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Parental Leaves and Female Skill Utilization: Evidence from PIAAC*

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Abstract

Most developed countries adopt parental leave policies to promote women's labor force participation without sacrificing family formation. Studies find that short-term parental leaves for women increase the time spent at home and promote their return to the labor force after childbearing, but some studies point out that long-term parental leaves hinder the career advancement of high-skilled women. This paper analyzes heterogeneous impacts of parental leave policies on women's skill-use intensity by skill level, drawing on rich information on individual skill and skill-use intensity available from the micro data of the Programme for the International Assessment of Adult Competencies (PIAAC), which covers 30 countries. The results show that longer parental leaves narrow the gender gap in skill-use intensity among low-skilled workers but widen it among high-skilled workers. This finding is robust after controlling for international differences in gender norms and labor market institutions and allowing for country fixed effects. The findings corroborate with the claim that a longer parental leave period suppresses the career advancement of high-skilled women.

Keywords: Skill use, Gender gap, Family policy, Parental leaves, Tax system
JEL classification: D12, H24, J16, J12, J13, J24

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1 Introduction

To promote women's labor-force participation without sacrificing family formation, most developed countries adopt parental leave systems that either legally protect jobs or pay benefits during the period of leave. As of 2011, for example, Austria, Denmark, Germany, Japan, Korea and Sweden all mandate that employers grant women a one-year or longer paid parental leave.[1] The goal of the policy is to ease mothers' career continuation and increase women's labor-market attachment after child bearing.

Studies assess the effects of parental leave policy on women's labor-market outcomes and arguably reach a nuanced conclusion that longer parental leave may lead to higher labor-force participation among mothers but that it may suppress their career advancement (Kunze, 2016; Rossin-Slater, 2018). Regarding the latter unintended negative effect of maternity leave on women's subsequent career advancement, Albrecht et al. (2003) and Albrecht et al. (2015) point to the possibility that the generous legal parental leave in the country unintentionally hinders career advancement of women through their human capital depreciation during the parental leave period or triggering statistical discrimination against them. These adverse effects are presumably larger among skilled women and result in the glass ceiling phenomenon, the observed larger gender wage gap at the higher end of the wage distribution. To assess their claim, we need to analyze the heterogeneous impacts of maternity leave on career advancements by skill levels.

Previous studies analyze the effect of maternity leave on the maternal labor supply in the short- and medium-run and reach mixed conclusions. Ruhm (1998), for example, reports that a one-year extension of paid parental leave increases women's employment rate but decreases women's wage relative to men's using 9 European countries from 1969 to 1993. Thévenon and Solaz (2013) confirm the robustness of the results using 17 Organisation for Economic Co-operation and Development (OECD) countries from 1970 to 2010. Olivetti and Petrongolo (2017) extend the analysis covering 30 countries between 1997 and 2013 and find the heterogeneous impacts of parental leave across women's skill distribution; longer job-protected leave narrows the gender employment gap among the less educated, while it widens the gender wage

[1] Other than these countries, former communist countries, Czech Republic, Estonia, Lithuania and Slovakia, mandate one and a half years or longer paid parental leave.

gap among the highly educated.

Another strand of research looks at a single country at a time and finds that shorter parental leave, up to half a year, has a positive impact on women's employment, but longer parental leave has limited impacts on employment or wages. Berger and Waldfogel (2004) find that the provision of the mandatory 12 weeks leave by Family and Medical Leave Act (FMLA) in the US expedites the return to the labor market. Baker and Milligan (2008) also find the introduction of 17-18 weeks of mandated leave increases the share of workers returning to their pre-birth employers in Canada. In contrast, studies focusing on the longer leave in Europe, exploiting the discontinuous extension of the parental leave period by the date of the birth of a child in several countries, find that parental leave has a negligible impact on women's labor market outcomes after the expiration of the parental leave periods, while the extension certainly prolongs the maternal time at home (Lalive and Zweimüller, 2009; Schönberg and Ludsteck, 2014; Dahl et al., 2016).

In sum, both cross-country and single-country studies point out that at least short parental leave, up to half a year, has a positive impact on women's employment. Almost all these studies, except for Olivetti and Petrongolo (2017), however, assess the impacts of the policy averaging out skill heterogeneity and thus are silent about the heterogeneous impacts of maternity leave provision on women's labor-market outcomes by their skill levels. Thus, little is known about how parental leave affects the career advancement of skilled women.

To understand the heterogeneous impacts of parental leave policy on women's labor-force participation and career advancement by skill level, we rely on micro data from the Programme for the International Assessment of Adult Competencies (PIAAC) compiled by the OECD, covering more than 30 countries (of which we use 30 countries) that differ substantially in the length of their respective parental leave periods. The PIAAC is the best-suited data set to analyze the impact of the maternity-leave period on women's post-birth career advancement by their skill levels, because the data set includes questions that measure the literacy and numeracy of adults who have taken an on-site test. The survey further includes questions that ask about the frequencies of implementing certain tasks requiring a specific skill, such as writing emails or reading manuals/reference sources. From these records, we can construct

an objective measurement of skill and skill use on the job for each individual; we construct composite measures of skill possession and skill use, using Item Response Theory (IRT). As an internationally comparable measure of career advancement, we draw on the calculated index of skill use on the job, constructed from objective measurements of tasks implemented on the job, beyond wages, job ranks, or occupations. We construct the measures separately for each country to focus on the gender gap in skill and its use, while avoiding potential problems arising from international differences in the variance of the skill distribution and the ways respondents answer skill-use questions. With this information, the PIAAC enables us to assess the heterogeneous impacts of maternity leave by skill levels on the skill use that presumably approximate career advancement.

There are several reasons why using a skill-use index is superior to examining wages that are the typical proxy variable of workers' productivity. First, the skill-use measure exactly corresponds to the skill measure; for example, we can examine the degree of literacy use conditional on the literacy skill score. Thus the concept of skill utilization is clearly defined. Second, explanations other than skill under-utilization, such as Becker-type taste discrimination by employers, coworkers, or customers can explain why female wages are lower than male wages. Third, parental leave provision affects the relative wage through various reasons beyond career segregation between genders. As claimed in previous studies, the increase of women's labor supply induced by extensive parental leave decreases women's wage relative to men's if women and men are not perfect substitutes in the production process (Ruhm, 1998). In addition, the cost of providing maternity leave could be shifted onto women's wage (Gruber, 1994). Thus, the suppressed wages of women after the extension of the maternity leave period does not necessarily imply that lengthier maternity leaves hinder women's career advancement.

Scrutiny of the PIAAC reveals limited gender gaps in literacy skill across countries, while in some countries, gender gaps in numeracy are substantial. These findings suggest that literacy is equally accumulated by both genders across countries, regardless of a significant difference in women's labor-market prospects, perhaps because literacy is equally useful in the market and in household production, whereas numeracy is endogenously formed, aimed at utilization in the labor market (Guiso et al., 2008; Fryer and Levitt, 2010; Nollenberger et al., 2016). This finding

leads us to focus on literacy use on the job.

We examine the association of literacy scores and employment status to analyze how literacy affects labor-force participation. Generally speaking, women are less likely to participate in the labor force, conditional on the literacy score, but the gender gaps are substantially different across countries. Furthermore, gender gaps in skill-employment gradients are heterogeneous across countries; in some countries, the literacy score and employment are strongly associated, while in other countries, they are not associated. We further examine the gender gaps in skill use among those who are employed to examine the gender gap in skill use at the intensive margin. For this purpose, we construct a skill-use measure using the objective measure of activities on the job and correlate it with the skill score. Generally, women use less skill given their skill level, and their skill-use/skill gradient is flatter than men's; but, again, there are substantial differences in gender gaps across countries. In sum, we find significant heterogeneity in the gender gaps in skill utilization at both the extensive and intensive margins.

We then associate the country-level index of the generosity of parental leave with the gender gaps in skill use to understand the association of parental leave policy and skill use. We quantify the generosity of parental leave of each country based on the OECD family database and the ILO legal database, constructing the length of paid maternity leave, the length of job protection, and the length of paid maternity leave, multiplied by the replacement rate. The analysis results indicate that the generosity of parental leave is positively associated with low-skilled women's skill utilization, but the association weakens as women's skill increases. These findings are consistent with the claim by Albrecht et al. (2003) and Albrecht et al. (2015) that a larger gender wage gap at the higher end of the wage distribution in Sweden is attributable to the generous legal parental leave that unintentionally triggers statistical discrimination against them and puts women in "mommy tracks." Perhaps contrary to the policy intention, the results suggest that generous parental leave policy induces women's skill under-utilization.

Our results based on a one-shot, cross-country comparison could suffer from omitted variable bias; unobserved country-specific factors can affect both maternity-leave policy and gender gaps of labor-market outcomes. We address this potential omitted variable bias by including variables that approximate factors that could determine parental leave policy, as well as gender gaps of

labor-market outcomes. The first candidate of such a variable is gender norms, which could affect both the generosity of parental leave and female skill utilization in the labor market. To handle this potential omitted variable bias, we construct the strength of traditional gender norms using World Value Surveys and European Value Surveys. It turns out that the conditioning on proxy variables for traditional gender norms does not change the association between family policies and the gender gaps in skill use in the labor market. Other tax and labor-market institutions may also play important roles as determinants of women's skill utilization, and these variables may be correlated with maternity leave policy. Family-based taxation, instead of individual taxation, makes the second earner's marginal tax rate high and discourages the labor-force participation of the second earner in a household, who is generally female (Bick and Fuchs-Schündeln, 2017). Stricter employment protection is known to reduce turnover in the labor market (OECD, 2013a). Reduced labor-market turnover may well work against women, rather than men, because family duties, such as child care, make women more likely to leave and reenter the labor market. Labor unions may also work against women's skill utilization by promoting gender-biased compensation policies based on traditional gender norms, while they may promote women's skill utilization by promoting family-friendly compensation policies. Indeed, Bryson et al. (2016) report contrasting roles of trade unions in the United Kingdom and Norway; UK labor unions exacerbate gender wage inequality, whereas their Norwegian counterparts mitigate it. In addition, a higher share of service employment may well promote women's skill utilization, as women tend to have a greater advantage in the service sector than in the manufacturing sector (Ngai and Petrongolo, 2017). We include proxy variables to capture these labor-market institutions as additional regressors to confirm the robustness of our result: Generous parental leave promotes women's skill utilization of low-skilled women but suppresses that of high-skilled women.

Furthermore, our findings are difficult to attribute to a simple omitted variable bias in the cross-country comparison, because our estimation goes beyond simple mean comparison of labor-market outcomes across countries; our estimation strategy exploits the skill heterogeneity within a country to implement the country-fixed effects estimation. The fixed-effects results indicate a robust relationship, in that the extension of maternity leave flattens the relationship

between skill level and skill use.

Overall, the contributions of this paper to the literature are to show the impact of parental leave policies on gender gaps in career advancement in the labor market through 1) quantifying the gender difference in skill and its utilization based on objective and internationally comparable measurements, and 2) explaining the international difference by indices of parental leave policies.

2 Data

2.1 Main data set

We draw on the Programme for the International Assessment of Adult Competencies (PIAAC) by the OECD, which aims to measure adults' cognitive and workplace skills. Twenty-four countries participated in the PIAAC Round 1 (2008 - 2013), and 9 countries participated in Round 2 (2012-2016); participating countries in each round are tabulated in Table 1. Our analysis sample consists of all participating countries in Rounds 1 and 2, except for Australia and Indonesia, whose data sets are not provided for public use, and Russia, whose data set does not include Moscow residents. Accordingly, our analysis sample includes individuals from 30 countries. We obtained the German scientific-use file from GESIS, because its public-use file does not contain the variables necessary for our analysis. The survey targets those individuals aged 16–65 and asks for basic background information, such as sex, educational attainment, and family composition.

The PIAAC tests literacy, numeracy, and problem-solving skills in respondents' technology-rich environments. None of the respondents completed all three test sections; rather, they completed two at most; possible combinations are "literacy and numeracy," "literacy and problem solving 1," "literacy and problem solving 2," "numeracy and problem solving 1," "numeracy and problem solving 2," and "problem solving 1 and problem solving 2." The PIAAC data set contains plausible values (PV), which are computed based on the test results, as well as background information, such as sex and educational attainment (OECD, 2013c). Because sex, which is the variable of interest in our analysis, is used to impute the PVs, we do not rely on

PVs contained in the original data sets; instead, we calculate proficiency scores based on Item Response Theory (IRT) by ourselves, as described in detail in the next section.

Test results of problem solving in technology-rich environments are subject to potential sample selection bias, and therefore, we do not use this test section for our analysis. This section requires respondents to solve some problems using information and communications technology (ICT) devices; if a respondent does not have the basic ability to use a computer or if he/she refuses to use a computer, he/she skips this section[2]. In other words, all test takers for this section have sufficient ICT skills to tackle the questions. Furthermore, Cyprus, France, Italy, and Spain do not implement the problem-solving section. For this reason, we do not study the problem-solving section in this paper.

OECD proposes a new measure of skill mismatch as follows (OECD, 2013b, p. 172):

> The survey asked workers whether they feel they "have the skills to cope with more demanding duties than those they are required to perform in their current job" and whether they feel they "need further training in order to cope well with their present duties." To compute the OECD measure of skill mismatch, workers are classified as well-matched in a domain if their proficiency score in that domain is between the minimum and maximum scores observed among workers who answered "no" to both questions in the same occupation and country. Workers are over-skilled in a domain if their score is higher than the maximum score of self-reported well-matched workers, and they are under-skilled in a domain if their score is lower than the minimum score of self-reported well-matched workers.

We do not rely on this proposed mismatch measure, because we suspect that the way respondents answer the two subjective questions depends on self-confidence, and experimental studies demonstrate that males are more confident than females (Niederle and Vesterlund, 2011). The gender gaps in self-confidence may well differ across countries, and the difference could be correlated with labor-market outcomes, as well as institutions, including maternity leave policy.

[2]Literacy and numeracy test sections are also computer-based, but if a respondent refuses or is unable to use a computer, he/she takes the corresponding paper-based tests. OECD (2013c) suggests that the computer-based test and the paper-based test are comparable.

Thus, we instead depend on the questions regarding the frequency of skill use on the job to calculate the skill-use intensity index, as explained in the next section.

To simplify the analysis, we restrict the sample to prime age adults, those between 25 and 59 at the time of the survey, while the entire sample is used to estimate skill and skill-use indices. We exclude full-time students and those who are permanently disabled from the sample. Also, we exclude observations with missing values in the variables necessary for our analysis.

