrier to women's economic activities and is often cited as a cause of breaking the career of married women with children.

Figure 2.1. 2018 Average Usual Weekly Hours Worked on a Main Job



Source: OECD.Stat (https://stats.oecd.org/)

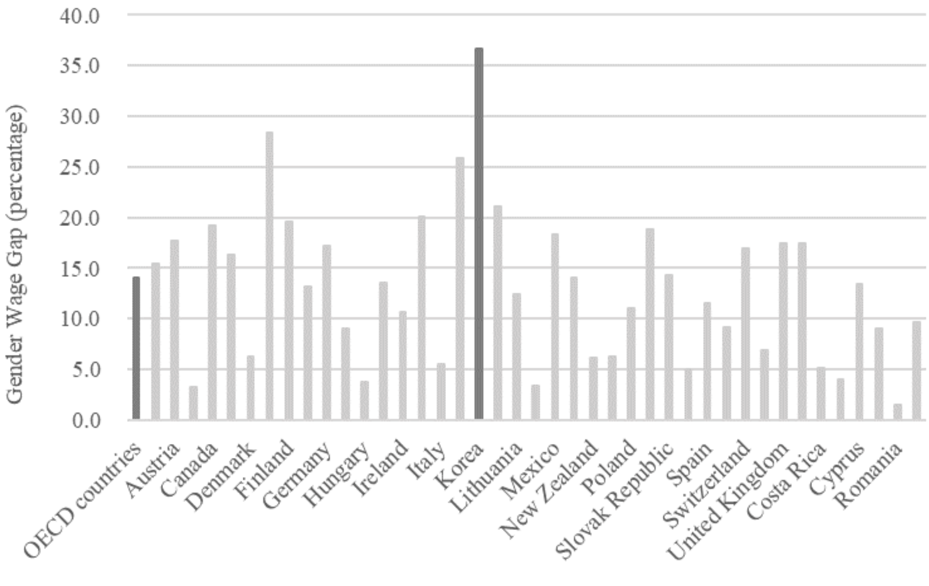
Figure 2.2. 2018 Average Usual Weekly Hours Worked on a Main Job by Sex



Source: OECD.Stat (https://stats.oecd.org/)

Meanwhile, the role of women in the labor market has been greatly expanded in Korea as well as in developed countries such as the U.S. and in Europe. In addition to the labor force participation, the gender differences have decreased remarkably in various aspects such as education level, career, and occupations. However, there are still significant gender gaps in terms of income, particularly hourly wages, compared to other changes. According to OECD statistics, the gender wage gap in Korea is overwhelmingly higher than in other countries. As presented in Figure 2.3, Korea's gender wage gap in 2014 was 36.7%, the largest among OECD countries. Also, Korea is the only OECD country with a gender wage gap of over 30%.

Figure 2.3. 2014 Gender Wage Gap of OECD Countries



Source: OECD.Stat (https://stats.oecd.org/)

Various factors may have affected the wage gap between men and women in Korea. Due to the influence of Confucian culture and patriarchy, it is possible that gender discrimination still exists in the Korean labor market and is reflected in wages. Also, this culture may have caused gender differences in human capital or productivity by allowing parents to invest differently according to the sex of their children, like in other Asian counties (Mishra et al., 2004; Jayachandran and Kuziemko, 2011; Hafeez and Quintana-Domeque, 2018). It has been shown that the parental input, such as the labor supply of parents, the time children spend on household chores, and the cost of private education, varies depending on the gender of the child in Korea (Choi and Hwang, 2015). Other possible explanations are that glass ceilings and different task assignments between sexes limit women's promotion (Babcock et al., 2017) and that women are less competitive and less active than men (Gneezy et al., 2003; Niederle and Vesterlund, 2007).

In this study, we aim to analyze the causes of the remaining gender wage gap in Korea in terms of flexibility in workplaces. Goldin (2014) suggested that the gender gap in earnings varies by occupation, and it is related to job flexibility and continuity. According to the study, for some occupations, it is difficult for workers to be perfect substitutes for each other, and transaction costs are incurred when communicating information to other workers. In this case, the firm may have an incentive to pay a premium to employees who work long hours and give penalties to employees who prefer lower hours and job flexibility. Consequently, the hourly wage is not constant but increases with respect to the hours worked, and the total earnings increase rapidly with the hours. Goldin (2014) explained that this nonlinear (convex) payment structure is responsible for the gender gap in earnings.

Considering the characteristics of the Korean labor market and prior literature, the long working hours that are common in Korea can be seen as evidence that the overall working environment is not flexible. Also, low workplace flexibility may be related to the fact that the gender wage gap in Korea is exceptionally high. The working hours of Korean women are shorter than those of men due to women’s performance of housework and childcare. In this case, if the workplace is inflexible, employers can penalize women with shorter working hours by lowering their hourly wages. As a result, while their total income does not decrease in proportion to the hours they work, it decreases faster. Accordingly, it is possible that the gender wage gap has occurred and the income gap between men and women has widened further.

In this case, the working culture and regime in which long working hours are general—or more fundamentally, the inflexible workplace—could explain much of Korea's gender wage gap. To verify this, using the data of occupational characteristics and difference-in-differences approach, we examine the effect of workplace flexibility on the gender wage gap in the Korean labor market. In the analysis comparing flexibility and gender wage gap between occupations, it is found that women’s relative hourly wage is high in flexible working environments. Also, these effects were more pronounced in workers with high education levels, such as college graduates.

This chapter is organized as follows. Section 2.2 reviews previous studies that link the gender gap in the labor market to the workplaces' flexibility and long working hours, along with the analysis of the Korean labor market. In Sections 2.3 and 2.4, we describe the data and estimation method. In Section 2.5, we analyze the effects of the workplace's flexibility on the gender wage gap and report our main results. Section 2.6 presents the robustness check results, and Section 2.7 concludes.

2.2 Literature Review

From the beginning of the 20th century to recent years, the gender gap has narrowed in various aspects of human capital and economic outcomes, such as labor force participation, working hours, work experience, and education. Women's relative earnings have also increased compared to those of men. However, as described in the previous section, there is still a significant difference in wages between males and females, particularly in Korea. In general, the gender wage gaps are divided into those derived from human capital differences and the residual. Several prior studies on the gender wage gap interpreted the residual portion as a result of discrimination (Blau and Kahn, 2007; Goldin, 2014; Yoo, 2001; Yoo and Hwang, 2005).

Goldin (2014) linked the residual gender wage gap to the flexibility or continuity of jobs and described the concept of workplace flexibility as including the number of hours worked, the specific working hours, being around for clients or colleagues, and the authority to decide one's own schedule. According to the paper, the payment structure is related to the possibility of substitution between workers. If workers are not a perfect substitute for each other, transaction costs are incurred when one worker hands over tasks to another. Because of the costs, the firms have an incentive to pay a premium to workers who work long hours and to give penalties to workers with fewer hours. Consequently, the hourly wage increases with respect to the hours worked, and the total earnings do not increase in proportion to hours but increase sharply. She explained that the nonlinear (convex) relationship between total earnings and the number of hours worked is responsible for the residual gender gap in earnings. That is, in the inflexible workplaces, gender gaps occur in both working hours and hourly wages, thereby widening the earnings gap between men and women.

Meanwhile, Goldin (2014) noted that the demands for workplace flexibility are more important for highly educated workers, such as college graduates. Accordingly, the analysis of her paper focused on college graduates and occupations at the top of the income distribution. For instance, the author representatively suggested a lawyer as an inflexible job and a pharmacist as a flexible job and analyzed them.

Goldin and Katz (2011) studied the financial penalties for workplace flexibility and explained that the penalty has decreased in professions such as pharmacy and veterinary medicine. This is largely due to the exogenous factors such as reduced self-employment in those high-end occupations, but the endogenous factor of the increase in working women also contributed to the change. In addition, workplace flexibility has improved differently depending on the occupation, and the business and financial sectors have lagged behind change.

Several studies have investigated the flexibility of working conditions through the analysis of specific occupations. Briescoe (2006; 2007) explored the influence of the large-scale organization on the temporal flexibility of professional service workers based on the field research of physicians. Those studies found that the organizational processes with bureaucracy provide greater flexibility in their schedules and careers. Blair-Loy (2009) analyzed the case of stockbrokers and concluded that stockbrokers in the firms with scheduling flexibility are more likely to have work-to-family conflicts than those in the firms with scheduling rigidity.

Meanwhile, Cortes and Pan (2017) used cross-sectional data of industrialized countries to discover that the prevalence of overwork in a country has a negative relationship with women's labor force participation. Also, the analysis using the country–occupation–year level variation showed that overtime work has a significant impact on women's occupational choices. The author suggested that the different needs for long hours and inflexible working conditions by occupation are responsible for the occupational segregation and insufficient number of women in certain sectors, such as in corporate and technological companies.

In Korea, there is little literature that associates the gender gap in labor market outcomes with workplace flexibility. Many studies have contributed to decomposing the gender wage gap into “difference” and “discrimination” and clarifying the causes of the wage gap (Yoo, 2001; Yoo & Hwang, 2005; Kim, Y., 2007; Kim, T., 2013). According to the studies, the gender wage gap in Korea has been narrowing since the 1980s, and this trend was mainly due to the reduction of gender differences in human capital or productivity, such as education, work experience, and occupational segregation. Wage discrimination has also decreased, but it remains considerable in recent years and accounts for a larger portion of the gender wage gap compared to the differences. Meanwhile, Heo (2003) showed that wage discrimination was greater than employment discrimination in both industries and occupations. In particular, wage discrimination against women was more prominent in occupations than in industries.

Bae (2012) studied the causes of the long working hours that persist in Korea. According to him, because only full-time work is perceived as the dominant system for working hours in the Korean labor market, the share of workers working less than full-time is small and part-time workers are at a significant disadvantage. He pointed out that the strong preference for full-time employment, low part-time employment rates, and low application rates for the 40-hour workweek, are institutional factors that sustain long working hours. Besides, it was also mentioned that the system of working long hours is applied equally to women in Korea, and there is no consideration for work–family balance. The following section describes the data used in this study.

2.3 Data

In this study, we use 2018 data from the Local Area Labor Force Survey (LAFS) to analyze full-time workers between the ages of 25 and 54 who work more than 30 hours, especially college graduates. The agricultural and forestry sector workers are excluded from the analysis. The LAFS is a survey that is conducted on a household basis and includes income, working hours, and occupational information for individual units. It also includes demographic information such as gender, age, education level, marital status, and career. Two advantages of the LAFS data are that the sample size is large and the occupation data is separated into detailed categories. The detailed information on occupation enables analysis that accurately reflects occupation characteristics.

Meanwhile, the concept of workplace flexibility described in Goldin (2014) includes not only working hours but also whether employees need to work at a specific time, whether they should be around for their customers and colleagues, and whether they have the authority to decide their own schedule. She measured the flexibility using the O*Net data on occupational characteristics. In the present study, the Korea Network for Occupations & Workers data—henceforth, KNOW—which is built on the American O*Net, is used to measure the flexibility of each occupation.

KNOW investigates the characteristics of each occupation, such as knowledge, personality, work ability, values, work environment, interests, job prospects, qualifications, and training required. The advantage of KNOW data is that incumbents respond directly to those characteristics of their work. As of 2017, KNOW surveyed 632 detailed occupations; data from 2014 to 2018 are analyzed in this paper. We measure the flexibility of the workplace mainly using KNOW items corresponding to the O*Net items used in Goldin (2014).

Table 2.1. O*Net and KNOW Characteristics for Flexibility Measure

KNOW Characteristics	O*Net Characteristics used in Goldin (2014)
1. Time Pressure (-)	Time Pressure
2. Contact with Others (-)	Contact with Others
3. Performing for or Working Directly with the Public (-)	Establishing and Maintaining Interpersonal Relationships
4. Structured vs. Unstructured Work (+)	Structured vs. Unstructured Work
5. Freedom to Make Decisions (+)	Freedom to Make Decisions
6. Importance of Being Exact or Accurate (-)	
7. Achievement (+)	

Note: We measure the workplace flexibility mainly using KNOW items 1 to 5, which correspond to O*Net items used in Goldin (2014). Exceptionally, the third item, "Performing for or Working Directly with the Public" is used in place of "Establishing and Maintaining Interpersonal Relationships." We also use items 6 and 7 additionally. The relationship between each item and workplace flexibility is indicated in parentheses.

In Table 2.1, items 1 to 5 are the same as O*Net items of Goldin (2014). Exceptionally, the third item, "Performing for or Working Directly with the Public" is used in place of "Establishing and Maintaining Interpersonal Relationships." Given that Goldin (2014) included "being around for clients" in the concept of workplace flexibility, "Performing for or Working Directly with the Public" is considered to be important in reflecting that concept well and determining flexibility. Each score is normalized, and the sum of the five scores is used as a flexibility measure. Furthermore, in the analysis, we use each individual score directly instead of the total score.

We also use items 6 and 7 additionally for robustness checks. In the case of "Importance of Being Exact or Accurate," the survey question is, "How important is producing the accurate number of items, doing the least work, or doing a specific task within a certain time in performing this job?" In the sense that time constraints are important, "Importance of Being Exact or Accurate" will indicate occupational characteristics similar to "Time pressure." Meanwhile, "Achievement" represents the occupational characteristics that "Occupations that satisfy this work value allow employees to set their own goals and achieve the goals themselves." This item is also used in the analysis because it is related to decision-making authority and decision-making possibility. The relationship between each item and workplace flexibility is indicated in parentheses. The distributions of these flexibility scores among workers are presented in Appendix Figure A2.1.

2.4 Estimation Methods

In this study, we examine the influence of a flexible workplace on the gender wage gap by using the difference-in-differences—henceforth, DID—approach. That is, the hourly wage differences between men and women are derived and compared between the flexible and rigid occupations. If the flexibility of the workplaces does not have any impact on gender wages, the gender wage gap would be similar for both occupation groups. However, as Goldin (2014) argues, there is a possibility that companies prefer workers who work long hours and impose penalties on workers with short working hours when the working environment is not flexible. In this case, it is more likely that women working in those inflexible occupations will experience additional gender wage gaps compared to women in flexible occupations. In this analysis, flexible occupations are determined using the KNOW flexibility measure described in the previous section.

Based on the idea, we use the following regression equation to identify the impact of flexibility in the workplace on the wage gap between men and women.

$$(2.1) \qquad y_i = \beta_0 + \beta_1 X_i + \beta_2 Female_i + \beta_3 Flexibility_i + \beta_4 (Female_i * X_i) + \beta_5 (Female_i * Flexibility_i) + \delta_{occ} + \theta_{ind} + \epsilon_i$$

In this equation, y_i is observation i's log hourly wage, and X_i indicates control variables such as age, age squared, marital status, education level, and career. $Female_i$ is a female dummy variable, and $Flexibility_i$ is an indicator of occupation flexibility. δ_{occ} is included to control the occupation fixed effect, and the industry fixed effect θ_{ind} is also added in the analysis. In addition to flexible jobs, age, marital status, education level, and work experience may also have different wage effects depending on gender. Therefore, we include both the interaction term of flexible occupation and the female dummy variable and that of each control variable and the female. The main interest of this study is the estimate of β_5. This estimate presents an additional gender wage gap in occupations with flexible working environments.

In the analysis, we use two indicators for workplace flexibility. First, if an occupation's flexibility score is higher than the average of all samples, it is defined as a flexible occupation. On the other hand, if the score is lower than the average, it is defined as a rigid occupation. In this case, $Flexibility_i$ has a value of 1 if observation i works in a flexible occupation, and it is 0 otherwise. Second, the normalized flexibility score (Z-score of flexibility) of observation i's occupation is also directly used as a continuous variable to estimate the effect of treatment intensity.

Before the DID analysis, we check whether the demographic characteristics are systematically different depending on the gender and type of occupation. Table 2.2 shows descriptive statistics of dependent variables and covariates by gender and occupation type. As mentioned earlier, since this paper mainly analyzes college graduates, on whom it presents only summary statistics. Columns (3), (4), (6), and (7) report the average values of the variables for each subgroup that are classified by observation's gender and occupation. Columns (5) and (8) are differences between men and women in each occupation type, and column (9) is the difference in the gender gap between flexible and inflexible occupations. In other words, column (9) presents the DID values without any control variables.

According to columns (5) and (8) of Table 2.2, women's hourly wages are 82% of men's when they are in occupations with a flexible working environment. Nevertheless, with the rigid working conditions, women's wages are only 71% of men's; that is, when nothing is controlled, the gender wage difference is smaller in flexible occupations than rigid occupations. More specifically, men working in flexible jobs have only slightly higher wages compared to men working in rigid ones. For women, however, the wage increase in flexible occupations is quite large. Even in the case of monthly payments, the gender income gap narrows in a flexible working environment.

Meanwhile, gender gaps in marital status and education level do not differ significantly depending on the occupation type. However, in the case of age and career, the gender gap of the flexible job is significantly different from rigid ones. Overall, women in jobs with flexible working environments tend to be older and have a longer career than women in rigid occupations. On the other hand, men are often older and have a longer career when working in rigid environments. In the DID analysis, all of these variables are controlled to minimize the impact of demographic characteristics.

