The Impacts of Firms' Technology Choice on the Gender Differences in Wage and Time Allocation: A Cross-Country Analysis

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Abstract

This paper investigates the impacts of firm technology choice on cross-country variations in gender gaps—particularly those variations in the wages and time devoted to home production. For this purpose, we construct a general equilibrium model that includes firm technology choice and home production. The numerical results reveal that the cross-country variations in both the wage and time gender gaps are substantially affected by technology choice—which suggests the persistence of the gender gap—and that a convergence in the technology choice across countries does not imply smaller cross-country variations in all gender gap–related measures.

Keywords: appropriate technology choice, gender wage gap, home production

JEL classification: E13, E24, D13, J22, J16, D58

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1 Introduction

Despite the enactment of equal pay acts, equal opportunity laws, and the progress made by females in terms of higher-education, substantial variations remain in the gender gaps of wage rates and time spent for home production—even in developed countries. What causes these differences in both the wage and time gender gaps across countries? Is there a unique mechanism that will explain the variations in both wage and time gender gaps?

This paper investigates the cross-country variation of the gender wage gap (hereafter *wage gap*) and the home production time gap (hereafter *time gap*) among a sample of eight industrialized nations.[1] We focus on home production hours—in contradistinction to focus on market work hours by many studies, such as Olovsson (2004), Ohanian et al. (2008), and McDaniel (2011)—because home production is more volatile than market hours between countries. In addition, recent studies emphasize the importance of the relationship between market work and home production when comparing cross-country differences in time usage.[2] However, to our knowledge, no study has yet provided a cross-country analysis of the time gap.

Meanwhile, since the mid-to-late 20th century, an increase in the female labor supply has been observed in many countries, and this trend will likely continue. Many developed countries are promoting the participation of females in the labor market to achieve work-life balance and to address the effects of the declining birthrate and an aging society. Changing the female relative labor supply can lead to technological and institutional change that is more appropriate to female workers, e.g., directed technical change à la Acemoglu (2002). If labor market institutions become equalized among countries, what happens to the wage gap and the time gap?

To answer these questions, we first construct a general equilibrium model of the gender wage gap with firms technology choice and home production of households consisting of two different marital statuses: single and couple. Firms can choose their production technologies and labor inputs. Depending on the factor abundance and relative cost of choosing different technologies, firms' technologies can be biased toward either males or females, which results in the wage gap. We call these technologies "gender-biased technology". The term "technology" in this context can be broadly interpreted to include labor market institutions, corporate culture, personnel allocation, employment regulations, and social norms that affect worker productivity.

Gender-biased technology also implicitly represents the degree of unequal treatment between male and female in an intra-firm and inter-firm labor market. Employee benefits such as parental

[1] These countries consist of Austria, Germany, Italy, Japan, Netherlands, Spain, the United Kingdom (U.K.), and the United States (U.S.).

[2] Prescott (2004) stresses the role of cross-country differences in tax rates to explain the difference in market hours worked between U.S. and European countries using a simple neoclassical framework without home production. Later, Rogerson (2009) subsequently reports that home production drastically changes the relationship between taxes and market hours worked.

leave, could be an example of technology chosen by firms that would encourage female workers to stay working in such firms after certain life events. When the female labor supply increases or more equal treatment of the genders is realized, firms would choose female-biased technology because it is more profitable for firms to employ abundant labor factors. However, there is some empirical evidence of unequal treatment for females even in the intra-firm context, e.g., Pfeifer and Sohr (2009), Gupta and Rothstein (2005), and Meyersson-Milgrom et al. (2001); these studies show that a distribution across job levels for female workers is strongly biased toward lower levels, and a large part of the gender wage gap can be explained by segregating males and females in different hierarchical levels and controlling for human capital differences. To capture these unequal treatments at the macro level, we assume unequal treatment in types of technologies that include institutions and rules, á la economic growth literature. Because it is difficult to take unequal treatment variables at the macro level and there are many unobserved factors that affect the working environment, we employ a strategy that is a standard quantitative analysis that uses the economic growth model. The total factor productivity (TFP) can capture these effects instead and explicitly include such a variable.

After constructing the model, we then calibrate the parameters such that the equilibrium matches the data under the calibrated parameters. With the exception of technology choice, the specification of the model follows the standard model in the literature and also focuses on the plainest form to facilitate interpretation. Given the limited availability of time use data, The advantages of this strategy are that we can still identify all the relevant parameters, particularly for home production; in addition, we can still identify the impacts of firm technology choice on gender gaps, which is our main interest and is clearly defined compared with other possible sources of gender gaps that have multiple interpretations due to our calibration strategy.

The model is an application of Caselli and Coleman's (2006) framework to the context of the gender gap context. The Caselli and Coleman (2006) model provides that firms can choose input-specific productivities to maximize profits, in addition to a standard choice of the levels of two production inputs, skilled and unskilled workers. As a result, the skill premium reflects the relative abundance of skilled workers, and these authors show that an important fraction of the cross-country differences in income per worker can be explained by this technology choice. Here, we treat the gender gaps instead of the skill premium. Specifically, firms distinguish male and female labor and choose gender-specific productivities as well as labor inputs to maximize profits.[3] Therefore, given our view that technology includes institutions, institutions are endogenous variables and

[3] The assumption that firms distinguish male and female labor is supported by the previous literature, which suggests that the elasticity of substitution between males and females in market activities ranges from two to three (Olivetti and Petrongolo, 2011). Although this result might reflect differences in the skill composition between male and female, the empirical studies discussed in the text support our modeling, i.e., firms distinguish male and female even when they have equal educational and/or skill levels.

are affected by the relative supply of each production input. We also note that there is also an exogenous friction—introduced as the relative cost of choosing technologies—that constraints firms technology choice. For example, the relative cost is affected by the degree of a taste discrimination and the higher quit rates of females due to childbearing. The general equilibrium approach then generates rich interactions between the wage and time gaps that are frequently neglected in the labor economics literature.

Given this approach, we restate the previous questions as follows: What are the impacts of firm technology choice on the cross-country variation in the observed gender differences in wage and time allocation. Are the sources of the variations the same for both the wage and time gaps? To answer these questions, we conduct counterfactual simulations that compare equilibria under appropriate and inappropriate technology choice in which firms can and cannot choose their technology depending on their environments, respectively.

The main finding is that technology choice has considerable impacts on the cross-country variations in not just the wage gap but also the time gaps of both households consisting of a single person (*single households*) and households consisting of one male and one female (*couple households*) in the sense that the observed cross-country variation in technology can significantly affect the equilibria of countries and therefore their gender gaps. Not surprisingly, technology choice reproduces a non-negligible part of the observed cross-country variation in the wage gap, which is also true for the time gap of single households. However, there is a different result for the time gap for couple households. That is, for the couple time gap, technology choice contributes to a reduction in the cross-country variation, mainly because an important part of the observed cross-country variation in the couple time gap is due to the cross-country variation in the factors related to home production, and the effect of these variations and that of technology choice on the cross-country variation offset each other.

Two policy implications are drawn from these results: The first is that there are major difficulties in narrowing gender gaps. This difficulty arises from the fact that these gaps arise largely from technology choice; this term is broadly interpreted to include labor market institutions, corporate culture, and social norms, which are all difficult to change dramatically. The second is that global policy coordination that aims to narrow these gender gaps by affecting firms' technology choices, even if they succeed in altering firms' behavior and shrinking the differences in technology choice across countries, might not result in smaller gender gaps for all measures. Instead, while achieving smaller gaps in the wage and time gaps of single households, such a policy is associated with a widened cross-country variation in the time gap of the couple households, i.e., in some countries, the couple time gap might shrink; however, other countries might experience a larger time gap.

There are some empirical studies that conduct an international comparison of the gender wage gap, e.g., Blau and Kahn (1992, 1995, 1996a, 1996b, 2003) and Olivetti and Petrongolo (2008, 2011). In labor economics, institutions are one of the main topics comprehensively reviewed in Blau and Kahn (1999), Nickell and Layard (1999) and Boeri (2011). Blau and Kahn also argue that institutions have an explanatory power of cross-country differences of the wage gap. However, due to their approach based on the traditional reduced form regression, they evaluate partial equilibrium effects. We overcome this limitation by using a general equilibrium model that is able to assess the indirect effects of changing equilibria. Another difference between our studies is that we assume endogenous institutions that are included in total factor productivity such as the economic growth model, e.g., Jones and Romer (2010), whereas Blau and Kahn treat only the observed exogenous effects of institution, e.g., parental leave and the degree of occupational segregation by gender. The treatments we employ can assess certain unobserved technological and institutional effects of productivities.

The structure of this paper is as follows. We first describe our model in Section 2. Then, we calibrate the model and quantify the effects of firm technology choice on the cross-country variations in the gender wage and time gaps for a benchmark case in Section 3, which is followed by a robustness analysis in Section 4. We conclude the paper in Section 5.

2 The Model

We consider a closed economy with no capital stock.[4] The economic agents consist of firms, households and the government. Households are further divided into two groups: single and couple. In addition to the production activities of firms, home production occurs in each type of household. The government conducts an income redistribution policy only. All markets are competitive.

2.1 Firms

Competitive firms employ male labor L_m and female labor L_f, which are measured in terms of efficiency units. The production technology exhibits constant returns to scale (CRS) and is specified by a constant elasticity of substitution (CES) form:

$$Y = [(A_m L_m)^\sigma + (A_f L_f)^\sigma]^{\frac{1}{\sigma}}, \quad \sigma < 1, \tag{1}$$

where Y is the output, A_s is sex-s labor-augmenting technology, and σ determines the elasticity of substitution ($1/(1-\sigma)$) between male and female labor. This general form of the production function is used to account for the literature. The number of empirical studies on the elasticity of substitution is small; however, these studies consistently suggest that the elasticity of substitution ranges from two to three (Olivetti and Petrongolo, 2011). Although this result might reflect the difference in the gender composition of the skill level between male and female, there is yet another rationale for firms to distinguish male and female labor-even when the skill levels are equal. Certain previous studies show that a distribution across job levels for female workers is strongly biased toward the

[4] In Section 4, this assumption is relaxed to perform robustness checks for our main results.

lower level, and a large part of the gender wage gap can be explained by the segregation of males and females in different hierarchical levels even after controlling for human capital differences (Pfeifer and Sohr, 2009; Gupta and Rothstein, 2005; Meyersson-Milgrom et al., 2001).

Similar to Caselli and Coleman (2006), the model differs from the standard model in that firms choose their own appropriate technology levels, i.e., (A_m, A_f):

$$A_m^{\omega} + \upsilon A_f^{\omega} \leq B, \tag{2}$$

where ω, υ and B are all positive parameters. B is interpreted as the inverse measure of the barrier to the world technology frontier, which means a subset of the production technologies of the most technologically advanced country, the country with the highest B. The combination of ω and υ governs the curvature of the country-specific technology frontier defined by the pair (A_m, A_f) implied by equation (2) at equality. As B increases or the barrier diminishes, the technology frontier expands and firms within a given country can access a wider subset of production technologies. When A_m/A_f equals one, then equal treatment between genders is realize in the country, and the gender wage gap is narrowed.

υ can be interpreted as the relative cost of shifting from the male to the female labor-augmenting technology choice (hereafter *relative cost*), which reflects all sources of the gender gap in efficiency wage rates other than relative labor abundance, L_s, of the labor of each sex s. Assume that $L_m = L_f$. If $\upsilon = 1$, then firms choose $A_m = A_f$, i.e., there is no gender wage gap. However, if $\upsilon > 1$, i.e., the relative cost is higher, firms choose the production technology such that $A_m > A_f$, which results in a gender wage gap. One possible interpretation of υ is sex discrimination (including the "glass ceiling").[5] Lazear and Rosen (1990) note that females' higher quit rates cost employers with respect to training and promotions into higher positions.

Formally, the firms' profit maximization problem is represented as the following:

$$\max_{\{L_s,\ A_s\}_{s\in\{m,f\}}} \left\{ [(A_m L_m)^{\sigma} + (A_f L_f)^{\sigma}]^{\frac{1}{\sigma}} - w_m L_m - w_f L_f \right\} \quad s.t. \quad (2).$$

In addition to the typical marginal productivity conditions used to obtain the wage gap equation,

$$\frac{w_m e_m}{w_f e_f} = \frac{e_m}{e_f} \left(\frac{A_m}{A_f} \right)^{\sigma} \left(\frac{L_m}{L_f} \right)^{-(1-\sigma)}, \tag{3}$$

[5] Arrow (1971) criticizes exogenously specified discrimination and estimates that the free entry of firms will expel prejudiced employers in the long run, and this decreasing trend in discrimination is estimated by Flabbi (2010). However, we do still observe discrimination. O'Neill (2003) reports that approximately 42% of the male-female gap in median earnings in 2000 could not be explained by gender differences in schooling, experience, and job characteristics. In addition, discrimination captured by υ includes not only the employer prejudice discussed by Arrow (1971) and Becker (1971) among others, but also the asymmetric effects of policies. Furthermore, the degree and speed of decrease in discrimination might differ across countries, which provides us a rationale for conducting a cross-country analysis in Section 3.

assuming a condition, $\omega > \sigma/(1-\sigma)$, for a unique interior solution to the technology choice as in Caselli and Coleman (2006),[6] we also have the optimality conditions for technology choice consolidated as

$$\frac{A_m}{A_f} = \upsilon^{\frac{1}{\omega-\sigma}} \left(\frac{L_m}{L_f} \right)^{\frac{\sigma}{\omega-\sigma}}, \tag{4}$$

which suggests that both endogenous and exogenous comparative advantages work in technology choice. That is, the relative sex-s augmenting productivity is determined by the relative abundance and relative cost of sex-s labor. Thus, the hourly wage gap, $w_m e_m/(w_f e_f)$, depends on firms' technology choice, A_m/A_f, as well as the gender gap in skill e_s and decreasing returns to scale, the latter of which is weakened by the technology choice as the result of the complementarity between the technology choice and labor supply under the empirically valid case, i.e., $\sigma/(\omega-\sigma) > 0$.

2.2 Households

Households are divided into single and couple households. Unlike single households, members in each couple household can cooperate with one another with respect to their time allocation, which implies that the elasticities of labor supply are different across these two different groups in general (Jones et al., 2003). Thus, letting N_s^* and N denote the measure of the single households of sex s and that of the couple households, respectively, the total population $\mathbb{N}$ of the economy is given by $\mathbb{N} = N_m^* + N_f^* + 2N$, which is normalized to unity without loss of generality.[7]

2.2.1 Single Household

A sex-s single household considers home production as well as the standard consumption and time allocation problem:[8]

$$\max_{c_s^*,\ g^*,\ h_{M,s}^*,\ h_{N,s}^* \geq 0} \left\{ \alpha_s^* \ln(c_s^*) + (1-\alpha_s^*) \frac{(1-h_{M,s}^* - h_{N,s}^*)^{1-\gamma_s^*} - 1}{1-\gamma_s^*} \right\}$$

[6] Intuitively, this inequality states that the degree, ω/σ, of decreasing returns to scale in technology choice dominates the degree, $1/(1-\rho)$, of the positive circular causation in technology choice, and there is thus no benefit from perfect specialization, and the optimal technology choice becomes the interior solution. We verify that the inequality actually holds given the result of our calibration.