2.2 Calculation of skill and skill-use indices

Although the data set includes the PV for each skill, we do not use it, because it is imputed based on individual background variables, such as educational attainment, age, and gender, as well as skill-use intensity, in addition to the test results. We instead estimate the latent score of literacy and numeracy skills by using IRT. Since the IRT is not included in the usual economists' toolbox, we briefly explain the method. The way the latent score is calculated in IRT is different from our daily grading routine. In our usual examination grading, we determine the allotment of points to each question before grading. In contrast, IRT assigns the scores to each question depending on the "difficulty" and "discrimination" of each question, estimated from the test takers' response patterns.

The two-parameter logistic model of IRT specifies the probability as

$$\Pr(y_{ij} = 1 \mid a_j, b_j, \theta_i) \equiv \frac{\exp\left(a_j(\theta_i - b_j)\right)}{1 + \exp\left(a_j(\theta_i - b_j)\right)}, \tag{1}$$

where y_{ij} takes one if the respondent i correctly answers test item j and zero otherwise, and θ_i is the latent trait of respondent i. Each test item j is characterized by two parameters: a_j, the "discrimination" parameter of item j that captures the sensitivity of being correct to the ability; and b_j, which captures the "difficulty" that shifts the probability of being correct irrespective of the ability. This specification assumes that test items measure the unidimensional latent trait summarized by θ. We further assume that observed item responses are independent, conditional on the latent trait, θ_i, which is sometimes referred to as the local independence assumption. Each test item in the PIAAC is indeed designed to satisfy the local independence assumption.

Then, letting $y_i = (y_{i1}, \cdots, y_{iJ})$ and $B = (a_1, \cdots, a_J, b_1, \cdots, b_J)$, the conditional distribution for respondent i is denoted as

$$f(y_i \mid B, \theta_i) = \prod_{j=1}^{J} \left[\Pr(Y_{ij} = 1 \mid a_j, b_j, \theta_i)\right]^{y_{ij}} \left[1 - \Pr(Y_{ij} = 1 \mid a_j, b_j, \theta_i)\right]^{1-y_{ij}}. \tag{2}$$

Given the prior distribution of the latent trait, θ_i, which is assumed to be the standard normal, $\hat{B}$ is chosen so that it maximizes the log-likelihood,

$$\ln L(B) = \sum_{i=1}^{N} \ln L_i(B), \tag{3}$$

where

$$L_i(B) = \int f(y_i \mid B, \theta) dG(\theta). \tag{4}$$

Finally, the latent trait parameter, θ_i, is estimated using Bayes' theorem; its immediate application shows that the posterior distribution of the latent trait, θ_i, conditional on the estimated parameters and response patterns, is

$$f(\theta | y_i, \hat{B}) = \frac{\Pr(y_i, \theta, |\hat{B})}{\Pr(y_i \mid \hat{B})} = \frac{\Pr(y_i \mid \theta, \hat{B})\phi(\theta)}{\int \Pr(y_i \mid \theta, \hat{B})\phi(\theta) d\theta}. \tag{5}$$

Hence, the empirical Bayes mean (or posterior mean) of θ_i is

$$\tilde{\theta}_i = \int_{-\infty}^{\infty} \theta f(\theta \mid y_i, \hat{B}) d\theta. \tag{6}$$

Although the estimated skill indices have nearly zero means and one standard deviations, as expected from the assumption on their prior distributions, we normalize them, so that they each have exactly zero mean and one standard deviation. We do this to facilitate the interpretation, because the standard deviations of the raw empirical Bayes mean tend to be slightly less than one (about 0.9 in many cases). We use 49 test items for calculating $\tilde{\theta}_i$ for literacy and 49 test items for numeracy.

In addition to skill possession, respondents in the PIAAC report their skill use at work with

well-defined responses, which enable us to compute the latent traits for skill use. For example, they are asked "In your job, how often do you usually read directions or introductions?" for use of literacy skill, and "In your job, how often do you usually calculate prices, costs or budgets?" for use of numeracy skill. Respondents answer these questions using a five-point frequency scale: (1) Never, (2) Less than once a month, (3) Less than once a week but at least once a month, (4) At least once a week but not every day, or (5) Every day. There are 8 items for literacy use and 6 items for numeracy use. These responses are more objective than responses such as "often" and "rare," because the measurement units are well defined. Using this information, we apply the general partial credit model (GPCM, Muraki, 1992) to each set of skill-use items. The GPCM is an extension of the two-parameter logistic model to the polytomous items. Estimating the latent parameters of skill use with the GPCM, we obtain two skill-use indices for each respondent as empirical Bayes means of the posterior distribution of latent skill-use intensity; i.e., skill use of literacy and skill use of numeracy. For the same reason as those for the skill indices, these skill-use indices are normalized to have zero mean and one standard deviation.

Figure 1 summarizes gender differences in skill and skill use, where each point is the gender gap of skill or skill use and the bars indicate the 95% confidence intervals. Literacy scores are roughly same for both sexes, except for in five countries – Ireland, Korea, Netherlands, Norway, and Singapore – where women's scores are about 0.1 standard deviation lower than men's in statistically significant ways. In contrast, the gender gaps in literacy usage scores are significantly different across countries: Women use literacy more in Lithuania, Poland, and Slovenia, while they use it less in Japan, Korea, Netherlands, Norway, and Singapore. In terms of numeracy, women tend to score lower and use it less at work than men. From casual observation, gender gaps in skill use tend to be small or reversed in ex-communist countries, such as Lithuania, Poland, and Slovakia [3]. Indeed, de Haan (2012) documents that these countries induce females to participate in the labor market by providing opportunities for education and training, in order to meet the demand of labor-intensive industries under socialist regimes.

Significant international variation in gender skill usage gaps is notable, but the gender gaps in skill use in this figure should be interpreted with caution due to self-selection into the labor

[3]We define ex-communist countries as including Czech, Estonia, Lithuania, Poland, and Slovakia.

force. Skill use at work is asked only for market participants, and we should pay attention to the fact that non-participants do not use their skills in the labor force. Thus, we need to pay careful attention to the non-participants when we analyze the skill use in the labor market. In the further analysis, we treat that non-participants use their skill in the labor market less than the minimum score value among participants by definition.

Before conducting a detailed analysis using the skill and skill-use indices, we check to see whether these indices are correlated with each worker's productivity proxy variable. Figures 2 and 3 show the relationship between the occupation-average hourly wages and literacy skill and skill use in each country, where the size of the circles indicates the number of observations in each occupation. The sample is restricted to men to avoid possible selection biases. The figures demonstrate the positive correlation in all countries, suggesting that occupations with skilled workers or intensive skill use are associated with higher wages. Hence, our indices are confirmed to be correlated with productivity. While we justify our use of the skill-use index by claiming that wage may not be a pure measure of productivity because it may reflect factors such as taste-based discrimination, the demonstrated positive correlation between wages and skill and skill use assures that skill and skill-use measures carry substantive information correlated with labor market outcomes.

To further confirm the correlation of skill, skill use, and log hourly wages, we estimate the following equation using only men as the analysis sample:

$$\ln(wage)_{ij} = \beta^{s} Skill_{ij} + \beta^{su} SkillUse_{ij} + X_{ij}\beta^{x}_{j} + \lambda_{s(i),j} + u_{ij}, \tag{7}$$

where i and j indicate each individual and country; $Skill_{ij}$ and $SkillUse_{ij}$ are literacy or numeracy skill and its use; X_{ij} include age indicators, years of education, and dummy variables, indicating that the test language is the same as the respondent's native language and that parents are immigrants; and $\lambda_{s(i),j}$ is country-occupation fixed effects, with $s(i)$ indicating individual i's occupation in country j.

The estimates indicate, for example, that one-standard-deviation increases in literacy skill and skill use are associated with 5.2% and 10.6% increases in hourly wages, respectively,

unconditional on occupation (Table 2). These correlations remain significant after controlling for occupation, suggesting that a worker with high skill or intensive skill use tends to earn higher wages even within each occupation. These estimation results confirm that the skill and skill-use indices are correlated with wage: a proxy variable for productivity. This finding implies that gender gaps in skill and its use on the job are potentially important determinants of gender wage gaps.

In the following analysis, to avoid repetition of discussions on the analysis based on literacy and numeracy, we focus only on the analysis results based on literacy. We report the results from the analyses on numeracy skill in Appendix D; the relationships between numeracy skill use and parental leave are qualitatively similar to the relationships between literacy skill use and parental leave, though the relationships are less precisely estimated. The choice of literacy over numeracy is partially based on the concern that numeracy skill is acquired taking labor-market prospective into consideration. The usage of numeracy is arguably rather limited to market production, in comparison with the usage of literacy, which applies to both market and household production. As a result, women with high numeracy skill might differ from other women in unobserved ways, such as attitudes toward work (Guiso et al., 2008; Fryer and Levitt, 2010; Nollenberger et al., 2016). Furthermore, items to measure numeracy skill use do not seem to be as general as items to measure literacy skill use. See Appendix A for each skill-use item.

2.3 Parental leave policies

We collected parental leave policies in 2011 from relevant laws in each country, as well as the Working Conditions Laws Database of the International Labour Organization (ILO) and the OECD family database. See Appendix B for a full description of the data sources. While many countries distinguish maternity leave from parental leave as a compulsory one to protect a pregnant body, we define the duration of parental leave as the sum of maternity and parental leave durations in a particular country, with years as its unit of measurement.

Since parental leave policies have two functions, job protection and income compensation, we characterize three aspects of these policies: the duration of paid leave, the duration of

job protection, and the replacement rate for paid leave. In previous studies of cross-country comparison, Ruhm (1998) used the duration of paid leave as a measure, whereas Olivetti and Petrongolo (2017) used the duration of job protection as a measure. To calculate the replacement rate, some countries have an upper or lower ceiling, or a constant amount of benefits. In particular, when the benefits are flat amounts, we evaluate the replacement rate at the median income of females in the PIAAC sample[4]. As a succinct measure of paid leave length and replacement rate, we calculate the full-rate equivalent by multiplying the replacement rate with the duration, which is the same as the definition in the OECD family database[5]. We should note that the imputation of the replacement rate using the median female earnings causes a non-classical measurement error of the replacement rate; the imputed replacement rate is smaller than the actual rate among low earners, and it is larger than the actual rate among high earners. From among the 30 countries, we apply the imputation for 6 countries (Belgium, Czech Republic, Finland, Slovakia, Sweden and the UK), and thus the measurement error could be non-negligible. For this reason, we conduct the analyses using the replacement rate as supplemental evidence. Note that we exclude the paid leave that is available conditional on not using public childcare services.

Figure 4 summarizes the duration of parental leave of each country in 2011 based on three definitions: the paid parental-leave period, the job protection period, and the full-time equivalent paid leave period. We confirm sufficient variation of paid parental leave periods across countries. The ranking of the generosity of the paid-leave period does not change significantly, even after adjusting for the replacement rate, except for Slovakia, where the replacement rate is substantially lower than in other countries. Many countries give substantially long job protected maternity leaves that extend more than three years, but some of them give paid leave less than one year, such as Finland, France, and Spain. Given the somewhat independent variations of the paid parental leave duration and the job protected leave duration, we use both measures of parental leave in the following analysis.

[4]The calculation of the replacement rates in Sweden and the United Kingdom is exceptional. A part of parental leave benefits in Sweden is a flat amount, and it is evaluated by women's mean earnings, due to data availability. A part of the benefits in the United Kingdom has a ceiling. Since it is quite low, we evaluate that part by the female median earnings in the PIAAC sample. (See Appendix B.)

[5]When the replacement rates of maternity leave and parental leave are different, we first compute the full-rate equivalent for each type of leave, and then add them up.

2.4 Indices of social institutions

Since we implement cross-country comparisons that associate the length of parental leave and the women's skill utilization, the correlation may be driven by gender norms and other market institutions that affect both the policy and the outcome. Thus, we need to control for those institutions that are likely to be correlated with women's opportunities to utilize their skill and with parental leave policy. For this purpose, we construct a quantitative measure of the strength of traditional gender norms using internationally comparable social surveys and construct other quantitative indicators for social institutions, such as tax policy, child care policy, the strength of employment protection, and unionization rate. Furthermore, the level of development and industrial structure could affect both the policy and the outcome; to control for it, we use GDP per capita, a fraction of public sector employment, and a fraction of service sector employment.

Recent studies emphasize the importance of the effects of gender norms on women's labor-market participation and family formation (Fortin, 2005; Feyrer et al., 2008; Bertrand et al., 2016). Gender norms could well be correlated with parental leave policy, because these policies partially reflect voters' preference. Those voters with neutral gender norms may well support generous parental leave policies and help increase women's labor-force participation through a mechanism other than the parental leave policy. To address this problem, we defined an index for view toward traditional gender roles using the World Values Survey Wave 6 and the European Values Survey 2008, because gender norms could be correlated with parental leave policies, as well as women's labor-market outcomes. Both surveys asked "When jobs are scarce, should men have more right to a job than women?" with possible responses "Agree" (= 1), "Neither" (= 0) and "Disagree" (= −1). We defined the index as the average of individual responses. See Appendix C for summary statistics for these indices.

To control for the tax policy that affects married couples' joint labor supply decision, we adopt the tax penalty for an equal dual-earner couple over a single-earner couple, who together earn 200% of the average single earner before taxes. The size of penalty depends on the progressiveness of the tax system and whether the tax is levied on individual or family; each

type of couples pay the same tax amount if the tax rate is flat and the taxation unit is individual.[6] Other institution-related variables include childcare-center enrollment rate for children aged 0–2, strictness of employment protection legislation, union density, GDP per capita, a fraction of the public sector, and a fraction of the service sector. The last two indicators were calculated using the PIAAC, while the other indicators were from the OECD database and of values in 2011 for the PIAAC Round 1 countries and in 2012 for Round 2 countries. Throughout the analyses, the indicators of social institutions and norms are demeaned for interpretation, and each skill and skill-use index is normalized to make its mean zero and standard deviation one.

3 Parental leave and women's skill utilization

Our main goal is to unpack the relationship between under-utilization of women's skills and parental leave policy, conditional on the current skill level, and to distinguish it from other social institutions and social norms. In particular, our main focus is on women's skill utilization. Although many studies have focused on the effect of parental leave policies on women's labor-force participation after child bearing, they are rather silent on how the characteristics of women's jobs are affected. Even if women participate in the labor force thanks to parental leave, they may be assigned to less skill-demanding jobs than men, given their skill. While Ruhm (1998) examine the impact of maternity leave on wage and find a negative impact on female wage, the finding does not necessarily imply that women are placed in a less demanding career track, because the increase of the female labor supply suppresses women's wage if men and women are not perfect substitutes. Furthermore, the cost of providing a generous maternity leave may be shifted on women's wage. Thus directly looking at skill-use intensity on the job is crucial to examine whether generous maternity leave provision unintentionally generates a "mommy" track.