Table 2.2. Descriptive Statistics by Occupation and Gender (For College Graduate+)

	Entire sample		Flexible Occupation			Rigid Occupation			Difference-in -differences
	Mean	Std. Dev.	Female	Male	Difference	Female	Male	Difference	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Dependent Variables									
Hourly Wage	1.804	0.943	1.697	2.073	-0.376	1.364	1.910	-0.546	0.170***
Monthly Payment	334.461	171.127	307.434	389.313	-81.879	247.177	356.503	-109.326	27.447***
Weekly Working Hours	43.121	5.876	41.992	43.958	-1.966	41.933	43.664	-1.731	-0.235*
Panel B: Covariates									
Marriage	0.702	0.457	0.635	0.744	-0.109	0.624	0.747	-0.124	0.014
Age	39.329	8.067	37.979	39.992	-2.013	37.606	40.470	-2.864	0.850***
Career	8.842	7.828	9.221	8.668	0.553	7.212	9.921	-2.709	3.262***
Education	16.384	1.090	16.588	16.650	-0.062	16.173	16.210	-0.038	-0.025
Observations	35,426		5,039	10,390	15,429	7,999	11,998	19,997	

Notes: We check the characteristics of subgroups to confirm that there are no demographic differences depending on the gender and occupation type. Columns (1) and (2) are summary statistics for the full-time college graduate workers aged 25–54. Columns (3), (4), (6) and (7) show the mean of each subgroup distinguished by gender and occupation type. Columns (5) and (8) present the gender gap in each occupation. The significance in the difference between the gender gap of the flexible occupation versus that of the rigid occupation is illustrated in column (9).

2.5 Main Results

In this section, we examine the effect of workplace flexibility on the gender wage gap using the DID approach. As explained in Section 2.4, two indicators for workplace flexibility are used. Table 2.3 shows the results of using the treatment dummy, or the flexible occupation dummy variable, as the index of flexibility. On the other hand, Table 2.4 reports the results of the treatment intensity analysis using continuous flexibility scores. In each table, columns (1) to (4) present the results of adding control variables sequentially. Column (1) includes only the female dummy variable, flexibility indicator, and the intersection terms of these two. In columns (2) and (3), the occupation fixed effect and industry fixed effect are added one by one. Lastly, column (4) is the result of an analysis that further controls marital status, age, career, and education level, and is the model to be finally used in this study.

As described earlier, we assess the impact of workplace flexibility on the gender wage gap for full-time college graduates aged 25 to 54. According to the results, women's relative hourly wages are significantly higher in occupations with flexible working conditions. These results are consistent regardless of the model. Column (4) of Table 2.3 reveals that when working in a flexible workplace, the women's relative hourly wages increase by about 3.9 percentage points compared to in rigid occupations. Also, column (4) of Table 2.4 shows that if the job's flexibility score is higher than the overall average by one standard deviation, the relative wage of women in that profession increases by 3.0 percentage points.

Table 2.3. Effects of Workplace Flexibility on Hourly Wage with Flexible Occupation Dummy (For College Graduate+)

	Dependent Variable: Log Hourly Wage			
	(1)	(2)	(3)	(4)
Female	-0.323***	-0.243***	-0.230***	0.221**
	(0.006)	(0.006)	(0.006)	(0.087)
Female×Flexible Occupation Dummy	0.153***	0.076***	0.072***	0.038***
	(0.010)	(0.010)	(0.010)	(0.008)
Flexible Occupation Dummy	0.060***			
	(0.006)			
Marriage				0.125***
				(0.006)
Female×Marriage				-0.092***
				(0.009)
Age				0.040***
				(0.003)
Female×Age				-0.012***
				(0.005)
Age2				-0.000***
				(0.000)
Female×Age2				0.000
				(0.000)
Career				0.016***
				(0.000)
Female×Career				0.007***
				(0.001)
Education Level 6. Master				0.082***
				(0.007)
Female×Education Level 6. Master				0.014
				(0.011)
Education Level 7. Ph.D.				0.194***
				(0.014)
Female×Education Level 7. Ph.D.				0.056**
				(0.025)
Occupation FE	No	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes
Controls	No	No	No	Yes
Observations	35,426	35,426	35,426	35,426
R-squared	0.104	0.349	0.383	0.562

Notes: We conduct equation (2.1) with the flexible occupation dummy variable and estimate the effect of treatment dummy. If an occupation's flexibility score is higher than the overall mean, it is defined as a flexible occupation, and the flexible occupation dummy refers whether observation works in a flexible occupation or not. Parentheses indicate standard errors. A single asterisk denotes statistical significance at the 90% level of confidence, two asterisks denotes 95%, and three asterisks denotes 99%.

Table 2.4. Effects of Workplace Flexibility on Hourly Wage with Flexibility Score (For College Graduate+)

	Dependent Variable: Log Hourly Wage			
	(1)	(2)	(3)	(4)
Female	-0.259***	-0.211***	-0.199***	0.238***
	(0.005)	(0.005)	(0.005)	(0.087)
Female×Z-score of Flexibility	0.076***	0.044***	0.042***	0.030***
	(0.005)	(0.005)	(0.004)	(0.004)
Z-score of Flexibility	0.023***			
	(0.003)			
Marriage				0.126***
				(0.006)
Female×Marriage				-0.092***
				(0.009)
Age				0.040***
				(0.003)
Female×Age				-0.012**
				(0.005)
Age2				-0.000***
				(0.000)
Female×Age2				0.000
				(0.000)
Career				0.016***
				(0.000)
Female×Career				0.007***
				(0.001)
Education Level 6. Master				0.084***
				(0.007)
Female×Education Level 6. Master				0.007
				(0.011)
Education Level 7. Ph.D.				0.197***
				(0.014)
Female×Education Level 7. Ph.D.				0.048*
				(0.025)
Occupation FE	No	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes
Controls	No	No	No	Yes
Observations	35,426	35,426	35,426	35,426
R-squared	0.104	0.349	0.383	0.562

Notes: We conduct equation (2.1) with Z-score of flexibility, and estimate the effect of treatment intensity. The normalized flexibility score of occupation is directly used as a continuous variable. Parentheses indicate standard errors. A single asterisk denotes statistical significance at the 90% level of confidence, two asterisks denotes 95%, and three asterisks denotes 99%.

Table 2.5. Effects of KNOW Characteristics (For College Graduate+)

KNOW Characteristics:	Less Time Pressure	Unstructured Work	Make Decision	Less Contact	Less Work with Public	Less Need for Accuracy	Achievement
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable: Log Hourly Wage							
Female	0.242***	0.233***	0.244***	0.249***	0.248***	0.242***	0.243***
	(0.087)	(0.087)	(0.087)	(0.087)	(0.087)	(0.087)	(0.087)
Female×Z-score of Characteristics	0.030***	0.029***	0.007*	0.016***	0.004	0.028***	0.018***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Observations	35,426	35,426	35,426	35,426	35,426	35,426	35,426
R-squared	0.562	0.562	0.562	0.562	0.562	0.562	0.562

Notes: We conduct equation (2.1) using each KNOW characteristics score. Each normalized KNOW score of occupation is directly used as a continuous variable. Parentheses indicate standard errors. A single asterisk denotes statistical significance at the 90% level of confidence, two asterisks denotes 95%, and three asterisks denotes 99%.

Table 2.5 presents the results of the analysis using each KNOW characteristics score instead of an integrated flexibility score. For example, as reported in column (1), less time pressure positively affects women's relative hourly wages. When the flexibility score of less time pressure is higher than the overall average by one standard deviation, the gender wage gap narrows by 3.0 percentage points. Overall, flexible working environments with less time pressure, higher authority or freedom to make a decision, less contact with others, and less importance of working directly with the public have a positive impact on women's relative wages. The same results are derived in the analysis using "less need for accuracy" and "achievement" scores. Our findings suggest that workplace flexibility has a significant influence on reducing the gender wage gap.

We expand the samples to full-time workers between the ages of 25 and 54 at all levels of education, including college graduates, and perform the same analysis. As shown in Table 2.6 and Table 2.7, when analyzing all full-time workers aged 25–54, women's relative wages increase significantly in jobs with flexible working conditions, as in the previous results. However, as the sample expands from college graduates to all levels of education, the magnitude of the flexibility effect becomes smaller. In other words, the effect of the workplace flexibility to alleviate the gender wage gap is weaker in the group with a lower education level than in the college graduate group.

Table 2.6. Effects of Workplace Flexibility on Hourly Wage with Flexible Occupation Dummy

	Dependent Variable: Log Hourly Wage			
	(1)	(2)	(3)	(4)
Female	-0.358***	-0.247***	-0.238***	0.322***
	(0.004)	(0.004)	(0.004)	(0.057)
Female×Flexible Occupation Dummy	0.133***	0.024***	0.033***	0.019***
	(0.006)	(0.006)	(0.006)	(0.005)
Flexible Occupation Dummy	0.068***			
	(0.004)			
Occupation FE	No	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes
Controls	No	No	No	Yes
Observations	83,068	83,068	83,068	83,068
R-squared	0.135	0.417	0.455	0.590

Notes: The same treatment dummy analysis as in Table 2.3 is used, but the samples are herein expanded to all full-time workers between the ages of 25 and 54. Parentheses indicate standard errors. A single asterisk denotes statistical significance at the 90% level of confidence, two asterisks denotes 95%, and three asterisks denotes 99%.

Table 2.7. Effects of Workplace Flexibility on Hourly Wage with Flexibility Score

	Dependent Variable: Log Hourly Wage			
	(1)	(2)	(3)	(4)
Female	-0.284***	-0.236***	-0.222***	0.331***
	(0.003)	(0.003)	(0.003)	(0.057)
Female×Z-score of Flexibility	0.033***	0.015***	0.015***	0.010***
	(0.003)	(0.003)	(0.003)	(0.003)
Z-score of Flexibility	0.063***			
	(0.002)			
Occupation FE	No	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes
Controls	No	No	No	Yes
Observations	83,068	83,068	83,068	83,068
R-squared	0.143	0.417	0.455	0.590

Notes: The same treatment intensity analysis as in Table 2.4 is used, but the samples are herein expanded to all full-time workers between the ages of 25 and 54. Parentheses indicate standard errors. A single asterisk denotes statistical significance at the 90% level of confidence, two asterisks denotes 95%, and three asterisks denotes 99%.

Table 2.8. Effects of KNOW Characteristics

KNOW Characteristics:	Less Time Pressure	Unstructured Work	Make Decision	Less Contact	Less Work with Public	Less Need for Accuracy	Achievement
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable: Log Hourly Wage							
Female	0.336***	0.336***	0.331***	0.334***	0.331***	0.327***	0.338***
	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)
Female×Z-score of Characteristics	0.018***	0.016***	0.008***	-0.007**	-0.008***	0.027***	0.011***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Observations	83,068	83,068	83,068	83,068	83,068	83,068	83,068
R-squared	0.590	0.590	0.590	0.590	0.590	0.591	0.590

Notes: The same KNOW characteristics analysis as in Table 2.5 is used, but the samples are herein expanded to all full-time workers between the ages of 25 and 54. Parentheses indicate standard errors. A single asterisk denotes statistical significance at the 90% level of confidence, two asterisks denotes 95%, and three asterisks denotes 99%.

Similar results are confirmed in the analysis using each KNOW characteristics score as a flexibility measure. Table 2.8 presents that flexibility indexes, such as less time pressure, unstructured work, and freedom to make decisions, have positive effects on bridging the gender wage difference. Analyses using the “less need for accuracy” and “achievement” scores also show the same results. As in the previous results, which analyzed only college graduates, women's relative wages are higher in jobs with weaker time constraints and more authority to make a decision.

However, the opposite results are derived from the analyses using “less contact” and “less work with public” scores. The gender wage gap is further widened in jobs where there is less contact with others and less importance in working directly with the public. The characteristics of “less contact” and “less work with public” are common in that they represent tasks that involve dealing with people. For college graduates, the gender wage gap decreases in professions that focus less on frequent contact and direct work with others. These results are in line with Goldin's (2014) claim that “being on call” or “being around for customers and colleagues” makes it difficult for workers to substitute for each other and allow employers to favor employees who work long hours. On the other hand, in a group with a relatively low level of education, the results contradict such claims. The gender wage gap narrows in jobs where dealing with people is important.

The reason for the different results depending on the education level can be inferred by checking the jobs with low relevant characteristics scores. The low scores for “less contact” and “less work with public” mean that workers in these jobs are frequently in contact with others and directly work with people. We first identify jobs with low scores for “less contact” and “less work with public” in college graduates. Among the occupations included in the bottom 25% of these scores, "Finance- and Insurance-Related Clerks," "Social Welfare Service-Related Workers," "Sales Workers," and "Technical Sales Representatives and Brokerage Related Workers" account for a large portion.

Specifically, “Finance- and Insurance-Related Clerks” includes bank tellers, insurance inspectors and clerks, and financial clerks. “Social Welfare Service-Related Workers” includes social welfare specialists, child care teachers, vocational counselors, and consultants. Also, “Sales Workers” covers automobile sales representatives, products and advertising sales representatives, insurance salespersons, and indirect investment securities salespersons. Lastly, appraisers, overseas sales representatives, technical sales representatives (automobile parts, electronics equipment, medical equipment, and medicine), and real estate consultants and estate agents belong to “Technical Sales Representatives and Brokerage Related Workers.”

These occupations have common characteristics. Workers in these jobs not only deal with people frequently but also need to keep in touch with and manage them. In other words, interaction with people is not a one-time event, and thus it is important to maintain relationships. As Goldin (2014) noted, in these jobs, workplaces are likely to be inflexible as workers are imperfect substitutes for each other.

We also check jobs with low scores for “less contact” and “less work with public” in the group with relatively low education levels. In this education group, where these scores are in the bottom 25%, occupations such as “Store Sales Workers,” “Sales Workers,” “Food Service Workers,” “Deliverers,” and “Chefs and Cooks” account for a high portion. The characteristics of these jobs are that workers meet and contact many people, but most relationships are one-time interactions and thus do not need to be sustained. Therefore, these jobs will be easier to substitute between workers, which is likely to result in flexible working conditions.

In summary, for occupations with “less contact” or “less work with public” scores, the characteristics vary depending on the level of education. In the college graduate group, the occupational characteristic of frequent contact and direct work with people is related to the importance of maintaining relationships. In this case, these characteristics make it difficult to replace workers within an occupation and make the working environment less flexible. On the other hand, in a less educated group, the same occupational characteristics are associated with a one-time relationship. As a result, these characteristics allow workers to be good substitutes for each other and thereby increases the flexibility of the workplaces.

Given the relationship between the level of education and the characteristics of occupation, the results of the analysis of all full-time workers in Table 2.8 do not contradict Goldin's argument (2014). Our findings suggest that even though the scores on occupational characteristics are the same, actual jobs and more specific characteristics may differ depending on the level of education. Therefore, the relationship between the job characteristics and workplace flexibility can vary by education level or other socioeconomic status, which should be sufficiently considered in the analysis.

From the results so far, this study confirms that the women's relative hourly wage is positively related to the flexibility of the workplace. Also, these relationships are more pronounced in workers with high education levels, such as college graduates. These results are consistent with the argument of Goldin (2014). The following section examines the robustness of the findings, taking into account the selection issue in this analysis.

2.6 Robustness Check

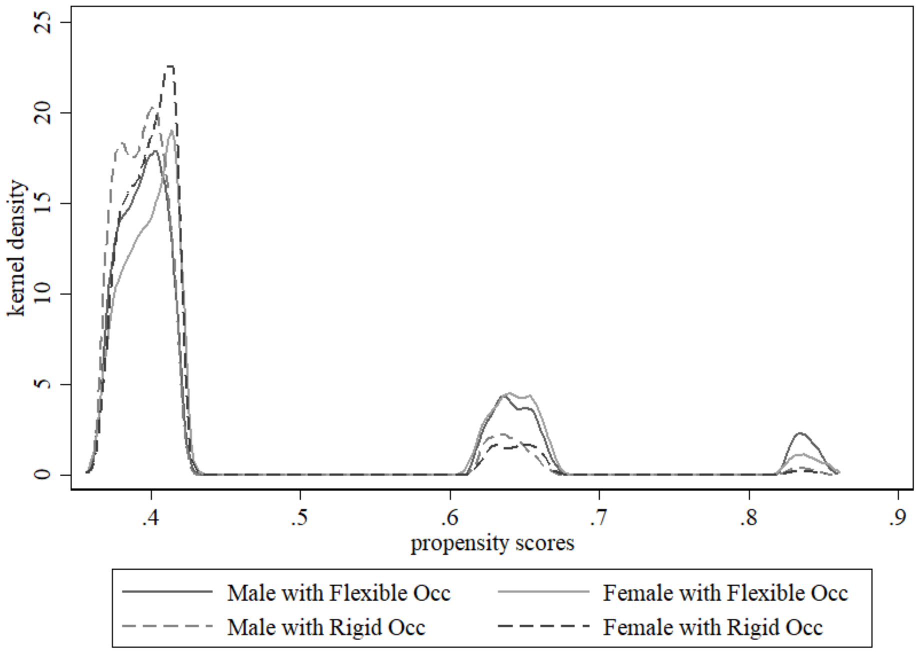
The flexible occupations identified in this study have a flexible working environment and relatively high wages. Therefore, there is a possibility that women with high abilities and a strong willingness to work actively pursued these flexible professions. In this case, the gender wage gap in flexible jobs can be smaller than in rigid jobs, since women's unobserved abilities are asymmetrically higher in the flexible occupation. Because of this selection issue, the positive impact of workplace flexibility on women's relative wages could be overestimated.

In the previous analysis, variables related to personal characteristics or abilities that affect wages, such as marriage, age, career, and education level, were controlled.

However, it is possible that the impact of unobserved skills on wages will remain. Therefore, this section verifies the robustness using a propensity score, taking into account the possibility of selection bias caused by unobserved skill. First, we use the probit model to calculate the propensity score—that is, the possibility of working in a flexible workplace. The distribution of the propensity scores by occupation type and gender is presented in Figure 2.4.