[7] In the quantitative analysis, we calibrate the measures (N, N_m^*, N_f^*) under the assumption of this household structure such that the model can match the ratio of the aggregate labor supply of each sex. Given this calibration procedure and the fact that the real world includes households with memberships other than those specified in the model, readers should not interpret the household consisting of a couple in the model literally. Instead, it should be simply interpreted as merely a virtual representative of household members that can cooperate with one another. Similarly, the single households should be interpreted as those without cooperation. In what follows, however, we use the terms single and couple households for convenience.

[8] The input structure of home production is the same as that in Becker (1965), who was followed by Olovsson (2004), Ragan (2013), and Rogerson (2009), among others. For preference, we follow Gronau (1977) as in Chang and Schorfheide (2003) and Rogerson (2009).

$$s.t.$$

$$c_s^* = \mathcal{H}^s(g_s^*, e_s h_{N,s}^*) = \left[\xi_s^* g_s^{*\eta} + (1-\xi_s^*)(e_s h_{N,s}^*)^\eta\right]^{\frac{1}{\eta}}, \xi_s^* \in (0,1), \eta < 1, \tag{5}$$

$$(1+\tau_c) g_s^* \leq (1-\tau_\ell) w_s e_s h_{M,s}^* + T, \tag{6}$$

$$h_{M,s}^* + h_{N,s}^* \leq 1,$$

where c_s^* is the consumption of home goods produced by means of a CRS technology $\mathcal{H}^s(g_s^*, e_s h_{N,s}^*)$ with an elasticity of substitution of $1/(1-\eta)$, having inputs that consist of market goods, g_s^* and, effective home production hours, i.e., skill e_s times home production hour $h_{N,s}^*$.[9] ξ_s^* is the weight of market goods in the home production of sex-s single households. Letting $h_{M,s}^*$ denote market hours and normalizing the time endowment to unity, $1 - h_{M,s}^* - h_{N,s}^*$ becomes the leisure time. τ_c is the consumption tax, τ_ℓ is the labor income tax, T is the lump-sum transfer per person, w_s is the wage rate of sex s, α_s^* is the share parameter for consumption, and γ_s is the inverse of the Frisch elasticity of leisure (defined as the elasticity of leisure with respect to the wage rate holding the marginal utility of consumption constant). [10]

First-order conditions (FOCs) state that marginal utility from the hours for each activity balance one another:[11]

$$\alpha_s^* \frac{\mathcal{H}_g^s}{\mathcal{H}^s} \frac{1-\tau_\ell}{1+\tau_c} w_s e_s = \alpha_s^* \frac{\mathcal{H}_N^s e_s}{\mathcal{H}^s},$$

$$\text{or} \quad \frac{\mathcal{H}_N^s}{\mathcal{H}_g^s} = \frac{1-\xi_s^*}{\xi_s^*} \left(\frac{g_s^*}{e_s h_{N,s}^*}\right)^{(1-\eta)} = \frac{1-\tau_\ell}{1+\tau_c} w_s, \quad \text{all } s \in \{m, f\}, \tag{7}$$

where $\mathcal{H}_g^s \equiv \partial \mathcal{H}^s / \partial g_s^*$, and $\mathcal{H}_N^s \equiv \partial \mathcal{H}^s / \partial h_{N,s}^*$. The interpretation of the first equation above is as follows. An additional market hour increases the labor income net of labor income tax by $(1-\tau_\ell) w_s e_s$, which is equivalent to $(1-\tau_\ell)/(1+\tau_c) w_s e_s$ units of market goods. Multiplying this amount by marginal productivity, the $\mathcal{H}_g^s$ of market goods in home production and marginal utility of consumption $\alpha_s^*/\mathcal{H}^s$, we obtain the left hand side (LHS), the marginal utility of an additional market hour. The right hand side (RHS), the marginal utility of an additional home hour, follows a similar reasoning.

[9] The inclusion of skill e_s in the labor input is consistent with the arguments by Gronau(1980, 2008) that more educated people are better at implementing their tasks. The assumption that efficiency in the home work is proportional to that in market activities appears less important when investigating the time gap, which is related to the ratio of efficiencies e_m/e_f more than to the levels themselves because the difference across sexes with respect to the impacts of education on home productivity are not decisive (Table 7 in Gronau and Hamermesh (2008)).

[10] Frisch elasticity is typically derived in relation to the intertemporal labor supply elasticity in dynamic models. Although our model is static, the Frisch elasticity of leisure in our static framework is equivalent to that in dynamic models in which the utility function specifies separate leisure and time function.

[11] We are assuming that the zero lower bound of $h_{M,s}^*$ does not bind, which is the case of interest given that agents within the same group of households are identical.

Taking the ratio of each sex results in the effective time gap:

$$\frac{e_m h^*_{N,m}}{e_f h^*_{N,f}} = \left\{ \frac{w_m/[(1-\xi^*_m)/\xi^*_m]}{w_f/[(1-\xi^*_f)/\xi^*_f]} \right\}^{-\frac{1}{1-\eta}} \frac{g^*_m}{g^*_f}. \tag{8}$$

The ratio is decreasing in the ratio of the efficiency wage, w_s, normalized by the relative weight $(1-\xi^*_s)/\xi^*_s$ of home production due to the opportunity cost and increase in the ratio of market goods g^*_s due to complementarity. The elasticity of the ratio with respect to the former is precisely the same as that between market goods and labor input in home production.

2.2.2 Couple Household

A typical couple household differs from a single household in that the budget constraint is consolidated and that members in the household solve a common allocation problem:[12]

$$\max_{g,\ \{c_s,\ h_{M,s},\ h_{N,s}, z_s\}_{s\in\{m,f\}}\geq 0} \left\{ \sum_{s\in\{m,f\}} \alpha_s \ln(c_s) + \ell(1-h_{M,m}-h_{N,m}, 1-h_{M,f}-h_{N,f}) \right\} \tag{9}$$

$$s.t.$$

$$\sum_{s\in\{m,f\}} c_s = \mathcal{H}(g, e_m h_{N,m}, e_f h_{N,f})$$

$$= \left\{ \xi g^\eta + (1-\xi)\left[z_m(e_m h_{N,m})^\rho + z_f(e_f h_{N,f})^\rho\right]^{\frac{\eta}{\rho}} \right\}^{\frac{1}{\eta}}, \rho < 1, \tag{10}$$

$$(1+\tau_c)g \leq (1-\tau_\ell) \sum_{s\in\{m,f\}} w_s e_s h_{M,s} + 2T, \tag{11}$$

$$h_{M,s} + h_{N,s} \leq 1, \quad \text{all } s \in \{m, f\}, \tag{12}$$

where ℓ is a leisure function, which is strictly increasing, twice continuously differential and concave, and $\mathcal{H}$ is the home production function for which the inputs consist of market goods and the CRS composite of the time of both members with an elasticity of substitution of $1/(1-\rho)$. The crucial difference between the above problem and the single problem is that members of the couple households can cooperate with one another by selecting their time allocation $\{h_{M,s}, h_{N,s}\}_{s\in\{m,f\}}$ for given weights (z_m, z_f), which we call z_s *home production effort*, or simply *effort*, of sex s hereafter. *Effort* is interpreted as human capital, the way in which members in a couple household cooperate with one another, and other factors. Variables and parameters that have the same notation except for an asterisk have the same meaning as for the single households. A household with two members receives a lump-sum transfer of $2T$.

Solving the allocation problem of the home goods, i.e., $\{c_s\}_{s\in\{m,f\}}$, we obtain the reduced-form problem, of which the FOCs with respect to time allocation hold that marginal utility from hours

[12] In this paper, we do not introduce any strategic behavior between members in the household. The input structure of the home production function is a direct extension of the single household case to the case of couple households.

to each activity balance one another as for single households:[13]

$$\frac{\mathcal{H}_g}{\mathcal{H}}\frac{1-\tau_\ell}{1+\tau_c}w_s e_s = \frac{\mathcal{H}_s e_s}{\mathcal{H}}, \quad \text{all } s \in \{m, f\},$$

where $\mathcal{H}_g \equiv \partial\mathcal{H}/\partial g$ and $\mathcal{H}_s \equiv \partial\mathcal{H}/\partial(e_s h_{N,s})$, and the LHS and RHS are the marginal utilities of an additional market and home hour, respectively.

Furthermore, taking the ratio of this equation for each sex s yields the effective time gap for the couple households, which is similar to that for single households:

$$\frac{\mathcal{H}_m}{\mathcal{H}_f} = \frac{z_m}{z_f}\left(\frac{e_m h_{N,m}}{e_f h_{N,f}}\right)^{-(1-\rho)} = \frac{w_m}{w_f}, \quad \text{or} \quad \frac{e_m h_{N,m}}{e_f h_{N,f}} = \left(\frac{w_m/z_m}{w_f/z_f}\right)^{-\frac{1}{1-\rho}}, \tag{13}$$

which states that the time gap depends on not only the efficiency wage gap representing the comparative advantage in market activities but also on the *effort gap* z_m/z_f, i.e., the comparative advantage in the home production.

This result corresponds to (8) for single households, and the effort gap z_m/z_f is the counterpart of the ratio of the relative weight $(1-\xi_s^*)/\xi_s^*$. However, the crucial difference appears in the elasticity of the time gap with respect to the relative efficiency wage gap. The absolute elasticity of single households is equal to the elasticity of substitution $(1/(1-\eta))$ between market goods and the time spent for home production, whereas that of the couple households is equal to the one $1/(1-\rho)$ between the male and female in home production. The cooperation between members in a couple household makes the market goods g public goods, which is why the above equation has no counterpart of g_m^*/g_f^*.

2.3 Government

The government levies consumption and proportional labor income taxes on households. The collected revenues are then used for redistribution through the lump-sum transfer T per person. Thus, the government budget constraint is

$$\mathbb{N}T = N\tau_c g + \sum_{s\in\{m,f\}} N_s^*\tau_c g_s^* + \sum_{s\in\{m,f\}} N\tau_\ell w_s e_s h_{M,s} + \sum_{s\in\{m,f\}} N_s^*\tau_\ell w_s e_s h_{M,s}^*. \tag{14}$$

2.4 Equilibrium

Now, we can define a competitive equilibrium of the economy. We focus on a symmetric equilibrium in which firms choose the same technology pair, i.e., (A_m, A_f).

Definition. *Given a tax system* (τ_c, τ_ℓ), *a symmetric competitive equilibrium of the economy is a set of a price system* (w_m, w_f), *time allocation* $\{h_{M,s}^*, h_{N,s}^*, h_{M,s}, h_{N,s}\}_{s\in\{m,f\}}$, *quantities* $(\{c_s^*, c_s, g_s^*\}_{s\in\{m,f\}}, g, \{L_s\}_{s\in\{m,f\}})$, *technology choice* $\{A_s\}_{s\in\{m,f\}}$, *and a lump-sum transfer* T *such that*

[13] Again, we are assuming the interior solution.

1. *given prices, households maximize their utility;*
2. *given prices and technology constraint, firms maximize their profit;*
3. *markets clear:*

$$\sum_{s\in\{m,f\}} N_s^* g_s^* + Ng = Y, \tag{15}$$

$$L_s = N_s^* e_s h_{M,s}^* + N e_s h_{M,s} \quad \forall s \in \{m,f\};\ \textit{and} \tag{16}$$

4. *the government budget constraint (14) is satisfied.*

3 Quantitative Analysis

In this section, while conducting counterfactual simulations with the model described in the previous section, we ask the following question: what are the quantitative effects of technology choice on the cross-country variations in the various gender gaps, including the hourly wage gap $w_m e_m/(w_f e_f)$ and time gap $h_{N,m}^*/h_{N,f}^*$ of the single households and that $h_{N,m}/h_{N,f}$ of the couple households. The results reveal that technology choice has a significant impact on all the gender gaps. In addition, the mechanisms determining the time gaps of the single and couple households are also considered to be different, which implies that the convergence in A_m/A_f is associated with a convergence in the single time gap $h_{N,m}^*/h_{N,f}^*$ but not in the couple time gap $h_{N,m}/h_{N,f}$.

In the following subsections, we first calibrate the model and design the simulation method, which allows us to quantify the effects of technology choice on the gender gaps. We then provide the results and focus on the importance of technology choice in the subsections that follow. In our study, we use cross-section datasets that consist mainly of the Multinational Time Use Study (MTUS), Survey on Time Use and Leisure Activities (Japan), and the EU KLEMS. We will discuss these datasets in Appendix A.

3.1 Calibration

In the couple households, we specify the leisure function, ℓ, in the couple households as follows:

$$\ell(1 - h_{M,m} - h_{N,m}, 1 - h_{M,f} - h_{N,f}) = \sum_{s\in\{m,f\}} (1-\alpha_s)\frac{(1 - h_{M,s} - h_{N,s})^{1-\gamma_s} - 1}{1-\gamma_s}, \tag{17}$$

where $\alpha_s \in (0,1)$ is the weight of consumption. Stated differently, we assume that within each couple household, members solve a Pareto problem with equal treatment where the actions of each member affect the partner's utility only indirectly.

Given this specification and those presented in the previous section, we calibrate the unknown variables, such as productivities A_s and consumption (c_s^*, c_s), and parameters together by solving the simultaneous equations derived from the FOCs and, in some cases, by using an estimation. Intuitively, we assume that under the calibrated parameters, the equilibrium is equivalent to the observed data.[14]

There are 24 parameters, each of which is categorized into one of two types of parameters: household- and firm-side parameters. The household-side parameters consist of preference $\{\alpha_s^*, \alpha_s, \gamma_s\}_{s\in\{m,f\}}$, home production $(\{\xi_s^*, z_s\}_{s\in\{m,f\}}, \xi, \eta, \rho)$, household structure $(\{N_s^*\}_{s\in\{m,f\}}, N)$ in workers, skill $\{e_s\}_{s\in\{m,f\}}$, and tax rates (τ_c, τ_ℓ). The firm-side parameters consists of the elasticity of substitution $(1/(1-\sigma))$ between males and females and the technology constraint (ω, υ, B). The results of the calibration are summarized in Tables 16 and 17.

3.2 Simulation Method

In quantifying the effects of technology choice on the cross-country variations in the gender gaps, we counterfactually assume that all countries converge to the same environment, e.g., the same U.S.-equivalent level of parameters, and then compare competitive equilibria under the following two scenarios. In each case, to obtain a competitive equilibrium, we solve the simultaneous equations derived from the equilibrium conditions of $\{$ Y, A_s, w_s, L_s, $h_{M,s}$, $h_{M,s}^*$, $h_{N,s}$, $h_{N,s}^*$, c_s, c_s^*, g_s^*, g, T $\}_{s\in\{m,f\}}$ in the way that is described in Appendix C. In the first scenario, firms can optimally choose their technology (we call this case the *appropriate technology choice*); by assumption, there are no cross-country variations in the gender gaps after convergence in the environment. By contrast, the second scenario assumes that firms cannot choose their optimal technology and are thus faced with the calibrated country-specific A_m/A_f because of sufficiently high adjustment costs or, more broadly interpreted, because of history dependence (we call this case the *inappropriate technology choice*). Specifically, (A_m, A_f) is determined by the country-specific result $A_m/A_m = A_{m,data}/A_{f,data}$ of the calibration and the technology constraint (2), the latter of which has the U.S. equivalent (υ, B) for all countries. In this case, we should observe cross-country variations in the gender gaps that arise purely due to the cross-country variations in firms' technology choices before the change in the environments.