Another feature of our study is that we investigate the impact on the entire female population without restricting it to those who are directly affected by the policy. As a result, we would

[6]Since the characteristics of the tax system depend on the levels of earnings, the OECD evaluates it at 133% and 200% of mean earnings of a single household. Although we employed the index evaluated at 200%, the differences associated with this choice are minor and the qualitative argument was unaffected.

obtain a mixture of direct and indirect impacts. Indirect impacts, for example, include statistical discrimination and substitution between women directly affected by the policy and other women. Although our identification strategy is weaker than those in studies with natural experiments (Lalive and Zweimüller, 2009; Schönberg and Ludsteck, 2014; Dahl et al., 2016), it is difficult to capture indirect impacts by such clear-cut identification strategies, because those who are not directly affected by the policy change are affected by the policy change through indirect effects. This study is the first step toward understanding the association between women's skill-utilization and parental leave policy.

3.1 Country by country analysis

As a step to document the gender differences in skill utilization at the extensive margin, we examine the gender difference in employment rate by skill level. We define those who engage in paid work or unpaid work for their own business in the week prior to the interview as those who are in employment; we also define those who are away from their job but will return, including those who are on parental leave, as those who are in employment. Figure 5 illustrates the employment rates by literacy skill score at each literacy test score. Remember that the literacy test score is calculated by the IRT method, pooling both genders by each country, and thus men's and women's literacy scores are comparable within a county. There are generally positive correlations between literacy test scores and employment rates across countries, except for in a few cases; the higher the literacy score, the higher the employment rate. As a whole, men's employment rates are higher than women's employment rates at a given literacy score, but the sizes of the gender gaps vary across countries. The gaps are smaller in Scandinavian countries, such as Denmark, Finland, Norway and Sweden, while the gaps are significant in southern European and Asian countries, such as Greece, Italy, Japan, Korea, Singapore and Turkey. In addition, the slopes of female labor-force participation profiles have some variation across countries. In some Northern European countries, such as Belgium, Denmark, and Sweden, skilled women are more likely to participate in the labor force than non-skilled women. In contrast, we do not find this tendency in Asian countries, especially in Japan and Korea.

We now repeat the same exercise focusing on the intensive margin; we examine the gender difference in literacy use by skill level among those who work. Figure 6 draws the relationship between skill and its use among labor-force participants. Note that both the literacy score on the horizontal axis and the literacy-use score on the vertical axis are calculated based on IRT and have zero mean and one standard deviation. Thus if workers and jobs are matched assortatively based on only literacy skill and its requirement on the job, we should observe 45 degree lines for all countries. In reality, the literacy scores and utilization scores are positively associated, but the slope is less than unity. Women's skill-use is less intensive than men's at each skill level in most countries, with ex-communist countries, such as Lithuania and Poland, as exceptions. The size of gender gaps in skill-use varies significantly across countries; for instance, the gaps are large in Austria, Chile, Japan, Norway, and Singapore. The slopes are upward, indicating that those who have high skill levels tend to use their skill more frequently, but the literacy-use/literacy gradients differ across genders in some countries. Hence, we study how parental leave policies explain gender differences in the intercepts and the gradients.

The analysis of the relationships between literacy and employment/literacy use conditional on employment shows that the international differences in gender gaps in skill use can be succinctly captured by two parameters: gender gaps in the intercept and the skill/skill use slope. We employ the Tobit estimation method to capture the both extensive and intensive margins in a comprehensive way to estimate the intercept and slope parameters. Given that individuals not working use no skills for market production, their skill-use scores are presumably lower than the lowest values observed among those in labor force. In other words, the skill-use indices are left-censored, where the threshold varies across countries. Since the Tobit method takes into account non-utilized skill due to non-participation as well as skill use within the market, it captures the effects of both intensive and extensive margins.

Specifically, we handle the left-censoring problem regarding actual skill use by estimating

the following censored Tobit model for each country j:

$$y_i^* = \alpha_j Female_i + \beta_j Female_i \times Skill_i + \gamma_j Skill_i + x_i'\delta_j + c_j + u_i, \tag{8}$$

$$y_i = \begin{cases} y_i^* & \text{if} \quad y_i^* > y_j^L, \\ y_j^L & \text{if} \quad y_i^* \leq y_j^L, \end{cases} \qquad u_i \mid \tilde{x}_i, c_j \sim N(0, \sigma_j^2), \tag{9}$$

where x_i is the collection of explanatory variables that include age indicators, years of education, and dummy variables indicating that the test language was the same as the native language of the respondent, or that the parents were immigrants, and $\tilde{x} = (x, Female, Skill)$. In this model, α_j is baseline gender gaps in each skill-use score at at mean skill level (i.e., $Skill_i = 0$) in country j, while β_j is gender gaps in literacy/literacy-use gradients in country j. We estimate the intercept α_j and the slope β_j by estimating Tobit models for each country.

Now we proceed to systematically examine the association between paid leave and women's skill use captured by the intercept and slope parameters. Figure 7 demonstrates relationships between the estimates and the duration of paid parental leave, suggesting that gender gaps in literacy skill use tend to be small in countries with longer parental leaves. Gender gaps in literacy use/literacy gradients expand as the duration of paid parental leaves becomes longer, however. This implies that skilled women are likely to be assigned less skill-intensive jobs than their male counterparts. If we interpret the literacy-use intensity on the job as a measure of career advancement, this finding corroborates with the notion that generous parental leave hinders the career advancement of skilled women. We cannot say anything definitive, however, because the length of paid parental leave could be correlated with country-specific factors that determine the gender gaps in literacy-use intensity. Moreover, we do not test whether the relationship is statistically significant.

3.2 Pooled countries analysis

We then examine whether relationships observed in those figures still hold after removing correlations associated with other institutions and whether the relationships are statistically significant. To that end, we construct a model that assumes a specific dependence of cross-

country parameter heterogeneity on the length of parental leave and other institution indexes and estimate the model parameters using a data set that pools all individuals from the sample countries. Then, the skill-use score, y^*_{ij}, of individual i in country j is described as follows:

$$y^*_{ij} = \alpha_j Female_{ij} + \beta_j Female_{ij} \times Skill_{ij} + \gamma_j Skill_{ij} + x'_{ij}\delta_j + c_j + u_{ij}, \tag{10}$$

$$y_{ij} = \begin{cases} y^*_{ij} & \text{if} \quad y^*_{ij} > y^L_j, \\ y^L_j & \text{if} \quad y^*_{ij} \leq y^L_j, \end{cases} \qquad u_i \mid \tilde{x}_i, c_j \sim N(0, \sigma^2_j) \tag{11}$$

where x_{ij} includes age indicators, years of education, dummy variables indicating that the test language is the same as the native language of the respondent, or the parents are immigrants, and $\tilde{x} = (x, Female, Skill)$. The variance of the error term, u_{ij}, is allowed to be heterogeneous across countries. The country-specific coefficients, $\alpha_j, \beta_j, \gamma_j$ are specified as the function of parental leave and other institutional characteristics of the country;

$$\alpha_j = \alpha_0 + \alpha_1(PL_j - \overline{PL}) + \alpha_2(Inst_j - \overline{Inst}) + \alpha_3 ExCommunist_j, \tag{12}$$

$$\beta_j = \beta_0 + \beta_1(PL_j - \overline{PL}) + \beta_2(Inst_j - \overline{Inst}) + \beta_3 ExCommunist_j, \tag{13}$$

$$\gamma_j = \gamma_0 + \gamma_1(PL_j - \overline{PL}) + \gamma_2(Inst_j - \overline{Inst}) + \gamma_3 ExCommunist_j, \tag{14}$$

where PL_j is the length of parental leave measured in three ways: paid leave length, job protection period, and the full replacement equivalent length, and $Inst$ is the vector of institutional variables. The dummy variable $ExCommunist_j$ indicates ex-communist countries. We use this dummy variable, because ex-communist countries may have social institutions different from those of other countries, as mentioned by de Haan (2012). To facilitate the interpretation, the length of parental leave is demeaned, so that α_0 indicates the gender gap of the intercept at a hypothetical country that has a mean length of parental leave (0.913 years for the paid leave length, 1.592 years for the job protection length, and 0.631 for the replacement rate $\times$ the length of parental leave). The parameter β_0 indicates the gender gap in skill-use/skill gradients evaluated at mean literacy skill score (i.e., $Skill = 0$) in the hypothetical country, with an average length of parental leave.

Since our sample is randomly sampled from each country, the error terms of the Tobit model above could be correlated among individuals in the same country because of unobservable factors common across individuals. Furthermore, misspecification regarding country-level variables would produce an error term common across individuals in a country. Thus, our model is potentially misspecified by failing to model the correlation of the error terms across individuals sampled from the same country, but the resulting estimator is regarded as a quasi-maximum likelihood estimator. Although the maximum likelihood estimator is inconsistent under misspecification, a quasi-maximum likelihood estimator has a favorable property to minimize the Kullback-Leibler information criterion, as suggested by White (1982). Because this information criterion indicates the degree of misspecification, the quasi-maximum likelihood estimation chooses the "best" one from the family of postulated quasi-likelihood functions. In this sense, we believe that our estimate well approximates reality. From this perspective, the standard errors are clustered by each country throughout the analysis, including the subsequent sections.

Panel A in Table 3 shows the estimation results of the Tobit model consisting of equations (10) and (11), using the length of paid leave as the measurement of parental leave length. As expected from Figure 6, skill use and skill are positively correlated, the estimates indicate that a one-standard deviation increase in male literacy skill raises the level of the corresponding skill use by 0.1 standard deviation. Judging from the near-zero statistically insignificant estimated coefficient for the interaction term of $Female$ and $Skill$, the association of skill use and skill is almost identical between men and women in a country with average parental leave length. This finding is consistent with the null long-run effect on labor-market outcomes, such as employment or earnings, as found by Dahl et al. (2016), Lalive et al. (2014), Lalive and Zweimüller (2009), and Schönberg and Ludsteck (2014). Given that these studies evaluate some effects averaging over heterogeneous skill levels, it seems reasonable that we find a negligible effect on women with mean skill, though the parameters that they estimated are not identical to ours in a rigorous sense. The estimated coefficient for the interaction term of skill and paid leave indicates that the association of skill use and skill are stronger among men in countries with longer paid leave. In contrast, the estimated coefficient for $Female \times Skill \times (PL - \overline{PL})$ implies that a woman with higher skill (i.e. $Skill > 0$) uses her literacy skill less frequently than a man does in a

country with a one-year-longer paid leave. These findings suggest that longer-paid leave makes literacy-use and literacy-score matching less assortative among women than among men.

We now add a caveat on our measure of skill use. Conceptually, the skill-use/skill gradient would be one if job allocation were completely assortative along with our skill-use/skill measures, such that the most able individual engages in the job with the most intensive skill use, and the second most able individual does the job with the second-most intensive skill use, and so on. Nevertheless, our estimates are far from one, suggesting incomplete assortative matching. We suspect that the flatter slopes are due to other skill dimensions not captured by literacy use on the job and literacy score; these other skill dimensions include motor skill, non-cognitive skill, and other firms-specific skills. It is natural to think that worker-job matching is formed based on these multiple dimension of skills. Hence, our discussion about the under-utilization of women's skill should be interpreted in terms of a limited measurement of cognitive abilities, which is literacy. However, unless other skill dimensions are dominantly more important in literacy-use and literacy-score matching among women than among men in countries providing longer parental leave, our estimation result is consistent with the notion that longer parental leave hinders the career advancement of skilled women.

The basic result reported in Column 1 is robust to controlling for the tax system, the childcare center enrollment rate, gender norms, other labor-market institutions and sector composition (Columns 2 through 4). We furthermore try a flexible specification that allows for country fixed effects that are interacted with literacy score and the female dummy variable. This flexible specification allows for country-specific literacy use / literacy score gradients and female-specific intercepts across countries. The country fixed-effects estimation results reported in Column 5 are virtually identical to the estimation results reported in Column 4, suggesting that the longer parental leave period flattens the literacy-use/literacy-score gradient for women.

To facilitate the interpretation of the estimation result, we implement a counterfactual simulation, using the estimates reported in Column 4 of Table 3. Specifically, we exogenously change the duration of paid leave, fixing the distribution of other variables to be constant, and examine gender skill-use difference under each duration of paid leave. Let $Y_g(s, x; d)$ be the level of skill use of a person with gender g, skill s, and characteristics x, under parental leave policy d. We

define the gender skill-use gap as the difference in the mean skill use of men and women at each skill level:

$$Gap(s;d) = E_X\left[Y_m(S,X;D) - Y_f(S,X;D) \mid S = s, D = d\right]. \tag{15}$$

As shown in Figure 8, we find that generous paid leave policies have a severe impact on the gender skill-use gap at the upper quantile of the skill distribution. Without the paid leave policy, the average gender gap is almost between 0.4–0.5 standard deviation across the skill distribution. Under the two years of paid leave policy, however, the gender gap had a steep positive slope; the gap is round 0.35 standard deviation at the -1.5 standardized literacy score, but the gap is around 0.80 at the 1.5 standardized literacy score. The counterfactual simulation demonstrates that generous parental leave policies could suppress the skill utilization of skilled women.

A long duration of paid leave seems to have heterogeneous impacts among women who would otherwise be away from the labor force due to childbearing and women who would remain in the labor force regardless of the parental leave provision (Olivetti and Petrongolo, 2017). We summarize that paid parental leave has at least three effects on women's skill utilization. First, job protection provided by parental leave allows women who would otherwise drop out from the labor force to continue working. Second, women's skills gradually depreciate during a long period of leave. Third, potential parental leaves for a long period presumably encourage employers to statistically discriminate against females. Note that women can avoid human capital depreciation by returning to their jobs early, but they do not have good control over the employers' statistical discrimination if women cannot send credible signal to their employers. Each one of these three factors arguably has heterogeneous impacts across skill levels. Job protection provided by parental leave is likely to work for unskilled women, who generally have weaker labor force attachment, while depreciation of skills and statistical discrimination are presumably more relevant for skilled women, particularly because they would otherwise enjoy higher job posts and be offered more opportunities for job training. We speculate that the effects of generous paid parental leave systems on women's skill use are a mixture of these factors, and as a result, gender gaps in skill use become serious at upper skill levels under the longer paid

parental leave, as the human capital depreciation and statistical discrimination effects dominate the job protection effect. Note that statistical discrimination can explain the negligible impact on women with mean skills. Since employers make their decisions according to women's average behavior, women with mean skills are unlikely to be discriminated against. In short, a long duration of parental leave does not necessarily favor skilled women.

This explanation is in line with Albrecht et al. (2003) and Albrecht et al. (2015), who found that the so-called glass ceiling faced by women in Sweden (and other Scandinavian countries) can be attributed to statistical discrimination originating from the generous parental leave system. That is, women may be treated similarly to men up to a certain point, but their market opportunities exceeding that point are limited. In our context, the glass ceiling takes the form of growing gender gaps in skill use across skill levels, represented by the negative estimate of the effect on the marginal effect of women's skill (i.e., the coefficient of $Female \times Skill \times (PL - \overline{PL})$). To sum up, despite its policy intention, a generous parental leave system cannot be a panacea for gender integration into the market, as it makes a barrier that blocks skilled women from getting the jobs for which they are well qualified.