The distribution of flexible occupations is more concentrated on the higher propensity scores than that of rigid occupations. For workers currently working in flexible jobs, the probability of being in the flexible occupations—that is, the probability of being treated—is higher than that of workers working in rigid jobs. Meanwhile, when comparing men and women in the same occupation type, the former are slightly more distributed on the higher propensity scores, but their distributions are almost the same. Therefore, it is difficult to say that the propensity score varies significantly by gender.

Figure 2.4. Propensity Score Distribution by Occupation Type and Gender



Notes: We depict the distribution of propensity scores by occupation type and gender. The probit model is used to calculate the propensity score—that is, the possibility of working in a flexible workplace.

Nevertheless, considering that unobservable skills may still affect wages, this study complements the analysis by using propensity scores. The results shown in Table 2.9 are the same analysis as equation (2.1) for college graduates only but is adjusted using a propensity score. In columns (1) and (2), the effect of unobserved characteristics is adjusted by applying the inverse probability weighting (IPW) method. Specifically, we assign the inverse of the propensity score of equation (2.2) as a weight. As a result of these adjustments, observations that are more likely to be treated or more likely to be controlled in the first place are given a lower weight.

Therefore, this robustness analysis adjusts the probability of treatment and the observed explanatory variables to be independent.

$$(2.2) \quad w_i = \begin{cases} {}^{1}/_{p_i} & if\ i\ works\ for\ the\ flexible\ occupation \\ {}^{1}/_{1-p_i} & if\ i\ works\ for\ the\ rigid\ occupation \end{cases}$$

$$where\ p_i\ is\ the\ propensity\ score$$

Also, columns (3) and (4) report the results, excluding outliers whose propensity score is above 0.8 or below 0.2. In this case, we eliminate observations with too high or too low of a probability to be treated. Lastly, columns (5) and (6) are the results of analyses that only consider men and women with the same propensity scores. That is, if a score is found in only one of the sexes, those observations are excluded. Columns (1), (3) and (5) are the results of using the treatment dummy, which indicates "working in flexible occupation or not," whereas columns (2), (4), and (6) are the results of estimating the effect of treatment intensity by directly using the flexibility score.

As shown in column (1) of Table 2.9, the estimated effect of the treatment dummy adjusted by IPW is slightly smaller than the previous result of column (4) of Table 2.3. Before adjustment, the flexible occupation had an effect of alleviating the gender wage gap by 3.9 percentage points, but after applying the IPW, the impact of flexibility decreases to 3.7 percentage points. When estimating the effect of treatment intensity in column (2), the positive influence of flexibility score on women's relative wages does not change compared to the results in column (4) of Table 2.4. Meanwhile, columns (3) to (6) reveal that the results of the analyses that limited the samples to have similar scores are very similar to the previous results.

Based on the propensity score distribution in Figure 2.4 and the adjusted estimation results in Table 2.9, it is difficult to completely rule out the possibility that the impact of flexibility on the gender wage gap has been partially overestimated because of unobservable skills or characteristics. However, as presented in Figure 2.4, this selection bias is unlikely to be large, and the robustness check results also show that workplace flexibility has an effect on alleviating the gender wage disparity. Overall, despite the possibility of some overestimation stemming from the selection issue, the consistent results of this study suggest that a flexible working environment has a positive impact on women's relative wages.

Table 2.9. Effects of Workplace Flexibility on Hourly Wage using Propensity Score (For College Graduate+)

	Dependent Variable: Log Hourly Wage					
	(1)	(2)	(3)	(4)	(5)	(6)
Female	0.242***	0.256***	0.207**	0.224**	0.180**	0.199**
	(0.087)	(0.086)	(0.088)	(0.088)	(0.090)	(0.089)
Female×Flexibility	0.036***	0.030***	0.038***	0.030***	0.039***	0.029***
	(0.009)	(0.004)	(0.009)	(0.004)	(0.009)	(0.004)
Adjustment Method	IPW	IPW	Outliers excluded	Outliers excluded	PSM sample	PSM sample
Flexiblility Measure	Treatment Dummy	Treatment Intensity	Treatment Dummy	Treatment Intensity	Treatment Dummy	Treatment Intensity
Observations	35,426	35,426	34,590	34,590	33,555	33,555
R-squared	0.554	0.554	0.554	0.555	0.554	0.554

Note: We adjust the same analysis in equation (2.1) using a propensity score. Columns (1) and (2) adjust by applying the inverse probability weighting (IPW) method. Specifically, we assign the inverse of the propensity score of equation (2.2) as a weight. Columns (3) and (4) exclude outliers, whose propensity score is above 0.8 or below 0.2. Columns (5) and (6) are the results of analyses that only consider men and women with the same propensity scores. If a score is found in only one of the sexes, those observations are excluded. Columns (1), (3), and (5) are the results using the treatment dummy, i.e., the flexible occupation dummy. Columns (2), (4), and (6) are the results of estimating the effect of treatment intensity by using the Z-score of flexibility. Parentheses indicate standard errors. A single asterisk denotes statistical significance at the 90% level of confidence, two asterisks denotes 95%, and three asterisks denotes 99%.

2.7 Conclusion

This chapter notes two characteristics of the Korean labor market. One is that the general working hours are much longer than in other OECD counties, and the other is that Korea has the widest gender wage gap. Based on Goldin (2014), long working hours can be seen as evidence that the overall working environment is not flexible—that is, it is difficult for workers to be substitutes for each other. Also, low workplace flexibility may be related to the fact that the gender wage gap in Korea is exceptionally high. Considering these characteristics of the Korean labor market and previous literature, we examine the effect of the workplace's flexibility on the gender wage gap in the Korean labor market by applying the DID approach. We use the KNOW data of occupational characteristics, the Korean version of American O*Net, to measure the flexibility of each occupation, and we then compare this flexibility and gender wage gap between jobs.

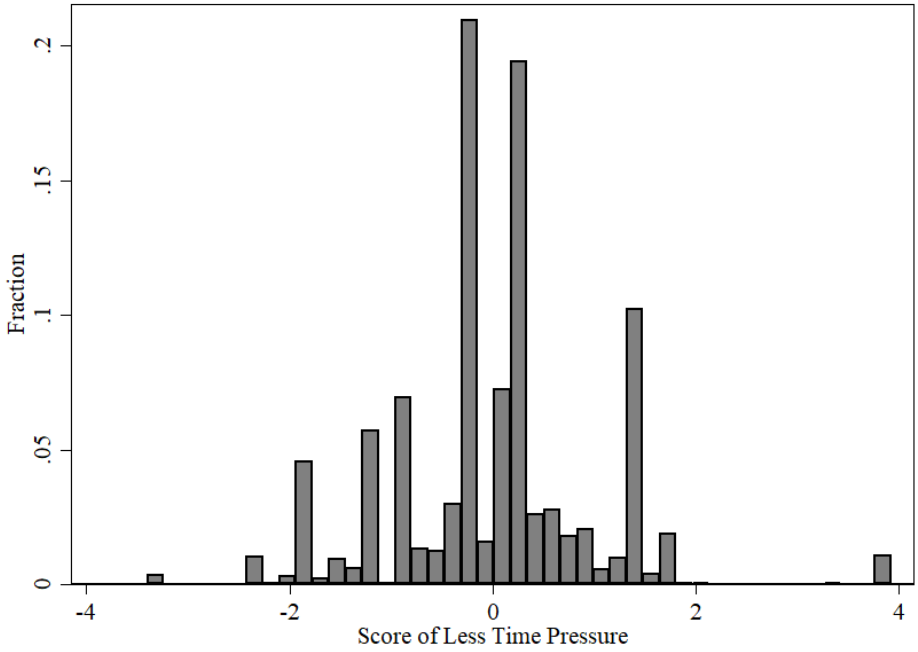
According to the analysis results, the women's relative hourly wage is positively related to the workplace flexibility. These relationships are more pronounced in workers with high education levels, such as college graduates. In addition, the robustness of these results is reviewed, taking into account the possibility that women with high abilities and a strong willingness to work actively pursued the flexible professions. Despite the possibility of overestimation stemming from the selection issue, this selection bias is unlikely to be large given the distribution of the probability of being treated. Furthermore, the adjusted analysis using the propensity score also consistently indicates that workplace flexibility affects alleviating the gender wage disparity.

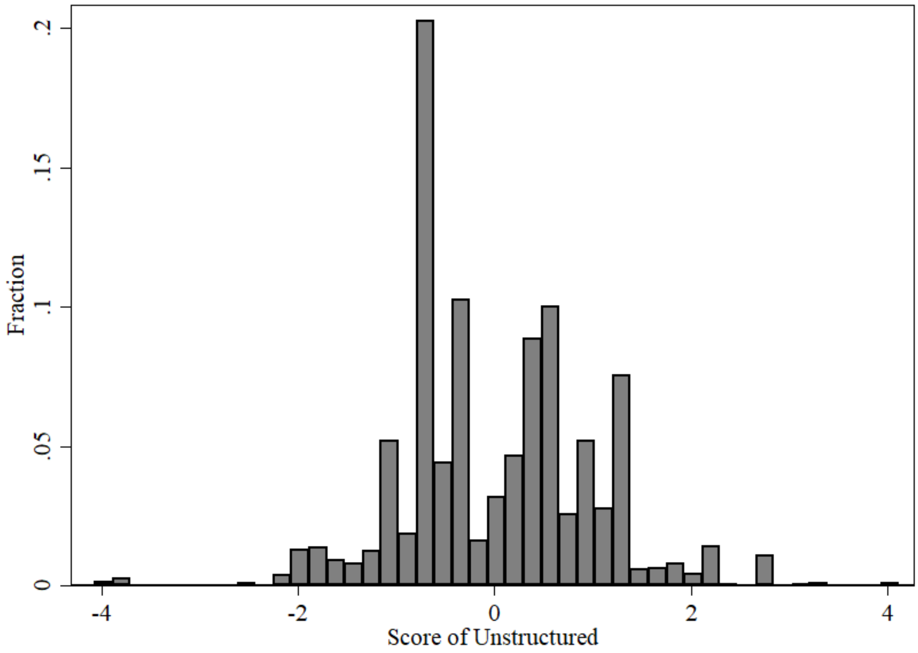
Our findings suggest that changes in the working environment—specifically improvements in workplace flexibility—may contribute to alleviating the gender wage gap. These changes can be triggered by the development of new technologies, the introduction of policies to promote workers' quality of life, and changes in the values of firms and workers. Therefore, it can be expected that the policies to improve the overall working culture and regime, such as the adoption of flexible work systems and the reduction of working hours, will also contribute to bridging the disparity between men and women.

It is also worth noting that these changes may begin unexpectedly. According to Alon et al. (2020), the Covid-19 outbreak has led many companies to introduce flexible work schedules and work-from-home policies, some of which are likely to persist. The authors suggest that these changes can promote gender equality after the crisis, as improved flexibility will be more beneficial to mothers than fathers. Along with the crisis, many businesses in Korea also have experienced telecommuting and flexible work systems. These experiences affect people's perception and social norms, and it remains possible that this change will become permanent. Therefore, it is worth carefully examining whether these changes can eventually lead to the spread of flexible working conditions and the narrowing of the gender gap.

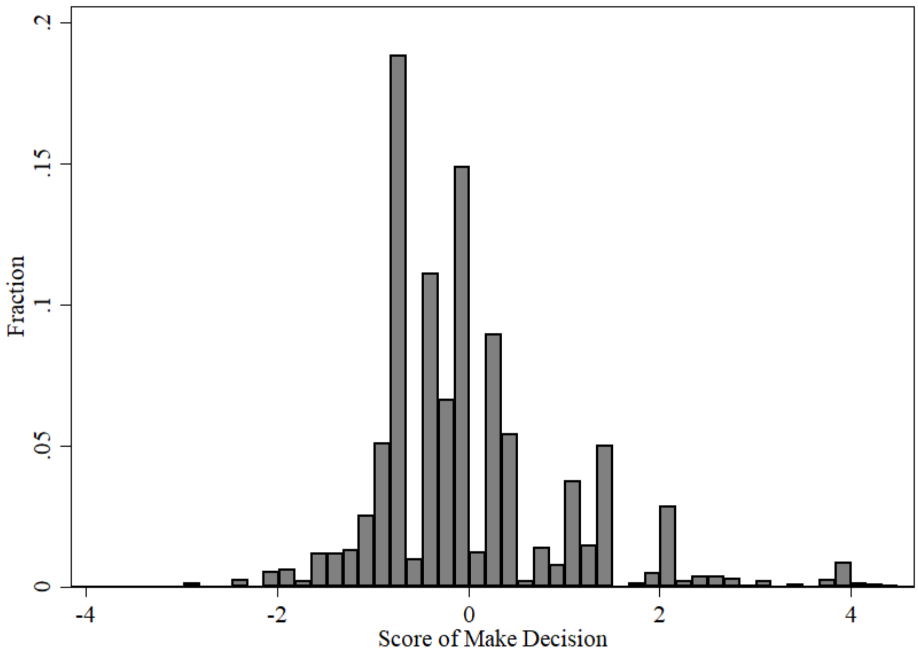
Appendix

Figure A2.1. Distribution of Five Flexibility Scores among Workers

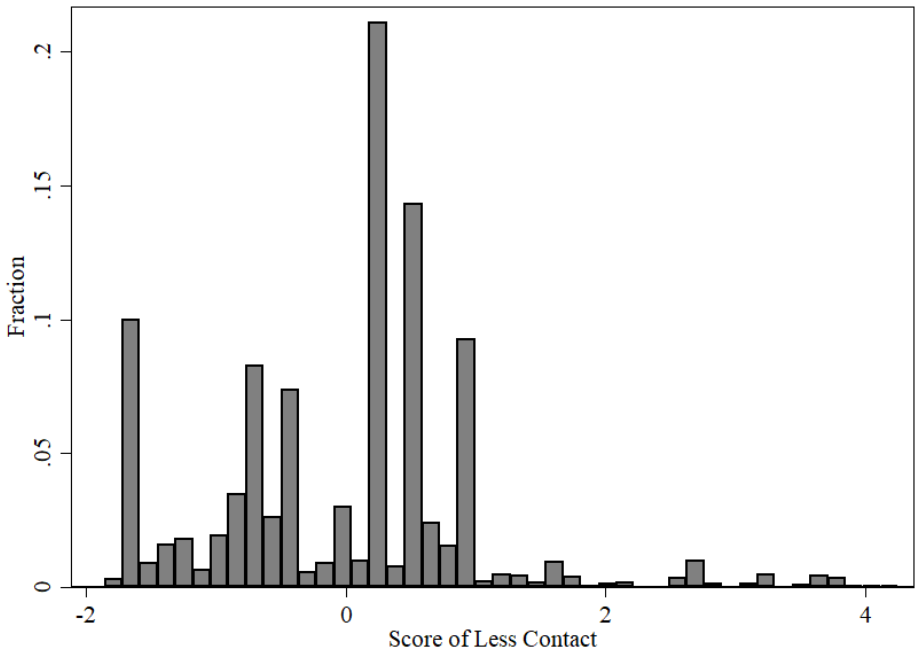


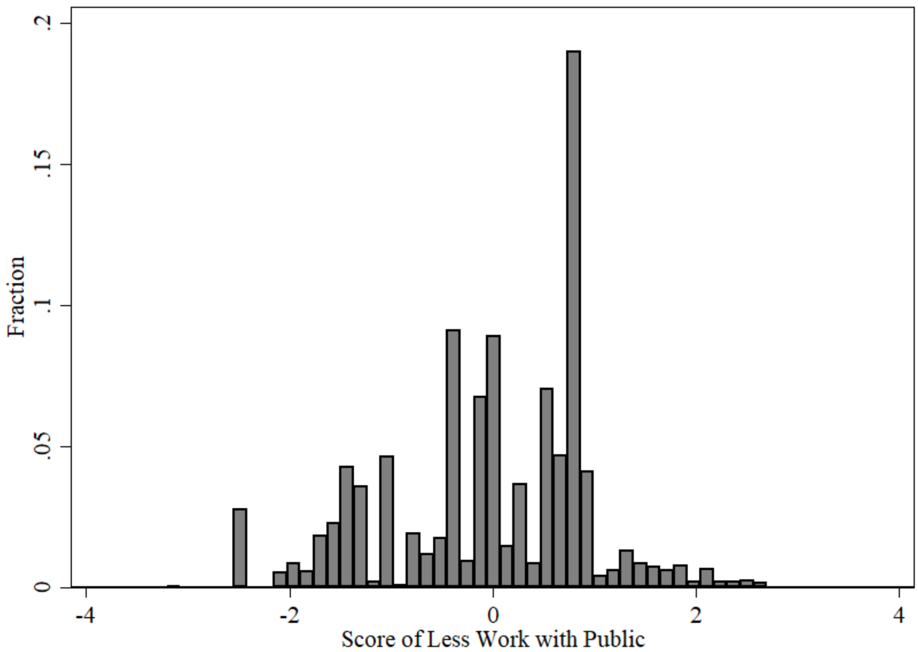


Fraction
Score of Unstructured



Fraction
Score of Make Decision


Fraction
0
.05
.1
.15
.2
-2
0
2
4
Score of Less Contact


Fraction
0
.05
.1
.15
.2
-4
-2
0
2
4
Score of Less Work with Public

3 Technological Change and Routinization: Implications for Women's Work

3.1 Introduction

Historically, technological advances have made it possible for machines to perform new tasks and take on more diverse functions. Naturally, these advances have changed the role of humans in the labor market. In particular, their implementation has eased gender restrictions and lowered barriers to women's roles. According to Goldin (2006), the expansion of female participation in the labor market in the early 1900s resulted from several exogenous factors, including the increased demand for office workers due to the development of new information technology and the expanded high school education. Consequently, unmarried young women have better jobs, and some of them remain in the labor market even after marriage. Besides, the development of household labor-related technology such as refrigerators and washing machines reduced the burden of women and changed their labor supply.