Thus, to the extent that the cross-country variations in the gender gaps observed in the data are reproduced by the inappropriate technology choice, we can say that the effects of technology choices on the cross-country variations in the gender gaps are substantial. More specifically, by measuring the correlation between the data and the counterfactual under the inappropriate technology choice (let $Corr(CF, Data)$ denote the correlation)— and then by calculating the ratio of

[14] Because we take the values of elasticities from previous studies, this calibration approach suggests that the parameters except for the elasticities are computed as residuals, which is why we follow the previous studies in the specification while keeping the model as simple as possible. Even with limited availability of the time use data, this method— together with the simple model— allows us to identify the values of the parameters. The procedure is described in more detail in Appendix B.

the cross-country variance $Var(CF)$ of some gender gap under the inappropriate technology choice to that $Var(Data)$ of the corresponding data— we can quantify the impacts of technology choice on the cross-country variations in the gender gaps. If $Corr(CF, Data) < 0$, then technology choice itself cannot explain the observed variation, and from a different perspective the larger values of $Var(CF)/Var(Data)$ imply that the observed technology choices affected the variations in the gender gaps more significantly. Therefore, if both $Corr(CF, Data)$ and $Var(CF)/Var(Data)$ are near one, it can be said that technology choice itself explains the observed variations in the gender gaps.

In what follows, we call the above method of comparing the inappropriate technology choice with the data the *independent experiment* of technology choice. A similar method can be applied to the other sources of the cross-country variation of the gender gaps, such as effort z_s, skill e_s and preference (α_s^*, α_s). Thus, to quantify the impacts of a factor, we counterfactually assume that countries are different only in this factor and compare the associated equilibrium with the data. We also call this experiment the independent experiment. In this case, however, to exclude the effect of technology choices, the technology choices are assumed to be exogenously given in the appropriate technology level.[15]

We also design another type of experiment, which we call *conditional experiments* of technology choice. Assuming that the environments of countries except for one or some parameters of interest converge to the U.S. equivalent, this experiment compares the two scenarios mentioned above. Thus, a conditional experiment is a slight extension of the independent experiment, and we thus quantify the impacts of factors in the same way as in the case of the independent experiment, i.e., using the correlation $Corr(CF, DATA)$ and the variance ratio $Var(CF)/Var(Data)$. Intuitively, this experiment quantifies the effects of the combination of several sources of cross-country variations in gender gaps, including (at the least) technology choice.

3.3 Wage Gap

The theoretical implications of inappropriate technology choice for the wage gap may be understood by comparing the inappropriate technology choice with appropriate technology choice, in which all countries have the same parameter values as the U.S. and firms choose their technology optimally. Then, the inappropriate technology choice is characterized by a shift of (A_m, A_f) on the U.S.-equivalent technology frontier.

Without loss of generality, suppose that A_m and A_f move from a northwest point US, which represents the U.S. or the appropriate technology choice, to a southeast point i, which represents country i on the U.S. equivalent technology frontier as illustrated in Figure 1, i.e., A_m and A_f increase and decrease, respectively. Because of the associated changes in labor productivities, the

[15] Even assuming that the technology choice is endogenously determined, these results have a negligibly small change from independent experiments in which the technology choice is given in the level of appropriate technology choice.

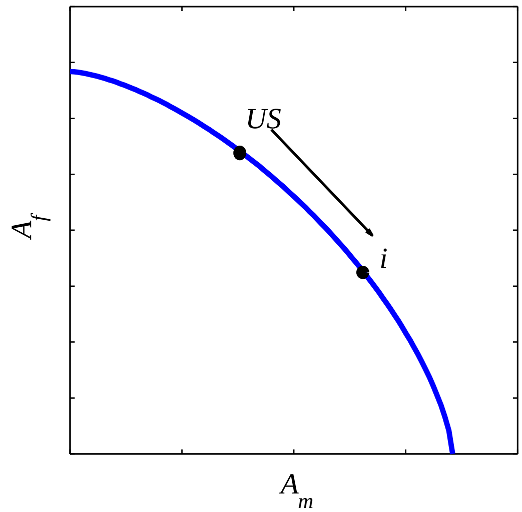

Figure 1: Technology Shift on the U.S.-equivalent Technology Frontier

wage rate of the males and that of the females increases and decreases, respectively, which implies that the efficiency wage gap, w_m/w_f, increases in the manner specified by (3), all other things equal. However, this increase appears weakened by the general equilibrium effect or the associated increase in the relative aggregate labor supply of males and, therefore, its negative effect on the wage gap due to the decreasing returns to scale. For the single household decision, the previous literature, such as Rogerson (2009), suggests that the single male (female) household increases (decreases) his (her) time spent on market activities with its response to the wage rate strengthened by substituting between market goods and time spent on his (her) home production. For couple households, the integrated budget constraint makes the sign of the associated change in the household's labor income ambiguous. Thus, the magnification effects described above are now ambiguous with respect to substituting between market goods and time devoted to home production on the response of the market hour for each sex. However, even with this ambiguous magnification effect, we might expect that an increase in the ratio $h_{M,m}/h_{M,f}$ of market hours is a natural consequence of comparative advantage, which is actually the case and is confirmed by our calculations.

This result is then compared with the observed cross-country variation in the hourly wage gap $w_m e_m/(w_f e_f)$ by the independent experiment, which suggests that technology choice contributes to the cross-country variation in the wage gap to a relatively large extent as illustrated by the left panel of Figure 2 and Table 1. The variance ratio $Var(CF)/Var(Data)$ of technology choice is largest among the sources of the gender gaps, 0.346. Not surprisingly, the correlation $Corr(Data, CF)$ between the data and counterfactual is positive and relatively close to one. Independent experiments also suggest that skill e_s and preference (α_s^*, α_s) are additional important sources of the cross-country variation in the wage gap. The variance ratios of these are approximately 78% and 36% of that of technology choice, respectively. The former is consistent with the literature and, together with the latter, suggests the importance of the general equilibrium analysis that can capture the effect of the latter and verifies its relatively large impact on the cross-country variation in the wage gap.

Conditional experiments support the result of the independent experiment that technology choice is important in understanding the cross-country variation in the wage gap. Both the variance ratio $Var(CF)/Var(Data)$ and correlation $Corr(Data, CF)$ are robust even when we add another source of the cross-country variation of the gender gaps in addition to technology choice. Importantly, the pair of technology choice and preference explains the majority of the cross-country variation in the wage gap with a variance ratio of 0.893 and a correlation of 0.927, as indicated in Table 1; moreover, the correlation of the combination is well above the summation of the variance ratios associated with the independent experiments of technology choice and preference. If we add either effort or skill in addition to preference, both measures move closer to one; however, compared with the combination of technology choice and preference, the improvements are relatively small.

3.4 Single Time Gap

Suppose again that technology (A_m, A_f) shifts toward the southeast on the U.S. equivalent technology frontier and the efficiency wage gap w_m/w_f thus also increases as demonstrated by the previous subsection. Each single household then takes these changes as given and chooses the time $h^*_{N,s}$ devoted to her or his own home production. According to (8), the associated change in the time gap $h^*_{N,m}/h^*_{N,f}$, is the sum of the two counteracting forces: The first is due to the associated increase in the relative opportunity costs, i.e., the change in $(w_m/w_f)^{-1/(1-\eta)}$, which is negative. The second is positive because of the complementarity between market goods and time devoted to home production, i.e., the change in g^*_m/g^*_f which appears to increase because g^*_m (g^*_f) is likely to increase (decrease) faced with an increase (decrease) in the wage rate w_m (w_f). The resulting change in the time gap is negative.

Then, the question is as follows to what extent can this cross-country variation in the time gap induced by technology choice explain the observed variation across countries? The independent experiment suggests that technology choice can explain not all but some non-negligible part of of the cross-country variation in the time gaps of single households. A positive correlation $Corr(Data, CF)$ between the data and counterfactual, although much smaller than that for of the wage gap (as shown by the center panel of Figure 2 or Table 2), implies that the cross-country variation induced by technology choice is consistent with the observed variation. In addition, the value of the variance ratio $Var(CF)/Var(Data)$, 0.228, indicates that its impact is not negligible.

The importance of technology choice in understanding the cross-country variation in the time gap is also suggested by comparisons between the independent experiment of technology choice with those of the other sources of the cross-country variation. Skill e_s, which directly affects the time gap, has the highest variance ratio, 0.478, which is approximately twice as large as that of technology choice. However, a negative correlation, -0.164, suggests that skill itself cannot explain the observed cross-country variation. Among the other sources affecting the time gap through general equilibrium effects only, preference has comparable numbers for both the variance ratio and correlation, 0.216 and 0.242, respectively. Effort, tax and population, the first of which is closely related to the couple households, have negligible impacts on the time gap because the variance ratio is relatively small compared with that of technology choice.

This conclusion is robust in the sense that neither the correlation $Corr(Data, CF)$ nor variance ratio $Var(CF)/Var(Data)$ change significantly, even if we allow for additional variations in the other sources of the gender gaps. As demonstrated in Table 2 (which reports the results of several conditional experiments), the correlation $Corr(Data, CF)$ between the data and counterfactual remains positive and range from 0.089 for the skill gap to 0.372 for tax, and the variance ratio $Var(CF)/Var(Data)$ is also far from zero, ranging from 0.158 for tax to 1.184 for skill and preference.

3.5 Couple Time Gap

We also assume a southeast shift of technology (A_m/A_f) on the U.S.-equivalent frontier. Then, unlike the single household, we should observe a clear-cut relationship between the associated increase in the efficiency wage gap w_m/w_f and the time gap $h_{N,m}/h_{N,f}$. According to (13), the couple household chooses its members' time devoted to home production such that the female engages in home production more than the male, or stated differently, the time gap $h_{N,m}/h_{N,f}$ is negatively correlated with the efficiency wage gap w_m/w_f. Intuitively, market goods, g, are shared as public goods within the households through cooperation between members and the effects of complementarity between market goods and time devoted to home production on the time gap thus cancel out across members; thus, only the effects of the opportunity costs prevail and result in a perfect log-linear relationship between the time and wage gaps.

To what extent can this cross-country variation in the time gap induced by technology choice explain the actual variation? Notably, the results contrast with the case of the single household. The independent experiment indicates that the correlation $Corr(Data, CF)$ between the data and counterfactual is negative, with a value of approximately -0.240, as shown in Table 3 or observed in the right panel of Figure 2, which suggests that technology choice cannot explain the observed cross-country variation in the time gap by itself. Thus, the observed cross-country variation in the time gap of the couple household is driven by some factor(s) whose effects are negatively correlated with the effects of technology choice.

However, this result does not indicate that technology choice is not an important source of the cross-country variation in the time gap. In terms of the impact of technology choice on the cross-country variation in the time gap, which is measured by the variation ratio $Var(CF)/Var(Data)$, the technology choice itself has a considerable impact on the time gap, $h_{N,m}/h_{N,f}$, of the couple household. Table 3 reports that the variance ratio is approximately 0.491. This effect is robust in the sense that the variance ratio does not change significantly and instead increases when combined with other sources of the cross-country variation of the gender gaps, as observed in conditional experiments.

In addition, technology choice is also important in the sense that there is no single factor that can explain the actual cross-country variation in the time gap of the couple households. Although effort z_s has a correlation $Corr(Data, CF)$ between the data and counterfactual that is sufficiently close to one, its variance ratio $Var(CF)/Var(Data)$ is too large to explain the cross-country variation. Instead, the combination of technology choice and effort or the triplet of technology choice, effort and preference has a variance ratio and correlation closer to one compared with those of either technology choice or effort by itself, which implies that without technology choice it is difficult to explain the cross-country variation in the time gap without technology choice. Among these parameters, the latter explains the cross-country variation the most with a variance ratio of 1.144 and correlation of 0.984.

The above results thus suggest that the mechanisms that determine the time devoted to home production are crucially different across different types of households not only in the sense that the cooperation between members makes the net effects of the opportunity costs larger but also in the sense that the actual cross-country variation in the time gap of the couple household deviates from the prediction with technology choice only to a small extent. An immediate implication of this result is that the global policy trend, which is expected to narrow gender gaps by affecting technology choice and is characterized by the convergence in A_m/A_f, might not achieve smaller wage and time gaps simultaneously (at least for couple households). As demonstrated by the independent and conditional experiments, the cross-country variation in technology choice A_m/A_f offsets the cross-country variation in the time gap of the couple households which is widened by the cross-country variation in effort z_s. Thus, if the A_m/A_f values of countries converge, the effect of effort becomes larger, resulting in a wider cross-country variation in the time gap. This result indicates that in some countries, the time gap will become narrower, whereas other countries will experience larger time gaps.[16]

4 Robustness Analysis

We performed sensitivity checks by changing parameter values, assumptions and utility function specifications within the context of the baseline. Tables 4–6 compare the results when the main

[16] As demonstrated in Section 4, the result that the correlation between couple time gaps from the data and counterfactual under the inappropriate technology choice is negative and robust to different parameter values and specifications. Thus, stated differently, the implication that a convergence in A_m/A_f results in a divergence in the couple time gap $h_{N,m}/h_{N,f}$ is also a robust result.

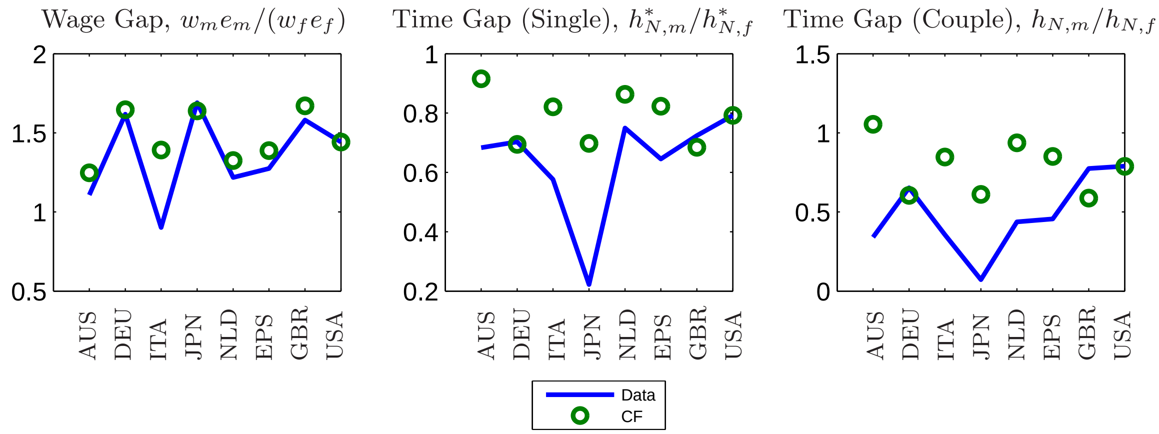

Figure 2: Effects of Technology Choice on the Gender Gaps: Independent Experiment

Notes: Figure shows the male-female to ratio for each variable. The green open circles are the counterfactual simulation results that are represented.

experiments are implemented under alternative assumptions. These results indicate that firm technology choice can explain the cross-country variance to some extent, even under different assumptions; thus, we concluded that firm technology choice has a significant impact on the gender wage and time gaps.

Specifically, we conduct four types of sensitivity experiments:

1. Endogenous Home Production Effort
2. With Physical Capital Model
3. Composite Type Utility Function
4. Changing Elasticity of Substitution Values

Different from calibration forms and simulation algorithms of the baseline model are discussed in Appendix D.

