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# Capital market integration and optimal employment protection policies

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## Abstract

This study analyzes the effect of capital markets integration on labor market policies. To that end, it incorporates imperfect labor markets into a tax competition model. There exist two types of households, types 1 and 2, that are risk-averse. Each type of household is endowed with one unit of a worker. Additionally, households are endowed with capital. Type 2 households own larger amounts of capital than type 1 households. The government can choose the following policies: unemployment benefits and layoff, payroll, and capital subsidies or taxes. When capital markets are integrated, households can invest their capital in foreign capital markets. This study shows that the integration of capital markets leads to inefficient policies under which labor productivity is high, but income inequality within a country and the risk of job loss are also high. As a result, the social welfare of each country in integrated capital markets is lower than in non-integrated capital markets.

JEL classification: F21; F66; H26; J63; J65

Keywords: Capital market integration; Unemployment risk; Labor market policies; Tax competition

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# 1 Introduction

The impact of global capital market integration on labor markets has provoked a great deal of controversy among economists, politicians, and commentators. Questions have been raised, such as, What impact does capital market integration have on the unemployment rate and wages? Does capital market integration trigger labor market deregulation? To answer these questions, this paper incorporates the model of imperfect labor markets proposed by Blanchard and Tirole (2008) into a tax competition model with multiple countries and analyzes the impact of capital market integration on labor markets through policy reforms.

In the literature on tax competition, Zodrow and Mieszkowski (1986) first argued that when capital markets are integrated, governments reduce capital tax rates to attract capital, and the provision of local public goods is then too low. A number of studies have analyzed the impact of governments' competition on various labor market policies, including unemployment benefits in Lejour and Verbon (1994), the minimum wage in Gabszewicz and van Ypersele (1996), and the bargaining power of trade unions in Boulhol (2009). These studies showed that tax competition pressures lead to inefficient policies, but each focused only on a single labor market policy. Recent literature on labor market policies, such as Blanchard and Tirole (2008) and Algan and Cahuc (2009), pointed out that policy interactions are important. The present study is the first to consider these interactions in the field of governments' competition on labor market policies.

In this study, there are two types of households; both are risk-averse and own one unit of labor, but they differ with respect to capital endowment. Firms in the final goods sector produce tradable consumption goods using two types of intermediate inputs. One type of the intermediate input is produced using only capital, while the other is produced using only workers. While capital and intermediate input markets are perfectly competitive, the labor market is imperfect as in Blanchard and Tirole (2008) in which firms post the (incomplete) wage contract before revealing their productivity. By this assumption, low productivity firms want to fire workers, and there exist unemployed workers.

We consider the following policy instruments: unemployment benefits and layoff, payroll, and capital subsidies or taxes. Following the tax competition literature, the government of each country can determine these policies to maximize the social welfare of its country. Since households are risk averse, the government has an incentive for income redistribution using unemployment benefits, payroll subsidies, and capital taxes. Additionally, the government chooses layoff tax rates to encourage firms to internalize the (social) cost of unemployment

and take an efficient layoff decision. Because of the utility costs of unemployment, layoff taxes are chosen in order to balance the trade-off between labor productivity and job security provisions.

In non-integrated capital markets, households cannot invest their capital in foreign countries. In this case, the government chooses very high capital tax rates and relatively high layoff tax rates and redistributes tax revenue to poor households through payroll subsidies and unemployment benefits. Under these policies, households are perfectly insured against the risk of income fluctuations, income inequality between households is eliminated, and the layoff tax provides moderate employment protection.

In integrated capital markets, households can invest their capital in foreign countries. In this case, the government chooses low capital tax rates to attract capital, which leads to income inequality within the country. Additionally, capital market integration decreases layoff tax rates because the shadow price of final goods increases with the degree of income inequality within a country, and then the government has an incentive to improve labor productivity. Capital market integration also decreases payroll subsidy rates because of declining tax revenue from capital and layoff taxes. On the other hand, the effects of capital market integration on unemployment benefits are ambiguous because there are both negative and positive effects; the negative effect is caused by declining revenue from capital and layoff taxes, while the positive effect is caused by reduced expenditure for payroll subsidies. These results are consistent with empirical studies such as Potrafke (2010), who argued that globalization has a negative impact on the protection of regular employment workers, but has no significant impact on unemployment benefits.