Greenwood, Seshadri, & Yorukoglu (2005) also explain that advances in household appliances, frozen foods, and ready-made clothes saved time spent on domestic labor, and allowed married women to enter the labor market. Bailey (2006) notes that in the 1960s, when the birth control pill was introduced and diffused in the U.S., the development of household technology, enforcement of anti-discrimination legislation, and the availability of abortion occurred simultaneously, resulting in an expansion of women's economic activities. In particular, the authors argue that the increased access to the birth control pill made it possible for women to plan for pregnancy and make labor market decisions. Such diverse technological advances have contributed to changing the position of women in the labor market.

Meanwhile, a representative hypothesis describing the relationship between technology and the labor market is Skill Biased Technology Change—henceforth, SBTC. The main argument of SBTC is that technological developments occur in a way that increases demand for high-skilled workers rather than low-skilled workers (Katz & Murphy, 1992; Krueger, 1993; Berman, Bound, & Griliches, 1994; Autor, Katz, & Krueger 1998; Goldin & Katz, 2008). However, with the introduction and dissemination of computers, some studies claimed that the effect of technology on the labor market depends on the task types, not the skill.

According to the Routine Biased Technology Change—henceforth, RBTC—hypothesis proposed by Autor, Levy, & Murnane (2003), due to the computer technology advancement and automation, computers and machines replace workers in charge of tasks performed routinely, such as operators, assemblers, and clerks. On the other hand, these new technologies complement the analytic and interpersonal-task-intensive jobs such as engineers, managers, and experts responsible for design and supervision. As a result, the demand for these workers increases and that for routine task workers decreases. For non-routine manual tasks, the effect is ambiguous. In the 1990s, in Western countries such as the U.S. and Europe, job polarization patterns were observed in which the share of middle-skilled occupations declined compared to that of high-skilled and low-skilled occupations. Several studies argue that RBTC explains this pattern (Autor, Levy, & Murnane, 2003; Goos & Manning, 2007; Acemoglu & Autor, 2011; Autor & Handel, 2013; Michaels, Natraj, & Van Reenen, 2014; Fonseca, Lima, & Pereira, 2018; Sebastian, 2018).

Many studies in Korea have shown that there were RBTCs, and some of them reported that job polarization was also observed in the Korean labor market (Cheon, 2007; Kim, 2014; Kim, 2015; Cheon, 2017). We also examine whether there has been RBTC in Korea and identify the subsequent impacts on women's roles and economic statuses in the labor market. This analysis is meaningful in that it investigates the effects of RBTC on the labor market in consideration of gender, as such literature remains insufficient in Korea. Moreover, this paper differs from existing studies in that it measures tasks using the KNOW data. The KNOW data is the Korean version of O*Net in the U.S., which contains information on the features of each occupation. Using this data, we can measure the task reflecting the detailed characteristics of jobs and make a consistent comparison with the prior research on Western countries.

This study finds that Korea has undergone an increase in abstract tasks and a reduction in routine tasks, which is the pattern of RBTC. The non-routine manual task has also decreased, but it changed more gradually than the routine manual task. These task shifts in Korea occurred intensively in the 1990s, and the change for female workers was more pronounced than for men. These gender differences in task changes are likely related to the rapid increase in female labor force participation at the time of RBTC and the frequent turnovers and reemployment of women compared to men. Therefore, these labor-demand shifts following RBTC may have a more significant impact on women's tasks and jobs.

We also confirm that wages are high for workers engaged in abstract tasks, and the gender wage gap in these tasks is small. On the other hand, routine tasks are linked to relatively low wages, and the wages of men and women specialized in these tasks are considerably different. Our findings suggest that routinization in the Korean labor market may have contributed to raising women's relative wages and narrowing the gender wage gap.

This chapter is organized as follows. Section 3.2 briefly reviews previous literature related to RBTC in Western countries and Korea. In Sections 3.3 and 3.4, we explain the data and the task measurement method used in this study. Section 3.5 reports the changes of tasks driven by RBTC in Korea and also describes the task shifts by gender. In Section 3.6, we analyze the wage effects of tasks and discuss whether routinization contributed to closing the gender wage gap. Lastly, Section 3.7 concludes the paper.

3.2 Literature Review

In the 1990s, the U.S. experienced U-shaped employment distribution changes. The middle-skilled occupation share decreased compared to the high-skilled and low-skilled occupation share in a phenomenon called job polarization. Because the existing SBTC could not explain these changes, Autor, Levy, & Murnane (2003) proposed the RBTC hypothesis. Since then, many studies have been conducted on RBTC and supported that RBTC explains job polarization in Western countries such as the U.S. and in Europe (Autor, Levy, & Murnane, 2003; Goos & Manning, 2007; Acemoglu & Autor, 2011; Autor & Handel, 2013; Michaels, Natraj, & Van Reenen, 2014; Fonseca, Lima, & Pereira, 2018; Sebastian, 2018).

According to RBTC, there are three major types of tasks: abstract, routine, and non-routine. Abstract tasks are divided into analytic and interpersonal tasks and involve the design, supervision, and analysis, in which workers need to solve non-routine problems or engage in complex communication. For these tasks, while it is difficult for machines to replace workers, computer technology instead complements them. Engineers, managers, and professionals are the representative jobs performing these tasks. On the other hand, routine tasks are repetitive and structured, making it easy to code. Thus, machines and computers can easily be programmed to replace workers. These jobs include routine cognitive tasks mainly performed by clerks and office workers, and routine manual tasks done by operators and assemblers. Lastly, non-routine manual tasks focus on physical activities and in-person interactions that are difficult to regularize, as they require the ability to adapt to the situation. These occupations include janitors, simple service personnel, and security guards.

Unlike SBTC, which argues that the technological impact depends on the skills held by workers, RBTC notes that the effect is related to the characteristics of the tasks performed by them. RBTC claims that the development of ICT technology increases the demand for workers in charge of abstract tasks and decreases for workers performing routine tasks. However, technological advancement does not directly affect non-routine manual tasks, and therefore the prediction about the changes in these tasks is ambiguous. According to the hypothesis, these demand shifts have led to changes in employment and jobs.

Several studies in Korea examine RBTC and job polarization. Cheon (2007) defines a combination of occupation and industry in which workers work as one job, and Kim (2015) applies the job classification system of Autor & Dorn (2013) to divide Korea's occupation classification into three skill groups: high, middle, and low. These studies provide evidence that there was RBTC in Korea and that job polarization occurred. However, their analysis focuses on the group divided by the profession or combination of the occupation and industry rather than directly measuring the tasks. Therefore, it is possible that these methods do not sufficiently reflect the actual tasks of the job. Meanwhile, Kim (2014) directly measures the routine tasks using the Korea Dictionary of Task (KDOT), and shows that Korea experienced RBTC between 2000 and 2008. However, it is difficult to consistently compare the results with studies of other countries because the latter used data such as O*Net to measure tasks. Also, Kim (2014) uses only the intensity of routine tasks, not all tasks of jobs, as KDOT provides limited information on job characteristics.

Some studies have focused on the impact of RBTC on women's labor, going beyond linking RBTC and changes in labor market structure called job polarization.

Black & Spitz-Oener (2010) analyze how RBTC changed jobs for men and women in West Germany. According to them, the gender wage gap has narrowed due to a relative increase in non-routine analytic and interactive tasks and a decrease in routine task input of women. On the other hand, in Korea, few studies analyze the effect of RBTC in terms of gender. Therefore, this paper aims to contribute to the literature on the effects of RBTC on women's labor using Korean data.

3.3 Data

This study uses the Wage Structure Survey (WSS) data from 1993 to 2018. The WSS investigates wage earners and collects information about their sex, age, educational level, and career, as well as the occupation, industry, and firm size. The advantage of the WSS is that it is relatively long-term data, dating back to the 1980s. Also, the research unit for the occupation is detailed compared to other long-term data, such as the Economically Active Population Survey. For the occupational group of managerial, professional/technical, clerical, service, and sales, the WSS provides a 2-digit Korean Standard Classification of Occupation (KSCO) code. For other groups, a 3-digit code for job information is available. Since the tasks are measured by occupation in this study, detailed information about the job is needed for accurate analysis.

The data from 1993 to 2018 are analyzed, but there were two revisions in the occupational classification system in 1999 and 2008. The WSS provides job information based on the 4th KSCO code from 1993 to 1999, the 5th KSCO code from 2000 to 2008, and the 6th KSCO code from 2009 to 2018. For this reason, there is a limit to accurately link different versions of classifications over the entire period using the occupation crosswalks. Thus, we divide the analysis into three periods, 1993–1999, 2000–2008, and 2009–2018, considering the revision of the occupational classification system.

This study analyzes full-time workers aged 16 to 65 who work more than 30 hours, excluding those in agriculture and forestry sectors. For reference, the WSS surveys firms with more than five employees; however, before 1999, only those with more than ten employees were investigated. To ensure the annual consistency of the analysis, this study includes only workers from companies with at least ten employees. The monthly payments are calculated by adding the special allowance to the basic salary and are adjusted using the 2015 Consumer Price Index. In addition, the hourly wages are calculated by dividing these monthly payments by working hours per month, including standard working hours and overtime.

Meanwhile, Acemoglu & Autor (2011) measured the intensiveness of abstract, routine, and non-routine manual tasks by using the information on work activities and work context for each job in the O*Net database. We also use the Korea Network for Occupations & Workers (KNOW) data, which is constructed by referring to the American O*Net, to measure the task by profession. This allows us to derive a task measure that can be consistently compared with existing research on other countries. This paper uses the KNOW data from 2014 to 2017, and measures the intensiveness of each task using the KNOW items corresponding to the O*Net task measure of Acemoglu & Autor (2011). Table 3.1 shows the KNOW items used in this study, and the details are provided in the Appendix.

Table 3.1. KNOW Descriptor and Scale Type by Task

KNOW Descriptor	Scale Type
Abstract	
A. Analytical	
Analyzing data / information	importance
Thinking creatively	importance
Interpreting information for others	importance
B. Interpersonal	
Establishing and maintaining personal relationships	importance
Guiding, directing, and motivating subordinates	importance
Coaching and developing others	importance
Routine	
A. Cognitive	
Importance of repeating the same tasks	content
Importance of being exact or accurate	content
Structured vs. unstructured work (reverse)	content
B. Manual	
Controlling machines and processes	importance
Keeping a pace set by machinery or equipment	content
Time spent making repetitive motions	content
Non-routine Manual	
Operating vehicles, mechanized devices, or equipment	importance
Knowledge of transportation	importance
Time spent using hands to handle, control, or feel objects, tools	content
Data processing(reverse)	importance
Manual dexterity	importance
Static strength	importance
Spatial orientation	importance
Spend Time Keeping or Regaining Balance	content

Note: KNOW measures selected for construction of each task measures following Acemoglu and Autor (2011). 2014–2017 KNOW data is used for the measure. The detailed method of measuring the tasks in this paper is based on Hwang and Lee (2019).

3.4 Task Score

This study measures task scores by referring to the methods used in previous literature, such as Acemoglu and Autor (2011) and Autor and Dorn (2013). The standardized scores of the items corresponding to each task presented in Table 3.1 are added together. These aggregated scores are normalized again to have an average of 0 and a standard deviation of 1. Thus, each profession has five task scores: analytic, interpersonal, route cognitive, route manual, and non-routine manual. If a job has a high task score of routine cognitive, it means that the workers in that job intensively perform those tasks. Before analysis, we check the features of the task scores. Table 3.2 shows representative occupations with high scores for each task. These professions fit the task characteristics described in Autor, Levy, & Murnane (2003).

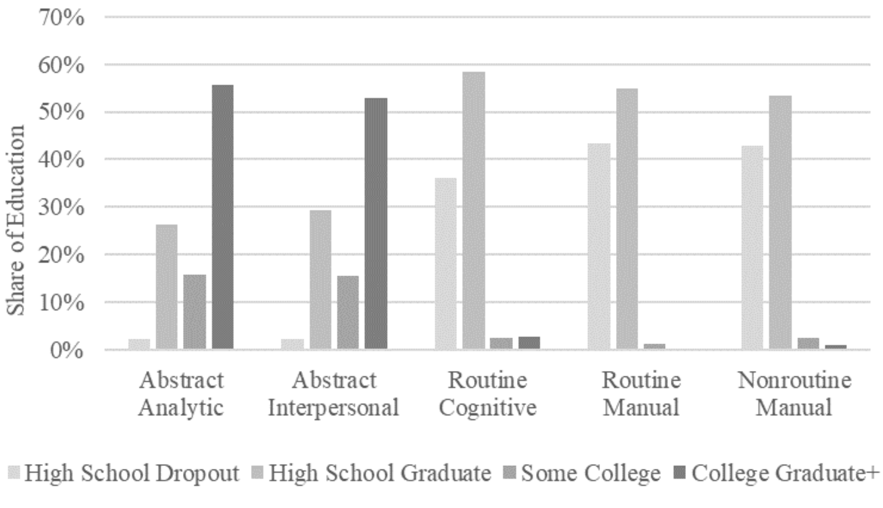
Table 3.2. Examples of Occupation and KNOW Task Scores

	Abstract		Routine		Non-routine
	Analytic	Inter-personal	Cognitive	Manual	Manual
Expert in Physics, Mathematics and Engineering	1.84	1.41	-0.70	-0.66	-0.57
Corporate Manager	1.54	2.44	-0.89	-0.90	-0.80
Counting Clerk	0.81	0.72	1.98	-1.05	-1.44
Operators for Printing, Binding and Paper Products	-0.29	-0.40	1.39	1.79	0.60
Motor Vehicle Operator	-1.16	-1.03	-0.69	1.26	1.95

Note: Task measure is calculated following the method of Autor et al. (2011) using KNOW measures. The scores are standardized to mean 0 and standard deviation 1.

In addition, we examine how each task score relates to socioeconomic statuses, such as education levels. Figure 3.1 shows the distribution of education levels for each task. Based on the task scores, we determine the occupations whose scores fall into the top 25% as of 1993 and report their education distribution. As presented in this figure, about 70% of analytic and interpersonal tasks are handled by college graduates and some college graduates. For routine cognitive tasks, high school graduates and high school dropouts account for 58% and 36%, respectively. In the case of routine manual and non-routine manual tasks, the proportion of high school graduates was about 55% and that of high school dropouts was 43%. Overall, highly educated workers tend to perform abstract tasks and workers with low education engage in manual tasks. This resembles the findings on U.S. data shown in Acemoglu & Autor (2011).

Figure 3.1. Education Distribution of Occupations with the Top 25% Task Score



However, in Figure 3.1, the education distributions of routine manual and non-routine manual tasks are not distinct. Although these two tasks are not clearly distinguished by the level of education, their wage effects are different, as is evidenced by the wage analysis in Section 3.6. We examine the task changes driven by RBTC by gender in the following section.

3.5 Gender Differences in Routinization

In this section, we identify the change in employment driven by RBTC using the task scores. However, as mentioned in Section 3.3, it is not easy to analyze all periods consecutively, as occupational classification standards changed in 1999 and 2008. When revising those standards, detailed occupations of different versions were not matched one-to-one but were instead divided or merged. Thus, this study examines the trend of the task score separately for the periods of 1993–1999, 2000–2008, and 2009–2018.

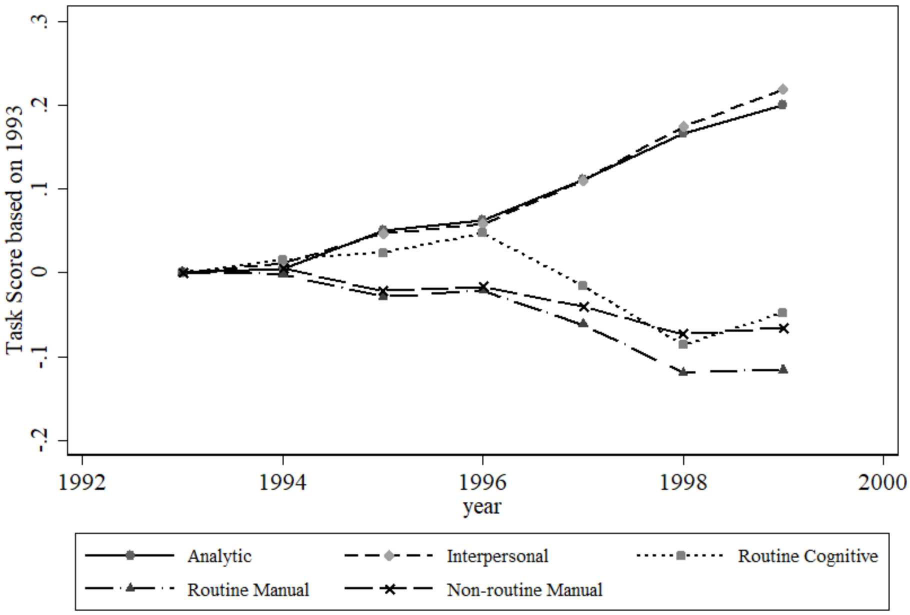
Before checking the trend of the task score, we revisit the meaning of change in these scores. Each profession has five task scores for analytic, interpersonal, routine cognitive, routine manual, and non-routine manual. Some occupations may show high scores for all tasks, while others may have a high score for the abstract and low score for the routine task. Moreover, the task score assigned to each occupation is constant. Therefore, in this study, the changes in the average task score result from the shift in the occupation composition, but this does not mean that the occupation's characteristics have changed. For example, if the average abstract task score rose and the routine task score declined in 1999 compared to 1993, it indicates that during this period, the share of jobs that intensively perform abstract tasks increased but the percentage of jobs that mainly do routine tasks decreased.

