

# Globalization, Gender Empowerment and Fertility

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## Abstract

This study explores the effects of globalization on fertility rates of countries. Globalization affects the income gap among certain groups and gender gap is not exception. Since a couple consisting of a man and a woman is one decision unit of family planning, there is a growing consensus that gender gap influences the population of countries. In this study, we depict that globalization in terms of integration of capital market alters the gender gap in wage rates through the changes in labor demand for capital-intensive sectors. Consequently, globalization leads an opposite effects on fertility decisions in capital-importing and capital-exporting countries, via changes in the bargaining positions of men and women. Moreover, by taking account of the properties of industrial structures of capital-importing and capital-exporting countries, our result shows that globalization induces empirically observed declines in fertility rates throughout the world.

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# 1 Introduction

Globalization affects gender empowerment and fertility outcomes all over the world through many factors in labor markets. As a direct effect of the integration of labor market attributed by globalization, we can raise the social remittance, which brought by immigrants into their home countries. For example, if the women are relatively empowered and family size is relatively small in your destination country, the immigrants may bring the culture or social norms back to their home countries and spread them to the community there.<sup>1</sup> Moreover, the globalization characterized by the market integration in production factors and final goods also causes an indirect effect. For instance, the capital mobility accompanied by the capital market openings will benefit the workers who are complementary to capital in production while it may harm the workers who has less complementary relationship with the capital. If either female or male workers tend to be complementary to capital in production, the capital flows effect on outcomes in labor market such as the wages and employment of men and women, leading changes in gender relation and household decisions.

Since the influential work by Galor and Weil (1996), many studies have explored the role of capital accumulation on the gender empowerment and household production, especially focusing on fertility decisions. These studies consider the situation in which the men and women are affected asymmetry by capital accumulation in the process of economic development. If we assume the economy where the female labor is relatively complementary to capital, capital accumulation leads to higher relative female wage. And this means the higher opportunity cost of having children followed by decline in fertility.

Looking an increase in the level of capital not from the view of in one country, but the view the economy composed by multiple countries allow us to shed new and different light on the relationship between a change in capital stock and gender empowerment. The total capital in the world is fixed at a certain period, implying that an increase in the capital level in one country means that capital is reduced somewhere in the rest of world. As such, the effects become more complicated. If a country who experiences the capital inflow enjoys higher female wage and lower fertility rate, the country with capital outflow may do opposite situation. The capital outflow causes the drop in female wage rates, leading to a rise in fertility rate. In this case, the effects of changes in the capital level on each country and the whole economy are not easy to determine. This study tries to answer this issue and fill the gap in the literature by exploring the effects of changes in capital level in this aspect.

For our purpose, we develop a model with three distinct features. First, in order to consider the situation of capital mobility, we utilize the tax competition theory. This framework was originally invented for analyzing the effects of market integration of economy which consists of multiple countries (e.g., EU integration), succeed in the contributing to the analyses on the impacts of globalization on each country. The theory predicts that globalization in terms of capital market integration allows the countries with the higher return from investment attract the capital from all over the world, resulting in asymmetric effects on individuals with the heterogeneities such as the level of skills, employment status, and capital

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<sup>1</sup>See, for example, Fargues (2011), Beine et al. (2013) and Ferrant and Tuccio (2014).

endowments (Gerber and Hewitt, 1987; Lai, 2010; Ogawa et al. 2015).<sup>2</sup> However, among these studies, workers and household are just defined as “rational individual”, often assumed to be homogenous within the household.

The second is the heterogeneity among workers: male and female workers are different production labor inputs in accordance with the degree of complementarity for capital. Galor and Weil (1996), Saure and Zoabi (2009), and among others assumed that women is complementary to physical capital. However, the degree of complementarity of workers, and the main industry of the country varies especially in accordance with the degree of economic development. So far, manufacturing and service represents the main industries in developed countries, while developing countries are more likely to rely on manufacturing and agriculture rather than service industry. Moreover, large portion of female employment in developing countries are machinery due automation of production processes with machines and to their lower wage (Juhn et al. 2014)<sup>3</sup>, while in developed countries women tend to engage in service and men are the main workers in manufacturing industries. Thus, newly built factories due to mobile capital do not necessarily create employment for workers of specific gender so that it is worth investigating without characterizing both country with the same production technology.

Growing literature on globalization and women’s empowerment look at this point and who is complementary to physical capital seems inconclusive. For example, different from the view that female labor are likely to be affected by globalization, Fontana and Wood (2000) pointed out that international trade affects male labor demand as well as female. Seguino (2000) found globalization influences oppositely gender wage gaps in manufacturing industries in Korean and Taiwan, while Wood (1991) found a trade attributed by an increase in the female employment in manufacturing industry in developing countries may result in the decrease in male employment in that of developed countries. Mayer (2006) explains this difference comes from the trades between countries with different development stages. Standing (1999) also confirmed that the three decades characterized with globalization induce increases in female labor participation in both developing and developed countries and decrease in male participation in developed countries. Following the literature for distinguishing male and female labor inputs, we introduce the analysis in which men are more complement to physical capital as a basic model, and then the existing opposite case without limiting into either of them.

The third feature is heterogeneity within a household: we assume that male and female form a couple but they have different preference for household production. One possible example can be the number of children. As Ray and Riezman (2012), the couple negotiate over their common consumption and the number of their children following the bargaining rule characterized by labor market outcome (e.g., relative wages or labor income). According to the comprehensive survey by Doepke and Kindermann

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<sup>2</sup>The literature originally presented by Zodrow and Miezskowski (1986) and Wilson (1986), demonstrated that the governments reduce the capital tax rate being involved in the race to the bottom to attract the capital from the other country.

<sup>3</sup>Juhn et al. (2014) both constructed a model to examine how automation of production process affect the gender inequality in labor market, which are supported by the panel data of Mexico.

(2014), it is observed in both developed and developing countries that men tend to prefer larger family size than their partners, and that fertility bargaining exists. In order to discuss the domestic work including childcare which is an inseparable part of gender empowerment, we here consider the effect of globalization on the intra-household allocation including household production.