Under equilibrium policies in integrated capital markets, labor productivity is high; however, income inequality within a country and the risk of job loss are also high. To maximize the social welfare of each country, governments should choose policies as they do in non-integrated markets, which implies that capital market integration reduces the social welfare of each country through policy reforms.

The present study's basic labor market framework is based on Blanchard and Tirole (2008), who characterized the optimal policies for layoff and payroll subsidies or taxes and unemployment benefits in a closed economy. The present study introduces mobile capital and capital taxes into their models. From this extension, we can analyze the effect of capital market integration on labor markets.

Several studies have analyzed the effects of tax competition in imperfect labor markets<sup>1</sup>. These studies

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<sup>1</sup>See for example, the fair wage model by Egger and Seidel (2011), the job search model by Konrad (2011) and Sato (2008),

analyzed the effects of tax competition on capital or corporate taxes, while the present study analyzes the effects on not only capital tax but also labor market policies.

This paper is structured as follows. Section 2 introduces the basic structure of the model. Section 3 demonstrates the properties of an equilibrium in non-integrated capital markets. Section 4 characterizes an equilibrium in integrated capital markets. Finally, Section 5 concludes.

## 2 Setting

There are many symmetric small countries, in each of which are two types of households indexed by  $i \in \{1, 2\}$ . The mass of type  $i$  households is  $l_i$ , and they are endowed with  $k_i$  units of capital and one unit of worker. The worker can be either employed or unemployed. Without loss of generality, we suppose that type-2 households are wealthier than type-1 households; then, we assume  $k_2 > k_1$ .

Both types of households are risk-averse, and their utility from consuming final goods is given by  $u(x)$  ( $u' > 0, u'' < 0$ , and  $u''' > 0$ ), where  $x$  is the consumption level of final goods. Additionally, according to Blanchard and Tirole (2008), households with an unemployed worker pay the utility cost of being unemployed,  $B$ . Some empirical studies suggest that the utility cost associated with becoming unemployed are indeed large (see, for example, Winkelmann and Winkelmann 1998, Darity and Goldsmith 1996, and Hallock 2009).

Two intermediate inputs are used in producing final goods. Let  $f(x_1, x_2)$  be the production function with constant returns to scale and  $\partial^2 f(x_1, x_2) / \partial x_i^2 < 0$ , where  $x_1$  and  $x_2$  are the input levels of intermediate inputs 1 and 2, respectively.

To simplify, producing the intermediate input 1 requires only workers. Following Blanchard and Tirole (2008), if an intermediate input firm enters the labor market, a worker is hired, and the productivity of this firm is then revealed. Let the productivity be denoted by  $y$ , which is drawn from the continuous cumulative distribution function  $G(y)$ , with density  $g(y)$  on  $(-\infty, \infty)^2$ . Additionally, we assume that the wage contract posted by firms cannot depend on  $y$ . These assumptions mean that some firms may be unproductive and have an incentive to lay off workers. Note that when the productivity of a firm is too low, a worker employed by

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the monopolistic labor supply (trade union) model by Ogawa, Sato, and Tamai (2011), and the fixed wage model by Ogawa and Sato (2006) and Piga (2010).

<sup>2</sup>An important assumption for this model is that the productivity of a firm may be negative. If the minimum value of  $y$  is positive, there is no unemployment in equilibrium. An alternative assumption is that the minimum value of  $y$  is non-negative, but unemployed workers can produce intermediate input 1 in home production.

the firm should become unemployed to maximize the social welfare.

Producing the intermediate input 2 requires only capital. Intermediate input firms hire capital from the perfectly competitive capital market with rental price  $r$ . For simplicity, the marginal productivity of capital is constant and normalized to one. A justification for this assumption is that under the perfectly competitive capital market, firms can hire capital after revealing their own productivity. As a result, only firms with the highest productivity can hire capital in equilibrium.

The policy instruments of the government are as follows: (i) layoff taxes ( $f > 0$ ) or subsidies ( $f < 0$ ) for intermediate input firms, (ii) unemployment benefits ( $b > 0$ ) or taxes ( $b < 0$ ) for unemployed workers, (iii) payroll taxes ( $t_e > 0$ ) or subsidies ( $t_e < 0$ ) for intermediate input firms, and (iv) capital taxes ( $t_k > 0$ ) or subsidies ( $t_k < 0$ ) for intermediate input firms. The government sets these policies to maximize its country's social welfare.