Figure 3.2 presents the trend of the average task score, weighted by each occupation's share. Analytic and interpersonal task scores have risen, while the rest of the task scores have dropped. The decline in the non-routine manual task score was gentler than the routine manual. These trends were most distinct in the 1993–1999 period, with notable slowdowns between 2000 and 2008. During the 2009–2018 period, the task scores were almost constant. These task score trends indicate that the occupation composition based on tasks significantly changed between 1993 and1999. At that time, the share of jobs that mainly carry out abstract tasks rose considerably, whereas that of professions with strong routine cognitive and routine manual characteristics dropped. The proportion of non-routine manual-task-intensive jobs also declined, albeit modestly. We confirm the routinization in the 1990s using the directly measured task scores, as existing research in Korea.

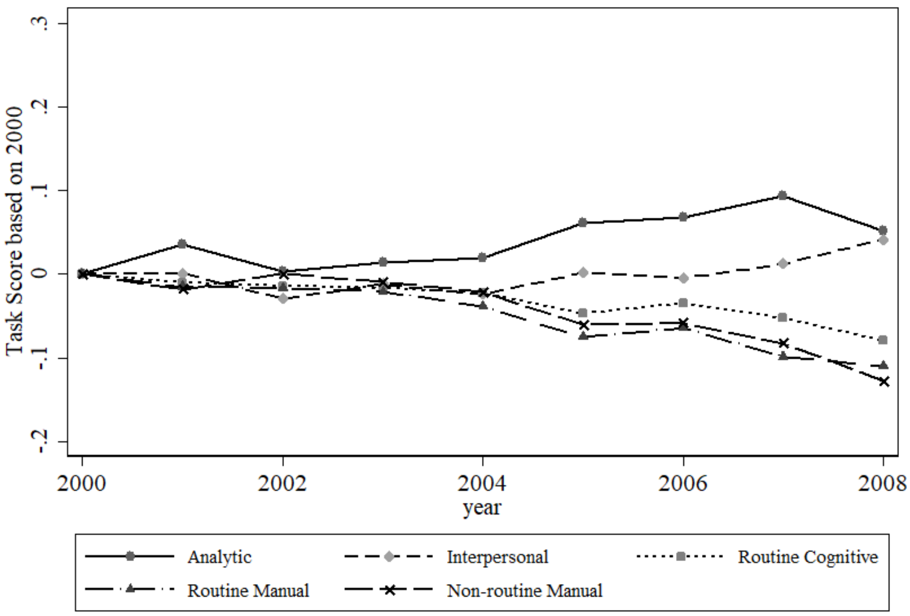
This pattern of task change is similar to that of the U.S. presented in Autor, Levy, & Murnane (2003). In the U.S., RBTC mainly occurred between 1980 and 2000, with the increase in analytics and interpersonal task scores, and the significant decrease in routine cognitive and routine manual task scores. The non-routine manual task score declined moderately.

Figure 3.2. Change in Task Score

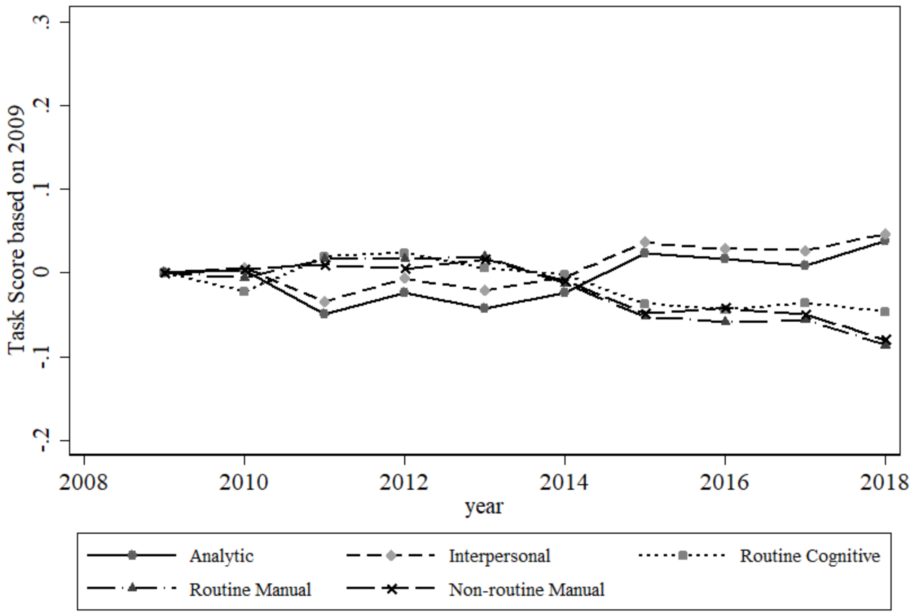
A. 1993–1999



B. 2000–2008



C. 2009–2018



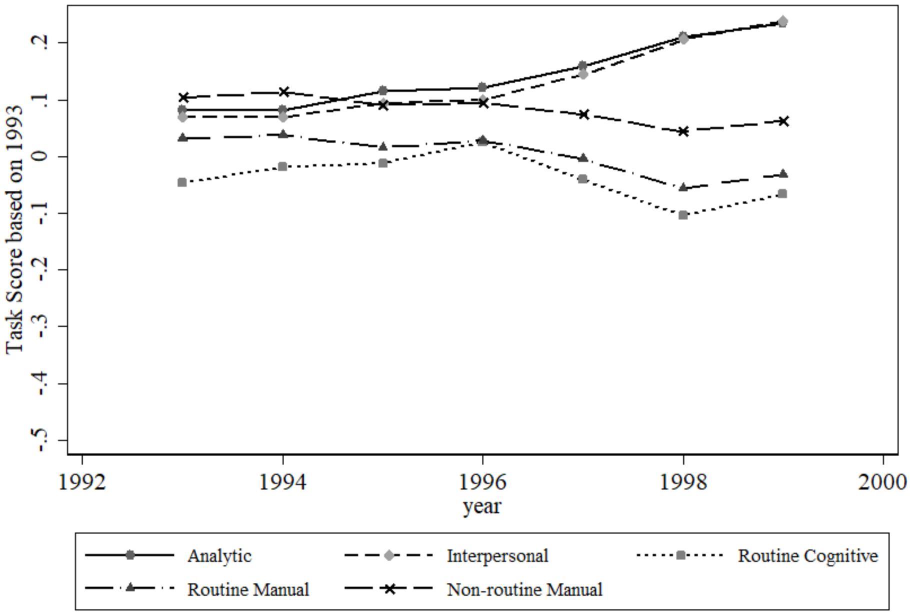
Source: KNOW data

Note: These results are based on Hwang and Lee (2019).

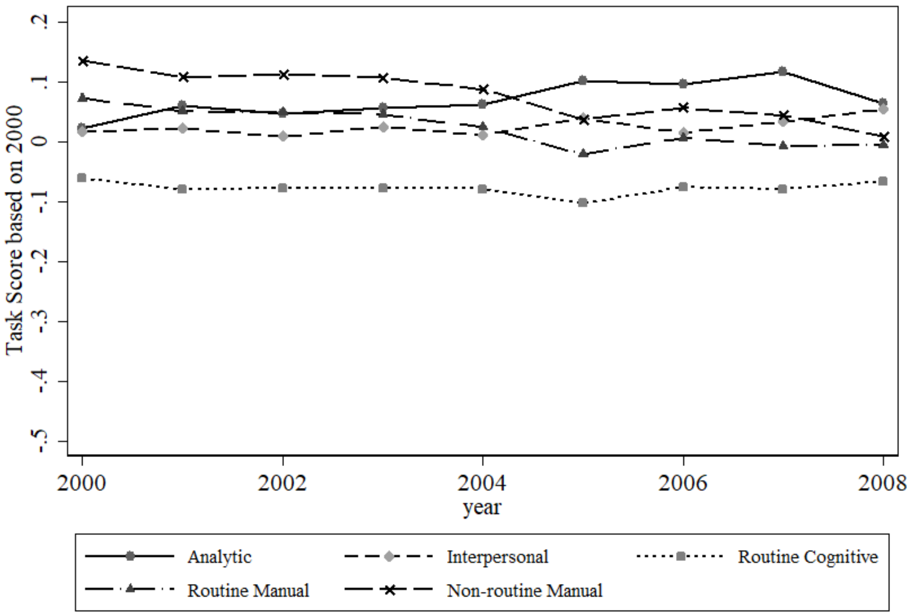
Meanwhile, these changes in task score are more apparent in women than in men. Figures 3.3 and 3.4 illustrate gender-specific trends in standardized task scores. For women in the 1993–1999 period, the analytic and interpersonal task scores increased sharply, while the routine cognitive scores smoothly decreased except for in 1999. The scores of routine manual and non-routine manual tasks have been steadily decreasing since 1993, but the slope of the latter has been slightly more modest than the former. The men's task scores have also changed in a similar pattern, but the variation was much smaller than women.

Figure 3.3. Change in Task Score (Male)

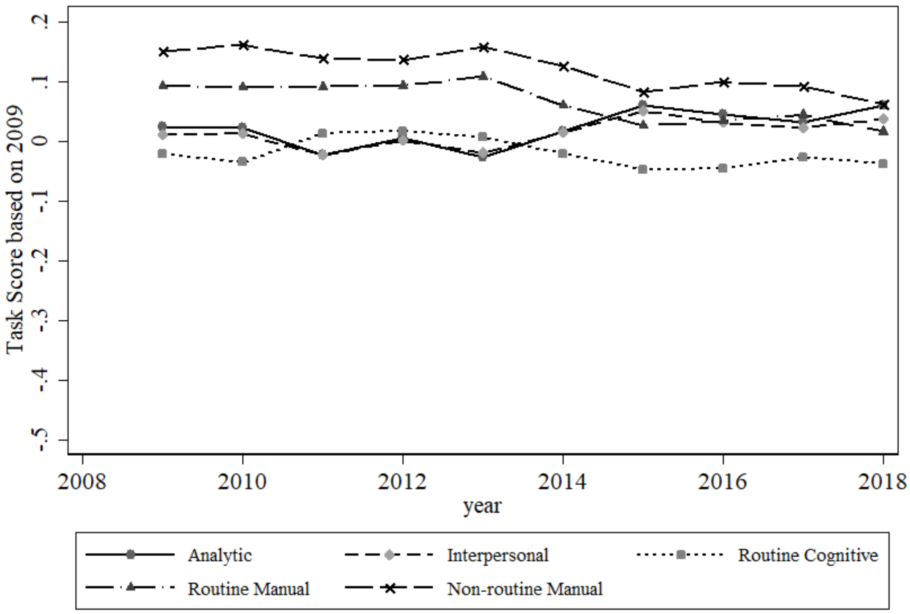
A. 1993–1999



B. 2000–2008



C. 2009–2018

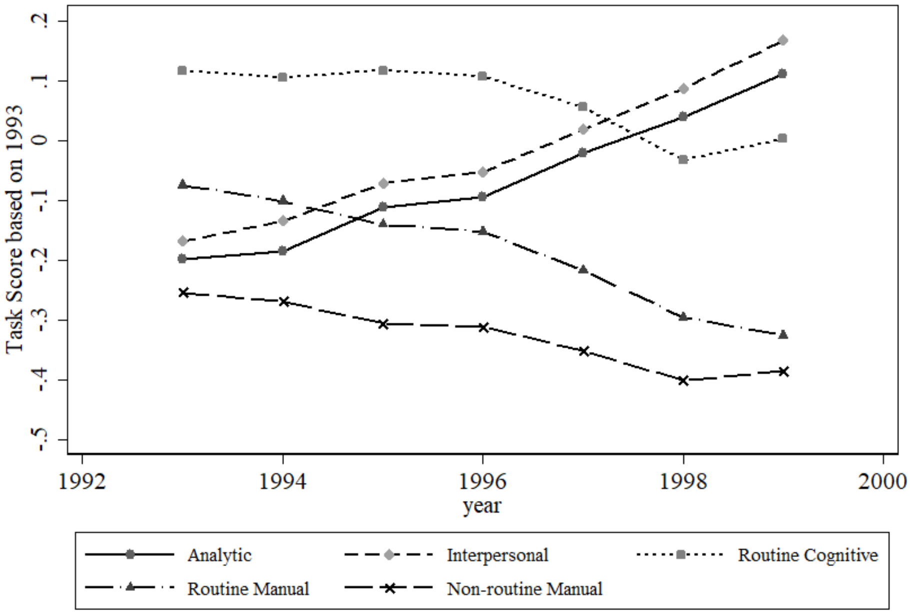


Source: KNOW data

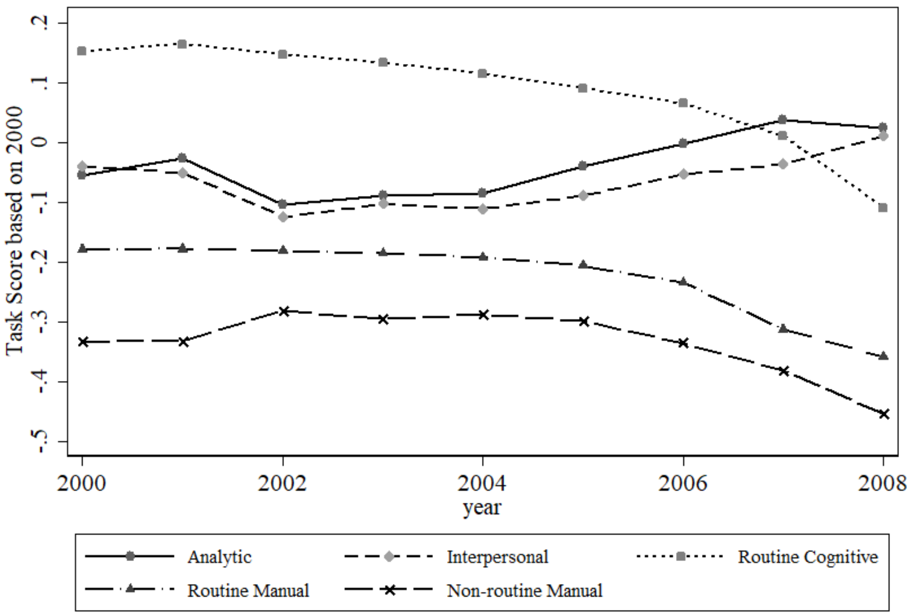
Between 2000 and 2008, the men's task score changed only slightly, while routinization continued gently for women. In particular, the routine cognitive task score of females decreased considerably. In the 2009–2018 period, there were differences in the task score levels between men and women, but neither of them changed significantly, and the patterns or widths of the changes were similar. Overall, employment changes by RBTC was more dramatic in females than in males, and women's changes progressed over a relatively longer period.

Figure 3.4. Change in Task Score (Female)

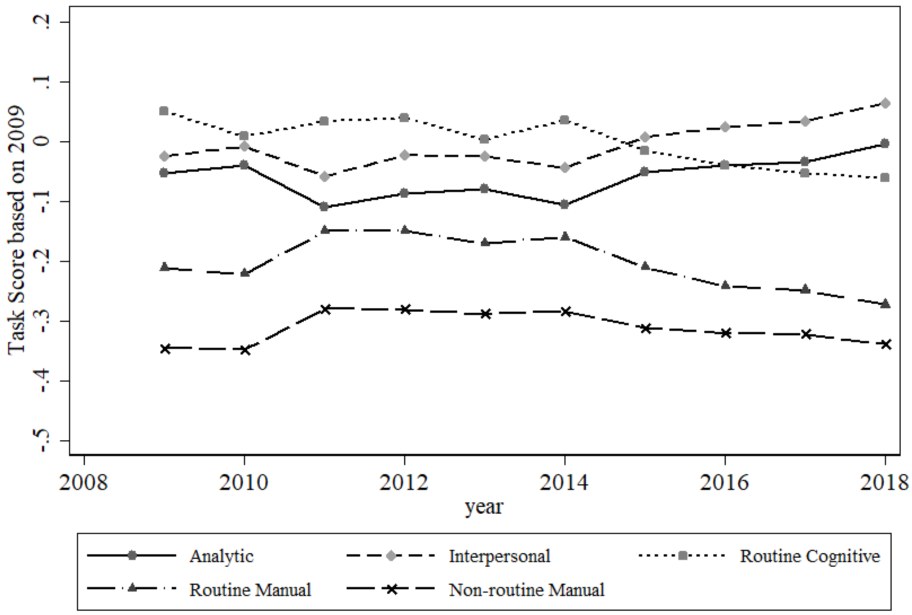
A. 1993–1999



B. 2000–2008



C. 2009–2018



Source: KNOW data

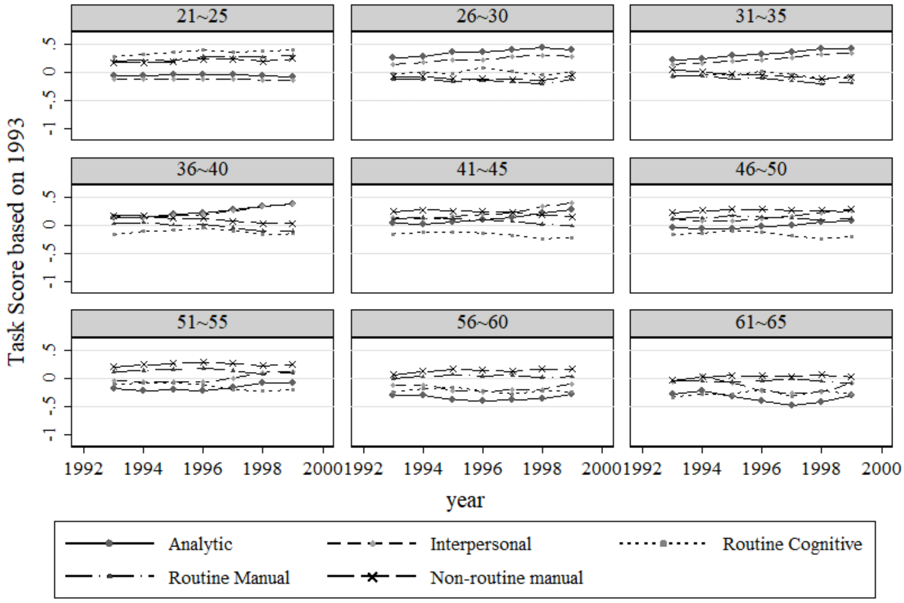
These gender differences in routinization have been observed in Western countries such as the U.S. and West Germany (Autor, Levy, & Murnane, 2003; Black & Spitz-Oener, 2010; Acemoglu & Autor, 2011). In these countries, women's task shifts were more prominent than men's. According to Autor, Levy, & Murnane (2003), changes in demand for tasks would likely affect women's job and tasks more remarkably than men's given the rapid influx of women into the labor market in recent decades. For reference, they suggest two channels where computerization leads to task shifts. As firms adopt computers, they employ highly educated employees who are superior in abstract tasks. Otherwise, employers can change existing employees' task assignments, reducing their allocation to routine tasks and extending it to abstract tasks. We can guess why women's tasks have changed more rapidly by referring to these channels.