We obtain two main results. We first show that, when two countries have the same production technology, globalization brings the opposite effects on household production to capital-importing and capital-exporting countries. This result is naturally expected when we consider globalization as an integration from two individual economies into one large one in the whole. Suppose a Galor and Weil production technologies for both countries as Saure and Zoabi (2009) assume, globalization leads to a reduction in female wage rate of capital-exporting country while an increase for that of capital-importing country. Since relative economic positions affect their autonomy in their marriage, household demand for domestic production (fertility) reflects the changes in their bargaining power followed by the smaller family size in the former country and the larger family size in the latter country. Then, taking account of the fact that the capital-complementarity labor differs between agricultural and machinery industries and that major industries are different between capital-importing and capital-exporting countries in the world-wide level, it is shown that fertility declines occurs in every country.

The rest of paper is organized as follows. First, Section 2 introduces a simple model of economy where men are the more complement labor input to the physical capital compared to women and gives main results. In Section 3, we extend the basic model in the various way to reflect the more realistic situations. Section 4 argues the alternative production technology in which female labor is more complement to the physical capital as the existing studies have assumed. Moreover we argue the effects of capital market integration of countries with heterogeneous technology in terms of the relative complementarity of labor inputs to physical capital. Finally, Section 5 concludes this paper.

## 2 Model

Following Galor and Weil (1996), this study develops a model which distinguishes the male and female labor as different production inputs. Let us start with the case in which male labor is more complement input with capital input than female labor. This case may capture the situation that male workers are more likely to engage in manufacturing industries where labor are combined with machinery associated with capital for the production (e.g., car industry) while women tend to engage in service industry which is relatively labor intensive industry than the former. It is also feasible case that female labor is more complement with capital than male labor is. This case is, however, more applicable to describe the situation that developing world with high weight on agricultural industry as Galor and Weil (1996) indicated. Besides, when we focus on the machinery industry which is typical example the industry relates to the capital mobility, which labor is more complement to physical capital depends on which type of labor the industry demands. Thanks to the automation of production processes with machines, the industry does not necessary require the physical labor which mainly rely on male labor. As Standing

(1999) and Anderson (2005) suggested, when the specific skills are not required due to these automations, since male and female labor are substitute so that firms are more likely to employ the female labor with lower wage for light task combined by machines. In this case, we can regard the female labor is implicitly more complement to the physical capital in the country. However, as in developed countries, if women can access to the labor market of industries which require much lighter tasks and they are more likely to apply in these labor markets, men can be more complement to the capital as a whole country. According to these complexity, empirical studies are inconclusive for the question which of female or male labors is more compliment input with capital since they differ across industries, countries and ages. This study, thus, begins with the analysis of the case where male labor is compliment to capital and that female labor is not, deferring the opposite case until later.

## 2.1 Firms

Firms produce the private good as the numéraire by using the inputs of male and female workers, and capital. The production technology is formulated as  $Y_i = F(K_i, M_i, F_i)$ , where  $K_i$ ,  $M_i$  and  $F_i$  are capital input, male labor input, and female labor input, respectively. We assume  $F(\cdot)$  is homogenous of degree one with respect to three inputs. To obtain clear result, we specify the production function as

$$Y_i = \left( A - \frac{K_i}{M_i} \right) K_i + bF_i. \quad (1)$$

In (1), we assume that capital complements male labor but women labors are less complements with capital.<sup>4</sup>

The profit function of firms in country  $i$  becomes:

$$\pi_i = \left( A - \frac{K_i}{M_i} \right) K_i + bF_i - m_i M_i - f_i F_i - r_i K_i.$$

$m_i$  and  $f_i$  define male wage rate and female wage rate, while  $r_i$  represents the price of capital. When the capital is mobile across the countries,  $r_1 = r_2 \equiv r$  holds. When capital is immobile, on the other hand, the price of capital differs between countries in accordance with the level of capital existing in each country ( $r_1 \neq r_2$ ).

The profit maximization gives the followings:

$$m_i = \frac{K_i^2}{M_i^2}, \quad (2)$$

$$r_i = A - \frac{2K_i}{M_i}, \quad (3)$$

$$b = f_i. \quad (4)$$

Note that a change in the level of capital in country  $i$ ,  $K_i$ , influences the male wage rate,  $m_i$  but not for female wage rate,  $f_i$ .<sup>5</sup>

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<sup>4</sup>The first term associated with capital and male labor is often used to make analysis more tractable in the tax competition literature (Wildasin 1991; Brueckner 2004; Kempf and Rota-Graziosi 2010; and Ogawa 2013; among others).

<sup>5</sup>A number of studies have examined the effects of globalization on gender gap in labor outcomes. For instance since

## 2.2 Household

*Constraints.* Suppose that each gender group is populated one in each country, and they form a family as a couple under the monogamy system. Each individual is endowed with one unit of time. The couple benefits from private goods consumption,  $c$ , and household public goods,  $n$ . The private goods are obtained from the market, but the household public goods are produced by the female labor: one unit of their time spent at home can produce one unit of household public goods. We here take the number of children as the household public goods for instance.

The relation of the number of children and the maternal time for raising children (the production function of children) is assumed as  $n_i + F_i = 1$ , implying that the relation between the number of children and female labor supply  $F_i$  is negative. We assume that men supply their entire time in the market work and that a couple in country  $i$  has an initial endowment of capital  $\kappa_i$ . Then, the couple's budget constraint is given as  $m_i + bF_i + r_i\kappa_i = c_i$ . The first two terms of LHS is the couple's labor income and the third term represents the capital income while  $c_i$  stands for level of (common) consumption of the couple.

*Preferences.* The utility function of each individual in country  $i$  is defined in the quasi-linear function as  $U_{fi} = c_i + \delta \ln n_i$  and  $U_{mi} = c_i + \ln n_i$ , where  $\delta > 0$  denotes parameter of women preference as to family size. Based on some evidences, it may be natural to assume that  $0 < \delta \leq 1$ , which indicates that women prefer smaller family size than men do (Ray and Riezman 2012; Doepke and Kindermann 2014).

To describe the situation where the couple negotiates over resource allocation of household, we follow the collective model developed by Apps and Rees (1988), Chiappori (1988,1992), and Komura (2013). We follow their analytical framework and assume that the couple will maximize the weighted average of household's and wife's welfare. The welfare function of the couple is, then, given as:<sup>6</sup>

$$W_i = \theta_i U_{fi} + (1 - \theta_i) U_{mi} = c_i + (1 - \theta_i + \theta_i \delta) \ln n_i,$$

where  $\theta_i$  is the bargaining power of women in county  $i$  relative to their husbands. Note that, when  $\theta_i = 1$ , the objective function of the household becomes the wife's utility, while in the opposite extreme case of  $\theta_i = 0$ , it corresponds to that of their husbands.