In the following analysis, we consider two situations: non-integrated capital markets and integrated capital markets. In non-integrated capital markets, capital cannot move between countries, and the domestic capital supply is then exogenously determined. On the other hand, in integrated capital markets, capital can move between countries with zero moving costs, and then capital supply is then endogenously determined by the international arbitrage condition (as shown later).

To summarize, the timing of events in the model is as follows:

**Step 1:** Each government simultaneously chooses policies  $f$ ,  $b$ ,  $t_e$ , and  $t_k$ .

**Step 2:** Both labor and capital markets are opened, in each of which wages  $w$  and rental price of capital  $r$  are determined. If capital markets are integrated, capital may move across national boundaries.

**Step 3:** Firms producing the intermediate input 1 observe their productivity  $y$ , after which they decide whether to lay off workers.

**Step 4:** The markets of intermediate inputs are opened, and final goods are produced.

Note that in integrated capital markets, households are supposed to spend capital income in the home country regardless of where their capital is employed<sup>3</sup>. Additionally, we assume that while neither intermediate

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<sup>3</sup>This is the footloose capital model proposed by Martin and Rogers (1995).

input is tradable, final goods are freely tradable. Therefore, the flows of capital income offset final goods trade imbalances, thereby ensuring the balance of payments equilibrium.

### 3 Equilibrium in non-integrated capital markets

In this section, we consider an equilibrium in non-integrated capital markets where capital cannot move between countries. The equilibrium concept in this model is the sub-game perfect Nash equilibrium characterized using the backward induction method.

#### 3.1 Market equilibrium

First, we derive the (subgame) equilibrium in step 4. Using the production function of final goods, the profits of a final goods firm  $\pi_x$  is defined by

$$\pi_x = f(x_1, x_2) - p_1 x_1 - p_2 x_2,$$

where  $p_1$  is the price of the intermediate input 1,  $p_2$  is the price of the intermediate input 2, and the price of final goods is normalized to one. A final goods firm determines the input level of  $x_i$  to maximize  $\pi_x$ , the optimal conditions of the firm are then given by

$$p_1 = \frac{\partial f(x_1, x_2)}{\partial x_1}, \quad p_2 = \frac{\partial f(x_1, x_2)}{\partial x_2}. \quad (1)$$

Because  $\partial^2 f(x_1, x_2) / \partial x_i^2 < 0$ , (1) implies that the signs of  $\partial p_1 / \partial x_1$  and  $\partial p_2 / \partial x_2$  are negative.

Next, we characterize the layoff decision-making in step 3. When an intermediate input firm with productivity  $y$  keeps an employed worker, the *ex-post* profits of the firm are given by  $p_1 y - t_e - w$  which is revenue  $p_1 y$  minus payroll taxes  $t_e$  and wages  $w$ . On the other hand, when the firm lays the worker off, the *ex-post* profits are  $-f$ , which is layoff taxes.

Let  $\bar{y}$  be the threshold productivity below which workers are laid off; the threshold is determined by

$$\underbrace{-f}_{\text{lay off the worker}} = \underbrace{p_1 \bar{y} - t_e - w}_{\text{continue to employ the worker}}. \quad (2)$$

Equation (2) shows that for any wages, the threshold productivity increases with payroll taxes and decreases with layoff taxes and the price of the intermediate input 1.

Next, we characterize equilibrium wages  $w$ , rental price  $r$ , and intermediate input prices  $p_i$  in step 2. The marginal profits of capital are given by  $p_2 - t_k - r$ . In the perfectly competitive capital market, the marginal profit must be zero, and rental price is then determined by

$$r = p_2 - t_k. \quad (3)$$

Naturally, rental price increases with  $p_2$  and decreases with  $t_k$ .

Next, we derive the equilibrium wages. The *ex-ante* expected marginal profits of an intermediate input firm  $E\pi_1$  are given by

$$E\pi_1 = \int_{\bar{y}} (p_1 y - t_e - w) dG(y) - G(\bar{y}) f,$$

where the first term on the right hand side represents the expected profits when the job is not terminated, and the second term is the expected layoff tax bill. Using the zero profit condition, which is defined by  $E\pi_1 = 0$ , the equilibrium wages are determined by

$$w = \frac{p_1 \int_{\bar{y}} y dG(y) - (1 - G(\bar{y})) t_e - G(\bar{y}) f}{1 - G(\bar{y})}. \quad (4)$$

Wages increase with  $p_1$  and decrease with  $f$  and  $t_e$ . Note that (2) and (4) show that both wages and the probability of layoff decrease with layoff taxes, which means that there would be a trade-off between job security and wages.