3.3 Other parental leave measures

As discussed in the data section, we construct three measures to quantify the generosity of parental leave: the duration of paid leave, the duration of job protection, and the duration of paid leave adjusted for the replacement rate. So far, we discussed the result based on the duration of paid leave as a measure of parental leave. We now analyze how sensitive the estimation results are when we use the alternative measurements of parental leave. Panel B of Table 3 reports the results based on the duration of job protection, and Panel C of the same table reports the results based on the replacement. While we estimate the exact same model, we only report the estimated coefficients for $Female \times Skill \times (PL - \overline{PL})$ and $Female \times (PL - \overline{PL})$ for the sake of saving space, because other coefficients are similar to the ones reported in Panel A.

The results reported so far hold qualitatively even when we use alternative measures of the generosity of parental leave; generous parental leave provision narrows the gender gap in

literacy usage, but the impact is less pronounced among high-skilled women, as represented by the negative coefficient for $Female \times Skill \times (PL - \overline{PL})$ and the positive coefficient for $Female \times (PL - \overline{PL})$ in Panels B and C. In terms of a baseline impact of job protection and the full-rate equivalent on women's skill use (i.e., coefficient of $Female \times (PL - \overline{PL})$), we find some positive impacts, but they became null after controlling for some institutions. In particular, the estimates lose statistical and economic significance when we partial out the correlation through the labor-market characteristics of each country. In comparison with the result based on the paid parental leave period, we generally find weaker association between parental leave and female skill use when we use the duration of job protection, as reported in Panel B. In contrast, we find a greater association when we use the full-rate equivalent, which is defined as the duration of paid leave × replacement rate, as reported in Panel C. These two results are presumably explained by the difference in the take-up rates; the take-up rates of parental leave are likely to be affected by the amount of benefits received during the leave. Women are less likely to take a long leave if the leave is not covered by pay, while they are more likely to take it if the leave is well compensated; then lower take-up rates weaken the association between parental leave and women's skill use, while higher take-up rates strengthen the association. In addition to this mechanical relationship, the difference in the take-up rates affects the formation of employers' expectation on the length of parental leave taken by their employees in the future, because employees would be likely to exploit longer periods of parental leave when the leave benefits are large. As a result, statistical discrimination against highly skilled women could be more severe when the replacement rate is high. In sum, our results are robust against the use of alternative measures of maternity leave generosity, and the change of the results is what we would expect.

4 Other market outcomes

4.1 Hours worked

In the analysis heretofore, we used the skill-use score as the degree of skill-use intensity. We now document the effect of maternity leave on the gender gap in skill utilization based

alternative measures. One form of skill under-utilization of women is working short hours. In countries where ports of entry to full-time jobs are limited, women who quit primary jobs around childbearing can only find part-time jobs when they come back to the labor market. Thus, longer parental leave enables women to stay in full-time jobs before and after their childbearing. At the same time, however, longer parental leave depreciates women's human capital or creates statistical discrimination against women and subsequently puts women on "mommy track" jobs that require short-hour commitments. Therefore, longer parental leave could affect the hours worked by women either positively or negatively.

To assess the impact of parental leave on the gender gaps in hours worked, we use hours worked in place of literacy-use score to estimate the previous models. The PIAAC asks for usual weekly hours worked, including overtime, and the female mass with zero working hours is taken care by the Tobit model specified as equations (10) and (11), with the cutoff point at zero and the same error variance across countries. In addition, we implement the OLS estimation admitting zero hours worked. Since the results are qualitatively the same, we report only the estimation result from the Tobit estimation.

The estimation results from the Tobit model using the length of paid leave are reported in Panel A of Table 4. Column 4 reports the results after controlling for international differences in the tax system, gender norms, labor market institutions, and industry composition of workers. According to this result, workers with high literacy scores work shorter hours: A one-standard-deviation increase in the literacy score reduces hours worked by 0.1 hours per week. While the estimated impact is small, the result is understandable as a result of the income effect. Women work about 13 hours less per week than men at the mean literacy score, but this gender gap narrows among high-skilled workers; the gender gap narrows by 1.2 hours when the literacy score increases by one standard deviation. Longer paid parental leave is positively associated with longer hours worked among women, but the impact is much less pronounced among women with high literacy scores, because a longer paid leave period flattens hours/skill gradient. While the women's skill slope is positive at baseline at the average length of paid leave, it turns negative at 1 year of duration of paid leaves, potentially suggesting the under-utilization of skilled women. Thus, under longer parental leaves, skilled women tend to work shorter hours than unskilled

women.

These observations are robust to alternative specifications (Columns 2 through 5) and different measures of parental leaves (Panels B and C). Furthermore, the signs for the estimated coefficient of $Female \times Skill \times (PL - \overline{PL})$ are same as the signs from the skill-use equation (Table 3), implying that the amount of leave benefits is an important determinant of the association between parental leave policy and women's skill use. Overall, our findings based on hours worked as a skill utilization measure reinforces our previous conclusion that longer parental leave suppresses the skill use of high-skilled women and widens the gender gap of skill use among high-skilled people.

4.2 Wage rates

An initial motivation for this project was to assess if a longer parental leave period hinders the career advancement of women speculated from the wider gender wage gap in Sweden at the top end of wage distribution by Albrecht et al. (2003) and Albrecht et al. (2015). Thus looking at wages as an outcome measure is a natural choice, and we estimate a wage equation to further confirm our findings by using the Heckman sample selection correction method to handle the endogenous sample selection into the labor force. Specifically, the empirical model is

$$y_{ij} = x'_{ij}\beta_j + u_{ij}, \tag{16}$$

and y_{ij} is observed if

$$x'_{ij}\delta_j + v_{ij} > 0, \tag{17}$$

where y_{ij} is the dependent variable, which is the natural logarithm of hourly wages[7]; x_{ij} is a collection of explanatory variables; the error terms are assumed to follow a multivariate normal distribution, conditional on the explanatory variables; and β_j's and δ_j's are specified as the function of the length of parental leave and the dummy variable indicating a post-communist country, as in equations (12) through (14). Unfortunately, we did not have any variables that do

[7]As done by Hanushek et al. (2015), we censor the top and bottom 1% of wages in each country to alleviate the influences of outliers.

not affect the skill-use score while affecting labor-force participation, and thus, the identification relies solely on the functional form assumption, or equivalently, non-linearity in the inverse Mill's ratio. Thus this should be understood as a supplementary analysis to the analysis based on the skill-use score.

In Panel A of Table 5, we find that men with higher literacy scores earn more; those with one standard deviation higher literacy score earn about 5% more. Women, on average, earn about 20 % less than men. There is no gender gap in the wage/skill gradients, and longer parental leave does not reduce women's wage relative to men's. Most importantly, we find that a long duration of paid leaves is associated with a flatter slope of women's wage-skill profile, and the size of the estimate is not negligible. This finding is consistent with our main finding based on skill-use score. A long duration of paid leave policy suppresses women's skill use in the workplace, thereby resulting in lower wage than that of men with the same skill level. In this respect, our findings seem to support the conjecture by Albrecht et al. (2003) and Albrecht et al. (2015) that the glass ceiling in Sweden is partly caused by its generous parental leave policy. It is also possible that the depreciation of skills during leave periods is more serious for skilled women than for unskilled women. We note, however, that the negative association between parental leave policy and the wage of skilled women disappears when we uses the duration of job protection instead of the duration of paid leave, as reported in Panel B. In terms of the full-rate equivalent, the relationship is not statistically significant in most specifications, but we still find a negative sign, and the size of the estimate is compatible with the estimate obtained using paid leaves, as reported in Panel C.

All in all, generous parental leave policies tend to be negatively associated with labor-market outcomes of skilled women, and thus, our findings provide suggestive evidence that generous parental leave policies have heterogeneous impacts across women's skill levels. Such policies basically work for unskilled women but against skilled women. Consequently, such policies may not be a quick remedy to utilize women's highly accumulated human capital.

5 Discussion

This paper has several caveats that warrant discussion. First of all, the range of skill captured by our measure is limited, in that we ignore some other dimensions, such as non-cognitive skills and firm-specific skills, as already discussed in the data section. Since information about these kinds of skills is unavailable, this issue is not addressed in this paper. Although it is difficult to measure levels of utilization of such skills, as well as to measure skill levels, they may play crucial roles in market production. Therefore, the results reported in this paper should be interpreted as the first step toward a systematic investigation.

Second, cognitive skill could well be used for domestic production and childcare, but we do not address this skill usage. In particular, skilled women out of the labor force might exploit their skills to educate their children more intensively than women in the labor force. In such cases, the analysis focusing only on skill use in the market is limited. In fact, some studies, such as Carneiro et al. (2015), find a substantial impact, but other studies find almost no impact of parental leave policy on child outcomes (Baker and Milligan, 2010; Dustmann and Schönberg, 2012). In addition to a lack of consensus of the average effect of the parental leave policy on children, its effect might be heterogeneous across parental skill, as skilled parents may spend their time during parental leaves with children effectively, in terms of child development. Thus, further research is necessary.

While the PIAAC carries the skill-use measure at home in addition to the skill-use measure at work, we do not use it, because distinguishing skill use for leisure and domestic production is difficult. For example, a respondent is asked how often he/she reads a book at home, but the objective of this activity is unclear, namely, whether the reading is for leisure or for the education of his/her child. For these reasons, the findings in this paper are interpreted in terms of cognitive skill use at work, but we dare not extend our findings to a more general context about skill use.

Finally, an alternative explanation for our findings on the under-utilization of women's skill is under-reporting of skill use by female respondents, especially under traditional gender norms. Although we cannot negate this possibility, our results are unlikely to be driven by such misreporting behavior for several reasons. First, the PIAAC employs objective units of

measurement for skill use. If respondents subjectively report their skill use as "often" or "rare," for example, gender norms could possibly induce misreporting. As mentioned in Section 2.2, however, respondents chose one from among a set of well-defined alternatives: (1) Never, (2) Less than once a month, (3) Less than once a week but at least once a month, (4) At least once a week but not every day, or (5) Every day. The measurement unit is presumably objective, and thus, gender norms or other institutions are less likely to be a source of gender differences in the reported frequency. Furthermore, there exist few reasons why skilled women would understate their skill use, say, under a generous parental leave system. One concern is the correlation between the duration of paid parental leaves and traditional gender norms, which may be the most plausible candidate of a source of misreporting behavior, but the correlation was almost zero. To sum up the foregoing discussion, we believe that our findings on the under-utilization of women's skill are not artifacts of the underreporting of women's skill use.

6 Conclusion

This paper investigates the determinants of gender gaps in skill utilization across countries, drawing on the PIAAC, which contains objective measurements of skill and skill use at work. Merging internationally comparable data on the length of parental leave, we quantitatively document that longer parental leave promotes women's skill use on the job among less-skilled women but suppresses that among high-skilled women. This finding is robust to the change in the measurement of parental leave, controlling for international differences in traditional gender norms, labor-market institutions, and industry composition, and allowing for country fixed effects. A systematic international comparison confirms that generous parental leave suppresses high-skill women's skill use in the labor market, contrary to policy makers' intention, as pointed out by Albrecht et al. (2003) and Albrecht et al. (2015).

Our analysis examines skill use, given the skills of each individual. The length of parental leave, however, may affect the gender gap in skill formation through affecting women's career plans and changing the effective return to skill investment. Thus, analyzing the impacts of parental leave on skill formation would be valuable future research. In the investigation, skill

use in household production would play an important role, because our analysis did not explain why women acquire skills despite their less intensive use of them in the labor market in some countries.

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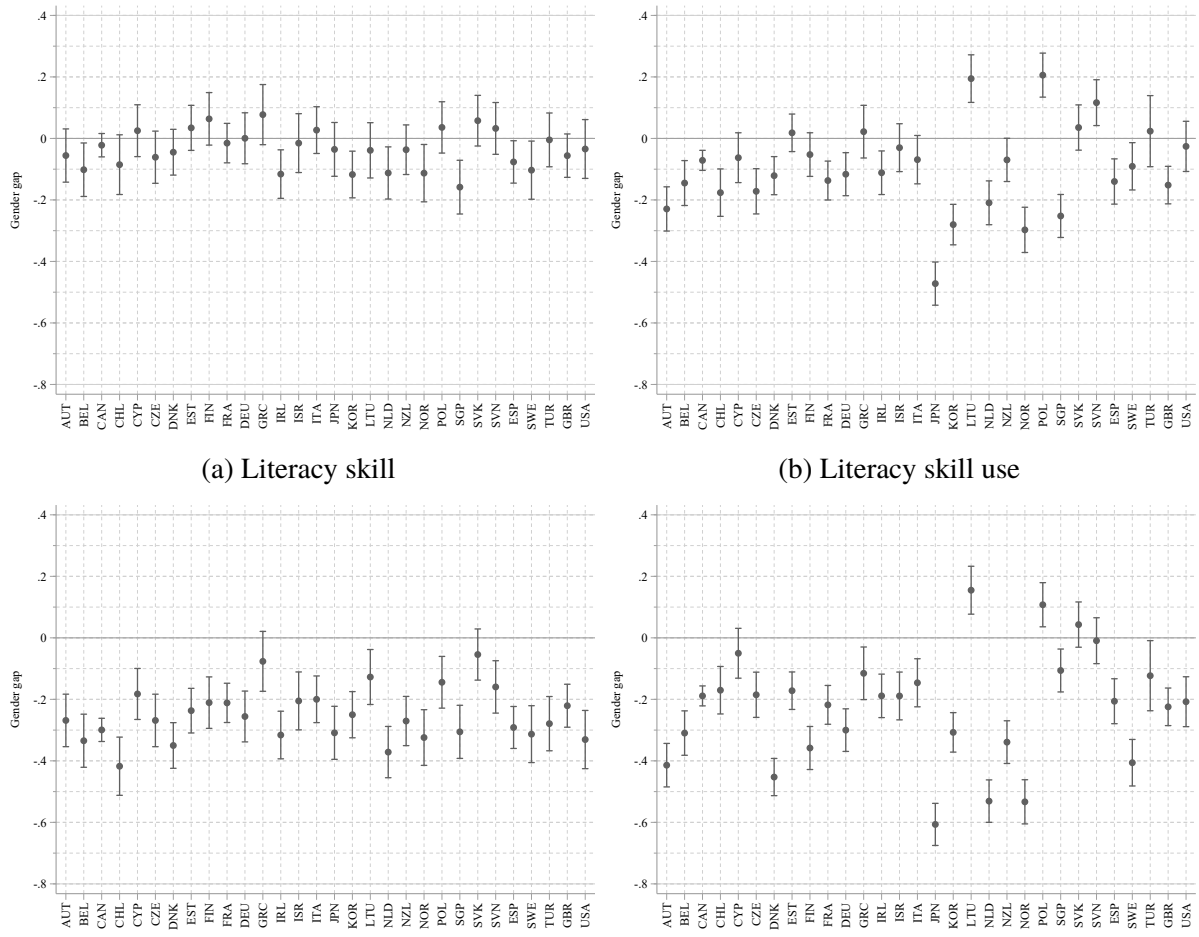


(a) Literacy skill

(b) Literacy skill use

(c) Numeracy skill

(d) Numeracy skill use

Figure 1: Gender gaps in skill and skill use

Note: This figure shows unconditional gender gaps in skill and skill use. Each point represents the gender gap, and the bars indicate its 95% confidential interval.