*Bargaining power.* We characterize the bargaining power of women as a function of female/male wage

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Wood (1991), some empirical studies have found asymmetry in the effects of globalization and men are more likely to be affected by the globalization of manufacturing industry in developed countries. This can be interpreted that men are more complement to physical capital in some economies. The discussion section also provides the analysis with the production function in which female labor input is more complement to physical capital so that we can compare the results and can analyze with the heterogeneous production function in two countries.

<sup>6</sup>Alternative specification of intra-household bargaining is based on Nash bargaining model (Mansar and Brown, 1980; McElroy and Horney, 1981; Lundberg and Pollak, 1993; Konrad and Lommerud, 2000). Excluding the possibility of break-down of their negotiation with the long-run relationship of couples, we can make use of the tractable specification of collecting model for intra-household bargaining, which assumes that family members can always achieve the efficient allocation within the household.

gap:  $\theta_i = \theta_i(f_i - m_i)$ . We assume  $\theta'_i \equiv \partial\theta_i/\partial f_i = -\partial\theta_i/\partial m_i \geq 0$ , where a prime denotes the first-order derivative. If  $\theta'_i = 0$  holds, bargaining power is fully determined by exogenous factors. On the other hand, if  $\theta'_i > 0$ , bargaining power is also influenced by gender wage gap. We here begin by describing the bargaining power is influenced by wage gap, deferring extension, in which it is determined by income gap, until later.

Using (4), the bargaining power of women is rewritten as:

$$\theta_i = \theta_i(b - m_i). \quad (5)$$

Since household cannot control the wage rates, bargaining power is exogenous for them. However, as the wage rates are determined in the market, the bargaining power is endogenous in the whole economy.

*Optimization.* The problem of the household is defined as:

$$\begin{aligned} \max \quad & W_i = c_i + (1 - \theta_i + \theta_i\delta) \ln(1 - F_i) \\ \text{s.t.} \quad & c_i = m_i + bF_i + r_i\kappa_i. \end{aligned}$$

Solving the problem gives the female labor supply as:

$$F_i = \frac{b - 1 + \theta_i(1 - \delta)}{b}. \quad (6)$$

### 2.3 Equilibrium

In the first part of this section, we consider autarky wherein the capital market is not integrated, i.e., capital is immobile. In the second part, we analyze the impacts of capital market integration on the female labor participation, the power balance within a couple, and the fertility.

*Autarky.* We have assumed that each county is initially endowed with  $\kappa_i$  of capital. Denoting the total capital in the whole economy as  $\kappa$ ,  $\kappa_i + \kappa_j = \kappa$  holds. Since the capital is stick to it's country in autarky,

$$K_i = \kappa_i. \quad (7)$$

Moreover, there is one unit of male worker in country  $i$ ,  $M_i = 1$ . Substituting (7) and  $M_i = 1$  into (2) gives:  $m_i = \kappa_i^2$ , which is used, with (5), to get  $\theta_i = \theta_i(b - \kappa_i^2)$ . Then, from (6), we have the equilibrium value in the autarky:

$$F_{ia} = \frac{(1 - \delta)\theta_{ia}}{b} + \frac{b - 1}{b}, \quad \text{where } \theta_{ia} = \theta_i(b - \kappa_i^2). \quad (8)$$

We here refer to the case of autarky, in which capital market is not integrated, as a subscript  $a$  in each variable.

Since  $\theta'_i \geq 0$  and  $\delta < 1$ , the following relation is satisfied:  $\theta_{ia} > (<)\theta_{ja} \leftrightarrow \kappa_i < (>)\kappa_j$ , which shows that women's bargaining power in the capital-rich country is relatively low in the autarky (before the capital market integration). This is because high male wage rate from the higher initial level of capital contributes to higher bargaining power of men.

From (8), the property of female labor supply is derived as:

$$\frac{\partial F_{ia}}{\partial \kappa_i} = -\frac{2(1-\delta)\theta'_i \kappa_i}{b} \quad \text{and} \quad \frac{\partial F_{ia}}{\partial b} = \frac{1 + (1-\delta)\theta_i}{b^2}.$$

It is implied from the first equation that, if  $\delta < 1$  holds, an increase in bargaining power of women, accompanied by the decrease of initial capital stock in country  $i$ , increases her labor supply, and thereby decreases the family size. This is because women prefer having children less, and thus she increases her labor supply to have smaller family size as she has endowed more power to determine the household allocation.

The second equation means that the impact of an increase in female wage rate on the female labor supply is positive. Basically, an increase in female wage simply increases the female labor supply (price effect). At the same time, when women prefer smaller family size,  $\delta < 1$ , a rise in their wage rates always increases the labor supply since bargaining power of women is enhanced (bargaining power effect), so that she reduces the number of children since she has weak preference for the family size. In this case, an increase in female wage rate always increases the female labor supply, and thus reduce the fertility.

*Capital Market Integration.* We now lift the curbs on capital mobility between the two countries. Reminding that  $M_i = 1$ , the difference in capital returns is eliminated under the integrated capital market, and the net return on capital is equalized in equilibrium:

$$r = A - 2K_i. \tag{9}$$

Moreover, since the capital is utilized in either of two countries in the integrated capital market, the condition of market equilibrium holds as:

$$K_1 + K_2 = \kappa_1 + \kappa_2 = \kappa. \tag{10}$$

Then, from (9) and (10),  $K_1 = K_2$  holds, which indicates that

$$K_i = \frac{\kappa_1 + \kappa_2}{2} = \frac{\kappa}{2}. \tag{11}$$

Comparing (7) and (11), we obtain the following lemma.

**Lemma 1.** *Suppose that  $\kappa_i > \kappa_j$ . Integration of capital market leads to a capital moving from country  $i$  to country  $j$ .*

Since country  $j$  has smaller amount of initial capital, the net return of capital investment in country  $j$  is higher than in country  $i$ . Once the capital market is integrated, capital flows from country  $i$  to country  $j$  to seek higher rents.