4.1 Endogenous Home Production Effort

The *home production effort*, or simply *effort*, z_s is given exogenously in the main experiments: thus, even, when a firm changes its technology choice, the home production effort does not change. For example, if a firm decides to enhance life-work balance to help female workers, the couple household may change each spouse's function and the husband may work more in home production, in which case, the male's home production effort will increase due to the changing comparative advantage. In this subsection, we examine such an effect for effort. The couple household can select the effort under the constraint of a technology frontier in home production in a similar manner as the firms' technology choice problem. The couple household maximizes its utility function subject to the following constraint

$$z_m^{\omega_H} + \upsilon_H z_f^{\omega_H} \leq B_H \tag{18}$$

and those that appear in the benchmark case. This constraint plays a similar role as in technology choice problem of the firm side. B_H is the inverse measure of the barrier to a household technology frontier, υ_H is the relative cost of shifting to spouse's home production productivity and ω_H governs the curvature of the household technology frontier. If $\rho > 0$, which is the case that we consider in this paper, then $\omega_H > 1$ guarantees an interior solution of the household.

Considering the FOCs with respect to z_m and z_f and taking the ratio of this equation for each sex s,

$$\frac{z_m}{z_f} = \upsilon_H^{\frac{1-\rho}{(1-\rho)\omega_H - 1}} \left(\frac{w_m}{w_f}\right)^{-\frac{\rho}{(1-\rho)\omega_H - 1}},$$

implies that the home production effort changes due to the comparative advantage of market work.

When we calibrate z_m and z_f using the data, we restrict ourselves to $z_m + z_f = 1$ as the main experiment settings to identify these parameters. However, when performing simulations, we can identify these parameters without this restriction, i.e., $z_m + z_f \neq 1$.

4.2 With Physical Capital Model

In this subsection, the endogenous home production effort model is further extended to include capital stock that is given exogenously. Each household has one unit of capital stock k and rents it to firms at rental rate r.[17] The total capital stock $\mathbb{N}k$ equals K. The couple and single households' budget constraint are added capital income,

$$\text{Couple household:} \qquad (1+\tau_c)g \leq (1-\tau_\ell)(w_m e_m h_{Mm} + w_f e_f h_{Mf}) + (1-\tau_k)2rk + 2T, \tag{19}$$

$$\text{Single household:} \qquad (1+\tau_c)g_s^* \leq (1-\tau_\ell)w_s e_s h_{M,s}^* + (1-\tau_k)rk + T, \tag{20}$$

where τ_k is the capital income tax, r is the rental rate of capital and k is the per capita physical capital, $k \equiv K/\mathbb{N}$.

The government's budget constraint also changes when including capital income tax revenue,

$$\mathbb{N}T = N\tau_c g + \sum_{s\in\{m,f\}} N_s^* \tau_c g_s^* + \sum_{s\in\{m,f\}} N\tau_\ell w_s e_s h_{M,s} + \sum_{s\in\{m,f\}} N_s^* \tau_\ell w_s e_s h_{M,s}^* + \tau_k K. \tag{21}$$

The FOCs of the household are the same as in the main model.

[17] We assume that each type of household has the same amount of capital stock, because we cannot observe a quantity of capital stock by type of households.

Firms then use capital, labor, and technology to produce output according to the two-tier production function,

$$\begin{aligned}
\max_{K,\ \{L_s,\ A_s,\ K\}s\in\{m,f\}} \quad & \{Y - w_m L_m - w_f L_f - rK\}, \\
& Y = K^{\theta}\left[(A_m L_m)^{\sigma} + (A_f L_f)^{\sigma}\right]^{\frac{1-\theta}{\sigma}} \\
s.t. \quad & A_m^{\omega} + \upsilon A_f^{\omega} \leq B,
\end{aligned} \tag{22}$$

where θ is the capital share and $0 < \theta < 1$.

The equilibrium definition is discussed in Appendix D.2.

4.3 Composite-type Utility Function

The utility function in the baseline model is separable between consumption and leisure and also between spouses. We examine whether we would obtain the same results under different specifications for the household utility function. In this subsection, we selected the following specification, which addresses the composite hours of leisure between husband and wife:

$$\max\left\{\sum_{s\in\{m,f\}} \alpha_s \ln(c_s) + b\ln\left\{\left[a_m(1-h_{M,m}-h_{N,m})^{\epsilon} + a_f(1-h_{M,f}-h_{N,f})^{\epsilon}\right]^{\frac{1}{\epsilon}}\right\}\right\}, \tag{23}$$

where $\epsilon < 1$ governs the elasticity $1/(1-\epsilon)$ between the male and female in leisure activities.

4.4 Elasticity of Substitution

Unfortunately, to our knowledge, there are no empirical studies on the elasticity of substitution of home production between couples, i.e., $1/(1-\rho)$. However, previous studies of the gender gap provide this elasticity with a lack of foundation. However, the sharing roles of home production might be affected by this elasticity. Therefore, we verified the sensitivity of the value of elasticity.

In addition, a few empirical works have estimated the elasticity of substitution between male labor and female labor, $1/(1-\sigma)$. Our baseline simulation is based on the mean value of these studies, and we verified the sensitivity of this value.

4.5 Results

We conduct several alternative specification and parameters checks to verify the robustness of the findings reported above. We do not experiment with *effort* because home production effort is determined endogenously in these models, with the exception of the baseline model. Tables 4–6 reveal that there is no significant difference among specifications and parameter settings. We can conclude that our results are robust.

5 Conclusion

To what extent and how does firm technology choice affect the cross-country variations in the gender gap in wage and time allocation?

To answer this question, we build a general equilibrium model of the gender wage gap and time allocation with technology choice and home production of households with different marital statuses. Firms choose their production technology depending on the relative abundance of labor for each sex and the relative costs of shifting their technology.

The main finding is that technology choice has considerable impacts on the cross-country variation in not only the gender wage gap but also the gender difference of time allocation, which implies that the effects of a policy aiming to narrow the gender gaps are gradual because the policy must face firms' technology choice, including the labor market institutions, corporate culture, and social norms, which are difficult to change dramatically. Our findings also indicate that there is no single mechanism determining the observed cross-country variations in gender gaps. Therefore, a convergence in the technology choice across countries itself does not result in a convergence in all the gender gap measures in general, which suggests that policy makers should set multiple targets when intending to narrow all gender gap measures.

A possible extension of this study would be to introduce bargaining into the household problem by considering the literature of the collective model (cf. Bourguignon et al. (2009)).

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Appendix A Data

Appendix A provides details of the data that we used for calibration and simulation.

Appendix A.1 Gross Domestic Product

We used the per worker GDP denoted by y. The GDP data are based on value added in the EU KLEMS. We convert national currency measured GDP into 1997-basis PPP value and exclude government expenditures. The government expenditures data are obtained from OECD statistics. The numbers of workers (number of persons engaged) are also obtained from EU KLEMS.

Appendix A.2 Time Allocation

The data source of time allocation differs depending on the country. We used the Survey on Time Use and Leisure Activities for Japan and the *Multinational Time Use Study* (MTUS) for all other countries. The procedure for the construction of time allocation consistent with the model is discussed below for each statistic.

Appendix A.2.1 Multinational Time Use Study (MTUS)

The time allocation data for market working hours and home production hours were obtained from the MTUS. This dataset contains the time allocation of individuals among countries. There are several versions of the data available, such as World 5.53, World 5.8, and World 6.0. The differences among these three versions include that the latter two versions include participants under 18 and the time allocation data are presented in a more detailed manner, whereas the data in World 5.53 are categorized more broadly. By dividing the time allocation of a day into three blocks, namely, market work, home production, and leisure, World 5.53 fully satisfies our aim. The countries included in World 5.53 are listed in Table 7.

MTUS time use data are provided in the form of a diary collected from individuals. The records of one's behaviors are divided into 41 harmonized activities, and the amount of time allocated (measured in minutes) for each activity is available. Therefore, we constructed the definition of time allocation for market work, home production, and leisure and reallocated the former 41 activities into each category. Specifically, we selected four variables to indicate market work, five variables to indicate home production, and the remaining variables to indicate leisure. Details are provided in Tables 8 and 9.

Next, we describe the methodology for constructing the time use data consistently for our analysis. We excluded individuals who were not employed (including retired people) and only used individuals in the range of 20 to 60 years old. Both students and individuals with military duty were omitted. In addition, we ignored the diaries recorded on weekends, as well as people working less than 25 hours per week or working more than 70 hours per week. The upper bound for home production hours was set to 10 hours per day. After filtering out the noisy samples, we were left with countries that had a sufficient sample size for constructing our time allocation data.

The method of construction the time allocation variables is fairly simple. We aggregate all the individuals' time allocations from their diaries that satisfied our requirements and employed the mean value as the representing time allocation for the economy. The basic statistics are presented in Tables 10 and 11.

Appendix A.2.2 Survey on Time Use and Leisure Activities

We obtained the time allocation data for Japan from the aggregated data of the *Survey on Time Use and Leisure Activities* (Ministry of Internal Affairs and Communications, Statistics Bureau of Japan.). The construction methods for our variables are almost the same as MTUS. We defined worked hours as the market working hours $h_{M,s}$ $\{s \in m, f\}$, and housework as home production hours $h_{N,s}$ $\{s \in m, f\}$. The data are presented in Table 12.

Appendix B Calibration

In this section, we describe the detailed procedure of our calibration. Table 13 presents all the variables in the baseline model. Variables are classified into three types: "Data" represents the variables given by data directly, "Exogenous parameters" are mainly taken from previous studies, and "Calibrated parameters" are determined from the equations presented below.

We first calibrate the household structure $(\{N_s^*\}_{s\in\{m,f\}}, N)$ and skill $\{e_s\}_{s\in\{m,f\}}$, and tax rates (τ_c, τ_L), which are independently calibrated. Then, given the result and also the fixed exogenous parameters, we calibrate the firm-side parameters. Finally, we calibrate the remainder of the parameters on the household side.

Appendix B.1 Independently Calibrated Parameters

Household Structure

The main purpose of our paper is to investigate the aggregate gender gap, which requires the male-female ratio of the labor supply in our model to match the data. To achieve this requirement, we calibrate the household structure to fit the male-female ratio of the labor supply data. Our model's population consists of three groups: couple households N with a male and a female, male single households N_m^* and female single households N_f^*, the members of which consist of only a male or only a female, respectively; thus, we calibrate the three parameters N, N_m^*, N_f^*. Regarding the matched labor supply ratio, we also uses the Census of each country to calibrate the data to fit the Census household structure as much as possible. We use the household structure as target in addition to the labor supply ratio because the household structure system in our model requires two calibration targets to satisfy the rank conditions.

Except for Japan and the U.S., we use *EU statistics on income and living conditions*, which reports the distribution of population by household type. This database contains no information about the age profile and presence or absence of children by gender for a single person. Therefore, we assume that a single person with dependent children has the same ratio by gender. We calculated

$$N_s^* = \frac{\text{Single person ratio} - \text{Single person with dependent children ratio}}{\text{Single person ratio}}$$

$$\begin{aligned} & \times \text{ Single person by sex ratio,} \\ N &= \text{Two adults younger than 65 years.} \end{aligned}$$

Japan's household structure data are obtained from the Ministry of Internal Affairs and Communications, *Census*, 2005 and the U.S. data are obtained from the Census Bureau, *Statistical Abstract of the United States*, 2009. We use the following figures:

$$\begin{aligned} N_s^* &= \text{Household living alone by sex,} \\ N &= \text{Married Couple without children.} \end{aligned}$$

Finally, we normalize the total number of households $\mathbb{N} = \sum_{s\in\{m,f\}} N_s^* + N$ to unity.

Skill

Skill e_s is calibrated by human capital accumulated in schooling. Specifically, we employ a methodology similar to that reported in Caselli and Coleman (2006) to construct the skill data using EU KLEMS (Release March 2008). As discussed above, skill is defined as a weighted sum of the daily working hour ratio per worker, in which the workers are divided into three groups based on their respective schooling: low, medium and high education. We set the low educated group as the baseline and take a weighted sum of the medium- and high-educated workers relative to the low-educated workers. The weight for the accumulation of a group is its relative labor income per unit of working hours to the baseline group. The skill measure is independently constructed for males and females, and each skill is normalized by the total sum of both efficiency units.

Tax Rates

Both consumption and labor income tax rates are acquired from McDaniel (2007), who provides these tax rates as well as the taxes on investment and capital for 15 OECD countries.

Appendix B.2 Firm-side Parameters

For the firm-side parameters, we first calibrate the hourly gender wage gap $w_m e_m/(w_f e_f)$, and fix the value of the elasticity of substitution between the market hours of males and females, $1/(1-\sigma)$. Then, using these results as well as those of the independently calibrated parameters and MTUS, we calibrate (A_m, A_f) for eight countries. Finally, we conduct a regression to obtain the values of (ω, υ, B) under a certain assumption.

Hourly Gender Wage Gap

The hourly gender wage gap $w_m e_m/(w_f e_f)$ is calculated from the real labor compensation level and total hours worked by male and female workers. Both variables are obtained from the EU KLEMS data. Note that the skill ratio can be obtained from the result found in Appendix B.1. The hourly wage rate can be defined as the real labor compensation level divided by the total hours worked by each group of workers.

Elasticity of Substitution between Market Hours of Male and Female Labor

We select $\sigma = 0.52$, which implies that the elasticity of substitution between the market hours worked by males and females is 2.08. This value falls within the empirically plausible range, from two to three. Olivetti and Petrongolo (2011) survey studies of the elasticity of substitution between market hours of males and females. Layard (1982) reports a value of two for the U.K. Lewis (1985) reports a value of 2.3 for Australia, and Weinberg (2000) and Acemoglu et al. (2004) report values of 2.4 and 3, respectively for the U.S.

Labor-Augmenting Technologies

The values of (A_m, A_f) are given by the following equations:

$$A_m = \frac{Y}{L_m}\left[\frac{\left(\frac{w_m e_m}{w_f e_f}\right)L_m}{\left(\frac{w_m e_m}{w_f e_f}\right)L_m + \frac{e_m}{e_f}L_f}\right]^{\frac{1}{\sigma}}, \quad A_f = \frac{Y}{L_f}\left[\frac{\frac{e_m}{e_f}L_f}{\left(\frac{w_m e_m}{w_f e_f}\right)L_m + \frac{e_m}{e_f}L_f}\right]^{\frac{1}{\sigma}}.$$

These values are obtained from the hourly wage gap equation (3) and the production function (1). We have previously determined the hourly wage gap $w_m e_m/(w_f e_f)$ and the skill ratio e_m/e_f. For the output of the market goods, we use the GDP net of government expenditure. The data source and calculation are explained in Appendix A. For L_s, we use the labor market clearing condition (40) with the market hour data obtained from MTUS and the previously calibrated household structure. Note that Y in the above equation corresponds to the GDP per capita if we normalize the total population $\mathbb{N}$ of the economy to unity.

Estimation of ω

The parameter ω of the technology frontier can be estimated using the following equation derived from the firms' optimality conditions. We recall from equation (4) and take the logarithm and the first-difference of both sides to arrive at the following specification,

$$\text{dlog}\left(\frac{A_{m,i,t}}{A_{f,i,t}}\right) = \frac{\sigma}{\omega-\sigma}\text{dlog}\left(\frac{L_{m,i,t}}{L_{f,i,t}}\right) + \frac{1}{\omega-\sigma}\text{dlog}\left(\upsilon_{i,t}\right)$$

We then build a fixed-effect model assuming that ω and σ are constant across all countries.

$$\text{dlog}\left(\frac{A_{m,i,t}}{A_{f,i,t}}\right) = \beta\ \text{dlog}\left(\frac{L_{m,i,t}}{L_{f,i,t}}\right) + FE_i,$$

where FE_i is a fixed effect term and equals to $\frac{1}{\omega-\sigma}\text{dlog}\left(\upsilon_{i,t}\right)$. Note that this specification implicitly assumes the constant time trend of υ, which cannot appear in our static model but is in the data.