There are two possibilities for why gender differences occur in task changes. First, as Autor, Levy, & Murnane (2003) claim, women, especially college graduates, entered the labor market rapidly during the period of RBTC. Under the influence of RBTC, they are likely to perform abstract tasks rather than routine tasks. Second, in the case of workers who were in the labor market, as females move jobs more frequently than males, it is possible that women responded more quickly to the changes in the labor demand. In other words, existing female employees may have moved from routine-task-intensive jobs to abstract-task-intensive jobs.

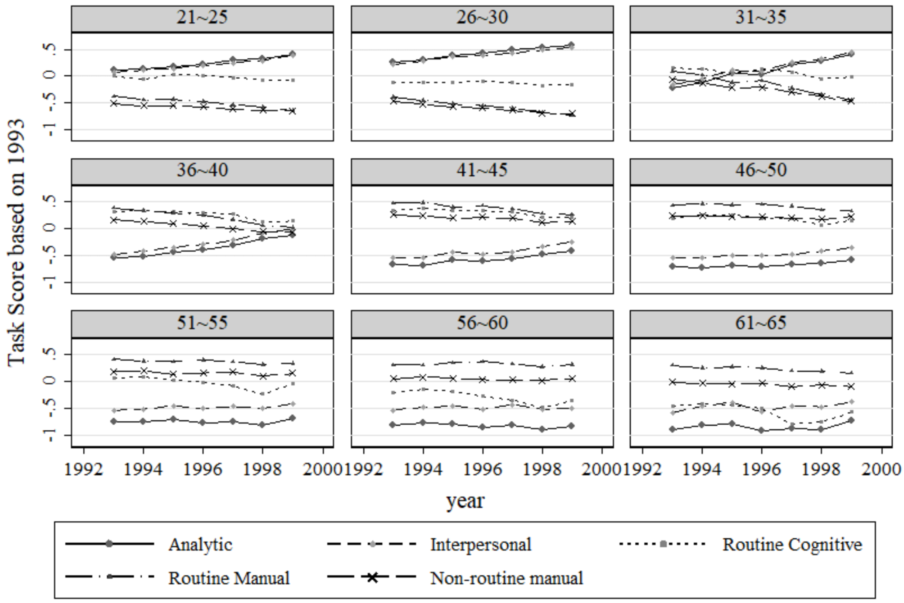
To examine these possibilities, we briefly analyze the task score change by age. Figure 3.5 presents the trend of the average task score by gender and age group in the 1993–1999 period. Graphs for the 2000–2008 and 2009–2018 periods can be found in Appendix Figure A3.1. Between 1993 and 1999, task scores changed markedly in the order of 30s, 20s, 40s, and 50s. Regardless of gender, the task-based occupational composition changed significantly in the relatively younger age group. Since new entry into the labor market and relatively frequent turnover are centered on younger people under the age of 45, they are more likely to respond promptly to the changes in labor demand. More detailed features can be observed in this figure.

Figure 3.5. Change in Task Score by Age Group (1993–1999)

A. Male



B. Female



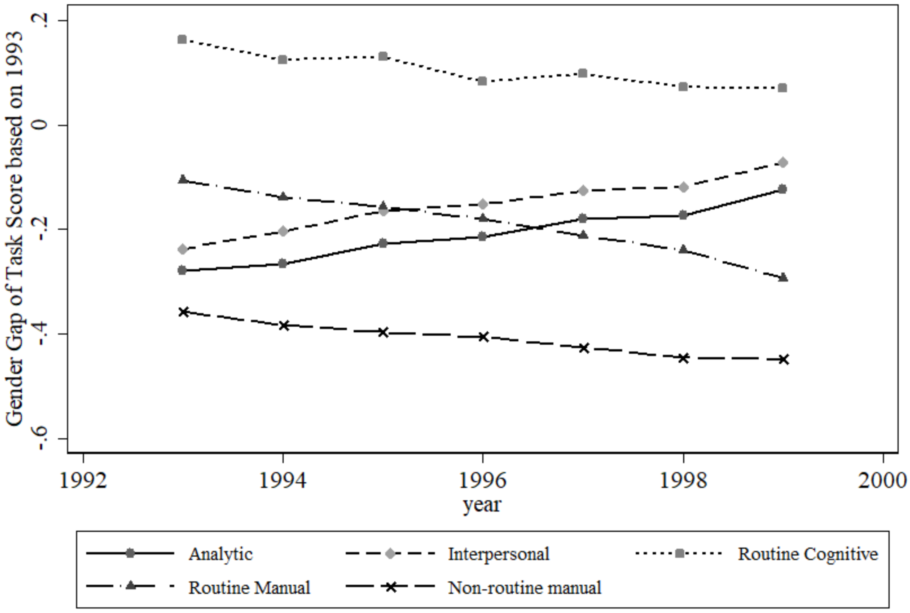
Source: KNOW data

In Korea, women generally begin their economic activities in their mid to late 20s and men in their late 20s and early 30s. The significant change in tasks in these age groups shows that technological changes may have influenced the jobs of new workers just starting their careers. In particular, the task change for women of these ages was more rapid than for men, meaning that routinization for new employees has been more active in women. These facts support the argument suggested by Autor, Levy, & Murnane (2003), namely that changes in demand for tasks have had a greater impact on women's jobs than men’s, considering the recent rapid increase in women's economic activity.

Meanwhile, the increase in abstract tasks and decrease in routine tasks among women aged 31–35 may have been partly due to task changes originating from moving jobs. Similarly, existing workers aged 36 to 45 are more likely to change tasks through turnover and reemployment. Even in these middle-aged groups, women's task shifts are more prominent compared to men. Considering that women of this age are more likely to switch jobs or return from a leave of absence than men for reasons such as childbirth and parenting, in such a situation, women may have responded relatively flexibly to changes in labor demand.

In summary, women's entry into the labor market increased rapidly at the time of labor-demand change following RBTC, so these demand shifts may have a greater impact on women's tasks and jobs than men. Besides, as women with frequent turnovers and reemployment respond more flexibly to changes in the labor market, the task changes are likely to have occurred more remarkably in women.

Figure 3.6. Change in Gender Gap in Task Score (1993–1999)



Source: KNOW data

Figure 3.6 is drawn by subtracting the male score from the female score; it describes how the gender difference in task scores changed between 1993 and 1999 when the most drastic change occurred. In 1993, men's analytic and interpersonal task scores were far higher than women's. However, as routinization progressed, women's abstract task scores sharply increased, and the gender gaps in these scores almost disappeared in 1999, approaching zero. In the case of routine manual and non-routine manual task score, the female scores were lower than those of the males in the beginning, but the female scores decreased more rapidly since then, leading to a wider gender gap. On the other hand, the routine cognitive task was the only task in which the female score was higher than the male score initially, and the gender difference has slightly narrowed during routinization. For reference, these patterns are not apparent in the 2000–2008 and 2009–2018 periods. Changes in the gender gap in task scores during these periods are presented in Appendix Figure A3.2.

Meanwhile, previous literature noted that the abstract task is related to the high socioeconomic status, including high income. Based on this relationship and the fact that this task score has increased more sharply in women than in men, we can infer that the task changes identified above may have worked in a way that reduces the gender gap in income. Similarly, according to existing studies, routine manual and non-routine manual tasks are associated with middle-income and low-income levels, respectively. In both men and women, the share of jobs with strong characteristics of these tasks decreased, but the decline was more active in women. Hence, these changes would also have had an impact on narrowing the gender income gap.

In summary, during the 1993–1999 period, the occupational composition changed in the pattern of RBTC, with an increase in abstract tasks and a decrease in routine tasks. In particular, women's changes were more pronounced than men’s, with a significant increase in the proportion of women who intensively perform the abstract task. From our findings and prior studies, it can be inferred that these task changes may have contributed to narrowing the gender income gap. The following section examines these possibilities by identifying the wage effects of tasks.

3.6 Wage Effects of Tasks

This section analyzes the wage effect of the task to investigate the subsequent impacts of RBTC on women's roles and economic statuses in the labor market. Although it is not directly assessed how the relative wage of women and the gender wage gap has changed due to RBTC, a rough inference is possible by examining the relationship each task has with the wage and gender pay gap, considering the gender task change patterns discussed earlier. That is, we combine the results of the cross-sectional wage analysis according to tasks with the gender-specific task change scenario and, indirectly, make time-series inferences.

We identify how the tasks measured by the job are related to wages, using the fact that the task composition is job-specific. After pooling data for all years within each period, the effects of the abstract, routine cognitive, routine manual, and non-routine manual task on wages are verified using OLS regression in equation (3.1). Furthermore, we examine how these effects change by year, including the interaction term between the task score and the year dummy, as shown in equation (3.2).

$$(3.1)\quad wage_{ct} = \beta_0 + \beta_1 task_c + \beta_2 X_{ct} + year_t + \theta_{ind} + \epsilon_{ct}$$

$$(3.2)\quad wage_{ct} = \beta_0 + \beta_1 task_c + \beta_{2t}(task_c * year_t) + \beta_3 X_{ct} + \beta_{4t}(X_{ct} * year_t) + year_t + \theta_{ind} + \epsilon_{ct}$$

The unit of analysis in this study is a cell comprising a combination of occupation, industry, firm size, education level, and age group divided by ten years. In these equations, $wage_{ct}$ is cell c's log median hourly wage in year t, and $task_c$ is the task score of the occupation of cell c. We use four task scores of the abstract, routine cognitive, routine manual, and non-routine manual to examine the wage effects of these scores. For jobs with high analytic task scores, the interpersonal task scores are also generally high (the correlation coefficient between them is 0.91), so we combine these two scores into an abstract task score. On the other hand, in the case of the routine cognitive and routine manual tasks, since the characteristics of these two tasks are quite different, both scores are included separately. X_{ct} includes control variables such as the share of females, age, age squared, education level, career, and firm size. The year dummies $year_t$ and industry dummies θ_{ind} are also controlled.

Table 3.3 reports the estimated results of equation (3.1) for the 1993–1999 period, which shows the average effect of the task score on the log-transformed median hourly wages during this period. As presented in column (3), the 1 standard deviation increase in the abstract task score raised the wage by 15 percentage points on average, which is the most significant impact. The positive wage effect of the routine manual task is 4 percentage points. On the other hand, when the routine cognitive and non-routine manual task scores increase by 1 standard deviation, the wages fall by 1.7 percentage points and 0.7 percentage points, respectively. Overall, the wage effects of tasks are positive in the order of abstract, routine manual, non-routine manual, and routine cognitive.

Table 3.3. Effect of Task Score on Hourly Wage Rate (1993–1999)

	(1)	(2)	(3)	(4)
Unit of Analysis	Cell	Cell	Cell	Individual
Dependent Variables	Log Median Hourly Wage	Log Median Hourly Wage	Log Median Hourly Wage	Log Hourly Wage
Abstract Task	0.348***	0.150***	0.140***	0.160***
	(0.001)	(0.001)	(0.001)	(0.000)
Routine Cognitive Task	0.005***	-0.001*	-0.017***	-0.015***
	(0.001)	(0.001)	(0.001)	(0.000)
Routine Manual Task	0.038***	0.043***	0.041***	0.047***
	(0.003)	(0.002)	(0.002)	(0.001)
Non-routine Manual Task	0.069***	-0.014***	-0.007***	-0.005***
	(0.002)	(0.001)	(0.001)	(0.001)
Female Ratio / Female		-0.220***	-0.264***	-0.228***
		(0.002)	(0.002)	(0.001)
Age		0.017***	0.026***	0.042***
		(0.000)	(0.000)	(0.000)
Age2		-0.000***	-0.000***	-0.001***
		(0.000)	(0.000)	(0.000)
Education Level. HSG		0.128***	0.112***	0.128***
		(0.002)	(0.002)	(0.001)
Education Level. SMC		0.183***	0.154***	0.159***
		(0.003)	(0.002)	(0.001)
Education Level. CLG+		0.412***	0.321***	0.314***
		(0.003)	(0.002)	(0.001)
Career. 1–2 years		0.222***	0.187***	0.166***
		(0.006)	(0.005)	(0.001)
Career. 2–3 years		0.320***	0.283***	0.242***
		(0.006)	(0.005)	(0.001)
Career. 3–4 years		0.389***	0.334***	0.280***
		(0.006)	(0.005)	(0.001)
Career. 4–5 years		0.432***	0.380***	0.318***
		(0.006)	(0.005)	(0.001)
Career. 5–10 years		0.676***	0.501***	0.409***
		(0.004)	(0.004)	(0.001)
Career. 10 years+		1.045***	0.798***	0.573***
		(0.004)	(0.004)	(0.001)
Firm size. 30–99			0.009***	0.007***
			(0.001)	(0.001)
Firm size. 100–299			0.080***	0.089***
			(0.002)	(0.001)
Firm size. 300–499			0.140***	0.147***
			(0.002)	(0.001)
Firm size. 500+			0.220***	0.233***
			(0.002)	(0.001)

Year Fixed Effect	Yes	Yes	Yes	Yes
Control Variables	No	Yes	Yes	Yes
Industry Fixed Effect	No	No	Yes	Yes
Observations	233,052	233,052	233,052	2,919,250
R-squared	0.371	0.711	0.787	0.662

Parentheses indicate standard errors
*** p<0.01, ** p<0.05, * p<0.1

Column (4) of Table 3.3 shows the result of the same analysis in individual units, not in cells. The analysis method is the same except that the female dummy variable is controlled instead of the female ratio of each cell. According to the results, although there are some differences in the estimates' magnitude, the direction and order of influences are consistent with the outcomes analyzed in cell units. These results prove that the findings of the cell-based analysis in this study are reliable.

Columns (2) and (3) of Table 3.4 show the results of the regression for the periods of 2000–2008 and 2009–2018. The abstract task score is found to have the most significant positive impact on hourly wages over the entire analysis period. The wage effect of the routine manual task is also consistently positive, but its size is relatively small. On the other hand, the routine cognitive task has a steady negative impact on wages. The influence of the non-routine manual task was ambiguous as it fluctuates between positive and negative depending on the period, but it is close to zero except in the 2009–2018 period. Except for the non-routine manual task, the directions of the effects were consistent across all periods, even though their magnitudes slightly decreased in the last period (2009–2018). For reference, there were changes in occupational classification during the analysis period, so it is challenging to compare the magnitude of the estimates over the period. Thus, we cannot conclude from the results of this study alone that the wage effect of tasks decreased over time. The results of the same analysis using cell c's log mean hourly wage in year t for the dependent variable are presented in Appendix Table A3.1. Despite that the size of the estimate is slightly different, the direction is consistent across all years.

Figure 3.7 is a coefficient plot that describes the impact of each task score on wage by year, using the estimated results in equation (3.2). From 1993 to 1999, the positive effect of the abstract task was 12~19 percentage points, whereas that of the routine manual task was 1~7 percentage points annually. On the other hand, the routine cognitive task had a negative wage effect of about -3 to -1 percentage points, and the non-routine manual task's impact was between -4 and 2 percentage points. Although there is a difference in magnitude for each year, the direction and order of influence are approximately constant. Moreover, even in the annual analysis, the results of cell units and that of individual units are similar, with only slight differences in the magnitude of estimates. From these results, we confirm that the analysis of the cell unit does not undermine the representativeness or consistency of this study. Also, Appendix Figure A3.3 depicts the coefficient plots by year for periods of 2000–2008 and 2009–2018.