Substituting (11) into (2) and using  $M_i = 1$  give the male wage rate after the capital market integration as  $m_i = \kappa^2/4$ . Denoting the bargaining power of women after the market integration as  $\theta_{io}$ , where the subscript  $o$  represents that the capital market is *opened*, from (5), (6), and  $m_i = \kappa^2/4$ , we have female labor supply after the integration of capital market as:

$$F_{io} = \frac{(1-\delta)\theta_{io}}{b} + \frac{b-1}{b}, \quad \text{where } \theta_{io} = \theta \left( b - \frac{\kappa^2}{4} \right). \quad (12)$$

## 2.4 Comparison

Comparison of (8) and (12) reveals how the capital market integration impacts on the female labor supply and the power balance within a couple:

$$n_{ia} \underset{>}{\overset{<}{<}} n_{io} \Leftrightarrow F_{ia} \underset{>}{\overset{<}{>}} F_{io} \Leftrightarrow \theta_{ia} \underset{>}{\overset{<}{>}} \theta_{io} \Leftrightarrow \kappa_j \underset{>}{\overset{<}{>}} \kappa_i. \quad (13)$$

From (13), we obtain the following propositions:

**Proposition 1:** *Suppose that  $\kappa_i > \kappa_j$ . The capital market integration increases the women's bargaining power in country  $i$  while it reduces that of the country  $j$ ,  $\theta_{ia} < \theta_{io}, \theta_{ja} > \theta_{jo}$ , followed by a decline in fertility rate of the country  $i$  and by a rise in that of the country  $j$ ,  $n_{ia} > n_{io}, n_{ja} < n_{jo}$ .*

The mechanism behind the results is follows. Initially, the county  $i$  is endowed with high level of capital while that of the country  $j$  is low. Since male labor is complement with capital, the male wage rate is higher in the country  $i$  than in country  $j$  (i.e., the wage gap in country  $i$  is larger than that of country  $j$ ) leading men in country  $i$  to have more autonomy compared to that of country  $j$ . Since men has larger ideal family size ( $\delta < 1$ ), ceteris paribus, fertility rate is higher in country  $i$  than country  $j$ .

Now, let us suppose that the capital market integration occurs. The capital flows from the country  $i$  endowed with abundant capital to the other, equalizing the prices of capital rent (i.e., interest rates) of two countries. Accordingly, the price of male labor, which is complement to capital, decreases in country  $i$ , while it increases in country  $j$ , narrowing the international wage gap in male wage rates. As a result of the capital market integration, fertility rate of country  $i$  decreases through a rise in the bargaining power of women whose ideal family size is small compared to their husbands and does opposite in country  $j$ .

## 3 Extension

This section extends the basic model to check the robustness of our main results. By extending the model, we also aim at reflecting the more realistic situation and at deepening our discussions. Specifically, we consider (i) the case in which the gender bargaining power is determined by earnings, (ii) the case in which the production technology differs across countries, and (iii) the case in which income effect exists.

### 3.1 Bargaining power determined by gender income gap

In this subsection, we consider the case where the bargaining power is determined by gender income gap or earnings rather than wage rates. In the literature of family economics, the marital bargaining whose bargaining power is determined by wage rate are considered that the couple can make an enforceable contract for entire life or can negotiate at front since achieving the efficient solution accompanied by domestic specialization may involve the hold-up problem. In contrast, the case the bargaining power is determined by earnings can be regarded as the case where women are in vulnerable position once she accepts to specialize in the domestic tasks. This analysis, however, looks at this two situation from different sight by looking at the global economy. Specifically we carry out the analysis regarding the bargaining power endogenous in the way that it is affected by the choice on labor supply. The equation of bargaining power is then modified as  $\theta_i = \theta(f_i F_i - m_i)$ , where  $\theta'_i > 0$  and  $\theta''_i < 0$  are assumed.

In this setting, it is required to consider the effects of households' control over  $F_i$  on bargaining power. The optimization problem of the household yields the first-order condition as follows.

$$\frac{\partial W_i}{\partial F_i} = b - \frac{1 - \theta_i(1 - \delta)}{1 - F_i} - (1 - \delta) \frac{\partial \theta_i}{\partial F_i} \ln(1 - F_i) = 0. \quad (14)$$

Reminding that, in (14),  $\theta_i = \theta(bF_i - K_i)$  since  $m_i = K_i^2$ , total differentiation of (??) with respect to  $F_i$  and  $K_i$  yields

$$\frac{dF_i}{dK_i} = \frac{(1 - \delta)n_i}{\Delta} \left( \frac{\partial \theta_i}{\partial K_i} - \frac{\partial \theta_i / \partial F_i}{\partial K_i} n_i \ln n_i \right), \quad (15)$$

where  $\Delta \equiv 1 - (1 - \delta)\theta_i - (1 - \delta)n_i\theta'_i + (1 - \delta)n_i(\theta''_i n_i \ln n_i - \theta'_i) > 0$  from the second-order condition for the maximization. The first term in parentheses of (15) is negative as before. The second term in parentheses of (15) is newly added due to a change in the equation of bargaining power. Since  $\partial^2 \theta_i / \partial F_i \partial K_i = -\theta''_i > 0$ , the sign of (15) is still negative. In sum, the modification of the equation of bargaining power would contribute to reinforce our results.

s empowerment can be achieved at the same time in spite of an increase in men's bargaining power as a result of exogenous event for them.

### 3.2 Productivity Differential

The analysis in Section 3 is conducted by assuming that two countries have identical technology in production. This assumption is well justified if we admit of international technology spillovers in the long-run. However, some studies on tax competition make a point of the effects on the equilibrium outcome of technological asymmetry in production between the two countries.<sup>7</sup> In this section, we provide an outcome that is useful for examining the effects of asymmetric production technology on the impacts of capital market integration.

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<sup>7</sup>See, for example, the initial work of Bucovetsky (1991).