To perform the estimation of the above equation, we compiled the (unbalanced) panel data from 1981 to 2005 for the following 14 countries, Australia, Austria, Belgium, Czech, Denmark, Finland, Germany, Italy, Japan, Korea, the Netherlands, Spain, the U.K., and the U.S. The descriptive statistics are presented in Table 14, and the estimated results are presented in Table 15. Because the estimated values correspond to the coefficients of the first term on the RHS of the equation, the parameter $\omega = 1.12$ can be easily calculated for a given σ from $\omega = \sigma/\beta + \sigma$. These estimation results are consistent with our assumption that the solution to the firm's problems is interior, i.e., $\omega > \sigma/(1-\sigma)$.

Relative Cost υ and Technology Frontier B

After estimating ω, we can calculate the relative costs υ and shift parameter B analytically. υ is computed from the firm-side FOCs of A_s,

$$\upsilon = \left(\frac{A_m}{A_f}\right)^{\omega-\sigma} \left(\frac{L_m}{L_f}\right)^{-\sigma},$$

and B is computed using the technology constraint (2),

$$B = A_m^{\omega} + \upsilon A_f^{\omega}.$$

Appendix B.3 Household-side Parameters

For the remaining household-side parameters, we first select the values of elasticities. Then, using the MTUS and FOCs of the households' problem, we calibrate $\{\xi_s^*, \alpha_s^*\}_{s\in\{m,f\}}$ related to the single household and $(\{z_s\}_{s\in\{m,f\}}, \xi, \{\alpha_s\}_{s\in\{m,f\}})$ related to the couple household in order.

The Inverse of the Frisch Elasticity of Leisure

We set $\gamma_s = \gamma_s^* = 0.9$, which is close to the value of one, as selected by Prescott (2004). According to Rogerson (2009), who studies a model of time allocation with home production that has the same specification as our model, time allocation does not depend significantly on the value of the Frisch elasticity of leisure.

Elasticity of Substitution between Home Goods and Composite Time

We conduct our quantitative analysis using several values of η in the range of 0.4 to 0.6, which is the empirically plausible range suggested by the literature. As a study using macro data, McGrattan et al. (1997) report a range of 0.40 to 0.45, whereas Chang and Schorfheide (2003) report a range of 0.55 to 0.60. Micro studies report similar ranges. Rupert et al. (1995) report a range of 0.40 to 0.45 and Aguiar and Hurst (2007) report a range of 0.50 to 0.60.

Elasticity of Substitution between a Male's and a Female's Time Devoted to Home Production

We set $\rho = 0.5$, which implies that the value of the elasticity of substitution between time devoted to home production of a male and a female is two. We also consider other values for ρ to verify the robustness of our results in Section 4.

Wage Rates and Lump-sum Transfer

To calibrate the remaining household-side parameters, we use the FOCs of the households' problem. However, we require the values of wage rates $\{w_s\}_{s\in\{m,f\}}$ and the lump-sum transfer T that are consistent with the model and previous calibration.

The wage rate w_s is given by the marginal productivity condition.

The lump-sum transfer T is given by

$$T = (\tau_c + \tau_\ell)\left[\left(\frac{N}{\mathbb{N}}\right)\sum_{s\in\{m,f\}} w_s e_s h_{M,s} + \sum_{s\in\{m,f\}}\left(\frac{N_s^*}{\mathbb{N}}\right) w_s e_s h_{M,s}^*\right],$$

which is obtained by substituting the budget constraints of the households, (6) and (11), into the government budget constraint and solving the result for T.

Single Household

For the single household, we first calibrate ξ_s^* by

$$\xi_s^* = \frac{(e_s h_{N,s}^*)^{\eta-1}}{g_s^{*\eta-1}\frac{1-\tau_\ell}{1+\tau_c}w_s + (e_s h_{N,s}^*)^{\eta-1}}, \quad \text{all } s \in \{m,f\},$$

which is obtained from (7). g_s^* is computed using the budget constraint (6). We use MTUS for the time allocation, i.e., $h_{M,s}^*$ and $h_{N,s}^*$.

Given the value of ξ_s^*, we then calibrate α_s^* using one of the FOCs:

$$\alpha_s^* = \frac{(1-h_{M,s}^* - h_{N,s}^*)^{-\gamma_s^*}}{(1-h_{M,s}^* - h_{N,s}^*)^{-\gamma_s^*} + \frac{(1-\xi_s^*)(e_s h_{N,s}^*)^{\eta-1}e_s}{\xi_s^* g_s^{*\eta} + (1-\xi_s^*)(e_s h_{N,s}^*)^{\eta}}}, \quad \text{all } s \in \{m,f\}.$$

Couple Household

For the couple household, we first calibrate $\{z_s\}_{s\in\{m,f\}}$ using

$$z_f = \frac{1}{\left(\frac{w_m}{w_f}\right)\left(\frac{e_m h_{N,m}}{e_f h_{N,f}}\right)^{1-\rho} + 1}, \quad z_m = 1 - z_f,$$

the former of which is given by substituting $z_m = 1 - z_f$ into (13) and solving the result for z_f.

Then, given this result, we obtain the value of ξ using

$$\xi = \frac{\left[z_m(e_m h_{Nm})^\rho + z_f(e_f h_{Nf})^\rho\right]^{\frac{\eta}{\rho}-1} z_s(e_s h_{Ns})^{\rho-1}}{g^{\eta-1}\frac{1-\tau_\ell}{1+\tau_c}w_s + \left[z_m(e_m h_{Nm})^\rho + z_f(e_f h_{Nf})^\rho\right]^{\frac{\eta}{\rho}-1} z_s(e_s h_{Ns})^{\rho-1}},$$

which is obtained from (13) with $s = m$.

Finally, we obtain $\{\alpha_s\}_{s\in\{m,f\}}$ using

$$\alpha_m = \frac{\frac{D_2 D_3}{D_1} + D_4 - D_3}{\frac{D_2 D_3}{D_1} + D_4 + D_3}, \quad \alpha_f = 1 - \frac{D_2}{D_1}(1-\alpha_m),$$

where

$$\begin{aligned}
D_1 &\equiv \frac{w_m e_m}{w_f e_f}, \quad D_2 \equiv \frac{(1-h_{M,m}-h_{N,m})^{-\gamma_m}}{(1-h_{M,f}-h_{N,f})^{-\gamma_f}}, \\
D_3 &\equiv \frac{\xi g^{\eta-1}}{\xi g^\eta + (1-\xi)(z_m(e_m h_{Nm})^\rho + z_f(e_f h_{Nf})^\rho)^{\frac{\eta}{\rho}}}\frac{1-\tau_\ell}{1+\tau_c}w_m e_m, \quad D_4 \equiv (1-h_{M,m}-h_{N,m})^{-\gamma_m}.
\end{aligned}$$

This system of equations is obtained by solving

$$\begin{aligned}
D_1 &= \frac{1-\alpha_m}{1-\alpha_f}D_2, \\
D_3 &= \frac{1-\alpha_m}{\alpha_m+\alpha_f}D_4,
\end{aligned}$$

which are obtained from the FOCs for (α_m, α_f).

Appendix C Algorithm for Computing a Competitive Equilibrium

In this appendix, we describe the detail of the computation of an equilibrium, which is to solve the following simultaneous equations consisting of the equilibrium conditions for endogenous variables:

$$g = \frac{1-\tau_\ell}{1+\tau_c}(w_m e_m h_{M,m} + w_f e_f h_{M,f}) + \frac{2T}{1+\tau_c}, \tag{24}$$

$$\begin{aligned}
&\frac{\xi g^{\eta-1}}{\xi g^\eta + (1-\xi)\left[z_m(e_m h_{N,m})^\rho + z_f(e_f h_{N,f})^\rho\right]^{\frac{\eta}{\rho}}}\frac{1-\tau_\ell}{1+\tau_c}w_s e_s \\
&\qquad = \frac{1-\alpha_s}{\alpha_m+\alpha_f}(1-h_{M,s}-h_{N,s})^{-\gamma_s}, \quad \forall s\in\{m,f\},
\end{aligned} \tag{25}$$

$$\begin{aligned}
&\frac{(1-\xi)\left[z_m(e_m h_{N,m})^\rho + z_f(e_f h_{N,f})^\rho\right]^{\frac{\eta}{\rho}-1}}{\xi g^\eta + (1-\xi)\left[z_m(e_m h_{N,m})^\rho + z_f(e_f h_{N,f})^\rho\right]^{\frac{\eta}{\rho}}} z_s(e_s h_{N,s})^{\rho-1}e_s \\
&\qquad = \frac{1-\alpha_s}{\alpha_m+\alpha_f}(1-h_{M,s}-h_{N,s})^{-\gamma_s}, \quad \forall s\in\{m,f\},
\end{aligned} \tag{26}$$

$$c_s = \frac{\alpha_s}{\alpha_m+\alpha_f}\left\{\xi g^\eta + (1-\xi)\left[z_m(e_m h_{N,m})^\rho + z_f(e_f h_{N,f})^\rho\right]^{\frac{\eta}{\rho}}\right\}^{\frac{1}{\eta}}, \quad \forall s\in\{m,f\}, \tag{27}$$

$$\frac{\alpha_s^*\xi_s^*\frac{1-\tau_\ell}{1+\tau_c}w_s e_s}{g_s^*\left[\xi_s^* + (1-\xi_s^*)\left(\frac{\xi_s^*}{1-\xi_s^*}\frac{1-\tau_\ell}{1+\tau_c}w_s\right)^{\frac{\eta}{\eta-1}}\right]}$$

$$= (1-\alpha_s^*)\left[1-h_{Ms}^*-\left(\frac{\xi_s^*}{1-\xi_s^*}\frac{1-\tau_\ell}{1+\tau_c}w_s\right)^{\frac{1}{\eta-1}}\frac{g_s^*}{e_s}\right]^{-\gamma_s^*}, \quad \forall s\in\{m,f\}, \tag{28}$$

$$g_s^* = \frac{1-\tau_\ell}{1+\tau_c}w_s e_s h_{M,s}^* + \frac{T}{1+\tau_c}, \quad \forall s\in\{m,f\}, \tag{29}$$

$$h_{N,s}^* = \frac{g_s^*}{e_s}\left(\frac{\xi_s^*}{1-\xi_s^*}\frac{1-\tau_\ell}{1+\tau_c}w_s\right)^{\frac{1}{\eta-1}}, \quad \forall s\in\{m,f\}, \tag{30}$$

$$c_s^* = \left[\xi_s^* g_s^{*\eta} + (1-\xi_s^*)(e_s h_{N,s}^*)^\eta\right]^{\frac{1}{\eta}}, \quad \forall s\in\{m,f\}, \tag{31}$$

$$A_m^\omega + \upsilon A_f^\omega = B, \tag{32}$$

$$\frac{A_m}{A_f} = \upsilon^{\frac{1}{\omega-\sigma}}\left(\frac{L_m}{L_f}\right)^{\frac{\sigma}{\omega-\sigma}}, \tag{33}$$

$$Y = [(A_m L_m)^\sigma + (A_f L_f)^\sigma]^{\frac{1}{\sigma}}, \tag{34}$$

$$w_s = [(A_m L_m)^\sigma + (A_f L_f)^\sigma]^{\frac{1}{\sigma}-1}(A_s L_s)^{\sigma-1}A_s, \quad \forall s\in\{m,f\} \tag{35}$$

$$T = \frac{\tau_c+\tau_\ell}{\mathbb{N}}\left\{N(w_m e_m h_{Mm} + w_f e_f h_{Mf}) + N_m^*(w_m e_m h_{Mm}^*) + N_f^*(w_f e_f h_{Mf}^*)\right\}, \tag{36}$$

$$L_s = N_s^* e_s h_{M,s}^* + N e_s h_{M,s}, \quad \forall s\in\{m,f\}, \tag{37}$$

where endogenous variables and parameters are as follows:

Endogenous variables: $\{Y,\ A_s,\ w_s,\ L_s,\ h_{M,s},\ h_{M,s}^*,\ h_{N,s},\ h_{N,s}^*,\ c_s,\ c_s^*,\ g_s^*,\ g,\ T\}_{s\in\{m,f\}}$

Parameters: $\{\upsilon,\ \omega,\ B,\ \xi,\ \xi_s^*,\ \alpha_s,\ \alpha_s^*,\ e_s,\ z_s,\ \sigma,\ \eta,\ \tau_c,\ \tau_\ell,\ \rho,\ N,\ N_s^*,\ \mathbb{N}\}_{s\in\{m,f\}}$

Instead of solving the above system straightforwardly, we compute the solution by iterative methods in which we make an initial guess of aggregate variables such as prices and the lump-sum transfer and then update those variables by solving the households' and firms' problems for the guessed prices.

The specific algorithm is described below. One of the important remarks is to apply a grid search to computing the optimal choice of the pair $(h_{M,m}, h_{M,f})$ of market work of the couple household to consider the division of labor among the couple household, i.e., there might be a corner solution, which makes it inappropriate to use the FOCs for the interior pair $(h_{M,m}, h_{M,f})$ presented in the text. The optimal time allocation other than market work is then uniquely determined for each pair $(h_{M,m}, h_{M,f})$ thanks to the Inada conditions, which allows us to use the FOCs. As for the single household, given the representative agent within the single household of each sex, we use the FOCs by focusing on the interest case in which singles do not fully depend on non-labor incomes, i.e., the lump-sum transfer.

Step 1: Make an initial guess $\{w_m = w_m^0,\ w_f = w_f^0,\ T = T^0\}$ and initialize the lower bound $(h_{M,s,1} = 0.001)$ and the upper bound $(h_{M,s,n} = 0.7)$ of the grid of couple households' market works, where we fix the number n of the grid points through the following whole processes in their entirely.