Table 3. 4. Effect of Task Score on Hourly Wage Rate

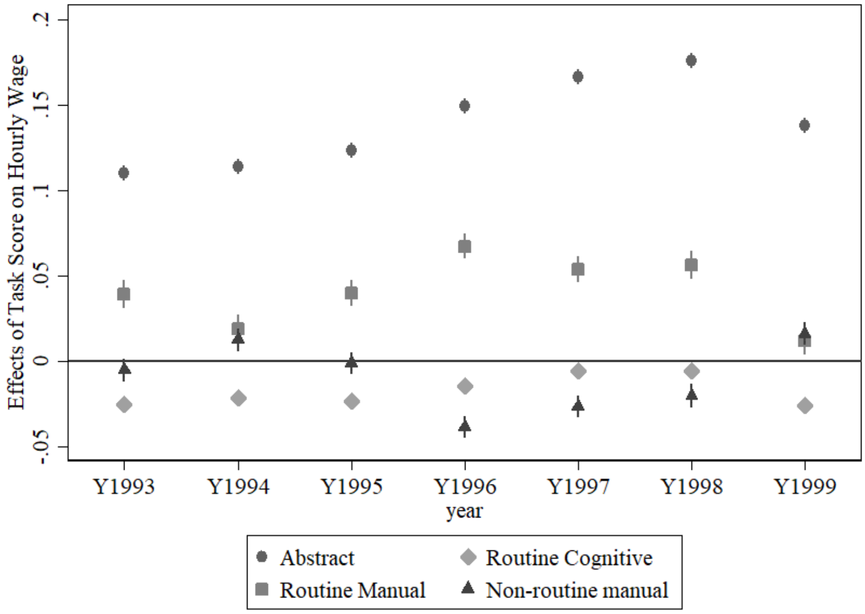
	(1)	(2)	(3)	(4)	(5)	(6)
Unit of Analysis		Cell			Individual	
Dependent Variables		Log Median Hourly Wage			Log Hourly Wage	
Period	1993–1999	2000–2008	2009–2018	1993–1999	2000–2008	2009–2018
Abstract Task	0.140***	0.142***	0.099***	0.160***	0.160***	0.113***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
Routine Cognitive Task	-0.017***	-0.023***	-0.007***	-0.015***	-0.019***	-0.004***
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Routine Manual Task	0.041***	0.009***	0.002**	0.047***	0.011***	-0.001***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
Non-routine Manual Task	-0.007***	0.006***	-0.021***	-0.005***	0.007***	-0.011***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	233,052	400,334	518,320	2,919,250	4,017,808	6,439,848
R-squared	0.787	0.766	0.775	0.662	0.638	0.586

Parentheses indicate standard errors

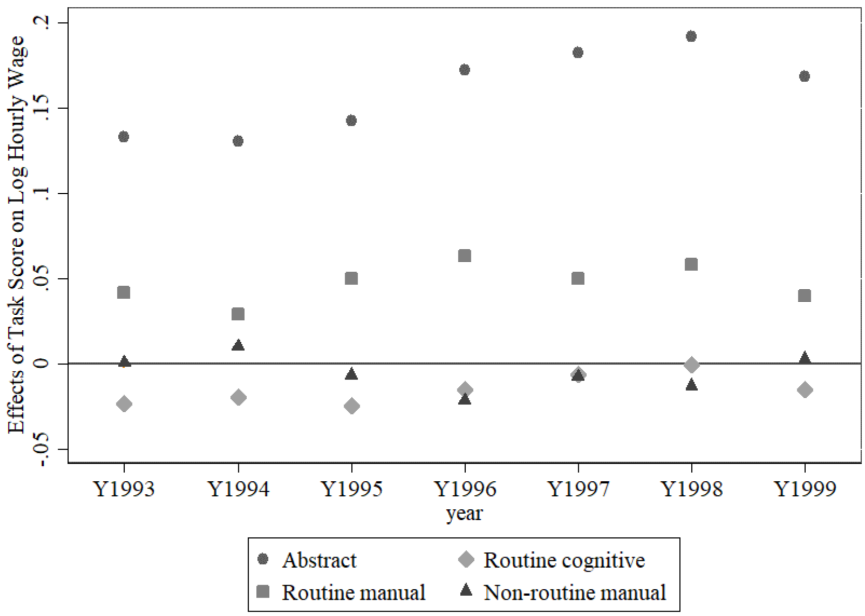
*** p<0.01, ** p<0.05, * p<0.1

Figure 3.7. Effects of Task on Wage (1993–1999)

A. Effects of Task on Wage 1993–1999 (Unit: Cell)



B. Effects of Task on Wage 1993–1999 (Unit: Individual)



Source: KNOW data

These results suggest that even after controlling the education, age, career, and industry fixed effect, the task is a robust predictor of wage. This is consistent with the results of previous studies in the U.S. Using the self-reported task measures, Autor & Handel (2013) verify that the relationship between tasks and wages remains, even when controlling human capital and demographic variables. According to them, the abstract task is associated with a wage premium, while routine and non-routine manual tasks are associated with wage penalties. Also, the routine manual and the non-routine manual task were not clearly distinguished in view of the education levels, without any control, as in Figure 3.1. However, these two tasks differ markedly in their impact on wages. The return for routine manual tasks was steadily positive and higher than the non-routine manual tasks during most of the analysis period, which is consistent with Western countries such as the U.S. and in Europe.

Previously, Section 3.5 confirmed that women's routinization was more active while increasing the share of abstract tasks and decreasing the proportion of routine tasks under the influence of RBTC in the 1990s. In this section, we found that wages are high for workers who intensively perform abstract tasks and relatively low for workers who specialize in routine tasks. Given the wage effects of these tasks, along with the varied routinization pattern by gender, it can be inferred that these task changes worked in a way to alleviate the gender wage gap.

Lastly, this study investigates how task score affects the gender pay gap by referring to estimation methods of Aksoy, Ozcan, and Philipp (2019). In equation (3.3), the unit of analysis is a cell of a combination of occupation, industry, firm size, education level, and age group divided by ten years as before. The dependent variable $gender\ wage\ gap_{ct}$ is the gender gap in median hourly wage for each cell. Therefore, $gender\ wage\ gap_{ct}$ indicates how high the female's hourly wage is compared to males when their age, education level, occupation, industry, and size of the company they work for are similar. $task_c$ is the task score of the occupation corresponding to cell c, and X_{ct} are control variables, including sex composition, demographic factors such as age, career and education level, and the size of the firm. The year dummies $year_t$ and industry dummies θ_{ind} are also controlled.

$$(3.3)\quad gender\ wage\ gap_{ct} = \beta_0 + \beta_1 task_c + \beta_2 X_{ct} + year_t + \theta_{ind} + \epsilon_{ct}$$

$$where\ \ gender\ wage\ gap_{ct} = \frac{median\ hourly\ wage\ of\ female - median\ hourly\ wage\ of\ male}{median\ hourly\ wage\ of\ male}$$

According to the results reported in Table 3.5, even after excluding the effects of industry, firm size, and demographic characteristics, tasks have a significant relationship with the gender wage gap. As shown in column (1), in 1993–1999, women engaged in abstract tasks faced high relative wages and low gender wage gaps. The 1 standard deviation increase in this task score is associated with the 1.5-percentage-point increase in the relative wage of women. On the other hand, the gender wage gap was higher for jobs in which routine tasks are performed intensively.

When the routine cognitive and manual task scores rise by 1 standard deviation, the gender wage gap becomes wider by 0.5 and 0.7 percentage points, respectively. In the case of the non-routine manual task, it leads to a 1 percentage point increase in the gender wage gap.

Columns (2) and (3) of Table 3.5 provide the results of the same analysis for different periods. In the case of abstract and routine tasks, the relationships between these tasks and the gender wage gap were consistent across all periods, even though the size of the effects varies depending on the period. However, the non-routine manual task had the effect of increasing the relative wages of women only in the 2009–2018 period, in contrast to other periods.

Table 3.5. Effect of Task Score on Gender Gap in Median Wage

	(1)	(2)	(3)
Period	1993–1999	2000–2008	2009–2018
Dependent Variables	Gender Gap in Median Hourly Wage	Gender Gap in Median Hourly Wage	Gender Gap in Median Hourly Wage
Abstract Task	0.015***	0.022***	0.012***
	(0.002)	(0.002)	(0.002)
Routine Cognitive Task	-0.005***	-0.021***	-0.019***
	(0.002)	(0.002)	(0.001)
Routine Manual Task	-0.007*	-0.004	-0.010***
	(0.004)	(0.004)	(0.003)
Non-routine Manual Task	-0.010***	-0.003	0.015***
	(0.003)	(0.003)	(0.002)
Observations	51,746	94,900	146,318
R-squared	0.102	0.055	0.031

Parentheses indicate standard errors

*** p<0.01, ** p<0.05, * p<0.1

In summary, the gender wage gap in abstract-task-intensive jobs is small, and the wages of men and women specialized in routine tasks are considerably different for all periods. The relationship between non-routine manual tasks and women's relative wages is ambiguous. For reference, the results of the same analysis using the gender gap in mean hourly wage for each cell as a dependent variable are presented in Appendix Table A3.2. In this case, the size of the estimate is slightly different, but the direction is consistent across all years.

For abstract tasks, physical activity is relatively less important, as computers and machines play a complementary role. Therefore, gender differences in physical characteristics or abilities are less likely to lead to wage gaps when performing these tasks. Weinberg (2000) argues that increasing computer use accounts for over 50% of the increase in demand for women's labor. The author explains that skill requirements and conditions of work change, such as reduced importance to physical abilities due to computers.

Also, the results can be interpreted in a context similar to the narrowing of the gender wage gap when the human capital, such as education level, is high. The importance of an individual's abilities in abstract and routine tasks may differ. It is not easy to regularize or code analytic and interpersonal tasks. In addition, the capabilities of workers to design, analyze, manage as well as communicate and sustain relationships with others are essential when carrying out these tasks. In this case, workers are likely to be evaluated and paid by their abilities or performances, and there would be relatively little room for discrimination based on gender.

On the other hand, routine cognitive tasks are repetitive and structured. When performing these tasks, workers only follow rules and regulations; they do not have the right to judge or make decisions by themselves. Therefore, there is no room for personal abilities, as long as they have the primary ability to carry out these tasks. In this case, if the culture that favors men remains in the labor market for various reasons, such as the predominance of long working hours and a low possibility to leave for childbirth and child care, it can lead to a gender pay gap.

This section analyzed the wage effect of the task to investigate the influence of RBTC on women's roles and economic statuses in the labor market. Although we did not directly assess how the relative wage of women and the gender wage gap has changed due to RBTC, a rough inference was possible from the gender task change patterns and the relationship each task has with the wage and gender pay gap. We combined the results of the cross-sectional wage analysis according to tasks with the gender-specific task change scenario and, indirectly, make time-series inferences.

As verified earlier, while increasing the abstract tasks and decreasing the routine tasks with RBTC, the change in women was more pronounced than in men. In other words, the share of women in occupations that involve intensively performing abstract tasks has increased rapidly. Given the positive impact of these tasks on wages, the task changes would have worked in a way that raises women's wages. Furthermore, since the gender wage gap in abstract tasks is small, we can infer that the increase in these tasks contributed to the narrowing of the gender wage gap.

The reduction of routine tasks has also been more active in women. Considering the wage effects, especially the negative impact of routine cognitive tasks, and that the wages of men and women specialized in these tasks are considerably different, the decrease in these tasks would also have been advantageous to women's wages. For non-routine manual tasks, its relationship with women's relative wages is ambiguous. However, since the increase in abstract and the decrease in routine tasks were evident and significant, these findings suggest that routinization would have contributed to the overall conversion of the gender wage gap.

3.7 Conclusion

This chapter examines whether there has been RBTC in Korea and identifies the subsequent impacts on women's roles and economic statuses in the labor market. We measure the tasks using KNOW data, the Korean version of O*Net in the U.S., which contains information on the features of each occupation. Using this data, we can measure the task reflecting the detailed characteristics of jobs and make a consistent comparison with the prior research of the Western countries.

According to the analysis, this study finds that Korea has undergone an increase in abstract tasks and a reduction in routine tasks, which is the pattern of RBTC. The non-routine manual task has also decreased, but the change was moderate. These task shifts in Korea occurred intensively in the 1990s, and the change in female workers was more pronounced than in men. These gender differences in task changes are likely related to the rapid increase in female labor force participation at the time of RBTC, as well as frequent turnovers and reemployment of women compared to men. Therefore, these labor-demand shifts following RBTC may have a more significant impact on women's tasks and jobs.

We also explore the wage effects of the tasks and confirm that those tasks have a significant impact even after controlling the human capital and demographic factors. We verify that wages are high for workers specialized in abstract tasks and relatively low for workers engaged in routine tasks. In particular, routine cognitive tasks are linked to a wage penalty. The influence of non-routine manual tasks was ambiguous. Given the varied task change pattern by gender and the wage effects of tasks, we can infer that routinization would have been advantageous to women in view of wages.

Lastly, we analyze how task scores are related to the gender pay gap. According to the results, women engaged in occupations with strong abstract characteristics face low gender wage gaps. On the other hand, the wages of men and women specialized in routine tasks are considerably different. The non-routine manual task has an insignificant relationship with the relative wages of women. These findings suggest that the task change driven by RBTC may have contributed to the overall conversion of the gender wage gap in the Korean labor market. This study examines how women's roles changed due to RBTC in terms of tasks rather than occupations, and investigates how these changes affected their economic statuses. We expect that this study could contribute to a further understanding of the gender wage gap in the Korean labor market.

Appendix

Based on Acemoglu & Autor (2011)'s task measure, we additionally use four more indices to complement non-routine manual task measure.

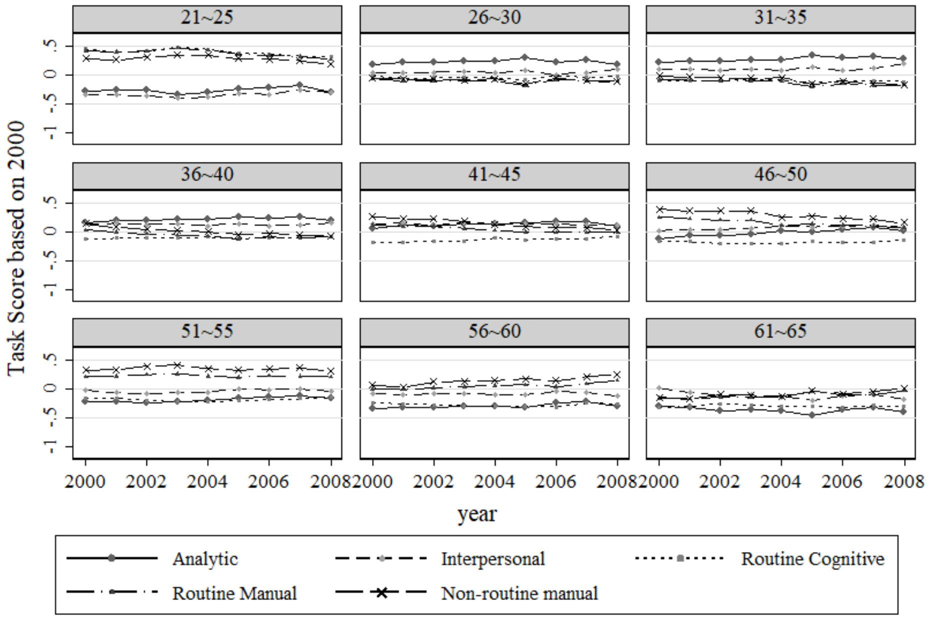
For descriptor of “Operating vehicles, mechanized devices, or equipment,” we add “Knowledge of transportation,” because operating devices may include characteristics of routine manual tasks. Considering that one of the representative occupations of non-routine manual task is truck driving, the transportation descriptor can reinforce the non-routine manual characteristics.

“Time spent using hands to handle, control, or feel objects, tools, or controls” is used together with reversed rating of “Data processing.” Data processing also requires a lot of manual activity to deal with computers or calculators, but it is close to routine task. Therefore, using the reversed rating of “Data processing” helps to eliminate the routine factors.

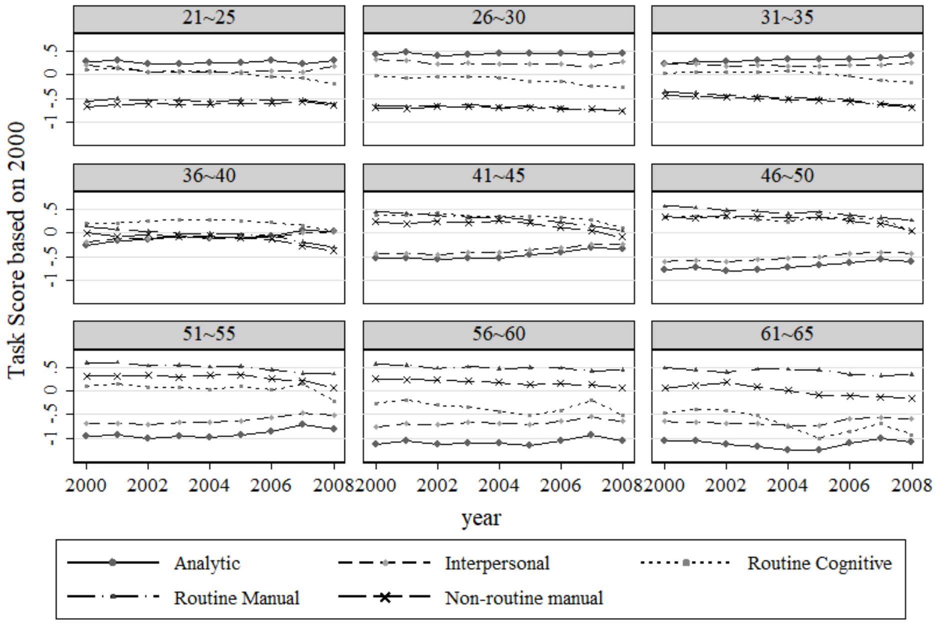
For “Manual dexterity,” we additionally consider “Static Strength,” and for “Spatial orientation,” “Spend Time Keeping or Regaining Balance” is added. “Static Strength” and “Keeping or Regaining Balance” can emphasize the importance of physical abilities, which are essential for non-routine manual tasks, such as janitorial services, street sweeper, and drivers.