The basic setup and notation of the previous sections can still be preserved here, except for the production function. We here assume that the production function is given by  $Y_i = (A_i - K_i/M_i)K_i + bF_i$ , where  $A_i$  is the country-specific parameter representing the productive efficiency. If  $A_i > A_j$ , country  $i$  is more attractive to be invested than country  $j$  for given capital per male labor. Note here that, under autarky, since capital is fixed in each country, the equilibrium agrees completely with the equilibrium presented in the previous section. In contrast, when capital is mobile, the technology differential effects on the equilibrium characteristics through capital mobility. However, since the analysis is based on the model in section 2, we simply present the key outcomes.<sup>8</sup>

In the integrated capital market, capital allocation in the integrated capital market satisfies  $K_i + K_j = \kappa$  and  $A_i - K_i = A_j - K_j$ , indicating that the total amount of capital located in country  $i$  is given by

$$K_i = \frac{\kappa}{2} + \frac{A_i - A_j}{4}. \quad (16)$$

To ensure  $K_i \geq 0$  in equilibrium, we make the following assumption:

**Assumption 1.**  $-2\kappa < A_i - A_j < 2\kappa$

Substituting (16) into (2), the wage rate of male labor under capital mobility is given by

$$m_{io} = \left( \frac{\kappa}{2} + \frac{A_i - A_j}{4} \right)^2. \quad (17)$$

Under the modified production function, from (6) and (17), the labor supply of women and women's bargaining power are given by

$$F_{io} = \frac{(1 - \delta)\theta_{io}}{b} + \frac{b - 1}{b}, \quad \text{where } \theta_{io} = \theta \left( b - \left( \frac{\kappa}{2} + \frac{A_i - A_j}{4} \right)^2 \right). \quad (18)$$

A comparison of (8) and (18) gives the followings:

$$F_{ia} \underset{<}{>} F_{io} \Leftrightarrow \theta_{ia} \underset{<}{>} \theta_{io} \Leftrightarrow \frac{(A_i - A_j + 2\kappa + 4\kappa_i)(A_i - A_j + 2\kappa - 4\kappa_i)}{16} \underset{<}{>} 0. \quad (19)$$

Under Assumption 1,  $A_i - A_j + 2\kappa + 4\kappa_i > 0$ . Hence, the sign in (19) depends on the sign of  $A_i - A_j + 2\kappa - 4\kappa_i$ , which is depicted in Figure 1. In the shaded area,  $F_{io} > F_{ia}$  and  $\theta_{io} > \theta_{ia}$  hold while the sign is reversed in other area. That is, if country  $i$  has a relatively sufficient quantity of initial capital to invest abroad,  $\kappa_i > 0.5\kappa$  ( $\kappa_i > \kappa_j$ ), and if it is not attractive to be invested due to inferior technology,  $A_i < A_j$ , then the capital market integration always increases the bargaining power of women, and thereby increases female labor supply and reduces the fertility in country  $i$ . This implies Proposition 1 still preserves if  $A_i \leq A_j$ . However, when  $A_i > A_j$ , the capital market integration may decrease the bargaining power of women, resulting a decrease in female labor supply if  $\kappa_i > 0.5\kappa$  but country  $i$  is considerably attractive place for capital investment, i.e.,  $A_i - A_j$  is sufficiently large.

Figure 1.

<sup>8</sup>The formal analysis is available upon request.

### 3.3 Income effect

We now take into account of the income effects in the basic model so as to show our conclusion holds. The utility function of each individual in country  $i$  is defined in the log linear function as  $U_{fi} = \ln c_i + \delta \ln n_i$  and  $U_{mi} = \ln c_i + \ln n_i$ . Solving the household problem, we have

$$F_i = \frac{b - (1 - \theta_i + \delta\theta_i)(m_i + \kappa_i r_i)}{b(2 - \theta_i + \delta\theta_i)}, \quad (20)$$

where  $\theta_i = \theta(b - m_i)$ .

In the autarky,  $r_{ia} = A - 2\kappa_i$  and  $m_{ia} = \kappa_i^2$  hold. Substituting these equations into (20), the female labor supply in the autarky is given by

$$F_{ia} = \frac{b - (1 - \theta_i + \delta\theta_i)\kappa_i(A - \kappa_i)}{b(2 - \theta_i + \delta\theta_i)}, \quad (21)$$

where  $\theta_{ia} = \theta(b - \kappa_i^2)$ . Using this equation, we have

$$\begin{aligned} \frac{\partial F_{ia}}{\partial \kappa_i} &= \frac{\partial F_{ia}}{\partial \kappa_i} + \frac{\partial F_{ia}}{\partial \theta_i} \frac{\partial \theta_i}{\partial \kappa_i} \\ &= -\frac{(A - 2\kappa_i)(1 - \theta_i + \delta\theta_i)}{b(2 - \theta_i + \delta\theta_i)} - 2\theta'_i \kappa_i \frac{(1 - \delta)(b + A\kappa_i - \kappa_i^2)}{b(2 - \theta_i + \delta\theta_i)^2} < 0. \end{aligned}$$

Hence, if  $\kappa_i > \kappa_j$ , then  $F_{ia} < F_{ja}$ .

In the open economy ( $K_i = K_j = \kappa/2$ ), on the other hand,  $r_{io} = A - \kappa$  and  $m_{io} = \kappa^2/4$  hold. Substituting these equations into (20), we have the female labor supply in the equilibrium of open economy as:

$$F_{io} = \frac{4b - (1 - \theta_i + \delta\theta_i)\kappa(1 + 2(A - \kappa))}{4b(2 - \theta_i + \delta\theta_i)}, \quad (22)$$

where  $\theta_{io} = \theta(b - \kappa^2/4)$ .

The comparison of (21) and (22) shows

$$F_{io} - F_{ia} = \frac{4b - (1 - \theta_{io} + \delta\theta_{io})\kappa(1 + 2(A - \kappa))}{4b(2 - \theta_{io} + \delta\theta_{io})} - \frac{b - (1 - \theta_{ia} + \delta\theta_{ia})\kappa_i(A - \kappa_i)}{b(2 - \theta_{ia} + \delta\theta_{ia})}, \quad (23)$$

where  $\theta_{ia} = \theta(b - \kappa_i^2)$  and  $\theta_{io} = \theta(b - \kappa^2/4)$ . From (23), we find that, in capital-exporting countries, a decrease in earnings of workers who are complementary to the capital reduces the household income as a whole thereby the decline in fertility rate. On the other hand, capital-importing countries experience a rise in earnings of these workers which increases household income, leading to the higher fertility rate. In sum, the presence of income effects enhance our main results of basic model.

## 4 Discussion

This section explores the effects of globalization on intra-household allocation on household production in the case, where the female labor is more complementary input to physical capital than that of men, as in

Galor and Weil (1996). Since the analysis is parallel to that in section 3, the description of the model will be brief.