Step 2: For the given lower and upper bounds, $h_{M,s,1}$ and $h_{M,s,n}$, generate the equidistant grid, i.e., $h_{M,m,i} \in \{h_{M,m,1}, \cdots\cdots, h_{M,m,n}\}, \;\; h_{M,f,j} \in \{h_{M,f,1}, \cdots\cdots, h_{M,f,n}\}, \;\; i,j = 1,2,\cdots,n.$

Step 3: Compute the optimal resource allocation and the associated utility for each fixed pair $(h_{M,m,i}, h_{M,f,j})$ of the grid: $\forall i,j = 1,\cdots,n$ set

$$(11): \qquad g_{i,j} = \frac{1-\tau_\ell}{1+\tau_c}(w_m e_m h_{M,m,i} + w_f e_f h_{M,f,i}) + \frac{2T}{1+\tau_c},$$

$$(h_{N,m,i}, h_{N,f,j}) \qquad \begin{cases} \dfrac{(1-\xi)\left[z_m(e_m h_{N,m,i})^\rho + z_f(e_f h_{N,f,j})^\rho\right]^{\frac{\eta}{\rho}-1}}{\xi g_{i,j}^\eta + (1-\xi)\left[z_m(e_m h_{N,m,i})^\rho + z_f(e_f h_{N,f,j})^\rho\right]^{\frac{\eta}{\rho}}} z_m(e_m h_{N,m,i})^{\rho-1} e_m \\ \qquad = \dfrac{1-\alpha_m}{\alpha_m+\alpha_f}(1-h_{M,m,i}-h_{N,m,i})^{-\gamma_m}, \\ \dfrac{(1-\xi)\left[z_m(e_m h_{N,m,i})^\rho + z_f(e_f h_{N,f,j})^\rho\right]^{\frac{\eta}{\rho}-1}}{\xi g_{i,j}^\eta + (1-\xi)\left[z_m(e_m h_{N,m,i})^\rho + z_f(e_f h_{N,f,j})^\rho\right]^{\frac{\eta}{\rho}}} z_f(e_f h_{N,f,j})^{\rho-1} e_f \\ \qquad = \dfrac{1-\alpha_f}{\alpha_m+\alpha_f}(1-h_{M,f,i}-h_{N,f,j})^{-\gamma_f}.. \end{cases}$$

$\Longrightarrow$ Solve the simultaneous equation for $(h_{N,m,i}, h_{N,f,j})$.

$$(10): \qquad c_{m,i,j} = \frac{\alpha_m}{\alpha_m+\alpha_f}\left\{\xi g_{i,j}^\eta + (1-\xi)\left[z_m(e_m h_{N,m,i})^\rho + z_f(e_f h_{N,f,j})^\rho\right]^{\frac{\eta}{\rho}}\right\}^{\frac{1}{\eta}},$$

$$\text{FOC of } c_{s,i,j}: \qquad c_{f,i,j} = \frac{\alpha_f}{\alpha_m} c_{m,i,j},$$

$$(9): \qquad U_{i,j} = \sum_{s\in\{m,f\}} \left\{\alpha_s \ln(c_{s,i,j}) + (1-\alpha_s)\frac{(1-h_{M,s,i}-h_{N,s,i})^{1-\gamma_s}-1}{1-\gamma_s}\right\},$$

Step 4: Compute $(i^*, j^*) = \text{argmax}_{i,j\in\{1,\cdots,n\}} U_{i,j}$.

If $\max\{|h_{M,m,i^*} - h_{M,m,i^*\pm1}|, |h_{M,m,i^*} - h_{M,m,i^*\pm1}|\} < \epsilon$, then set $h_{M,m} = h_{M,m,i^*}$ and $h_{M,f} = h_{M,f,i^*}$ and proceed to *Step 5*. Otherwise, update the lower and upper bounds for the grid as follows and return to *Step 2.*: For the male,

$$\begin{cases} h_{M,m,1} = h_{M,m,i^*-1}, \; h_{M,m,n} = h_{M,m,i^*+1}, & \text{if } i^* > 1 \text{ and } i^* < n, \\ h_{M,m,1} = h_{M,m,i^*}, \; h_{M,m,n} = h_{M,m,i^*+1}, & \text{if } i^* = 1, \\ h_{M,m,1} = h_{M,m,i^*-1}, \; h_{M,m,n} = h_{M,m,i^*}, & \text{if } i^* = n. \end{cases}$$

For the female,

$$\begin{cases} h_{M,f,1} = h_{M,f,j^*-1}, \; h_{M,f,n} = h_{M,f,j^*+1}, & \text{if } j^* > 1 \text{ and } j^* < n, \\ h_{M,f,1} = h_{M,f,j^*}, \; h_{M,f,n} = h_{M,f,j^*+1}, & \text{if } j^* = 1, \\ h_{M,f,1} = h_{M,f,j^*-1}, \; h_{M,f,n} = h_{M,f,j^*}, & \text{if } j^* = n. \end{cases}$$

Step 5: Solve the equation for single households' market work, $h^*_{M,s}, \;\; s \in \{m,f\}$,

$$\frac{\alpha_s^* \xi_s^* \frac{1-\tau_\ell}{1+\tau_c} w_s e_s}{g_s^*\left[\xi_s^* + (1-\xi_s^*)\left(\frac{\xi_s^*}{1-\xi_s^*}\frac{1-\tau_\ell}{1+\tau_c}w_s\right)^{\frac{\eta}{\eta-1}}\right]} = (1-\alpha_s^*)\left[1 - h^*_{Ms} - \left(\frac{\xi_s^*}{1-\xi_s^*}\frac{1-\tau_\ell}{1+\tau_c}w_s\right)^{\frac{1}{\eta-1}}\frac{g_s^*}{e_s}\right]^{-\gamma_s^*}.$$

Step 6: Compute $(g_s^*, h_{N,s}^*, L_s)$, $s \in \{m, f\}$, using

$$
\begin{aligned}
(6): \qquad & g_s^* = \frac{1-\tau_\ell}{1+\tau_c} w_s e_s h_{M,s}^* + \frac{T}{1+\tau_c}, \\
(7): \qquad & h_{N,s}^* = \frac{g_s^*}{e_s}\left(\frac{\xi_s^*}{1-\xi_s^*}\frac{1-\tau_\ell}{1+\tau_c} w_s\right)^{\frac{1}{\eta-1}}, \\
(5): \qquad & c_s^* = \left[\xi_s^* g_s^{*\eta} + (1-\xi_s^*)(e_s h_{N,s}^*)^\eta\right]^{\frac{1}{\eta}}, \\
(40): \qquad & L_s = N_s^* e_s h_{M,s}^* + N e_s h_{M,s}.
\end{aligned}
$$

In addition, compute (A_m, A_f) as follows: In the case of appropriate technology choice,

$$
\begin{aligned}
(2)+(4): \qquad & A_f = \frac{B^{\frac{1}{\omega}}}{\left(\upsilon + \upsilon^{\frac{\omega}{\omega-\sigma}}\right)\left(\frac{L_m}{L_f}\right)^{\frac{\omega\sigma}{\omega-\sigma}}}, \\
(2): \qquad & A_m = \left(B - \upsilon A_f^\omega\right)^{\frac{1}{\omega}},
\end{aligned}
$$

In the case of *inappropriate* technology choice,

$$
\begin{aligned}
A_f &= \left(\frac{B}{\overline{A}^\omega + \upsilon}\right)^{\frac{1}{\omega}}, \\
A_m &= \overline{A} A_f,
\end{aligned}
$$

where $\overline{A}$ is an exogenous gender biased technology ratio given by the calibration using data by country, $\overline{A} \equiv A_{m,data}/A_{f,data}$.

After calculating A_m and A_f, compute (w_s, Y, T) using

$$
\begin{aligned}
\text{FOC of } L_s: \qquad & w_s = [(A_m L_m)^\sigma + (A_f L_f)^\sigma]^{\frac{1}{\sigma}-1}(A_s L_s)^{\sigma-1} A_s, \\
(1): \qquad & Y = [(A_m L_m)^\sigma + (A_f L_f)^\sigma]^{\frac{1}{\sigma}}, \\
(6)+(11)+(14): \qquad & T = \frac{\tau_c + \tau_\ell}{\mathbb{N}} \{N(w_m e_m h_{Mm} + w_f e_f h_{Mf}) \\
& \qquad + N_m^*(w_m e_m h_{Mm}^*) + N_f^*(w_f e_f h_{Mf}^*)\}.
\end{aligned}
$$

Step 7: Set $\Lambda = 0.5$ and compute

$$
\begin{aligned}
w_s^1 &= \Lambda w_s^0 + (1-\Lambda) w_s, \\
T^1 &= \Lambda T^0 + (1-\Lambda) T.
\end{aligned}
$$

Step 8: If $\sqrt{(w_m^1 - w_m^0)^2 + (w_f^1 - w_f^0)^2 + (T^1 - T^0)^2} > \epsilon$, then set $w_s^0 = w_s^1$, $T^0 = T^1$ and return to *Step 1*.

If $\sqrt{(w_m^1 - w_m^0)^2 + (w_f^1 - w_f^0)^2 + (T^1 - T^0)^2} < \epsilon$, then stop.

Appendix D Robustness

In this section, we present calibration forms and a simulation algorithm that are different from the benchmark model. The calibration and simulation results are available upon request.

Appendix D.1 Endogenous Home Production Effort

Appendix D.1.1 Calibration Forms

In this endogenous home production model, the only difference from the benchmark model is the inclusion of the home production technology frontier, which has three unknown parameters $(\omega_H, \upsilon_H, B_H)$. We set $\omega_H = 3$ exogenously to avoid corner solutions. For the remaining two parameters υ_H and B_H, we analytically derive the solutions,

$$\upsilon_H = \left(\frac{z_m}{z_f}\right)^{\omega_H - 1} \left(\frac{e_m h_{Nm}}{e_f h_{Nf}}\right)^{-\rho}, \tag{38}$$

$$B_H = z_m^{\omega_H} + \upsilon_H z_f^{\omega_H}, \tag{39}$$

the former of which is obtained from the FOCs with respect to z_s.

Appendix D.1.2 Simulation Algorithm

We substitute

$$z_f = \left[\frac{B_H}{\upsilon_H + \left\{\upsilon_H \left(\frac{e_m h_{Nm}}{e_f h_{Nf}}\right)^{\rho}\right\}^{\frac{\omega_H}{\omega_H - 1}}}\right]^{\frac{1}{\omega_H}},$$

$$z_m = (B_H - \upsilon_H z_f^{\omega_H})^{\frac{1}{\omega_H}},$$

(38) in *Step 3* of the simulation algorithm presented in Appendix C.

Appendix D.2 With Physical Capital Model

Appendix D.2.1 Equilibrium

Definition. *Given a tax system* $(\tau_c, \tau_\ell, \tau_k)$*, a symmetric competitive equilibrium of the economy is a set of a price system* (w_m, w_f, r)*, time allocation* $\{h^*_{M,s}, h^*_{N,s}, h_{M,s}, h_{N,s}\}_{s\in\{m,f\}}$*, quantities* $(\{c^*_s, c_s, g^*_s\}_{s\in\{m,f\}}, g, \{L_s\}_{s\in\{m,f\}}, K)$*, technology choice* $\{A_s\}_{s\in\{m,f\}}$*, and a lump-sum transfer* T *such that*

1. *given prices, households maximize their utility;*

2. *given prices and technology constraint, firms maximize their profit;*

3. markets clear:

$$\begin{aligned}
\sum_{s\in\{m,f\}} N_s^* g_s^* + Ng &= Y, \\
L_s &= N_s^* e_s h_{M,s}^* + N e_s h_{M,s} \quad \forall s \in \{m,f\}, \\
\sum_{s\in\{m,f\}} N_s^* k + Nk &= K; \ \textit{and}
\end{aligned}$$

4. the government budget constraint (14) is satisfied.

Appendix D.2.2 Calibration Forms

Couple Household:

$$k = \frac{K}{\mathbb{N}}$$

$$(19) + (20) + (21): \qquad T = \frac{\tau_c + \tau_\ell}{\mathbb{N}} \{N(w_m e_m h_{Mm} + w_f e_f h_{Mf}) + N_m^*(w_m e_m h_{Mm}^*) + N_f^*(w_f e_f h_{Mf}^*)\} + (\tau_c + \tau_k) rk$$

$$(19): \qquad g = \frac{1-\tau_\ell}{1+\tau_c}(w_m e_m h_{Mm} + w_f e_f h_{Mf}) + \frac{(1-\tau_k)2rk}{1+\tau_c} + \frac{2T}{1+\tau_c}$$

Single Household:

$$(20): \qquad g_s^* = \frac{1-\tau_\ell}{1+\tau_c} w_s e_s h_{M,s}^* + \frac{(1-\tau_k)rk}{1+\tau_c} + \frac{T}{1+\tau_c},$$

Firm:

$$\text{FOC of } K: \qquad \theta = \frac{rK}{Y}$$

$$(22) + \text{FOC of } L_s: \qquad A_s = \frac{1}{L_s}\left(\frac{Y}{K^\theta}\right)^{\frac{1}{1-\theta}} \left[\frac{w_s L_s}{w_m L_m + w_f L_f}\right]^{\frac{1}{\sigma}}$$

$$\text{FOC of } L_s: \qquad w_s = (1-\theta)K^\theta[(A_m L_m)^\sigma + (A_f L_f)^\sigma]^{\frac{1-\theta}{\sigma}-1}(A_s L_s)^{\sigma-1} A_s$$

The remaining variables and parameters are the same as those used in the benchmark model.

Appendix D.2.3 Data

This model requires real capital stock data k, the capital compensation-to-GDP ratio θ, and capital income tax rate τ_k. The capital stock and capital compensation-to-GDP ratio are obtained from the EU KLEMS 2009 version, and the capital income tax rate is obtained from McDaniel (2007) (see Table 12). EU KLEMS 2009 is the newest version: however this version does not include detailed labor statistics, such as labor compensation by gender and by skill. Therefore, we also use the EU KLEMS 2008 version for labor data.

Appendix D.2.4 Simulation Algorithm

1. In *Step 1* of the algorithm in Appendix C, add "$r = r^0$ and r^0 is given".

2. In *Step 3*, use

$$g = \frac{1-\tau_\ell}{1+\tau_c}(w_m e_m h_{Mm} + w_f e_f h_{Mf}) + \frac{1-\tau_k}{1+\tau_c}2rk + \frac{2T}{1+\tau_c}.$$

3. In *Step 7*, use

$$\begin{aligned} g_s^* &= \frac{1-\tau_\ell}{1+\tau_c} w_s e_s h_{M,s}^* + \frac{1-\tau_k}{1+\tau_c} rk + \frac{T}{1+\tau_c}, \\ w_s &= (1-\theta)K^\theta[(A_m L_m)^\sigma + (A_f L_f)^\sigma]^{\frac{1}{\sigma}-1}(A_s L_s)^{\sigma-1}A_s, \\ T &= \frac{\tau_c+\tau_\ell}{\mathbb{N}}\left\{N(w_m e_m h_{Mm} + w_f e_f h_{Mf}) + N_m^*(w_m e_m h_{Mm}^*) + N_f^*(w_f e_f h_{Mf}^*)\right\} + (\tau_c+\tau_k)rk, \end{aligned}$$

and add the following equations:

$$\begin{aligned} (22): \quad & Y = K^\theta\left[(A_m L_m)^\sigma + (A_f L_f)^\sigma\right]^{\frac{1-\theta}{\sigma}}, \\ \text{FOC of } K: \quad & r = \frac{\theta Y}{K}. \end{aligned}$$

4. In *Step 8*, add

$$r^1 = \Lambda r^0 + (1-\Lambda)r.$$

5. In *Step 9*, modify the convergence criterion,

$$\sqrt{(r^1-r^0)^2 + (w_m^1 - w_m^0)^2 + (w_f^1 - w_f^0)^2 + (T^1 - T^0)^2} < \epsilon.$$

Appendix D.3 Composite Leisure Function

With this specification, we calibrate ϵ such that ϵ is consistent with the Frisch elasticity of labor supply reported in the previous studies. Thus we first derive the form of the Frisch elasticity of labor supply. We use the reduced couple household's problem,

$$\begin{aligned} & \max_{g,\ \{h_{M,s},\ h_{N,s},\ z_s\}} \left\{\ln[\mathcal{H}(\cdot)] + \tilde{b}\ln\left([a_m(1-h_{M,m}-h_{N,m})^\epsilon + a_f(1-h_{M,f}-h_{N,f})^\epsilon]^{\frac{1}{\epsilon}}\right)\right\} \\ s.t. \quad & \mathcal{H}(g, e_m h_{N,m}, e_f h_{N,f}) = \left\{\xi g^\eta + (1-\xi)\left[z_m(e_m h_{N,m})^\rho + z_f(e_f h_{N,f})^\rho\right]^{\frac{\eta}{\rho}}\right\}^{\frac{1}{\eta}}, \\ & (1+\tau_c)g \leq (1-\tau_\ell)\sum_{s\in\{m,f\}} w_s e_s h_{M,s} + 2(1-\tau_k)rk + 2T, \qquad (40) \\ & h_{M,s} + h_{N,s} \leq 1, \quad \text{all } s \in \{m,f\}, \\ & z_m^{\omega_H} + \upsilon_H z_f^{\omega_H} \leq B_H, \\ & a_m + a_f = 1, \end{aligned}$$

where $\tilde{b} \equiv b/(\alpha_m + \alpha_f)$.