To characterize the equilibrium price of the intermediate inputs 1 and 2, we first characterize the total output of the intermediate inputs. Using the definition of  $\bar{y}$ , the total output of  $x_1$  is given by

$$x_1 = \int_{\bar{y}} y dG(y) L, \quad (5)$$

where  $L = l_1 + l_2$ . It is straightforward to verify that  $x_1$  is maximized at  $\bar{y} = 0$ , which is called the production-efficient threshold productivity in Blanchard and Tirole (2008).

In non-integrated markets, the total output of  $x_2$  can be easily determined because the domestic supply of



capital is exogenously determined by  $K^N = k_1 l_1 + k_2 l_2$ . The total output of  $x_2$  is then given by

$$x_2 = K^N. \quad (6)$$

The equilibrium prices of intermediate inputs 1 and 2 are determined by substituting (5) and (6) into (1).

Note that in this model, all workers are employed at the beginning of step 3. Thus, the unemployment rate at step 4 is  $G(\bar{y})$  because a worker becomes unemployed if and only if her or his productivity is less than  $\bar{y}$  at step 3.

### 3.2 Equilibrium policies

We characterize the government policy in non-integrated capital markets. To do so, we first define the market clearing condition of final goods.

The total income of a type  $i$  household with an employed worker is the sum of capital income  $r k_i$  and labor income  $w$ , while the total income of a household with an unemployed worker is the sum of capital income  $r k_i$  and unemployment benefits  $b$ . Thus, the market clearing condition of final goods can be defined by

$$f(x_1, x_2) = [(1 - G(\bar{y})) w + G(\bar{y}) b] L + r K^N. \quad (7)$$

The left hand side of (7) is the total supply, and the right hand side represents the total demand which is aggregate income.

Given a constant returns to scale production function, using (5) and (6), equation (7) can be rewritten as

$$f\left(\int_{\bar{y}} y dG(y), k^N\right) = (1 - G(\bar{y})) w + G(\bar{y}) b + r k^N, \quad (8)$$

where  $k^N = K^N/L$ . The left-hand side of (8) indicates the average household output, and the right-hand side is the average household income.

Next, we define the government's budget constraint for each household as

$$t_k k^N + (1 - G(\bar{y})) t_e + G(\bar{y}) f = G(\bar{y}) b. \quad (9)$$

The right hand side of (9) is the average expenditure for unemployment benefits, and the left hand side is the average revenue from capital, payroll, and layoff taxes.

The government chooses capital taxes  $t_k$ , payroll taxes  $t_e$ , unemployment benefits  $b$ , and layoff taxes  $f$  to maximize the social welfare  $S$  which is defined by

$$S = \sum_i [(1 - G(\bar{y})) u(w + rk_i) + G(\bar{y})(u(b + rk_i) - B)] l_i.$$

Because the expected profits of firms are zero, the aggregate utility of households is then equivalent to the social welfare  $S$ . Note that the government considers not only the utility from final goods consumption but also the utility cost of unemployment  $B$ .

The optimal problem of the government is given by

$$\max_{t_k, t_e, b, f} S, \text{ s.t. (1) to (6) and (9).}$$

The above problem means that the government sets policies to maximize the social welfare subject to market equilibrium conditions (1) to (6) and the government's budget constraint (9).

Following Blanchard and Tirole (2008), we rewrite the government's problem as a choice problem of labor income  $w$ , unemployed benefits  $b$ , capital income  $r$ , and threshold productivity  $\bar{y}$  subject to the market clearing condition of final goods (8) as

$$\max_{w, b, r, \bar{y}} \sum_i [(1 - G(\bar{y})) u(w + rk_i) + G(\bar{y})(u(b + rk_i) - B)] l_i, \text{ s.t. (8).}$$

After solving the above problem and characterizing the optimal conditions for  $w$ ,  $b$ ,  $r$ , and  $\bar{y}$ , we find the equilibrium policies that implement these optimal conditions.

The equilibrium values are indicated by superscript  $N$ . We show the following lemma.