#### 4.1 When female labor and capital are complements in two countries

*Firms.* In this case, since the female labor is more complement input than that of men, the specification of the firms' production activities are different from the basic model. Firms now produce goods by using the inputs of male and female workers, and capital. The CRS production function in country  $i$  is as defined as:  $Y_i = (A - K_i/F_i)K_i + bM_i$ . The profit function of firms in country  $i$  becomes:

$$\pi_i = \left( A - \frac{K_i}{F_i} \right) K_i + bM_i - m_i M_i - f_i F_i - r_i K_i.$$

The profit maximization gives the followings:

$$f_i = \frac{K_i^2}{F_i^2}, \quad (24)$$

$$r_i = A - \frac{2K_i}{F_i}, \quad (25)$$

$$m_i = b. \quad (26)$$

Note that a change in the level of capital in country  $i$ ,  $K_i$ , influences the female wage rate,  $f_i$  but not for male wage rate,  $m_i$ .

*Household.* While firms differs in production function, households are modeled identically from the basic model. Thus, the optimization of household is summarized as

$$\begin{aligned} \max \quad & W_i = c_i + (1 - \theta_i + \theta_i \delta) \ln(1 - F_i) \\ \text{s.t.} \quad & c_i = m_i + f_i F_i + r_i \kappa_i. \end{aligned}$$

Solving the problem, we have the female labor supply as:

$$F_i = 1 - \frac{1 - \theta_i(1 - \delta)}{f_i}. \quad (27)$$

Substituting (24) and (26) into (27), we have the equilibrium amount of female labor which satisfies  $F_i^2 + K_i^2(F_i - 1) - (1 - \delta)F_i^2\theta_i = 0$ , where  $\theta_i = \theta(K_i F_i^{-2} - b)$ . To see how it relates with the amount of capital located in the country, we totally differentiate this equation with respect to  $F_i$  and  $K_i$  to get

$$\frac{dF_i}{dK_i} = \frac{n_i + (1 - \delta)F_i\theta'_i}{K_i^2 + 2F_i[1 - (1 - \delta)\theta_i] + 2(1 - \delta)f_i F_i \theta'_i}.$$

Since  $1 - (1 - \delta)\theta_i > 0$  and  $\theta'_i \geq 0$ , we have  $dF_i/dK_i > 0$ . Hence, we derive the following relationship:

$$K_i \begin{matrix} > \\ < \end{matrix} K_j \Leftrightarrow F_i \begin{matrix} > \\ < \end{matrix} F_j \Leftrightarrow n_i \begin{matrix} < \\ > \end{matrix} n_j.$$

Intuitively, when the initial endowment of capital is large, female wage rate is high. When women prefer smaller family size than their husbands,  $\delta < 1$ , a higher female wage rates leads to the higher labor supply of women through the positive price effect and the positive bargaining power effect, resulting in the lower in fertility rate.

*Autarky.* Suppose that each county is initially endowed with  $\kappa_i$  of capital. It is assumed that the total capital in the whole economy is  $\kappa$  and the following equation holds:  $\kappa_i + \kappa_j = \kappa$ .

Before economic integration,  $K_{ia} = \kappa_i$  holds because capital does not move across countries. A subscript  $a$  denotes the autarky outcome. Without any loss of generality, we assume that country  $i$  is endowed more capital;  $\kappa_i > \kappa_j$ . Then, we have the following lemma.

**Lemma 2.** When  $\kappa_i > \kappa_j$ , in the autarky,  $F_{ia} > F_{ja}$  and  $n_{ia} < n_{ja}$ .

*Market integration.* From the property of economy that the price of capital (the return from the capital) of each country is equalized after integration of its market, we have the following equations:

$$r = A - \frac{2K_i}{F_i}, \quad (28)$$

implying that  $K_i/F_j = K_j/F_j$ . Since  $f_i = (K_i/F_i)^2$ , we have  $f_i = f_j$  in the open economy equilibrium. Hence, from (5), we have  $\theta_i = \theta_j$ . Since the amount of female labor is given by (27), we have  $F_{io} = F_{jo}$ , showing that  $K_{io} = K_{jo}$  holds in the equilibrium.

**Lemma 3.** Assume that  $\kappa_i > \kappa_j$  holds. Once the capital market is integrated, the capital moves from country  $i$  to country  $j$ ;  $K_{ia} = \kappa_i > K_{io}$  and  $K_{ja} = \kappa_j < K_{jo}$ .

Once the capital market is integrated, capital moves from capital-rich to capital-poor country. In this sense, country 1 exports capital and country 2 imports it.

**Lemma 4.** In the open-market equilibrium,  $F_{io} = F_{jo}$  and  $n_{io} = n_{jo}$ .

From Lemma 2 and 4, we have the following result.

**Proposition 2.** Suppose that  $\kappa_i > \kappa_j$ .  $F_{ia} > F_{io}$ ,  $F_{ja} < F_{jo}$ ,  $n_{ia} < n_{io}$ , and  $n_{ja} > n_{jo}$ . That is, once the capital market is integrated, the amount of female labor in country  $j$  increases and the fertility declines. In contrast, in country  $i$ , the woman tends to work less and that the fertility rate increases when the capital market is integrated.

## 4.2 When two technology coexists

When the two production technology coexists (MK technology: male labor is complement to physical capital and FK technology: female labor is complement to physical capital), we can have the following

discussions. In the following part, we define the technology compliment to female labor as  $FK$  technology, while that to male labor as  $MK$  technology. Taking account of these different production technologies between capital-importing and capital-exporting countries, we can explore the effects of delocalization in the following four cases.

1. Capital-exporting country with  $MK$  technology v.s. Capital-importing country with  $MK$  technology
2. Capital-exporting country with  $FK$  technology v.s. Capital-importing country with  $FK$  technology
3. Capital-exporting country with  $FK$  technology v.s. Capital-importing country with  $MK$  technology
4. Capital-exporting country with  $MK$  technology v.s. Capital-importing country with  $FK$  technology

For the first and second combinations have already examined in Sections 2 and 4, respectively. On the other hand, we can expect the following consequences in the rest two combinations where not only capital endowments and production technologies differ between two countries.

In the capital-exporting country with  $MK$  technology, globalization leads to a reduction in capital associated with a decrease in male wage rates. As such, women's bargaining power is increased followed by a decline in fertility rate. In the third combination, the capital importing country experience with a decrease in female wage rates due to a reduction in capital, therefore, an increase in fertility from bargaining outcome. The capital-importing country with  $MK$  technology, male wage rates is risen due to globalization with higher capital. As a result of a decrease in women's bargaining power, fertility increases.