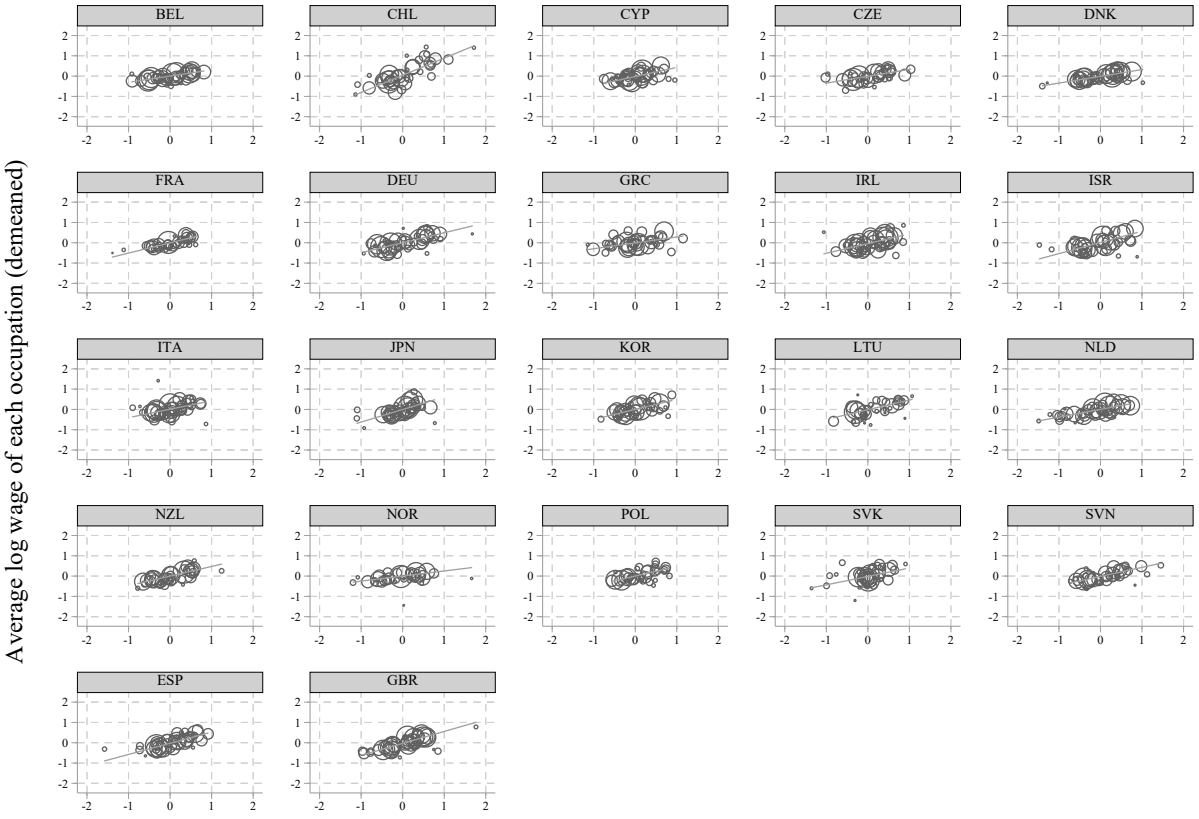


Figure 2: Occupation-average wage rates and literacy skill

Note: This figure shows the correlation between occupation-average wage rates and average literacy skill. The size of each circle indicates the number of observations engaging in each occupation. The line is the fitted value by the weighted least squares, where the number of observations in each occupation is used as a weight.

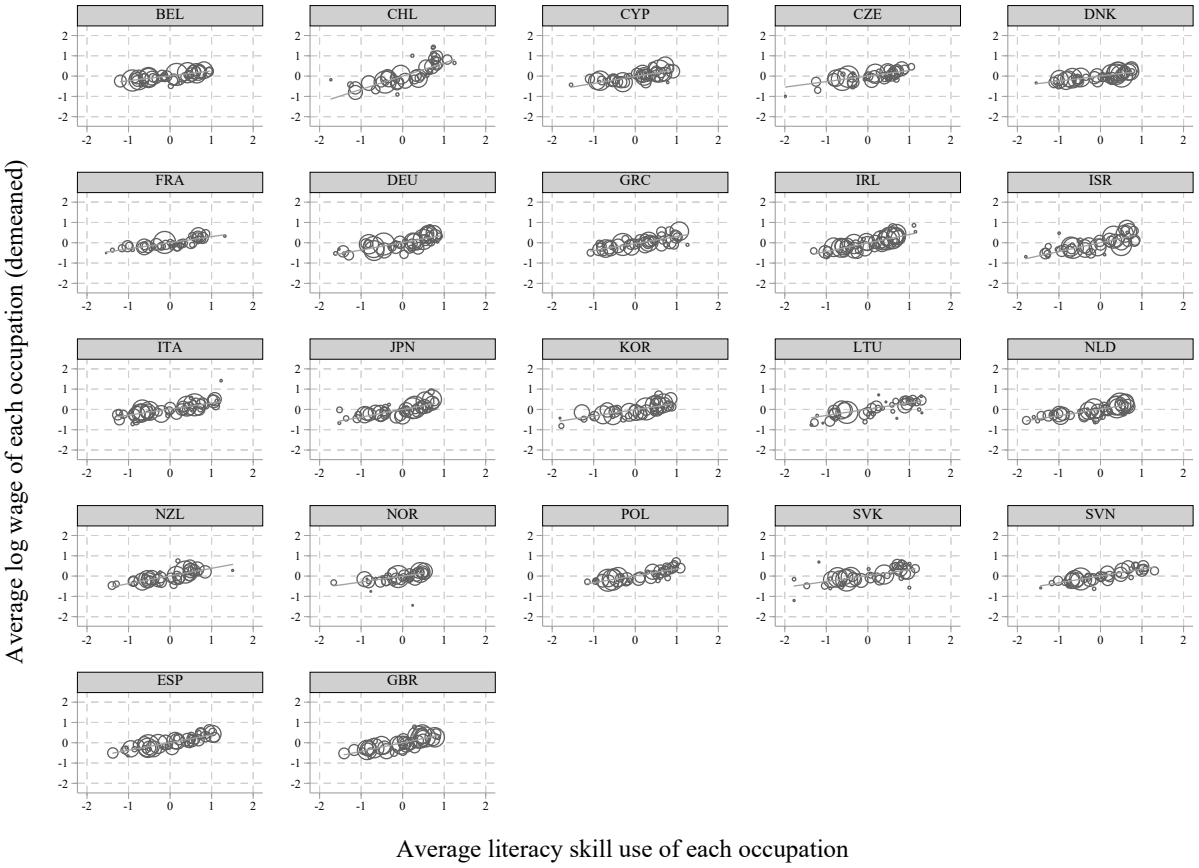
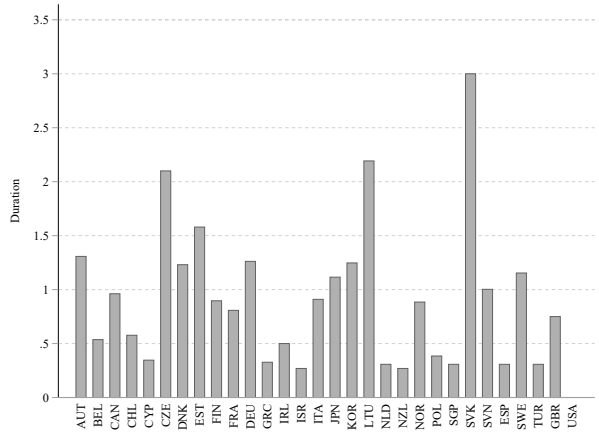
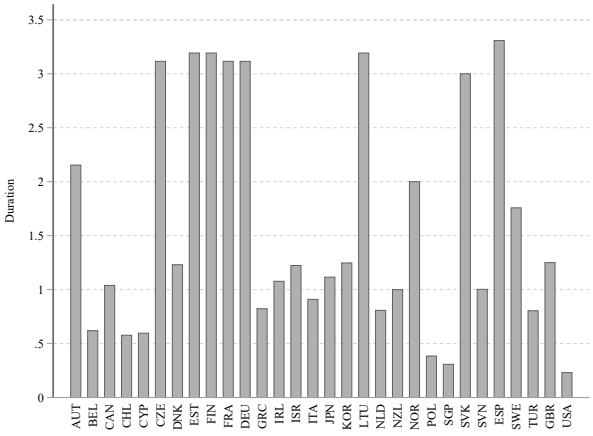


Figure 3: Occupation-average wage rates and literacy skill use

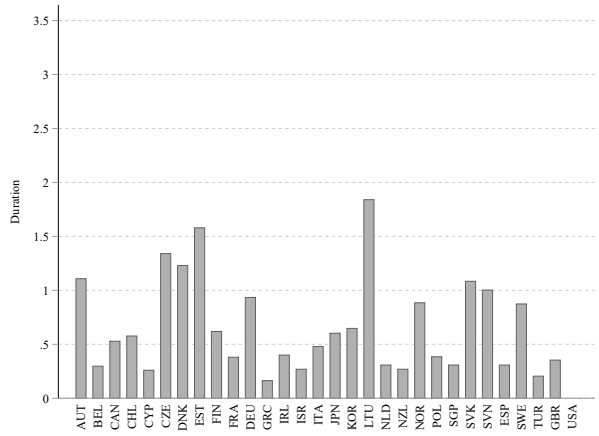
Note: This figure shows the correlation between occupation-average wage rates and average literacy skill use. The size of each circle indicates the number of observations engaging in each occupation. The line is the fitted value by the weighted least squares, where the number of observations in each occupation is used as a weight.



(a) Paid parental leave in 2011



(b) Job protection in 2011



(c) Full-rate equivalent in 2011

Figure 4: Summary of parental leave policies

Data source: The Working Conditions Laws Database of the ILO and the OECD family database. See Appendix B for a full description of the data sources.