**Lemma 1** *Equilibrium labor income is*

$$w^N = b^N = c^N, \tag{10}$$

where

$$c^N = f(x_1^N, x_2^N). \quad (11)$$

Equilibrium capital income  $r^N$  is

$$r^N = 0, \quad (12)$$

and the equilibrium threshold productivity  $\bar{y}^N$  is

$$\bar{y}^N = -\frac{BL}{\lambda^N p_1^N}, \quad (13)$$

where

$$p_i^N = \frac{\partial f(x_1^N, x_2^N)}{\partial x_i^N}, x_1^N = \int_{\bar{y}^N} y dG(y), x_2^N = k^N, \text{ and } \lambda^N = u'(c^N) L.$$

**Proof.** See Appendix A. ■

Equation (10), which is called the insurance condition, implies that households should be insured against the risk of income fluctuations caused by a change in employment status because households are risk-averse. Equation (12), which is called the redistribution condition, implies that capital income should be zero in order to eliminate income inequality between type-1 and type-2 households. The consumption level of each household is determined by (11) which is the average household output.

Equation (13), which is called the threshold condition, implies that the equilibrium threshold productivity  $\bar{y}^N$  is negative if the utility costs of unemployment  $B$  are positive. To maximize the total output of final goods,  $\bar{y}$  should be the production-efficient threshold productivity as  $\bar{y} = 0$  because the output of the intermediate input 1 should be maximized. However, there would be a trade-off between production efficiency and the utility costs of unemployment, and a lower threshold of productivity requires balancing this trade-off. It is straightforward to show that the equilibrium threshold productivity decreases with the utility costs of unemployment.

Finally, the threshold productivity increases with an increase in the price of the intermediate input 1  $p_1^N$  and the shadow price of final goods  $\lambda^N$ . This is because when  $p_1^N$  or  $\lambda^N$  is high, the social value of the intermediate input 1 is also high. Thus, the government wants to reduce the gap between the production-efficient threshold productivity and  $\bar{y}^N$  to improve labor productivity.

Finally, we characterize the equilibrium policies. Because a government chooses policies to implement equilibrium conditions characterized by Lemma 1, we show the following proposition.

**Proposition 1** *The equilibrium policies are*

$$f^N = p_1^N \int_{\bar{y}^N} y - \bar{y}^N dG(y), \quad (14)$$

$$t_k^N = p_2^N, \quad (15)$$

$$b^N = p_1^N \int_{\bar{y}^N} y dG(y) + p_2^N k^N, \quad (16)$$

$$t_e^N = G(\bar{y}^N) p_1^N \bar{y}^N - p_2^N k^N. \quad (17)$$

**Proof.** See Appendix B. ■

Note that because the equilibrium threshold productivity is negative, equilibrium payroll tax rates are negative. Thus, in non-integrated capital markets, the government chooses very high capital tax rates and positive layoff tax rates and redistributes revenue from these taxes to households through payroll subsidies and unemployment benefits. These policies lead to an attainment of the first-best social welfare, in which there is no income inequality between type-1 and type-2 households, and households are perfectly insured against the risk of income fluctuations and moderately protected against unemployment risk.

Finally, from comparative statics, we obtain the following proposition for layoff tax rates.

**Lemma 2** *Layoff tax rates  $f^N$  decreases with the threshold productivity  $\bar{y}^N$ .*

**Proof.** See Appendix C. ■

In combining with Proposition 1, layoff taxes increase with  $B$  and decrease with  $\lambda^N$  and  $p_1^N$  because the equilibrium threshold productivity is decreasing in  $B$  and increasing in  $\lambda^N$  and  $p_1^N$ .

## 4 Equilibrium in integrated capital markets

Similar to the previous section, we characterize the market equilibrium in integrated capital markets using the backward induction method. Equations (1) and (2) are prices of intermediates goods and the threshold productivity in integrated capital markets because sub-game equilibria in steps 3 and 4 are same as the equilibria

in non-integrated markets. Moreover, in step 2, equilibrium wages are the same as in (4). Thus, to characterize the market equilibrium in integrated capital markets, we derive the equilibrium domestic capital supply and the (world) rental price.