In the fourth combination, globalization brings to lower capital and decline in male wage rates in the capital-exporting country with  $MK$  technology. This leads to a rise in women's bargaining power, followed by a decline in fertility rate. For the capital importing country with  $FK$  technology, a globalization causes a rise in female wage rates with higher capital, reducing fertility rate of the country.

The following analysis demonstrate that, the household production goods decrease in all over the world in the presence of heterogeneous production technology of the fourth case. Suppose that country 1 has the  $MK$  technology and that country 2 has the  $FK$  technology. From the household's optimization problem, female labor supply in country 1,  $F_1$ , satisfies  $F_1 = (b - 1 + (1 - \delta)\theta_1)/b$ , where  $\theta_1 = \theta_1(b - m_1)$ . The female labor supply in country 2,  $F_2$ , satisfies  $[1 - \theta_2(1 - \delta)]F_2^2 + K_2^2F_2 - K_2^2 = 0$ , where  $\theta_2 = \theta_2(f_2 - b)$ . From the inelastic male labor supply,  $M_1 = 1$ , the profit maximization problem gives  $m_1 = K_1^2$  and  $f_2 = K_2^2/F_2^2$ . Substituting them into functions determining the female labor supply allows us to have female labor supply as functions of  $K_1$  and  $K_2$ :

$$F_1 = \frac{b - 1 + (1 - \delta)\theta_1}{b} \quad \text{where } \theta_1 = \theta_1(b - K_1^2), \quad (29)$$

$$(1 - \theta_2(1 - \delta))F_2^2 + K_2^2F_2 - K_2^2 = 0 \quad \text{where } \theta_2 = \theta_2\left(\frac{K_2^2}{F_2^2} - b\right). \quad (30)$$

*Autarky.* Without capital mobility between two countries, the capital used for production correspond to their initial level of capital for each country;  $K_1 = \kappa_1$  and  $K_2 = \kappa_2$ . For simplicity, we assume  $\kappa_1 = \kappa_2 = \kappa/2$  in this section. From (29) and (30), in the closed economy, female labor supplies of two country in equilibrium  $(F_{1a}, F_{2a})$  are such that satisfy the both equations:

$$1 - F_{1a} = \frac{1 - (1 - \delta)\theta_1}{b} \quad \text{where } \theta_1 = \theta_1\left(b - \frac{\kappa^2}{4}\right), \quad (31)$$

$$(1 - \theta_2(1 - \delta))F_{2a}^2 = \frac{\kappa^2}{4}(1 - F_{2a}) \quad \text{where } \theta_2 = \theta_2\left(\frac{\kappa^2}{4F_{2a}^2} - b\right). \quad (32)$$

*Market Integration.* Since the interest rates are equalized between countries, we have  $r_1 = r_2$ , and thereby  $A - 2K_1/M_1 = A - 2K_2/F_2$ . Thus, we have the capital used for production in the country 1 as:

$$K_1 = \frac{K_2}{F_2}. \quad (33)$$

From  $F_2 < 1$ , the relations of capitals for productions are  $K_1 > K_2$ . And from (33) and  $\kappa = K_1 + K_2$ , we obtain:

$$K_1 = \frac{1}{1 + F_2}\kappa \quad \text{and} \quad K_2 = \frac{F_2}{1 + F_2}\kappa \quad (34)$$

Substituting (29) and (30) provide with female labor supply in the open economy in the equilibrium  $(F_{1o}, F_{2o})$  which satisfy the both equations of:

$$1 - F_{1o} = \frac{1 - (1 - \delta)\theta_1}{b}, \quad (35)$$

$$\kappa^2(1 - F_{2o}) = (1 - \theta_2(1 - \delta))(1 + F_{2o})^2, \quad (36)$$

where

$$\theta_1 = \theta_1\left(b - \frac{\kappa^2}{(1 + F_{2o})^2}\right) \quad \text{and} \quad \theta_2 = \theta_2\left(\frac{\kappa^2}{(1 + F_{2o})^2} - b\right).$$

By comparing (31) and (35) let us confirm  $\theta' > 0$ , the following relation holds

$$F_{1a} \underset{<}{>} F_{1o} \leftrightarrow \frac{\kappa^2}{4} \underset{>}{<} \frac{\kappa^2}{(1 + F_{2o})^2},$$

where superscript  $a$  is autarky, while  $o$  stands for open-market.

Rewriting the equation, we have:

$$F_{1a} \underset{<}{>} F_{1o} \leftrightarrow 0 \underset{>}{<} 1 - F_{2o}.$$

From  $1 - F_{2o} > 0$ , the following relation always holds:  $F_{1a} > F_{1o}$ , indicating that country 1 with  $MK$  technology experience a fall in female labor supply and an increase in fertility rate after globalization.

Intuition behind this result is as follows. From (34),  $\bar{\kappa} = \bar{\kappa} - K_1 < 0$  holds, leading the capital flows from country 2 to country 1 caused by the capital market integration. Because male labor is complementary to capital in country 1 and that their labor supply is inelastic to be one, (while in country 2 female labor is less than one, which complements to capital), the marginal productivity in country 1 is higher. Therefore, capital market integration causes a capital flow into country 1 causing a rise in male wage rate. This change in the relative wages weakens the women's bargaining power leading to larger family size (less female labor supply).

Conversely, we can expect that capital market integration forces country 2 to experience the capital outflow followed by a decrease in female wage rates and their bargaining power and an increase in fertility (a reduction in female labor supply) of country 2. Specifically, under the natural assumption that females prefer smaller family size compared with males,  $\delta < 1$ ,  $F_{2o} < F_{2a}$  holds, meaning that female labor supply is smaller and fertility rate is higher after the economic integration.<sup>9</sup>

In sum, when country 1 employs *MK* technology, and country 2 does *FK* technology, declines in fertility rates (rises in female labor participation) in both countries occur with capital flow from country 1 to country 2. This corresponds to the extreme case in which initial endowments are held at country 1 as  $\kappa_2 \rightarrow 0$ ,  $\kappa_1 \rightarrow \kappa$ . In the real world, developing countries tend to be capital-importing countries with agriculture as a main industry while the developed countries show the different properties of capital-exporting countries with a machinery as their major industry. Globalization in the real world, therefore, applies the fourth case, so that the fertility rate declines all over the world.