Figure A3.1. Change in Task Score by Age Group (2000–2008, 2009–2018)

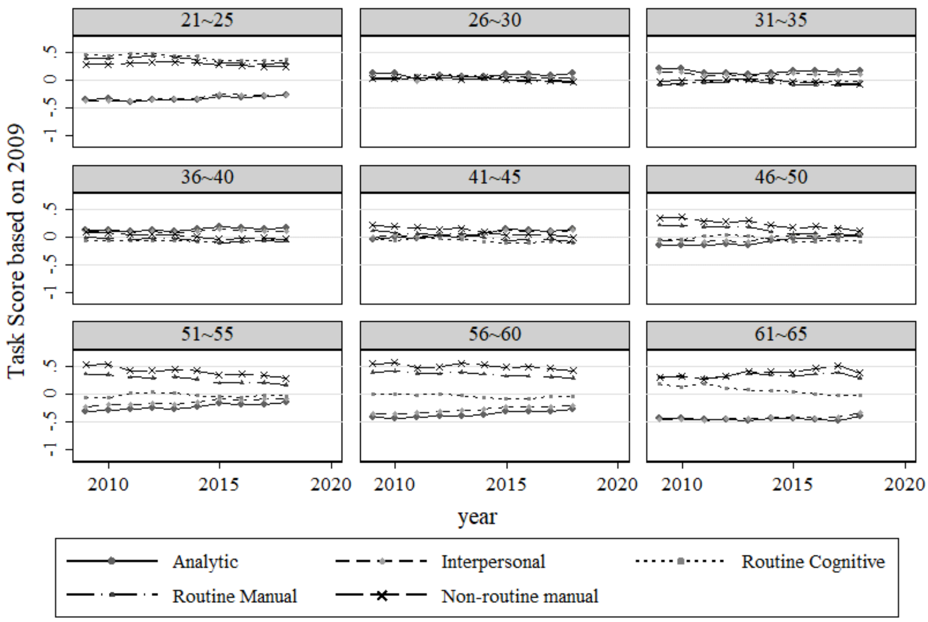
A. 2000–2008 (Male)



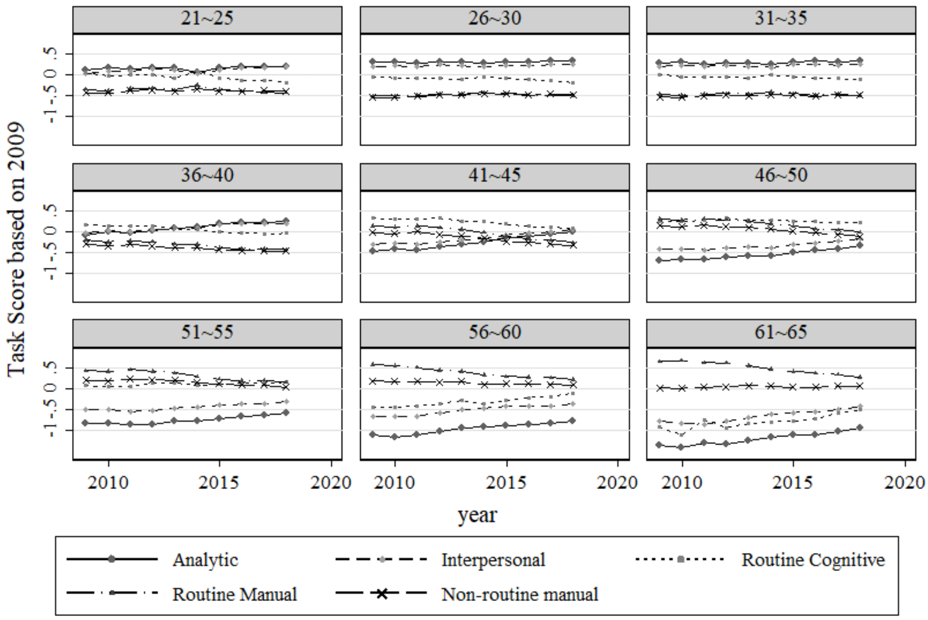
B. 2000–2008 (Female)



C. 2009–2018 (Male)



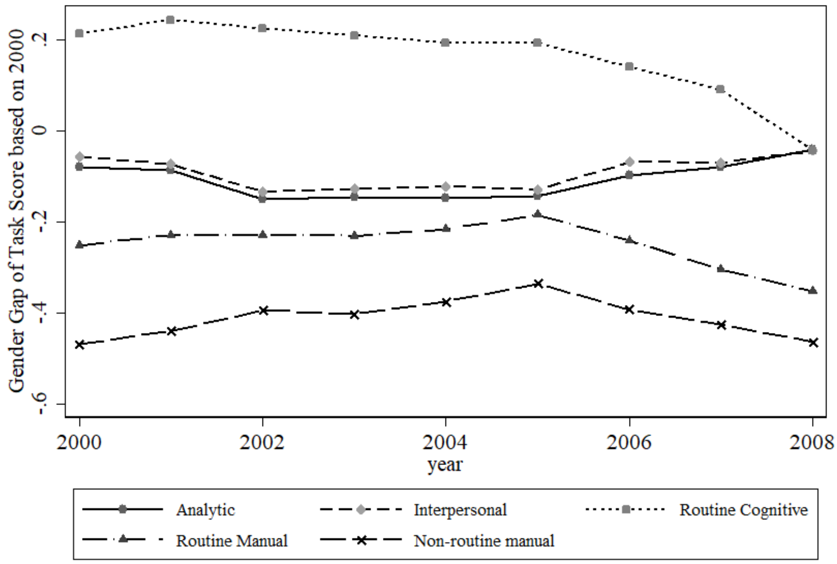
D. 2009–2018 (Female)



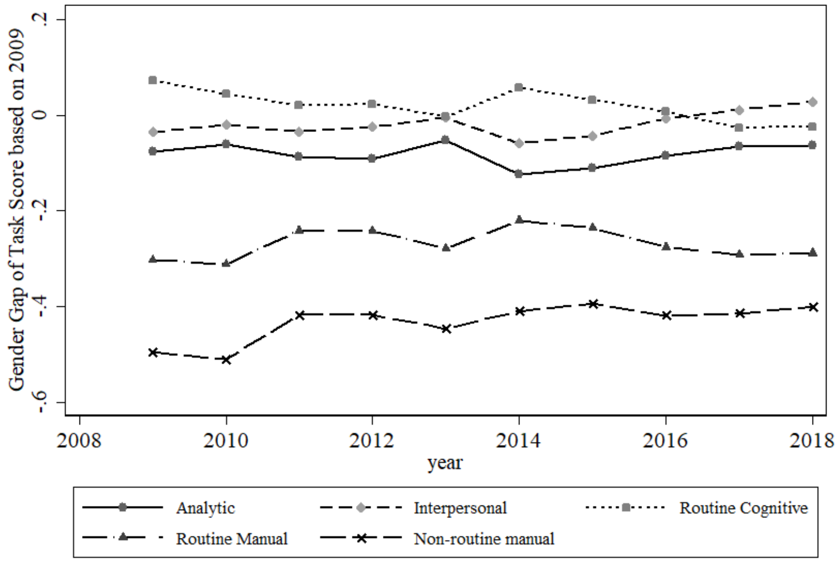
Source: KNOW data

Figure A3.2. Change in Gender Gap in Task Score (2000–2008, 2009–2018)

A. 2000–2008



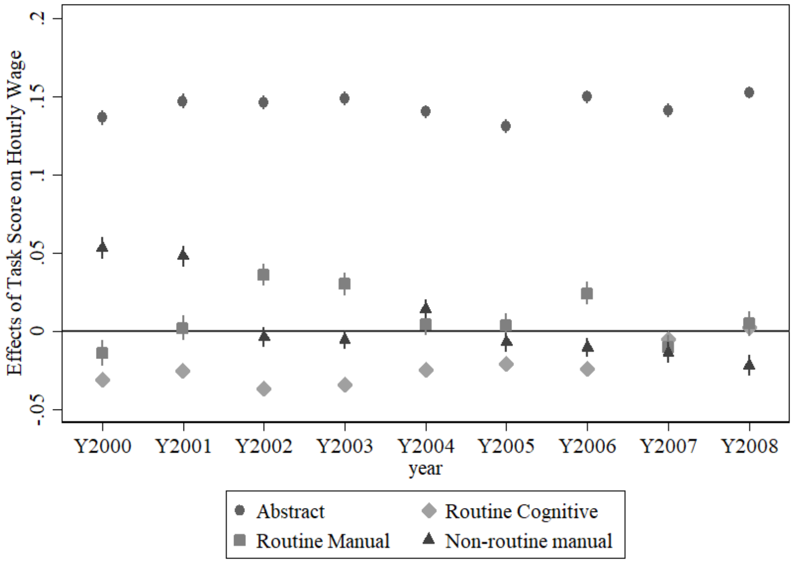
B. 2009–2018



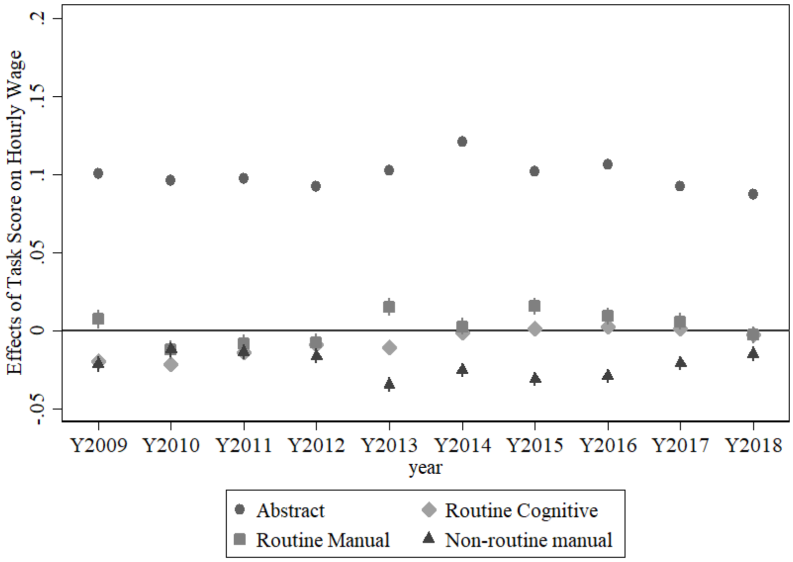
Source: KNOW data

Figure A3.3. Effects of Task on Wage (Unit: Cell) (2000–2008, 2009–2018)

A. 2000–2008



B. 2009–2018



Source: KNOW data

Table A3.1. Effect of Task Score on Average Hourly Wage Rate

	(1)	(2)	(3)
Unit of Analysis		Cell	
Dependent Variables		Log Mean Hourly Wage	
Period	1993–1999	2000–2008	2009–2018
Abstract Task	0.144***	0.146***	0.096***
	(0.001)	(0.001)	(0.001)
Routine Cognitive Task	-0.018***	-0.023***	-0.008***
	(0.001)	(0.001)	(0.000)
Routine Manual Task	0.050***	0.016***	0.002**
	(0.001)	(0.001)	(0.001)
Non-routine Manual Task	-0.012***	0.003***	-0.026***
	(0.001)	(0.001)	(0.001)
Year Fixed Effect	Yes	Yes	Yes
Control Variables	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes
Observations	233,052	400,334	518,320
R-squared	0.806	0.783	0.786

Parentheses indicate standard errors
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table A3.2. Effect of Task Score on Gender Gap in Average Wage

	(1)	(2)	(3)
Period	1993–1999	2000–2008	2009–2018
Dependent Variables	Gender Gap in Mean Hourly Wage	Gender Gap in Mean Hourly Wage	Gender Gap in Mean Hourly Wage
Abstract Task	0.013***	0.019***	0.008***
	(0.002)	(0.002)	(0.002)
Routine Cognitive Task	-0.005***	-0.021***	-0.017***
	(0.002)	(0.002)	(0.001)
Routine Manual Task	-0.008**	-0.003	-0.014***
	(0.004)	(0.003)	(0.002)
Non-routine Manual Task	-0.010***	-0.007**	0.012***
	(0.003)	(0.003)	(0.002)
Observations	51,746	94,900	146,318
R-squared	0.109	0.062	0.037

Parentheses indicate standard errors

*** p<0.01, ** p<0.05, * p<0.1

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국문초록

성별에 따른 노동시장 성과 및 부모의 투자 차이에 관한 연구

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이정민

한국은 급격한 경제 성장과 함께 여성의 꾸준한 사회경제적 지위 향상을 경험하였다. 그러나 이러한 변화에도 불구하고, 노동시장 성과의 측면에서는 아직까지 상당한 성별 격차가 존재하는 것으로 알려져 있다. 본 연구는 한국에 남아있는 남아선호와 이로 인한 부모의 차별적 투자를 살펴본다. 이러한 차별적 투자는 장기적으로 인적 자본의 차이를 유발할 수 있다는 점에서 주목할 필요가 있다. 또한 근무환경의 유연성과 기술 변화의 측면에서 한국 노동시장에서의 남녀 성과 차이를 논의한다.

첫 번째 논문은 한국에 남아있는 남아선호를 고려하여, 자녀의 성별에 따른 차별적인 투자가 아동의 건강 관리 측면에서도 나타나는지 다룬다.

여성의 사회경제적 지위 향상과 성별 규범에 대한 사회적 인식 변화에도 불구하고, 한국에 남아선호가 남아있다는 근거는 다수 존재한다. 본 연구는 부모가 자녀 의료비 지출을 결정하는 데 있어서 이러한 남아선호가 어떠한 영향을 미치는지 확인한다. 남아선호는 부모 출생 이후 20년간의 출생 성비로 측정하였으며, 이렇게 측정한 남아선호가 지역마다 다르다는 사실을 이용하여 이중차분법으로 분석하였다. 그 결과, 여아의 의료비 지출액이 남아보다 낮으며, 이와 같은 성별 격차는 남아선호지역에서 더욱 뚜렷하게 나타났다. 이는 부모가 어린 시절 경험한 남아선호의 관습과 문화가 그들의 성별 규범을 형성하고 자녀의 성별에 따른 투자 결정에 영향을 미침을 보여준다.

두 번째 논문은 한국 노동시장의 두 가지 특징에 주목한다. 첫 번째는 다른 국가에 비해 노동시간이 길다는 점이고, 두 번째는 성별 임금격차가 크다는 점이다. 한국에서 보편적으로 이루어지고 있는 장시간 노동은 전반적인 근무환경이 유연하지 못한 근거로 볼 수 있으며, 낮은 근무환경 유연성은 성별 임금격차가 유독 높다는 사실과 연관지을 수 있다. 본 연구에서는 이러한 한국 노동시장의 특징과 선행 연구에 근거하여, 근무환경의 유연성이 성별 임금격차를 설명할 수 있는지 살펴본다. 직업별 특성을 조사한 KNOW 데이터와 이중차분법을 적용하여 분석한 결과, 근무환경이 유연한 직업에서 여성의 상대적 임금이 높음을 확인하였다. 이와 같은 관계는 대졸자 집단에서 더욱 분명하게 나타났다.

마지막 논문에서는 정형편향적 기술진보(Routine Biased Technological Change) 가설이 설명하는 업무 변화가 한국에서도 있었는지 확인하고, 이러한 변화가 노동시장에서 여성의 역할과 경제적 지위에 어떠한

영향을 미쳤는지 살펴본다. O*Net 의 한국 버전인 KNOW 데이터를 사용하여 분석한 결과, 한국에서도 다른 서구 국가와 마찬가지로 RBTC 형태의 업무 변화가 있었음을 확인하였다. 즉, 비정형적 분석업무(non-routine analytic task) 및 비정형적 상호교류 업무(non-routine interactive task)는 증가하고, 정형적 업무(routine task)는 감소하였다. 비정형적 육체업무(non-routine manual task)의 비중 또한 감소하였으나, 그 변화는 상대적으로 미미하였다. 이러한 업무 변화는 1990 년대에 집중적으로 발생하였으며, 남성에 비해 여성 노동자의 변화가 더욱 뚜렷하였다. 또한 본 연구는 비정형적 인지 업무에 종사하는 근로자의 임금이 높고, 그들의 성별 임금격차가 작음을 확인하였다. 반면, 정형적 업무는 상대적으로 낮은 임금과 연결되며, 해당 업무를 주로 수행하는 남녀의 임금이 상당히 다른 것으로 나타났다. 이러한 결과에 근거하여, 한국 노동시장에서의 루틴화(routinization)가 여성의 상대적 임금을 향상하고 성별 임금격차를 감소시키는 데 기여했을 것으로 판단된다.

주요어: 성별 경제학, 부모의 투자, 남아선호, 아동, 성별 임금격차, 근무환경 유연성, 기술 변화, 루틴화

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