#### 4.1 Equilibrium capital supply and world rental price

Let  $K^I$  denote capital supply in a country; it is endogenously determined by factor price equalization:

$$\hat{r} = r = p_2 - t_k, \quad (18)$$

where  $\hat{r}$  and  $r$  are the world and the domestic rental prices. (18) states that the domestic rental price must be equal to the world rental price. Now, the total output of  $x_2$  is given by

$$x_2 = K^I. \quad (19)$$

Equations (18) and (19) imply that capital taxes  $t_k$  can be connected to the domestic capital supply  $K^I$ . Total differentiation of (18) yields

$$\frac{\partial p_2}{\partial K^I} \frac{\partial K^I}{\partial t_k} = 1.$$

Using (1) and (19),

$$\frac{\partial p_2}{\partial K^I} = \frac{\partial^2 f(x_1, x_2)}{\partial x_2^2}.$$

Combining the above two equations gives

$$\frac{\partial K^I}{\partial t_k} = \left[ \frac{\partial^2 f(x_1, x_2)}{\partial x_2^2} \right]^{-1}. \quad (20)$$

Because  $\partial^2 f(x_1, x_2)/\partial x_2^2 < 0$ , (20) indicates the negative relationship between capital tax rates and capital supply in a country, which is an additional constraint of the government's problem in step 1 (as shown later).

Finally, similar to the non-integrated markets case, we define the market clearing condition in integrated capital markets as

$$f\left(\int_{\bar{y}} y dG(y), k^I\right) = (1 - G(\bar{y}))w + G(\bar{y})b + \hat{r}k^I, \quad (21)$$

where  $k^I = K^I/L$ . Note that the country is a capital importer if  $k^I > k^N$  and a capital exporter if  $k^I < k^N$ .

The left hand side of (21) represents the average household output. The first and second terms in the right hand side are labor income and unemployment benefits, respectively, and the final term is the capital income which may include the capital income of households in foreign countries.

## 4.2 The equilibrium in step 1

In step 1, each government simultaneously chooses capital, payroll, and layoff subsidy/tax rates, as well as unemployment benefits. By the assumption of a small open economy, each government cannot affect the world rental price  $\hat{r}$ . Moreover, given the world rental price, each government chooses policies to maximize the social welfare  $S$  in its home country.

The original problem of a government is then given by

$$\max_{t_k, t_e, b, f} S, \text{ s.t. (1), (2), (4), (5), (9), (18), and (19).}$$

Under the assumption of a small economy<sup>4</sup>, as in the non-integrated capital markets case, the government's optimization problem can be rewritten as a choice problem of labor income  $w$ , unemployment benefits  $b$ , and the threshold productivity  $\bar{y}$ . However, governments cannot directly choose capital income which is determined by the world rental price  $\hat{r}$ . This is a significant difference from the non-integrated capital markets case. Thus, we define the optimization problem in which a government chooses  $k^I$  in addition to  $w$ ,  $b$ , and  $\bar{y}$  subject to the market clearing condition (21).

The optimization problem of a government is then rewritten as

$$\max_{w, b, k^I, \bar{y}} \sum_i [(1 - G(\bar{y})) u(w + \hat{r}k_i) + G(\bar{y})(u(b + \hat{r}k_i) - B)] l_i, \text{ s.t. (21).}$$

The above optimization problem reveals important effects of capital market integration. Because a government cannot choose capital income which is determined by the world rental price, an increase in the domestic capital supply has no direct impact on the social welfare.

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<sup>4</sup>If we suppose large countries, for example the two country model, the solution of a choice problem of  $w$ ,  $b$ ,  $\bar{y}$ , and  $k^I$  is not equivalent to the solution of an original problem because governments play the strategic game. Generally, the same game with different strategic variables leads to different outcomes because deviations from equilibrium may differ.

However, the market clearing condition are affected by the capital supply. If the government attracts more capital from foreign countries, both the total output of final goods and the export of final goods are increased. Thus, the government's choice problem of capital supply is equivalent to the maximization problem of the consumption of domestic households.

The equilibrium values in non-integrated capital markets are indicated by superscript  $I$ . We focus on the symmetric equilibrium in which all governments choose the same capital supply  $k^I$ , labor income  $w^I$ , unemployment benefits  $b^I$ , and the threshold productivity  $\bar{y}^I$ . Note that in the symmetric equilibrium,  $k^I = k^N$  because capital does not move across borders.

Formally, we summarize the results in Lemma 3.