## 5 Conclusion

In this study, we examine the effects of globalization on the household production chosen by intra-household allocation of multiple family members. Specifically, we develop a two-country model where physical capital is traded in countries with its different endowment and that the firms distinguish two types of male and female labor as production inputs. The model showed that globalization in terms of integration of the capital market brings opposite directions to the household production goods. When the male labor is more complementary to the physical capital in both countries as in the basic model, globalization results in higher household production goods in the capital-exporting country while the capital-importing country experiences the opposite. We also consider the case in which female labor is more complementary to capital and the case in which both production technologies coexist in the economy.

## Appendix

Rewriting (32) and (36) with (35) gives:

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<sup>9</sup>See Appendix.

$$4 \left( \frac{1}{1-\delta} - \theta_2 \left( \frac{\kappa^2}{4F_{2a}^2} - b \right) \right) F_{2a}^2 = \frac{\kappa^2}{1-\delta} (1 - F_{2a}), \quad (37)$$

$$\left( \frac{1}{1-\delta} - \theta_2 \left( \frac{\kappa^2}{(1+F_{2o})^2} - b \right) \right) (1+F_{2o})^2 = \frac{\kappa^2}{1-\delta} (1 - F_{2o}). \quad (38)$$

Denote  $y$  to express the LHS of (37):

$$y \equiv 4 \left( \frac{1}{1-\delta} - \theta_2 \left( \frac{\kappa^2}{4F_{2a}^2} - b \right) \right) F_{2a}^2.$$

Then, we have

$$\frac{\partial y}{\partial F_{2a}} = 8F_{2a} \left( \frac{1}{1-\delta} - \theta_2 \left( \frac{\kappa^2}{4F_{2a}^2} - b \right) \right) + \frac{2\theta_2' \kappa^2}{F_{2a}}.$$

Since the first two terms of this equation are positive, we have  $\partial y / \partial F_{2a} > 0$ , showing that LHS of (37) is increasing functions of  $F_{2a}$ . In a similar manner, we can easily find that LHS of (38) increases with  $F_{2o}$ , and RHSs of (37) and (38) are decreasing functions of  $F_{2i}$ , leading us to obtain Figure 2, in which (37) and (38) are depicted.

Figure 2.

Next, we compare the value of LHS in (37) and (38) at the arbitrary  $F$ . Using  $F_{2a} = F_{2o} = F$ , the subtraction obtains:

$$\begin{aligned} & 4 \left( \frac{1}{1-\delta} - \theta \left( \frac{\kappa^2}{4F^2} - b \right) \right) F^2 - \left( \frac{1}{1-\delta} - \theta \left( \frac{\kappa^2}{(1+F)^2} - b \right) \right) (1+F)^2 \\ &= \frac{(3F+1)(1-F)}{\delta-1} - \left( 2F \sqrt{\theta \left( \frac{\kappa^2}{4F^2} - b \right)} + (1+F) \sqrt{\theta \left( \frac{\kappa^2}{(1+F)^2} - b \right)} \right) \\ & \quad \times \left( 2F \sqrt{\theta \left( \frac{\kappa^2}{4F^2} - b \right)} - (1+F) \sqrt{\theta \left( \frac{\kappa^2}{(1+F)^2} - b \right)} \right). \end{aligned}$$

Under the case of interior solution of  $0 < F < 1$ ,

$$2F \sqrt{\theta \left( \frac{\kappa^2}{4F^2} - b \right)} - (1+F) \sqrt{\theta \left( \frac{\kappa^2}{(1+F)^2} - b \right)} > 0.$$

Therefore, when men prefer the larger size than women as  $\delta < 1$ , LHS of (37) is smaller than that of (38). These relations are depicted in the Figure 2 as the upward-sloping curve. Accordingly,  $F_{2o} < F_{2a}$  holds, meaning that female labor supply is smaller and fertility rate is higher after the economic integration.

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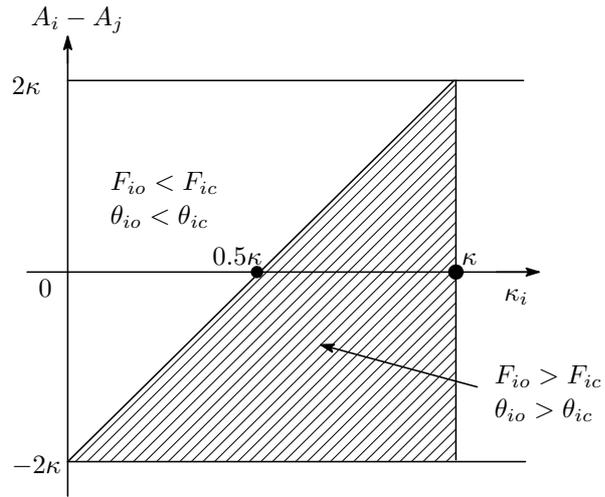


Figure 1. Impacts of market integration when countries differ in technology and endowment of capital.

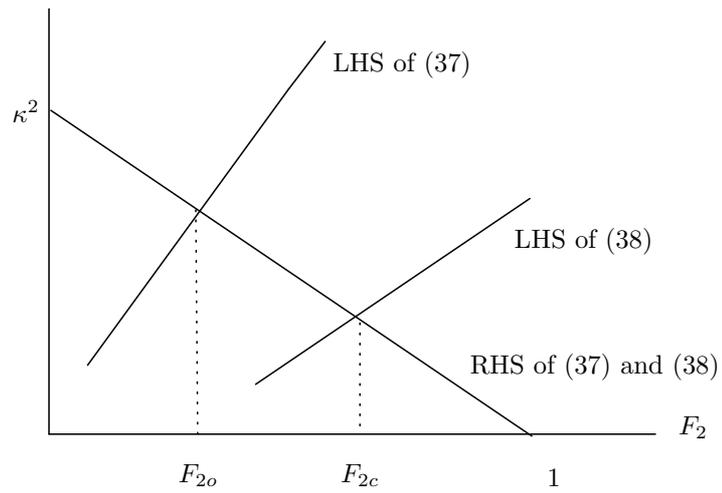


Figure 2. Female labor supply in country 2 when country 1(2) has the  $MK(FK)$  technology.