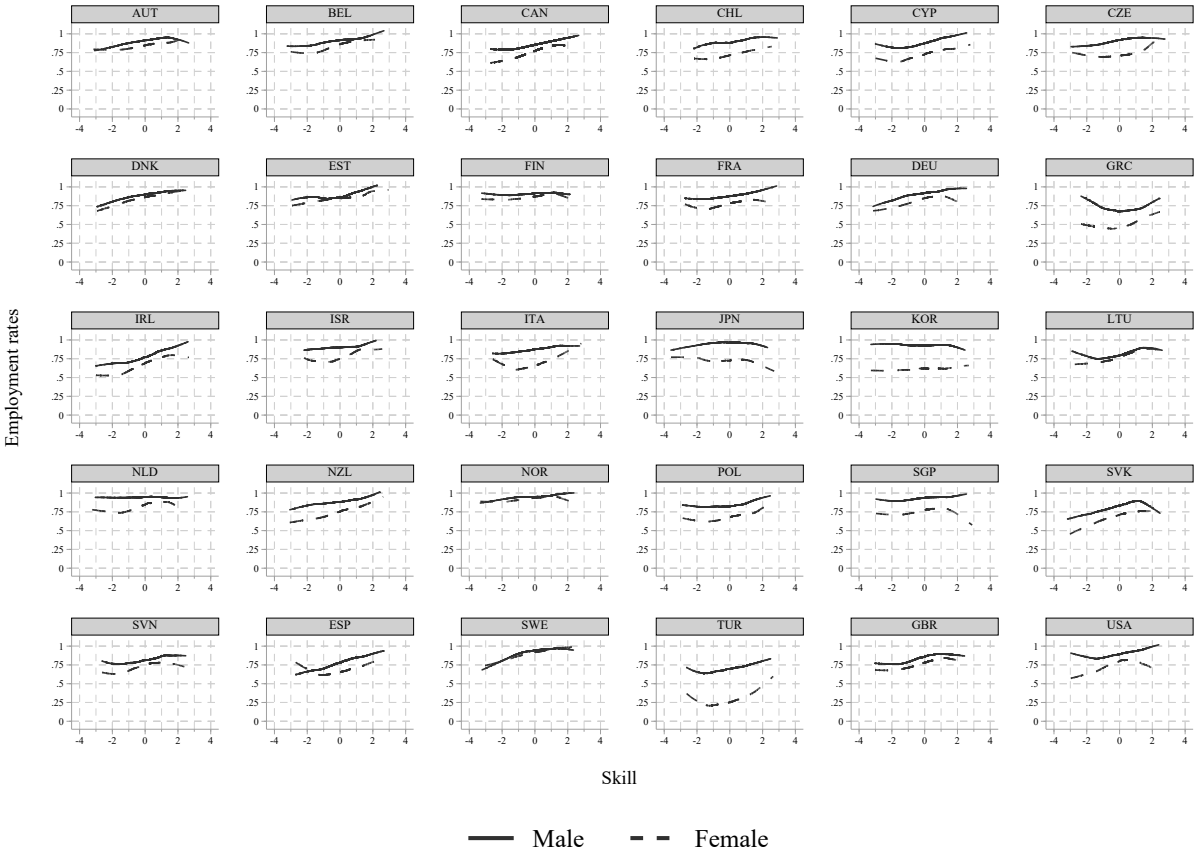


Figure 5: Employment rates at each literacy skill level

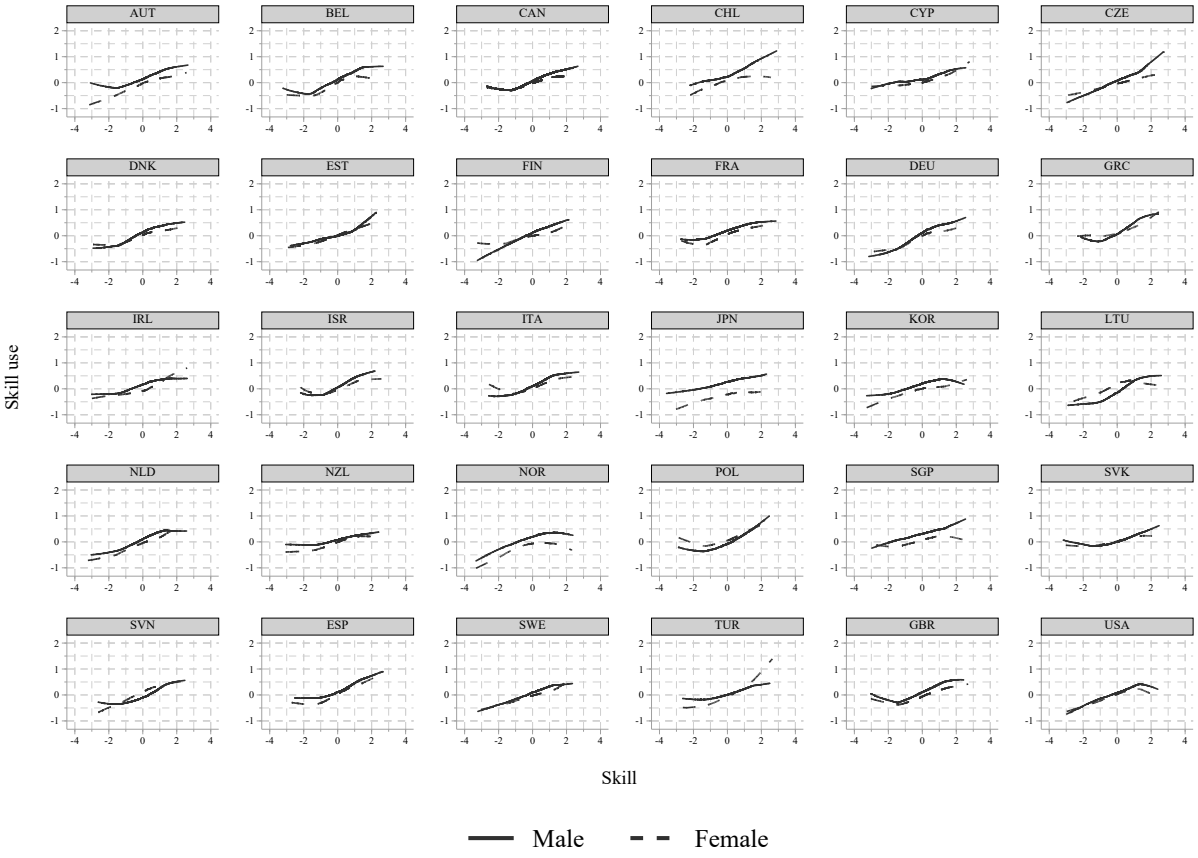
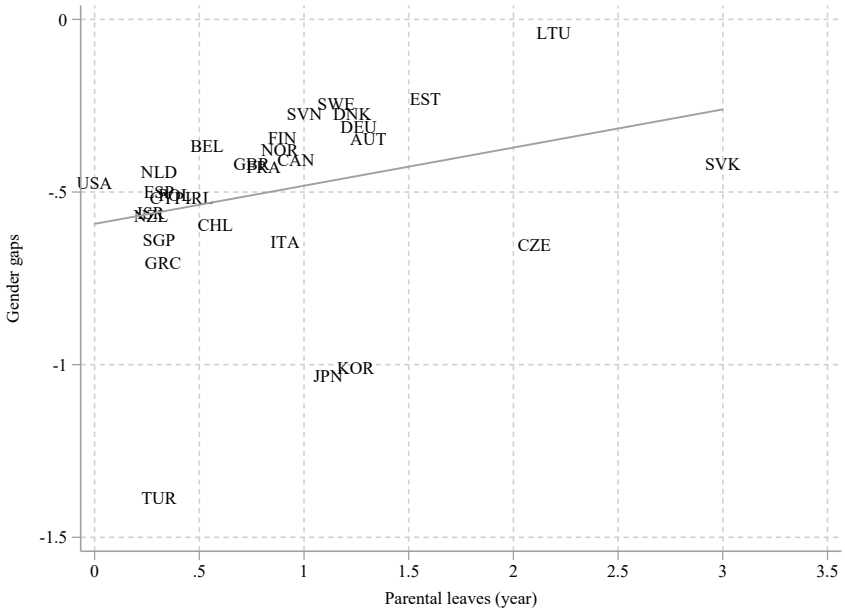
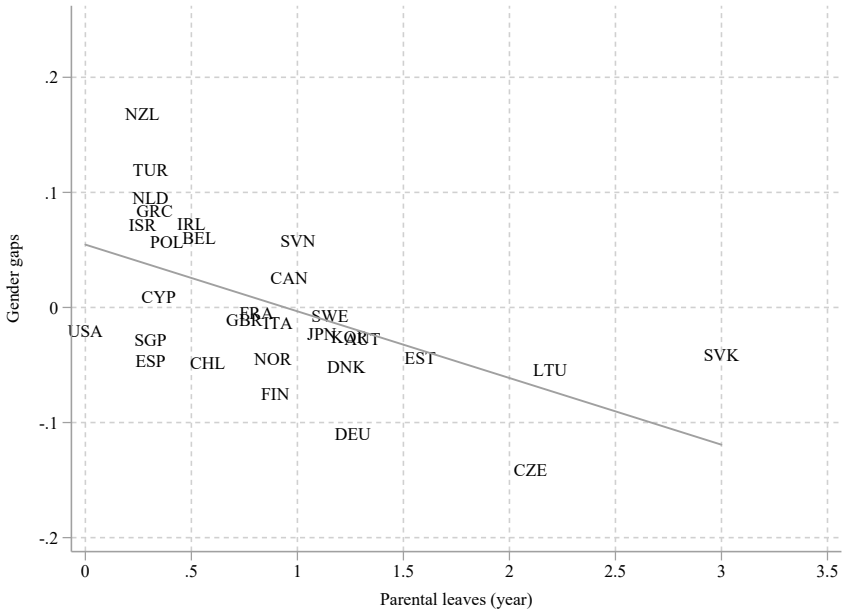


Figure 6: Skill use and skill within labor-force participants (Literacy)



(a) Gender gaps of literacy use at literacy score = 0 in country j, $\hat{\alpha}_j$



(b) Gender gaps of literacy/literacy-use gradients in country j, $\hat{\beta}_j$

Figure 7: Literacy skill use and paid leave

Note: This figure shows relationship between parental leaves and the estimates of coefficients on $Female$ and $Female \times Skill$ from the skill-use equation for each country. The estimates are obtained by estimating the censored Tobit model represented by equations (8) and (9) for each country. The explanatory variables used in estimation are the female dummy variable, literacy skill index, their interaction term, age indicators, years of education, and dummy variables indicating that the test language was the same as the native language of the respondent, or that the parents were immigrants. The line is the fitted value by the weighted least squares, where the number of observations in each country is used as a weight.

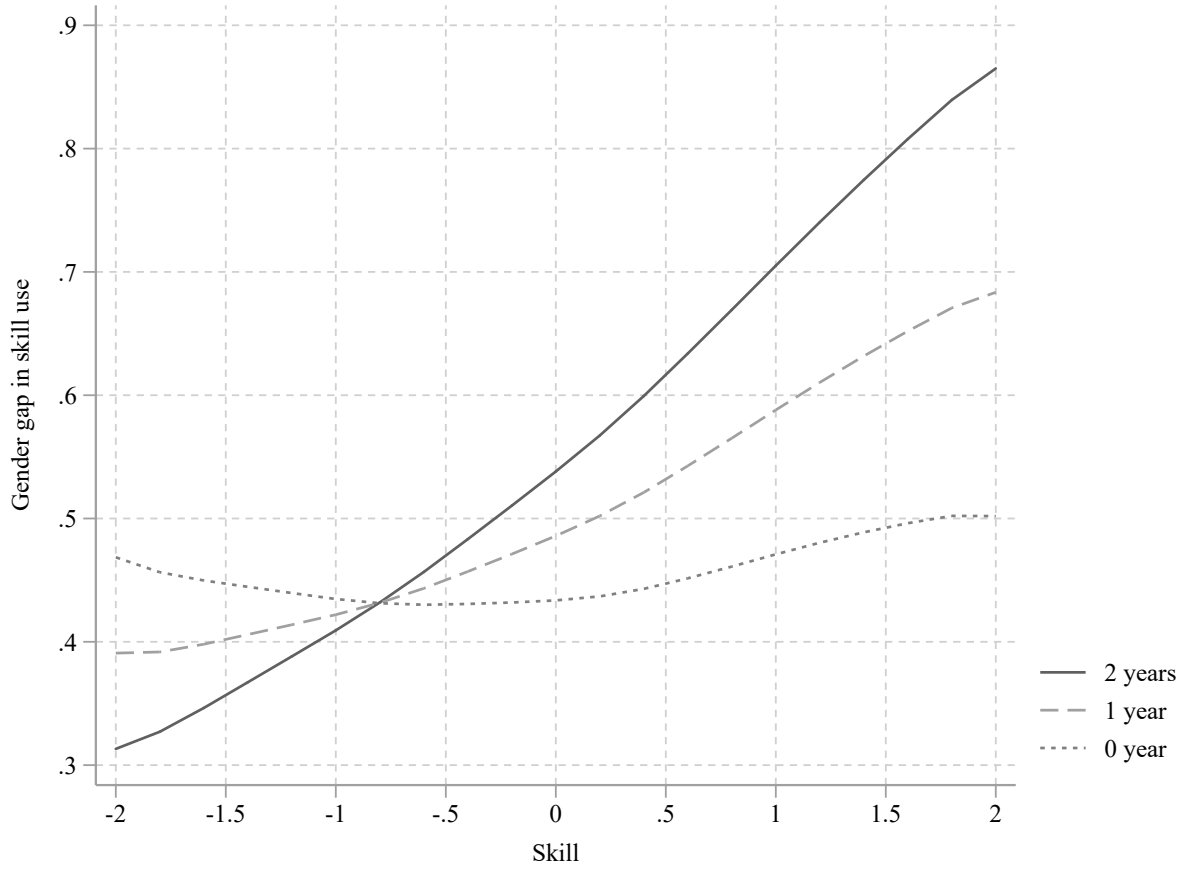


Figure 8: Impact of paid parental leave length on the gender gap in literacy use

Note: This figure shows the result of the counterfactual simulation, using the estimates in Column 4 of Table 3 Panel A. The gender skill-use gap is defined by equation (15). The gender gap in skill use at skill s and paid parental leave duration d is defined as $Gap(s;d) = E_X\left[Y_m(S,X;D) - Y_f(S,X;D) \mid S = s, D = d\right]$, where $Y_g(s,x;d)$ is the level of skill use of a person with gender g, skill s, and characteristics x, under parental leave policy d.

Table 1: Participating countries in PIAAC

Round 1 (2008–2013)	Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea, Netherlands, Norway, Poland, Russian Federation, Slovak Republic, Spain, Sweden, United Kingdom, United States
Round 2 (2012–2016)	Chile, Greece, Indonesia, Israel, Lithuania, New Zealand, Singapore, Slovenia, Turkey
Round 3 (2016–2019)	Ecuador, Hungary, Kazakhstan, Mexico, Peru, United States

Table 2: Correlation between hourly wages and skill and skill use

Skill	Literacy		Numeracy	
	(1)	(2)	(3)	(4)
Skill	0.052***	0.039***	0.052***	0.036***
	(0.006)	(0.005)	(0.005)	(0.004)
Skill use	0.106***	0.071***	0.080***	0.047***
	(0.007)	(0.007)	(0.007)	(0.004)
Occupation	No	Yes	No	Yes
Observations	15788	15788	15651	15651
Countries	22	22	22	22

Note: This table shows the estimation results of equation (7). We did not report the estimates of the constant term or the coefficients of age indicators, years of education and dummy variables indicating that the test language was the same as the native language of the respondent, or that parents were immigrants. Standard errors clustered by each country are in parenthesis. * p< 0.1, ** p< 0.05, *** p < 0.01.

Table 3: Utilization of female literacy Literacy at work and parental leave policies

Panel A: Paid leave	(1)	(2)	(3)	(4)	(5)
Female	-0.485***	-0.518***	-0.550***	-0.465***	
	(0.046)	(0.058)	(0.022)	(0.031)	
Literacy	0.106***	0.098***	0.094***	0.097***	
	(0.014)	(0.015)	(0.012)	(0.020)	
Female × Literacy	-0.003	-0.014	-0.014	-0.011	-0.011
	(0.011)	(0.010)	(0.010)	(0.011)	(0.011)
Female × $(PL - \overline{PL})$	0.079	0.040	0.033	-0.046	
	(0.070)	(0.059)	(0.032)	(0.032)	
Literacy × $(PL - \overline{PL})$	0.051**	0.039**	0.039***	0.049***	
	(0.020)	(0.017)	(0.015)	(0.019)	
Female × Literacy × $(PL - \overline{PL})$	-0.057***	-0.055***	-0.055***	-0.065***	-0.066***
	(0.019)	(0.019)	(0.019)	(0.024)	(0.024)
Panel B: Job protection	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Female × $(PL - \overline{PL})$	0.070***	0.053*	0.008	-0.001	
	(0.023)	(0.028)	(0.019)	(0.015)	
Female × Literacy × $(PL - \overline{PL})$	-0.033***	-0.031***	-0.031***	-0.035***	-0.036***
	(0.009)	(0.008)	(0.009)	(0.008)	(0.008)
Panel C: Full-rate equivalent	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Female × $(PL - \overline{PL})$	0.287***	0.215***	0.138***	0.051	
	(0.065)	(0.067)	(0.047)	(0.073)	
Female × Literacy × $(PL - \overline{PL})$	-0.081***	-0.079***	-0.077***	-0.124***	-0.121***
	(0.024)	(0.024)	(0.024)	(0.029)	(0.029)
Country FE	Yes	Yes	Yes	Yes	Yes
Other family policies	No	Yes	Yes	Yes	Yes
Gender norm	No	No	Yes	Yes	Yes
Other institutions	No	No	No	Yes	Yes
Country specific Literacy slope	No	No	No	No	Yes
Country specific female coef.	No	No	No	No	Yes
Countries	30	25	25	24	24
Observations	77067	58257	58257	56201	56201

Note: This table shows estimation results of the censored Tobit model consisting of equations (10) and (11) for literacy score. We do not report the estimates of the constant term or the coefficients of age indicators, years of education and dummy variables indicating that the test language is the same as the native language of the respondent, or that parents are immigrants. We also omit some estimates of the coefficients of the interaction terms associated with the literacy skill index and the indicators for social institutions and social norms. In Panels B and C, the estimates of coefficients on Female × Skill, Skill, Female are omitted as they are similar to those in Panel A. Standard errors clustered by each country are in parenthesis.
* p < 0.1, ** p < 0.05, *** p < 0.01.