From the FOCs of h_{Ms},

$$\tilde{b}\frac{a_s \ell_s^{\epsilon-1}}{a_m \ell_m^\epsilon + a_f \ell_f^\epsilon} = \chi(1-\tau_\ell)w_s e_s, \quad \forall s, \tag{41}$$

where χ is the Lagrange multiplier of the budget constraint. We further take the total differentiation of this equation and suppose that $d\chi = 0$:

$$\begin{aligned} -\tilde{b}&\left[\epsilon(a_m\ell_m^\epsilon + a_f\ell_f^\epsilon)^{-2}a_m\ell_m^{\epsilon-1}d\ell_m + \epsilon(a_m\ell_m^\epsilon + a_f\ell_f^\epsilon)^{-2}a_f\ell_f^{\epsilon-1}d\ell_f\right]a_s\ell_s^{\epsilon-1} \\ &+\tilde{b}(\epsilon-1)\left(a_m\ell_m^\epsilon + a_f\ell_f^\epsilon\right)^{-1}a_s\ell_s^{\epsilon-2}d\ell_s = \chi(1-\tau_\ell)e_s dw_s, \quad \forall s. \end{aligned} \tag{42}$$

Using (41), we obtain,

$$-\epsilon\frac{a_m\ell_m^\epsilon}{a_m\ell_m^\epsilon + a_f\ell_f^\epsilon}\frac{d\ell_m}{\ell_m} - \epsilon\frac{a_f\ell_f^\epsilon}{a_m\ell_m^\epsilon + a_f\ell_f^\epsilon}\frac{d\ell_f}{\ell_f} - (1-\epsilon)\frac{d\ell_s}{\ell_s} = \frac{dw_s}{w_s}, \quad \forall s \in \{m, f\}. \tag{43}$$

Finally, substituting $dw_f/w_f = 0$ for (43) and solving for $\frac{d\ell_m/\ell_m}{dw_m/w_m}$, we obtain the Frisch elasticity of labor supply for males,

$$\phi_m \equiv \left.\frac{d\ell_m/\ell_m}{dw_m/w_m}\right|_{dw_f = d\chi = 0} \quad = \quad -\left(1 + \frac{\epsilon}{1-\epsilon}\frac{a_f\ell_f^\epsilon}{a_m\ell_m^\epsilon + a_f\ell_f^\epsilon}\right). \tag{44}$$

Appendix D.3.1 Calibration Forms

Couple Household: We solve the following equation for ϵ numerically:

$$(44): \qquad \phi_m = -\left(1 + \frac{\epsilon}{1-\epsilon}\frac{a_f\ell_f^\epsilon}{a_m\ell_m^\epsilon + a_f\ell_f^\epsilon}\right),$$

where $1/\phi_m$ is set to the value of two used by many macroeconomic studies. a_m and a_f are computed using

$$\text{FOC of } h_{Mm}/h_{Mf}: \qquad \begin{aligned} a_m &= \frac{\frac{w_m e_m}{w_f e_f}\left(\frac{1-h_{M,m}-h_{N,m}}{1-h_{M,f}-h_{N,f}}\right)^{1-\epsilon}}{1 + \frac{w_m e_m}{w_f e_f}\left(\frac{1-h_{M,m}-h_{N,m}}{1-h_{M,f}-h_{N,f}}\right)^{1-\epsilon}}, \\ a_f &= 1 - a_m. \end{aligned}$$

$\tilde{b}$ is obtained from

$$\text{FOC of } h_{Mm}: \qquad \tilde{b} = \frac{\xi g^{\eta-1}}{\xi g^\eta + (1-\xi)[z_m(e_m h_{N,m})^\rho + z_f(e_f h_{N,f})^\rho]^{\frac{\eta}{\rho}}}\frac{1-\tau_\ell}{1+\tau_c}w_m e_m \frac{a_m\ell_m^\epsilon + a_f\ell_f^\epsilon}{a_m\ell_m^{\epsilon-1}}.$$

The other parameters are computed in the same manner as in the benchmark case.

Appendix D.3.2 Simulation Algorithm

In *Step 3* of the simultaneous equation of the algorithm presented in section Appendix D.2.4, replace the FOC of h_{Mm} and h_{Mf} with

$$\begin{cases} \dfrac{(1-\xi)}{\Phi}[z_m(e_m h_{N,m})^\rho + z_f(e_f h_{N,f})^\rho]^{\frac{\eta}{\rho}-1} z_m e_m^\rho h_{N,m}^{\rho-1} = \tilde{b}\dfrac{a_m \ell_m^{\epsilon-1}}{a_m \ell_m^\epsilon + a_f \ell_f^\epsilon} \\ \dfrac{(1-\xi)}{\Phi}[z_m(e_m h_{N,m})^\rho + z_f(e_f h_{N,f})^\rho]^{\frac{\eta}{\rho}-1} z_f e_f^\rho h_{N,f}^{\rho-1} = \tilde{b}\dfrac{a_f \ell_f^{\epsilon-1}}{a_m \ell_m^\epsilon + a_f \ell_f^\epsilon} \end{cases},$$

and replace the utility with

$$U = \left\{\ln[\mathcal{H}(\cdot)] + \tilde{b}\ln\left([a_m(1-h_{M,m}-h_{N,m})^\epsilon + a_f(1-h_{M,f}-h_{N,f})^\epsilon]^{\frac{1}{\epsilon}}\right)\right\}.$$

	Var	$\frac{Var(CF)}{Var(Data)}$	$Corr(Data, CF)$
Data	0.076	—	—
Independent Experiments			
– Technology Choice A_m/A_f	0.026	0.346	0.840
– Effort z_s	0.002	0.022	0.289
– Skill e_s	0.020	0.270	0.359
– Preference $\alpha_s,\ \alpha_s^*$	0.009	0.125	0.958
– Tax $\tau_\ell,\ \tau_c$	0.000	0.001	0.527
– Population $N,\ N_s^*$	0.001	0.011	-0.624
Conditional Experiments of Technology Choice A_m/A_f			
– Effort z_s	0.032	0.423	0.797
– Skill e_s	0.039	0.510	0.929
– Preference $\alpha_s,\ \alpha_s^*$	0.068	0.893	0.927
– Tax $\tau_\ell,\ \tau_c$	0.018	0.243	0.854
– Population $N,\ N_s^*$	0.021	0.274	0.798
– Effort & Preference $z_s,\ \alpha_s,\ \alpha_s^*$	0.075	0.987	0.905
– Skill & Preference $e_s,\ \alpha_s,\ \alpha_s^*$	0.084	1.111	0.966

Table 1: Counterfactual Experiments: Wage Gap Variation

Notes: "Independent Experiments" refers to the effect of independently setting the simulated exogenous variables in cross-country variations by comparing the individual variable to calculate variance and correlation. "Conditional Experiments of Technology Choice $A_m = A_f$" refers to the effect of several combinations that all include technology choice. Other exogenous variables and parameters are set to be equivalent to the U.S.-calibrated values. The second column from the left indicates the variance between each sample country by data and counterfactual simulations, respectively. The third column calculates the variance ratio of the data and counterfactual simulation that is defined as the second column of each row divided by the second column of the first row. The fourth column calculates the correlation between the data and simulation results.

	Var	$\frac{Var(CF)}{Var(Data)}$	$Corr(Data, CF)$
Data	0.032	—	—
Independent Experiments			
– Technology Choice A_m/A_f	0.007	0.228	0.329
– Effort z_s	0.001	0.017	-0.714
– Skill e_s	0.015	0.478	-0.164
– Preference $\alpha_s,\ \alpha_s^*$	0.007	0.216	0.242
– Tax $\tau_\ell,\ \tau_c$	0.000	0.000	-0.008
– Population $N,\ N_s^*$	0.000	0.008	-0.780
Conditional Experiments of Technology Choice A_m/A_f			
– Effort z_s	0.010	0.299	0.127
– Skill e_s	0.026	0.808	0.089
– Preference $\alpha_s,\ \alpha_s^*$	0.026	0.807	0.286
– Tax $\tau_\ell,\ \tau_c$	0.005	0.158	0.372
– Population $N,\ N_s^*$	0.006	0.187	0.256
– Effort & Preference $z_s,\ \alpha_s,\ \alpha_s^*$	0.032	0.973	0.186
– Skill & Preference $e_s,\ \alpha_s,\ \alpha_s^*$	0.038	1.184	0.198

Table 2: Counterfactual Experiments: Time Gap Variation of Single Households

Notes: "Independent Experiments" refers to the effect of independently setting the simulated exogenous variables in cross-country variations by comparing the individual variable to calculate variance and correlation. "Conditional Experiments of Technology Choice $A_m = A_f$" refers to the effect of several combinations that all include technology choice. Other exogenous variables and parameters are set to be equivalent to the U.S.-calibrated values. The second column from the left indicates the variance between each sample country by data and counterfactual simulations, respectively. The third column calculates the variance ratio of the data and counterfactual simulation that is defined as the second column of each row divided by the second column of the first row. The fourth column calculates the correlation between the data and simulation results.

	Var	$\frac{Var(CF)}{Var(Data)}$	$Corr(Data, CF)$
Data	0.059	—	—
Independent Experiments			
– Technology Choice A_m/A_f	0.029	0.491	-0.240
– Effort z_s	0.175	2.942	0.887
– Skill e_s	0.006	0.099	-0.263
– Preference $\alpha_s,\ \alpha_s^*$	0.013	0.220	-0.111
– Tax $\tau_\ell,\ \tau_c$	0.000	0.002	-0.168
– Population $N,\ N_s^*$	0.001	0.019	-0.494
Conditional Experiments of Technology Choice A_m/A_f			
– Effort z_s	0.090	1.514	0.964
– Skill e_s	0.039	0.654	-0.275
– Preference $\alpha_s,\ \alpha_s^*$	0.079	1.325	-0.249
– Tax $\tau_\ell,\ \tau_c$	0.021	0.359	-0.208
– Population $N,\ N_s^*$	0.024	0.406	-0.302
– Effort & Preference $z_s,\ \alpha_s,\ \alpha_s^*$	0.068	1.144	0.984
– Skill & Preference $e_s,\ \alpha_s,\ \alpha_s^*$	0.080	1.349	-0.275

Table 3: Counterfactual Experiments: Time Gap Variation of Couple Households

Notes: "Independent Experiments" refers to the effect of independently setting the simulated exogenous variables in cross-country variations by comparing the individual variable to calculate variance and correlation. "Conditional Experiments of Technology Choice $A_m = A_f$" refers to the effect of several combinations that all include technology choice. Other exogenous variables and parameters are set to be equivalent to the U.S.-calibrated values. The second column from the left indicates the variance between each sample country by data and counterfactual simulations, respectively. The third column calculates the variance ratio of the data and counterfactual simulation that is defined as the second column of each row divided by the second column of the first row. The fourth column calculates the correlation between the data and simulation results.

$Var(CF)/Var(Data)$	**Independent Experiments**			**Conditional Experiments**		
	Technology Choice	Skill	Preference	Skill & Preference	Skill	Preference
Baseline	0.35	0.27	0.12	1.11	0.51	0.89
4.1: Endogenous effort	0.23	0.36	0.09	0.95	0.51	0.60
4.1 + 4.2: With capital	0.53	0.56	0.34	1.03	0.70	0.87
4.1 + 4.2 + 4.3: Alt. Utility func.	0.69	0.70	0.23	1.07	0.89	1.05
4.4: $1/(1-\rho) = 1.11$	0.37	0.24	0.13	1.14	0.51	0.96
4.4: $1/(1-\rho) = 3.33$	0.32	0.31	0.11	1.07	0.52	0.81
4.4: $1/(1-\sigma) = 1.4$	0.27	0.09	0.19	1.13	0.44	0.92
4.4: $1/(1-\sigma) = 2.6$	0.44	0.39	0.10	1.09	0.55	0.93

$corr(Data, CF)$	**Independent Experiments**			**Conditional Experiments**		
	Technology Choice	Skill	Preference	Skill & Preference	Skill	Preference
Baseline	0.84	0.36	0.96	0.97	0.93	0.93
4.1: Endogenous effort	0.84	0.36	0.95	0.91	0.85	0.93
4.1 + 4.2: With capital	0.84	0.35	0.96	0.95	0.90	0.93
4.1 + 4.2 + 4.3: Alt. Utility func.	0.84	0.35	0.85	0.92	0.89	0.89
4.4: $1/(1-\rho) = 1.11$	0.84	0.36	0.96	0.97	0.94	0.93
4.4: $1/(1-\rho) = 3.33$	0.84	0.36	0.96	0.95	0.91	0.93
4.4: $1/(1-\sigma) = 1.4$	0.93	0.37	0.96	0.95	0.87	0.98
4.4: $1/(1-\sigma) = 2.6$	0.75	0.35	0.96	0.97	0.95	0.87

Table 4: Robustness Analysis of Wage Gap Variation

$Var(CF)/Var(Data)$	**Independent Experiments**			**Conditional Experiments**		
	Technology Choice	Skill	Preference	Skill & Preference	Skill	Preference
Baseline	0.49	0.10	0.22	1.35	0.65	1.32
4.1: Endogenous effort	1.58	1.37	0.69	7.38	3.96	4.41
4.1 + 4.2: With capital	1.29	1.24	0.97	2.84	2.01	2.27
4.1 + 4.2 + 4.3: Alt. Utility func.	1.67	0.96	0.02	2.58	2.12	0.26
4.4: $1/(1-\rho) = 1.11$	0.16	0.07	0.07	0.61	0.21	0.43
4.4: $1/(1-\rho) = 3.33$	1.26	0.90	0.60	4.83	2.60	3.56
4.4: $1/(1-\sigma) = 1.4$	0.39	0.32	0.35	1.20	0.49	1.59
4.4: $1/(1-\sigma) = 2.6$	0.63	0.03	0.17	1.43	0.75	1.38

$corr(Data, CF)$	**Independent Experiments**			**Conditional Experiments**		
	Technology Choice	Skill	Preference	Skill & Preference	Skill	Preference
Baseline	-0.24	-0.26	-0.11	-0.28	-0.28	-0.25
4.1: Endogenous effort	-0.22	-0.36	-0.13	-0.22	-0.25	-0.25
4.1 + 4.2: With capital	-0.25	-0.36	-0.16	-0.24	-0.27	-0.28
4.1 + 4.2 + 4.3: Alt. Utility func.	-0.26	-0.33	0.27	-0.22	-0.25	0.42
4.4: $1/(1-\rho) = 1.11$	-0.24	0.20	-0.10	-0.17	-0.13	-0.23
4.4: $1/(1-\rho) = 3.33$	-0.25	-0.33	-0.13	-0.25	-0.27	-0.27
4.4: $1/(1-\sigma) = 1.4$	-0.11	-0.29	-0.13	-0.25	-0.23	-0.19
4.4: $1/(1-\sigma) = 2.6$	-0.28	-0.25	-0.10	-0.29	-0.30	-0.27