**Lemma 3** *The equilibrium capital income is*

$$\hat{r}^I = r^I = p_2^I, \quad (22)$$

*labor income and unemployment benefits are*

$$w^I = b^I = c^I = f(x_1^I, x_2^I) - p_2^I k^I, \quad (23)$$

*and equilibrium threshold productivity is*

$$\bar{y}^I = -\frac{BL}{\lambda^I p_1^I}, \quad (24)$$

*where*

$$p_i^I = \frac{\partial f(x_1^I, x_2^I)}{\partial x_i^I}, x_1^I = \int_{\bar{y}^I} y dG(y), x_2^I = k^I, \text{ and } \lambda^I = \sum_i u'(c^I + p_2^I k_i) l_i.$$

**Proof.** See Appendix D. ■

From the comparison of Lemmas 1 and 3, we can show that capital market integration has several effects on the equilibrium conditions of a government. Comparing (12) and (22) reveals that capital market integration increases capital income because tax competition arises between countries. Moreover, as a result of tax competition, each government chooses a capital supply at which  $p_2^I = \hat{r}$ . Intuitively, an increase in the capital supply increases not only the total output of final goods, but also the export of final goods. The later effect represents the *costs* of attracting capital. To maximize the total income of domestic households, the government should

choose a capital supply under which the marginal final goods output of capital  $p_2^I$  is equal to the marginal cost of attracting capital  $\hat{r}$ . Moreover, capital market integration leads to income inequality within a country, which means that type-2 households can obtain higher incomes than type-1 households.

Comparing (13) and (24) reveals that the equilibrium threshold productivity in integrated capital markets is higher than the productivity in non-integrated capital markets (see Appendix E for a formal proof). Intuitively, an increase in capital income has two opposite effects on the shadow value of final goods. Given the threshold productivity, an increase in capital income increases the total income of type-2 households but decreases the total income of type-1 households. Thus, while the marginal utility of type-2 households with respect to final goods is decreased, which is the negative effect on the shadow value, the marginal utility of type-1 households is increased, which is the positive effect. Under the assumption that  $u''' > 0$ , the positive effect always dominates the negative effect, and an increase in capital income then increases the shadow value. As a result, each government wants to increase the threshold productivity to improve labor productivity.

Next, we characterize the equilibrium policies in the following proposition.

**Proposition 2** *The equilibrium policies are*

$$f^I = p_1^I \int_{\bar{y}^I} y - \bar{y}^I dG(y), \quad (25)$$

$$t_k^I = 0, \quad (26)$$

$$b^I = p_1^I \int_{\bar{y}^I} y dG(y), \quad (27)$$

$$t_e^I = G(\bar{y}^I) p_1^I \bar{y}^I. \quad (28)$$

**Proof.** See Appendix F. ■

The comparison of Propositions 1 and 2 provides the main results of this study. (15) and (26) imply that capital market integration decreases capital tax rates because of tax competition pressures. This is a standard result in the tax competition literature. Intuitively, in the non-integrated capital markets case, a government chooses capital tax rates to eliminate income inequality completely. In integrated capital markets, the degree of income inequality depends only on the world rental price, and no government can then eliminate income inequality. Instead, capital supply depends on capital tax rates, and each government chooses capital tax rates



to maximize the consumption of domestic households in their countries, which leads to zero capital tax rates.

From (25), the equilibrium layoff tax rates have the same functional form as (14). From Lemma 2, the equilibrium layoff tax rates in integrated capital markets are lower than in non-integrated capital markets because the equilibrium threshold productivity in integrated capital markets is higher than in non-integrated capital markets. In other words, capital market integration triggers the deregulation of firing restrictions.

Decreases in capital and layoff tax rates imply that tax revenue also decreases. Through this channel, capital market integration affects payroll subsidies and unemployment benefits. Capital market integration unambiguously decreases payroll subsidies (see (17) and (28)). However, it has an ambiguous effect on unemployment benefits (see (16) and (27)) because it decreases not only tax revenue but also expenditure for payroll subsidies.

Finally, we analyze the effect of capital market integration on the social welfare of each country. Because all countries are symmetric, it is straightforward to verify that the global optimal policies by which the social welfare of each country is maximized are the same as the policies in the non-integrated market. Then, we obtain the following proposition.