Table 4: Hours worked by females and parental leave policies (Literacy)

Panel A: Paid leave	(1)	(2)	(3)	(4)	(5)
Female	-13.310***	-14.103***	-14.271***	-13.026***	
	(0.034)	(0.032)	(0.037)	(0.032)	
Literacy	0.041	-0.107***	-0.073**	-0.109***	
	(0.029)	(0.030)	(0.029)	(0.029)	
Female × Literacy	1.234***	1.261***	1.213***	1.232***	1.222***
	(0.042)	(0.043)	(0.042)	(0.038)	(0.015)
Female × $(PL - \overline{PL})$	2.243***	1.259***	1.710***	0.247**	
	(0.079)	(0.098)	(0.103)	(0.100)	
Literacy × $(PL - \overline{PL})$	1.242***	1.380***	1.407***	1.997***	
	(0.049)	(0.050)	(0.043)	(0.051)	
Female × Literacy × $(PL - \overline{PL})$	-1.349***	-1.315***	-1.284***	-1.570***	-1.588***
	(0.068)	(0.073)	(0.061)	(0.069)	(0.037)
Panel B: Job protection	(1)	(2)	(3)	(4)	(5)
Female × $(PL - \overline{PL})$	2.050***	1.649***	0.828***	1.037***	
	(0.029)	(0.035)	(0.040)	(0.033)	
Female × Literacy × $(PL - \overline{PL})$	-0.655***	-0.734***	-0.879***	-0.949***	-0.965***
	(0.039)	(0.048)	(0.045)	(0.046)	(0.009)
Panel C: Full-rate equivalent	(1)	(2)	(3)	(4)	(5)
Female × $(PL - \overline{PL})$	7.710***	5.108***	4.507***	2.763***	
	(0.067)	(0.080)	(0.100)	(0.115)	
Female × Literacy × $(PL - \overline{PL})$	-1.441***	-1.397***	-1.485***	-2.201***	-2.141***
	(0.121)	(0.133)	(0.115)	(0.171)	(0.056)
Country FE	Yes	Yes	Yes	Yes	Yes
Other family policies	No	Yes	Yes	Yes	Yes
Gender norm	No	No	Yes	Yes	Yes
Other institutions	No	No	No	Yes	Yes
Country specific Literacy slope	No	No	No	No	Yes
Country specific female coef.	No	No	No	No	Yes
Lagged policy variables	No	No	No	No	No
Countries	30	25	25	24	24
Observations	64075	54666	54666	52699	52699

Note: This table shows estimation results of the censored Tobit model consisting of equations (10) and (11) for literacy score, where the dependent variable is usual weekly hours worked. We do not report the estimates of the constant term or the coefficients of age indicators, years of education and dummy variables indicating that the test language is the same as the native language of the respondent, or that parents are immigrants. We also omit some estimates of the coefficients of the interaction terms associated with the literacy skill index and the indicators for social institutions and social norms. In Panels B and C, the estimates of coefficients on Female × Skill, Skill, Female are omitted as they are similar to those in Panel A. Standard errors clustered by each country are in parenthesis.
* p< 0.1, ** p< 0.05, *** p < 0.01.

Table 5: Wage of females and parental leave policies (Literacy)

Panel A: Paid leave	(1)	(2)	(3)	(4)	(5)
Female	-0.214***	-0.230***	-0.234***	-0.209***	
	(0.044)	(0.063)	(0.037)	(0.017)	
Literacy	0.052***	0.051***	0.052***	0.061***	
	(0.009)	(0.011)	(0.011)	(0.013)	
Female × Literacy	0.012	0.011	0.010	0.007	0.005
	(0.007)	(0.009)	(0.008)	(0.010)	(0.010)
Female × $(PL - \overline{PL})$	-0.029	-0.028	-0.022	-0.009	
	(0.031)	(0.028)	(0.020)	(0.026)	
Literacy × $(PL - \overline{PL})$	0.006	0.006	0.008	0.011	
	(0.009)	(0.010)	(0.009)	(0.012)	
Female × Literacy × $(PL - \overline{PL})$	-0.025***	-0.016*	-0.017**	-0.022**	-0.022**
	(0.008)	(0.009)	(0.008)	(0.010)	(0.010)
Panel B: Job protection	(1)	(2)	(3)	(4)	(5)
Female × $(PL - \overline{PL})$	-0.007	-0.010	-0.037***	-0.046***	
	(0.016)	(0.017)	(0.011)	(0.006)	
Female × Literacy × $(PL - \overline{PL})$	-0.007	0.001	0.002	0.009	0.010
	(0.006)	(0.008)	(0.008)	(0.007)	(0.007)
Panel C: Full-rate equivalent	(1)	(2)	(3)	(4)	(5)
Female × $(PL - \overline{PL})$	-0.002	-0.031	-0.048	-0.040	
	(0.045)	(0.039)	(0.033)	(0.046)	
Female × Literacy × $(PL - \overline{PL})$	-0.029**	-0.015	-0.015	-0.027	-0.025
	(0.011)	(0.016)	(0.016)	(0.024)	(0.024)
Country FE	Yes	Yes	Yes	Yes	Yes
Other family policies	No	Yes	Yes	Yes	Yes
Gender norm	No	No	Yes	Yes	Yes
Other institutions	No	No	No	Yes	Yes
Country specific Literacy slope	No	No	No	No	Yes
Country specific female coef.	No	No	No	No	Yes
Lagged policy variables	No	No	No	No	No
Countries	24	22	22	21	21
Observations	47515	44215	44215	42378	42378

Note: This table shows estimation results of the Heckman sample selection correction model consisting of equations (16) and (17) for literacy score. We do not report the estimates of the constant term or the coefficients of age indicators, years of education and dummy variables indicating that the test language is the same as the native language of the respondent, or that parents are immigrants. We also omit some estimates of the coefficients of the interaction terms associated with the literacy skill index and the indicators for social institutions and social norms. In Panels B and C, the estimates of coefficients on Female × Skill, Skill, Female are omitted as they were similar to those in Panel A. Standard errors clustered by each country are in parenthesis.
* p< 0.1, ** p< 0.05, *** p < 0.01.

A Skill use items

A.1 Literacy skill-use items

1. Read directions or instructions
2. Read letters, memos or e-mails
3. Read articles in newspapers, magazines or newsletters
4. Read articles in professional journals or scholarly publications
5. Read books
6. Read manuals or reference materials
7. Read bills, invoices, bank statements or other financial statements
8. Read diagrams, maps or schematics

A.2 Numeracy skill-use items

1. Calculate prices, costs or budgets
2. Use or calculate fractions, decimals or percentages
3. Use a calculator – either hand-held or computer-based
4. Use simple algebra or formulas
5. Use more advanced math or statistics such as calculus, complex algebra, trigonometry or use of regression techniques
6. Prepare charts, graphs or tables

B Data source of parental leave policies

Table B1: Data source of parental leave policies

Country	Paid leave	Job protection	Full-rate equivalence	Source	Note
Austria	1.308	2.154	1.108	Maternity Protection Act: 3, 5, 14.4, 15.1. General Social Insurance Act: 162. Child Care Benefit Act 14.1.	For parental leave benefits, there are some alternatives: 14.53 EUR/day for 30 months, 20.80 EUR/day for 20 months, 26.60 EUR/day for 15 month, 33 EUR/day for 12 months, or for 12 months with replacement rate, 0.8. We employed the last one, which is also the one employed in the OECD family database.
Belgium	0.537	0.619	0.297	Labour Act Art: 39, Royal Decree Regarding the Establishment of a Parental Leave in the Framework of Interruption of Professional Career Art: 2, 10, Royal Decree to Execute the Act Respecting Compulsory and Indemnity Insurance Scheme Art, 114, 115, 216, 217	The duration of job protection is 4 months. Parental leave benefits are flat-rate (679.59 EUR/month) for 3 months. We calculated the replacement rate using the median value of female monthly earnings (= 679.59/2187.625).
Canada	0.962	1.038	0.529	Canada Labour Code: 205.1, 206-208, Employment Insurance Act: 12, 13, 14, 17, 22, 23, 25	Federal-level and state-level policy may be different, but we employed the Federal-level policies.
Chile	0.577	0.577	0.577	Labour Code: 195, 197	
Cyprus	0.346	0.596	0.260	Social Insurance Guide in Cyprus, Maternity Protection Act: 3, 4, 5	
Czech	2.100	3.115	1.340	Labour Code: 195, 196	The duration of parental leave is up to 3 years of a child, after the end of the maternity leave. Parental leave benefits are fixed amount with four alternatives: 11,400 CZK until the child is 24 months old, 7,600 CZK until 36 months old, 7,600 CZK until 9 months old and after it 3,800 CZK until 48 months old, and lower rate with 3,000 CZK for some periods. We employed the first one, and calculated the replacement rate using median female wage in PIAAC.
Denmark	1.231	1.231	1.231	Consolidation Act no. 1084 of 13 November 2009 on Entitlement to Leave and Benefits in the Event of Childbirth: 6, 7, 9, 10, 21, 33, 35, 36, 37	The weekly maternity leave benefits are capped by DKK 3,332. Since parents are allowed to prolong the parental leave (from 32 weeks) up to 46 weeks, we employed 46 weeks as the duration of parental leave.

Country	Paid leave	Job protection	Full-rate equivalent	Source	Note
Estonia	1.580	3.192	1.580	Holidays Act: 27, 30, 31, Health Insurance Act: 58, 84, Parental Benefits Act: 2, 3, 4	Although there is no paid parental leave, parents have right to receive parental benefits for 435 days. If the mother takes unpaid parental leave, the amount of the benefits is calculated on the basis of her wage. If she does not take parental leave, the amount may be calculated on the basis of his spouse's wage. The amount is capped by three time the average income.
Finland	0.896	3.192	0.619	Health Insurance Act: 9, 10, 11	The replacement rate of maternity leave benefits is progressive: 70 percent up to 26,720 EUR, 40 percent up to 41,100 EUR, and then 25 percent. The replacement rate of maternity leave benefits was evaluated at median of female earnings using PIAAC. Finland may have home-care leave until the child becomes age 3, if that child does not enroll public childcare. We excluded this type of leave from our definition of paid parental leave. Note that home-care leave benefit is 327.46 EUR/month, which is relatively small amount (female median monthly earning in PIAAC is 2,457 EUR, so if we take the replacement rate into account, equivalent weeks will be similar, regardless of inclusion of home care benefits).
France	0.808	3.115	0.380	Labour Code: 1225-17, 1225-18, 1225-19, 1225-2020, 1225-47, 1225-48, 1225-54, Social Security Code: 331-3, 331-4, 331-5, 331-6, 323-4, OECD family database	According to the OECD family database, parental leave benefits may be available, but not referred to in the ILO database. Thus, we followed the OECD family database. While the duration of paid leave was of 2011, the replacement rate was of 2016, due to data availability.
Germany	1.262	3.115	0.934	Maternity Protection Act: 3.2, 6.1, 13.1, 14.1. Parental Allowance and Parental Leave Act: 1, 2.1, 2.2, 2.5, 15.2, 15.3, 16.1, 16.3.	The parental leave benefits are capped by EUR 1,800 (monthly).
Greece	0.327	0.823	0.163	Social Security Programs Throughout the World: Europe, 2010	OECD family database suggests that Greece has 26 weeks special parental leave with flat amount, which is not shown in ILO database, and we did not take it into account. (Note that this value from the OECD family database was about policy in 2016.)
Ireland	0.500	1.077	0.400	Maternity Protection Act: 8, 10-11, 14, 16. Parental Leave Act: 6. Social Welfare Consolidation Act: 6, 47, 49.	The maternity leave benefits are capped by EUR 280 per week.
Israel	0.269	1.223	0.269	National Insurance Law: 50, 51, 53, 57. Employment of Women Law: 6, 7.	
Italy	0.910	0.910	0.480	Legislative Decree No. 151 of 2001: 16, 20, 22, 26, 32, 34	
Japan	1.115	1.115	0.603	Labor Standards Act 1947: 65, Employment Insurance Act: 61. National Health Insurance Law: 8. Childcare and Elderly care Act: 5, 9	Information about parental leave policy in the ILO database is incorrect.

Country	Paid leave	Job protection	Full-rate equivalent	Source	Note
Korea	1.247	1.247	0.647	Labor Standards Act: 20, 74, 76. Act on Equal Employment and Support for Work-Family Reconciliation: 19. Enforcement Decree of the Employment Insurance Act: 95, 100, 101.	The parental leave benefits should be between 500,000 won/month and 1 million won/month.
Lithuania	2.192	3.192	1.840	Labour Code: 178, 179, 180. Law on Sickness and Maternity Social Insurance: 17, 18, 20, 21.	
Netherlands	0.308	0.808	0.308	Work and Care Act: 3.1.2, 3.1.3, 3.8, 6.1.1, 6.2	
New Zealand	0.269	1.000	0.269	Parental Leave and Employment Protection Act 1987: 9.1, 26, 28, 29, 30, 71J.	The rate of maternity leave payments is the lesser of USD 325 or 100 percent of weekly payment.
Norway	0.885	2.000	0.885	Working Environment Act: 12. National Insurance Act 14.7.	Norway has two alternatives 46 weeks with 100 percent replacement rate and 56 weeks with 80 percent replacement rates. Although we employed the first one, these two has little difference in terms of full-rate equivalent. Norway has home care leave benefits, which are available for 23 months (3,303 NOK/month for 23 months from 13 months old) if the child does not use public early childhood education and care services, but we did not include this in the definition of paid parental leave.
Poland	0.385	0.385	0.385	Social Security Program throughout the World, Europe 2010.	Although Poland has care leave for 60 days per year if the child is younger than 8 years old, we did not include this because this seems to be a temporal leave, say, when a child gets sick.
Singapore	0.308	0.308	0.308	Employment Act: 7, 76, 80. Children Development Co-Savings Act 9.	
Slovak Republic	3.000	3.000	1.084	Labour Code: 166.1, Act on Social Insurance 48.2, 48.3, 53, 55. Social Security Programs throughout the World, Europe 2010, 2012.	In terms of the duration of maternity leave, the ILO database seems incorrect, which may be the duration in 2009 but not 2011. The amount of parental leaves benefit is fixed, 164.22 EUR/month in 2010. The replacement rate was evaluated at the median female wage in PIAAC.
Slovenia	1.003	1.003	1.003	Parental Protection and Family Benefits Act: 17, 26, 29, 31, 41, 43, 44	
Spain	0.308	3.308	0.308	Decree No.1/1995 enacting the Worker's Charter Art: 46, 48. Royal Decree No295/2009 on Cash benefits of the Social Security System concerning Maternity, Paternity, Risk during Pregnancy and Risk during Breastfeeding Art: 3, 8	

Country	Paid leave	Job protection	Full-rate equivalent	Source	Note
Sweden	1.154	1.758	0.874	Parental Leave Act: 4, 5. Public Insurance Act: 4.3, 4.5, 4.6.	Sixty days out of 480 days are given to each parent as exclusive right and the remaining 300 days can be divided between them however they choose. Thus, we defined 420 days as paid leave period for the mother. Since the parental leave benefits exceeding 390 days are the flat amount, 180 SEK/day. The replacement rate of this flat part was evaluated at female mean monthly earnings in 2011 (SEK 26,200) from "Sweden and gender equality."
Turkey	0.308	0.804	0.205	Labour Act: 74, Turkey-ISSA report-Social Security Programs throughout the World 2010	
United Kingdom	0.750	1.250	0.354	Employment Rights Act 1996: 71. The Maternity and Parental Leave Regulations 1999: 7, 14, 15. Social Security Contributions and Benefits Act 2002: 165, 166. Statutory Maternity Pay (General) Regulations 1986: 2	The replacement of the maternity leave benefits is 90 percent for the first 6 weeks (without ceiling), and the lower of either 128.73 pounds or 90 percent of average weekly earnings for the remaining 33 weeks. The replacement rate was evaluated at the median female wage in PIAAC.
United States	0.000	0.231	0.000	Family and Medical Leave Act: 102	While there is no Federal-level paid leaves, some states have paid leave systems.