Table 5: Robustness Analysis of Time Gap Variation of Couple Households

$Var(CF)/Var(Data)$	Independent Experiments			Conditional Experiments		
	Technology Choice	Skill	Preference	Skill & Preference	Skill	Preference
Baseline	0.23	0.48	0.22	1.18	0.81	0.81
4.1: Endogenous effort	0.17	0.39	0.18	0.93	0.64	0.63
4.1 + 4.2: With capital	0.53	0.62	0.59	1.16	0.87	1.07
4.1 + 4.2 + 4.3: Alt. Utility func.	0.67	0.48	0.44	1.10	0.88	1.17
4.4: $1/(1-\rho) = 1.11$	0.24	0.51	0.23	1.27	0.86	0.85
4.4: $1/(1-\rho) = 3.33$	0.21	0.44	0.20	1.08	0.74	0.74
4.4: $1/(1-\sigma) = 1.4$	0.17	0.73	0.30	1.08	0.71	0.92
4.4: $1/(1-\sigma) = 2.6$	0.29	0.37	0.18	1.23	0.86	0.81

$corr(Data, CF)$	Independent Experiments			Conditional Experiments		
	Technology Choice	Skill	Preference	Skill & Preference	Skill	Preference
Baseline	0.33	-0.16	0.24	0.20	0.09	0.29
4.1: Endogenous effort	0.39	-0.16	0.23	0.22	0.11	0.32
4.1 + 4.2: With capital	0.33	-0.16	0.28	0.27	0.13	0.31
4.1 + 4.2 + 4.3: Alt. Utility func.	0.33	-0.15	0.36	0.31	0.21	0.35
4.4: $1/(1-\rho) = 1.11$	0.33	-0.17	0.24	0.20	0.09	0.29
4.4: $1/(1-\rho) = 3.33$	0.33	-0.16	0.24	0.20	0.09	0.29
4.4: $1/(1-\sigma) = 1.4$	0.38	-0.17	0.24	0.21	0.08	0.27
4.4: $1/(1-\sigma) = 2.6$	0.28	-0.16	0.24	0.19	0.09	0.27

Table 6: Robustness Analysis of Time Gap Variation of Single Households

Country	Survey Years
Austria	1992
Germany	1991-92, 2001-02
Italy	2002-03
Netherlands	1990, 1995, 2000, 2005
Spain	2002-03
United Kingdom	1995, 2000-01, 2005
United States	1992-94 , 2003

Table 7: MTUS: Countries and Survey Years

Variable Name	Variable Label	Variable Name	Variable Label
AV1	Paid work	AV21	Walking
AV2	Paid work at home	AV22	Religious activities
AV3	Paid work, second job	AV23	Civic activities
AV4	School, classes	AV24	Cinema or theatre
AV5	Travel to/from work	AV25	Dances or parties
AV6	Cook, wash up	AV26	Social clubs
AV7	Housework	AV27	Pubs
AV8	Odd jobs	AV28	Restaurants
AV9	Gardening	AV29	Visit friends at their homes
AV10	Shopping	AV30	Listen to radio
AV11	Childcare	AV31	Watch television or video
AV12	Domestic travel	AV32	Listen to records, tapes, cds
AV13	Dress/personal care	AV33	Study, homework
AV14	Consume personal services	AV34	Read books
AV15	Meals and snacks	AV35	Read papers, magazines
AV16	Sleep	AV36	Relax
AV17	Free time travel	AV37	Conversation
AV18	Excursions	AV38	Entertain friends at home
AV19	Active sports participation	AV39	Knit, sew
AV20	Passive sports participation	AV40	Other leisure
		AV41	Unclassified or missing

Table 8: Definition of harmonized activities in MTUS

Variable	MTUS Variables
Market Work	AV1, AV2, AV3, AV5
Home Production	AV6, AV7, AV8, AV9, AV10
Leisure	All the others

Table 9: Definition of time allocation for market work, home production, and leisure

Variable	Obs.	Mean	S.D.	Min	Max
		Austria			
h_{M_m}	696	0.357	0.157	0.010	0.573
h_{M_f}	696	0.327	0.244	0.042	0.573
h_{N_m}	696	0.048	0.074	0.000	0.396
h_{N_f}	696	0.142	0.093	0.000	0.365
		Germany			
h_{M_m}	1767	0.334	0.157	0.003	0.580
h_{M_f}	1767	0.317	0.277	0.035	0.580
h_{N_m}	1767	0.070	0.078	0.000	0.368
h_{N_f}	1767	0.107	0.090	0.000	0.309
		Italy			
h_{M_m}	368	0.343	0.140	0.063	0.576
h_{M_f}	368	0.300	0.236	0.139	0.549
h_{N_m}	368	0.042	0.054	0.000	0.319
h_{N_f}	368	0.119	0.088	0.000	0.264
		Netherlands			
h_{M_m}	2855	0.358	0.160	0.010	0.573
h_{M_f}	2855	0.234	0.212	0.010	0.542
h_{N_m}	2855	0.052	0.066	0.000	0.396
h_{N_f}	2855	0.118	0.107	0.000	0.354
		Spain			
h_{M_m}	1016	0.356	0.155	0.014	0.569
h_{M_f}	1016	0.331	0.270	0.014	0.576
h_{N_m}	1016	0.048	0.061	0.000	0.438
h_{N_f}	1016	0.106	0.081	0.000	0.271
		United Kingdom			
h_{M_m}	963	0.335	0.169	0.014	0.576
h_{M_f}	963	0.320	0.253	0.007	0.552
h_{N_m}	963	0.055	0.069	0.000	0.431
h_{N_f}	963	0.071	0.046	0.000	0.365
		United States			
h_{M_m}	2474	0.348	0.166	0.003	0.580
h_{M_f}	2474	0.333	0.308	0.007	0.580
h_{N_m}	2474	0.052	0.077	0.000	0.417
h_{N_f}	2474	0.069	0.059	0.000	0.299

Table 10: Basic Statistics (Couples)

Variable	Obs.	Mean	S.D.	Min	Max
		Austria			
$h^*_{M,m}$	269	0.355	0.174	0.021	0.552
$h^*_{M,f}$	269	0.338	0.118	0.073	0.573
$h^*_{N,m}$	269	0.067	0.086	0.000	0.406
$h^*_{N,f}$	269	0.097	0.078	0.000	0.365
		Germany			
$h^*_{M,m}$	676	0.345	0.163	0.007	0.576
$h^*_{M,f}$	676	0.329	0.168	0.014	0.569
$h^*_{N,m}$	676	0.062	0.060	0.000	0.326
$h^*_{N,f}$	676	0.088	0.076	0.000	0.347
		Italy			
$h^*_{M,m}$	179	0.338	0.187	0.132	0.569
$h^*_{M,f}$	179	0.304	0.024	0.014	0.542
$h^*_{N,m}$	179	0.053	0.056	0.000	0.292
$h^*_{N,f}$	179	0.092	0.044	0.000	0.243
		Netherlands			
$h^*_{M,m}$	1815	0.345	0.194	0.010	0.573
$h^*_{M,f}$	1815	0.309	0.013	0.010	0.573
$h^*_{N,m}$	1815	0.057	0.062	0.000	0.365
$h^*_{N,f}$	1815	0.077	0.051	0.000	0.281
		Spain			
$h^*_{M,m}$	282	0.324	0.169	0.014	0.576
$h^*_{M,f}$	282	0.313	0.127	0.007	0.576
$h^*_{N,m}$	282	0.063	0.062	0.000	0.368
$h^*_{N,f}$	282	0.098	0.034	0.000	0.340
		United Kingdom			
$h^*_{M,m}$	507	0.337	0.197	0.007	0.569
$h^*_{M,f}$	507	0.295	0.032	0.007	0.573
$h^*_{N,m}$	507	0.056	0.069	0.000	0.361
$h^*_{N,f}$	507	0.077	0.054	0.000	0.438
		United States			
$h^*_{M,m}$	2002	0.352	0.181	0.001	0.578
$h^*_{M,f}$	2002	0.335	0.122	0.002	0.580
$h^*_{N,m}$	2002	0.052	0.077	0.000	0.410
$h^*_{N,f}$	2002	0.066	0.069	0.000	0.451

Table 11: Basic Statistics (Singles)

	Austria	Germany	Italy	Japan	Netherlands	Spain	UK	US
L_m/L_f	1.37	1.04	0.69	2.49	2.49	1.39	1.12	1.40
L_f	0.07	0.08	0.09	0.04	0.05	0.07	0.08	0.07
L_m	0.10	0.08	0.07	0.11	0.11	0.10	0.09	0.10
N	0.35	0.37	0.34	0.29	0.38	0.41	0.43	0.34
N_f^*	0.18	0.16	0.19	0.19	0.14	0.10	0.08	0.18
N_m^*	0.12	0.10	0.13	0.24	0.11	0.07	0.07	0.14
e_m/e_f	1.43	1.11	0.69	1.77	1.88	1.37	1.09	1.45
e_f	0.41	0.48	0.59	0.36	0.35	0.42	0.48	0.41
e_m	0.59	0.52	0.41	0.64	0.65	0.58	0.52	0.59
$h_{M,m}^*/h_{M,f}^*$	1.05	1.05	1.11	1.23	1.12	1.04	1.14	1.05
$h_{M,f}^*$	0.34	0.33	0.30	0.28	0.31	0.31	0.29	0.34
$h_{M,m}^*$	0.36	0.35	0.34	0.34	0.34	0.32	0.34	0.35
$h_{N,m}^*/h_{N,f}^*$	0.68	0.70	0.58	0.22	0.75	0.65	0.72	0.79
$h_{N,f}^*$	0.10	0.09	0.09	0.06	0.08	0.10	0.08	0.07
$h_{N,m}^*$	0.07	0.06	0.05	0.01	0.06	0.06	0.06	0.05
$h_{M,m}/h_{M,f}$	1.09	1.05	1.14	1.30	1.53	1.08	1.05	1.05
$h_{M,f}$	0.33	0.32	0.30	0.25	0.23	0.33	0.32	0.33
$h_{M,m}$	0.36	0.33	0.34	0.32	0.36	0.36	0.34	0.35
$h_{N,m}/h_{N,f}$	0.34	0.65	0.36	0.07	0.44	0.46	0.77	0.79
$h_{N,f}$	0.14	0.11	0.12	0.13	0.12	0.11	0.07	0.07
$h_{N,m}$	0.05	0.07	0.04	0.01	0.05	0.05	0.06	0.05
τ_c	0.20	0.19	0.23	0.13	0.23	0.17	0.17	0.07
τ_ℓ	0.41	0.41	0.38	0.25	0.37	0.30	0.29	0.21
w_m/w_f	0.77	1.46	1.30	0.96	0.65	0.93	1.45	0.99
w_f	0.18	0.15	0.13	0.29	0.23	0.13	0.13	0.24
w_m	0.14	0.21	0.17	0.28	0.15	0.12	0.19	0.24
$w_m e_m/(w_f e_f)$	1.11	1.62	0.90	1.69	1.22	1.28	1.58	1.44
y	0.03	0.03	0.02	0.04	0.03	0.02	0.03	0.04

Table 12: Data

Data :	$\mathbb{N},\ N,\ N_s^*,\ \tau_c,\ \tau_\ell,\ w_s,\ h_{M,s},\ h_{M,s}^*,\ h_{N,s},\ h_{N,s}^*,\quad \forall s \in \{m,f\}$
Exogenous parameters :	$\sigma,\ \rho,\ \eta,\ \gamma_s,\ \gamma_s^*,\quad \forall s \in \{m,f\}$
Calibrated parameters :	$A_s,\ B,\ \omega,\ \alpha_s^*,\ \alpha_s,\ \upsilon,\ \xi,\ \xi_s^*,\ z_s,\ \upsilon,\ c_s,\ c_s^*,\ g,\ g_s^*,\ T,\quad \forall s \in \{m,f\}$

Table 13: Variable list

Variable	Obs.	Mean	Std. Dev.	Min	Max
dlog(A_m/A_f)	322	-0.031	0.047	-0.290	0.099
dlog(L_m/L_f)	322	-0.024	0.040	-0.304	0.103

Table 14: Descriptive statistics

Variables	dlog $\left(\frac{A_m}{A_f}\right)$
dlog(L_m/L_f)	0.866***
	(0.047)
Observations	322
Adjusted R^2	0.69
Implied Parameter (ω)	1.12

Notes: The table presents the results from fixed-effect panel regressions. Standard errors are indicated in parentheses. *** denotes a result that is significant at the 1% level.

Table 15: Estimation Results

Parameter	Value	Description
$1/(1-\eta)$	2.00	EOS b/w g and $h_{N,s}$
$\gamma_s = \gamma_s^*, s \in \{m, f\}$	0.90	the inverse of the Frisch elasticity of leisure
ω	1.12	firm production technology frontier curvature
$1/(1-\rho)$	2.00	EOS b/w $h_{N,m}$ and $h_{N,f}$
$1/(1-\sigma)$	2.10	EOS b/w L_m and L_f
ω_H	3.00	home production technology frontier curvature

Note: EOS = elasticity of substitution

Table 16: Exogenous parameters

	Austria	Germany	Italy	Japan	Netherlands	Spain	UK	US
A_m/A_f	0.82	2.15	1.19	2.11	1.00	1.18	2.26	1.34
A_f	0.09	0.06	0.07	0.10	0.10	0.06	0.05	0.11
A_m	0.08	0.13	0.09	0.20	0.10	0.07	0.12	0.15
B	0.11	0.18	0.14	0.24	0.12	0.09	0.15	0.20
α_f^*	0.57	0.58	0.52	0.44	0.52	0.52	0.49	0.47
α_m^*	0.55	0.52	0.53	0.41	0.51	0.48	0.47	0.45
α_f	0.61	0.66	0.52	0.59	0.54	0.58	0.60	0.55
α_m	0.52	0.43	0.55	0.26	0.48	0.44	0.37	0.36
c_f^*	0.33	0.33	0.32	0.36	0.32	0.29	0.30	0.37
c_m^*	0.34	0.37	0.31	0.45	0.35	0.30	0.35	0.43
c_f	0.03	0.03	0.02	0.05	0.03	0.02	0.03	0.04
c_m	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
g	0.05	0.06	0.05	0.09	0.05	0.04	0.05	0.08
g_f^*	0.03	0.03	0.02	0.03	0.03	0.02	0.02	0.04
g_m^*	0.03	0.03	0.02	0.06	0.03	0.02	0.03	0.05
υ	0.75	1.54	1.34	0.97	0.62	0.93	1.53	1.00
ξ	0.88	0.87	0.88	0.84	0.86	0.88	0.87	0.82
ξ_f^*	0.90	0.92	0.91	0.86	0.89	0.90	0.91	0.87
ξ_m^*	0.93	0.91	0.92	0.93	0.92	0.92	0.90	0.88
z_f	0.65	0.45	0.61	0.75	0.63	0.58	0.43	0.48
z_m	0.35	0.55	0.39	0.25	0.37	0.42	0.57	0.52
υ_H	0.42	1.82	0.84	0.33	0.38	0.69	1.93	1.06
B_H	0.16	0.33	0.25	0.15	0.15	0.21	0.34	0.26

Table 17: Calibrated parameters: Endogenous Productivity of Home Production Model

	Austria	Germany	Italy	Japan	Netherlands	Spain	UK	US
k	0.19	0.21	0.14	0.28	0.15	0.10	0.11	0.14
θ	0.37	0.35	0.36	0.44	0.35	0.39	0.28	0.36
τ_k	0.18	0.13	0.18	0.17	0.18	0.20	0.31	0.27

Table 18: Capital stock data