Note: One year was counted by 52 weeks and one month was counted by 4.3 weeks.

C Summary statistics of social institutions and gender norms

Table C1: Summary statistics of institutional indices

	Dual earner penalty	Gender norms	Emp. protect.	Union density	Public sector	Service sector	GDP per capita
AUT	-0.128	-0.571	2.440	0.284	0.228	0.706	5.050
BEL	-0.089	-0.611	3.131	0.551	0.257	0.730	4.811
CAN	-0.163	.	1.506	0.269	0.295	0.787	5.115
CHL	-0.071	-0.348	1.800	0.153	0.140	0.710	1.400
CYP	.	-0.260	.	.	0.288	0.830	3.144
CZE	0.011	-0.305	2.751	0.158	0.218	0.652	2.093
DNK	-0.145	-0.934	2.320	0.664	0.359	0.768	6.300
EST	0.000	-0.335	2.066	0.070	0.257	0.656	1.688
FIN	-0.271	-0.818	2.167	0.696	0.316	0.733	5.009
FRA	0.029	-0.712	2.823	0.077	0.235	0.737	4.440
DEU	0.172	-0.478	2.842	0.185	0.206	0.695	4.456
GRC	-0.254	-0.263	2.440	0.228	0.217	0.738	2.735
IRL	-0.446	-0.549	1.978	0.326	0.267	0.777	4.852
ISR	.	.	2.220	0.228	0.289	0.794	3.329
ITA	-0.244	-0.467	3.032	0.363	0.215	0.689	3.705
JPN	-0.175	0.359	2.085	0.190	0.120	0.697	4.577
KOR	-0.216	0.060	2.168	0.099	0.122	0.682	2.375
LTU	-0.066	-0.445	.	.	0.315	0.661	1.414
NLD	-0.259	-0.527	2.884	0.184	0.257	0.794	5.141
NZL	-0.300	-0.606	1.010	0.209	0.212	0.743	4.094
NOR	-0.209	-0.913	2.310	0.535	0.358	0.804	9.659
POL	-0.012	-0.236	2.391	0.136	0.193	0.610	1.324
SGP	.	-0.085	.	.	0.171	0.795	5.307
SVK	0.020	-0.239	2.635	0.141	0.241	0.614	1.789
SVN	-0.095	-0.658	2.670	0.220	0.296	0.613	2.690
ESP	-0.164	-0.581	2.558	0.169	0.205	0.747	3.330
SWE	-0.399	-0.895	2.517	0.675	0.351	0.778	6.110
TUR	-0.094	0.347	2.330	0.070	0.198	0.660	1.099
GBR	-0.243	-0.654	1.759	0.258	0.303	0.818	3.960
USA	0.000	-0.595	1.171	0.113	0.204	0.802	4.815

D Analysis of numeracy skill

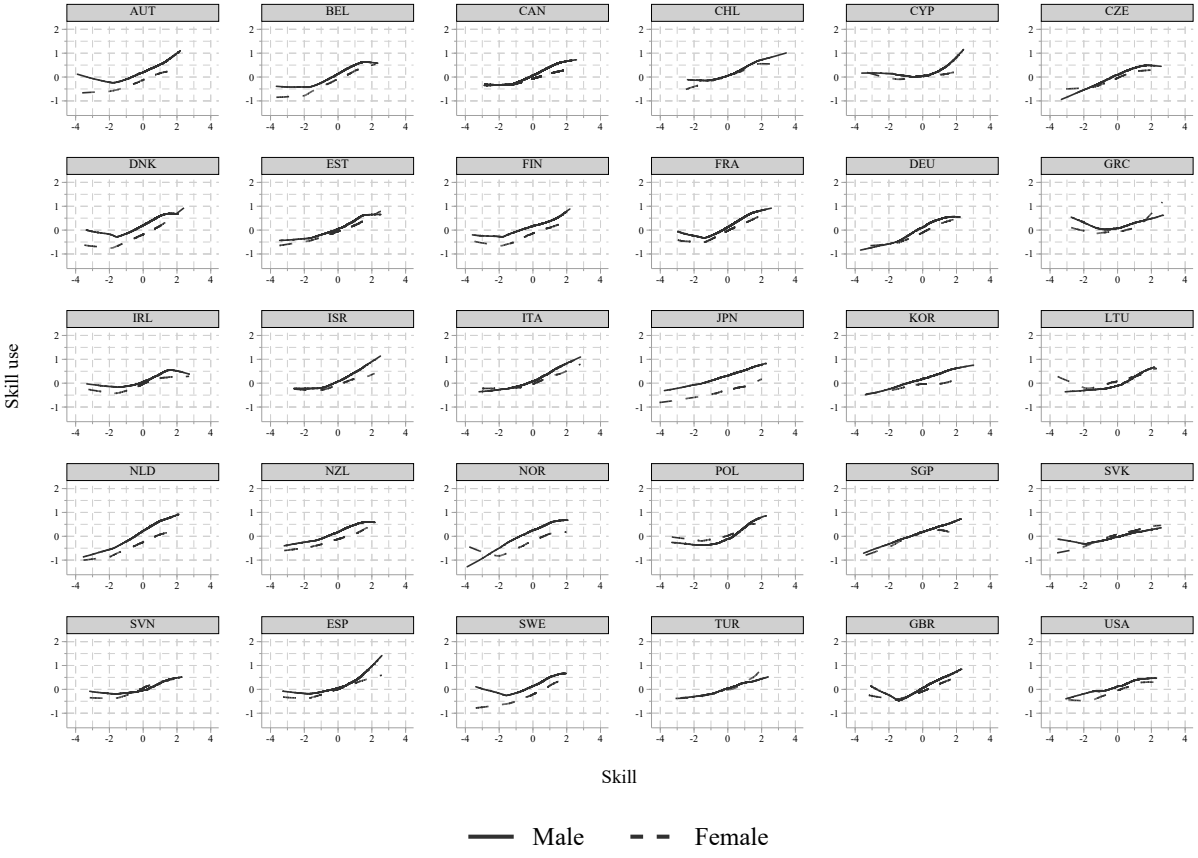
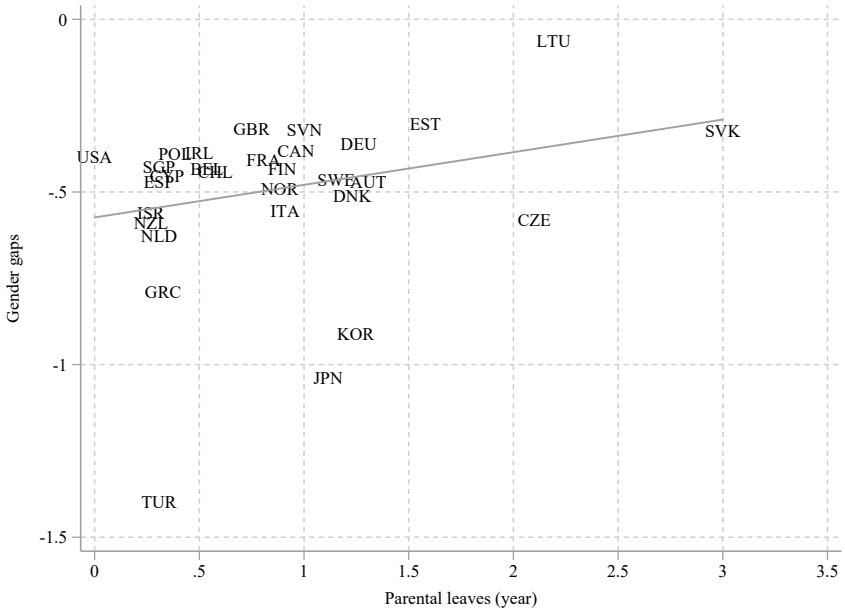
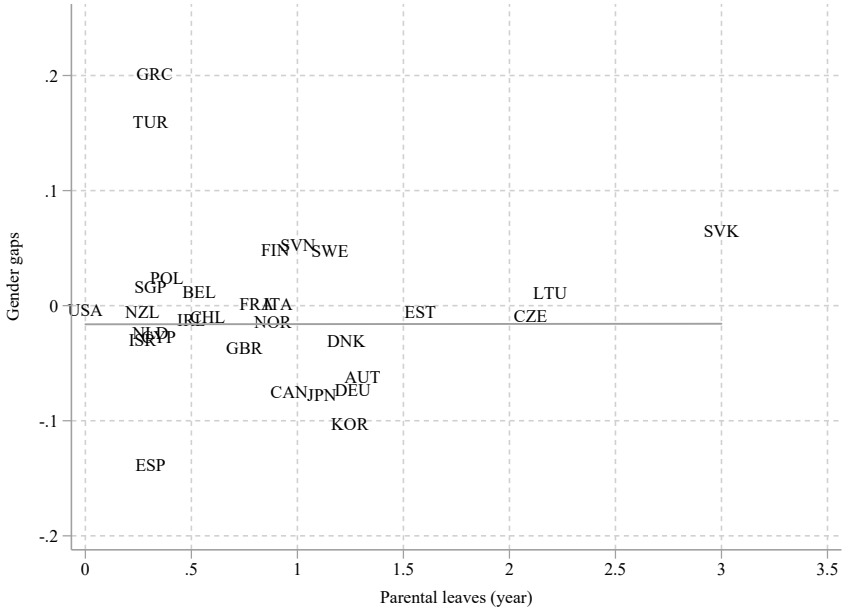


Figure D1: Skill use and skill within labor-force participants (Numeracy)



(a) Gender gaps, $\hat{\alpha}_j^f$



(b) Gender literacy skill-slope gaps, $\hat{\alpha}_j^{fs}$

Figure D2: Numeracy skill use and paid leave

Note: This figure shows the relationship between parental leaves and the estimates of the coefficients on $Female$ and $Female \times Skill$ from the skill-use equation for each country. The estimates are obtained by estimating the censored Tobit model represented by equations (8) and (9) for each country. The explanatory variables used in the estimation are the female dummy variable, the numeracy skill index, their interaction term, age indicators, years of education, and dummy variables, indicating that the test language was the same as the native language of the respondent, or that parents were immigrants. The line is the fitted value by the weighted least squares, where the number of observations in each country is used as a weight.

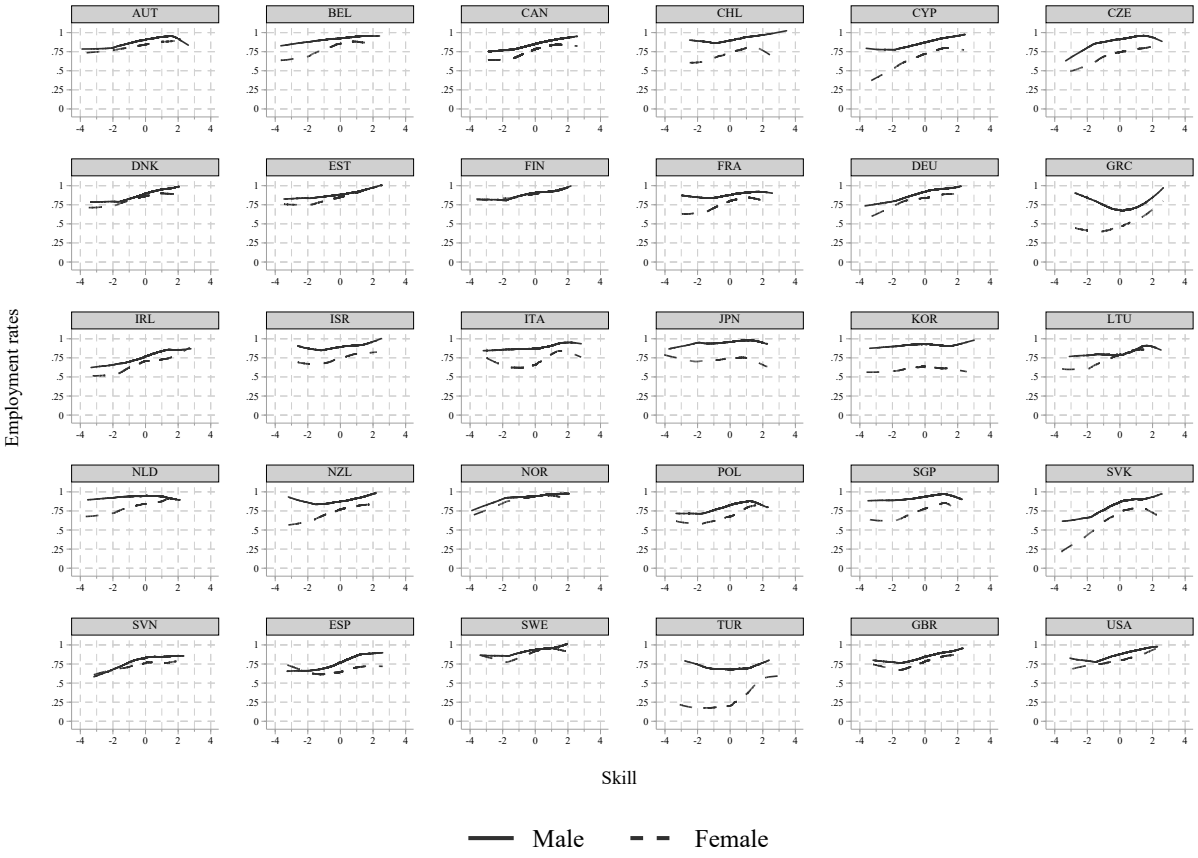


Figure D3: Employment rates at each numeracy skill level