**Proposition 3** *Capital market integration reduces the social welfare of each country.*

The integration of capital markets leads to inefficient policies under which labor productivity and the aggregate consumption level become high. However, income inequality within a country and the risk of job loss also become high because capital and the layoff tax rates are too low. As a result, the social welfare of each country in integrated capital markets is lower than in non-integrated capital markets.

## 5 Conclusion

This study considered the impacts of capital market integration on labor markets through policy reforms. The governments of each country try to redistribute income between households and lead to the optimal layoff decision. Tax competition between countries arises as the result of capital market integration, which reduces capital tax rates and leads to income inequality within a country. Additionally, capital market integration affects labor market policies. Each government reduces layoff tax rates to increase labor productivity. As a result, capital market integration has negative impacts on the social welfare of each country through policy

reforms.

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## Appendix A

The Lagrangian of the government program is given by

$$\begin{aligned} \Gamma = & \sum_i [(1 - G(\bar{y})) u(w + rk_i) + G(\bar{y}) (u(b + rk_i) - B)] l_i \\ & + \lambda^N \left\{ f \left( \int_{\bar{y}} y dG(y), k^N \right) - (1 - G(\bar{y})) w - G(\bar{y}) b - rk^N \right\}, \end{aligned}$$

where  $\lambda^N$  is the Lagrangian multiplier. The first-order conditions read

$$\frac{\partial \Gamma}{\partial w} = 0 \iff \sum_i u'(w + rk_i) l_i = \lambda^N, \quad (\text{A1})$$

$$\frac{\partial \Gamma}{\partial b} = 0 \iff \sum_i u'(b + rk_i) l_i = \lambda^N, \quad (\text{A2})$$

$$\frac{\partial \Gamma}{\partial r} = 0 \iff \sum_i [(1 - G(\bar{y})) u'(w + rk_i) + G(\bar{y}) u'(b + rk_i)] k_i l_i = \lambda^N k^N, \quad (\text{A3})$$

and

$$\frac{\partial \Gamma}{\partial \bar{y}} = 0 \iff \sum_i [-u(w + rk_i) + u(b + rk_i) - B] l_i = \lambda^N \left\{ \frac{\partial f(x_1, x_2)}{\partial x_1} \bar{y} + \sum (-w + b) \right\}. \quad (\text{A4})$$

(A1) and (A2) together imply  $c^N = w = b$  which is the insurance condition. Under the redistribution condition, (A3) can be rewritten as

$$\sum_i u'(c^N + rk_i) k_i l_i = \lambda^N k^N.$$

Substituting this expression into (A1) yields

$$\sum_i u'(c^N + rk_i) k_i l_i = \sum_i u'(c^N + rk_i) k^N l_i.$$

This condition implies that  $r^N = 0$  which is the redistribution condition. Using  $r^N = 0$  and  $c^N = w = b$ , the market clearing condition of final goods (7) can be rewritten as

$$c^N = f \left( \int_{\bar{y}} y dG(y), k^N \right).$$

Using  $p_1^N = \partial f(x_1, x_2) / \partial x_1$ , (A4) can thus be rewritten as

$$\bar{y}^N = -\frac{BL}{\lambda p_1^N}.$$

Finally, from (A1), we obtain the equilibrium shadow value as

$$\lambda^N = u'(c^N) L.$$

## Appendix B

To implement (12), from (3), capital taxes  $t_k^N$  must be

$$t_k^N = p_2^N.$$

To implement (13), from (2) and (4), layoff taxes  $f^N$  must satisfy following condition:

$$\begin{aligned} f^N &= -p_1^N \bar{y}^N + \frac{p_1^N \int_{\bar{y}^N} y dG(y) - G(\bar{y}^N) f^N}{1 - G(\bar{y}^N)} \\ &= p_1^N \int_{\bar{y}^N} (y - \bar{y}^N) dG(y). \end{aligned}$$

Next, we characterize the equilibrium payroll subsidies  $t_e^N$  and unemployment benefits  $b^N$ . From (2) and the insurance condition  $w^N = b^N$ , (13) can be rewritten as

$$b^N + t_e^N = f^N - \frac{B}{u'(c^N)}. \quad (\text{B1})$$

Now, the budget constrains of government (9) can be rewritten as

$$(1 - G(\bar{y}^N)) t_e^N = G(\bar{y}^N) (b^N - f^N) - p_2^N k^N. \quad (\text{B2})$$

Combining (B1) and (B2), unemployment benefits  $b$  are given by

$$b^N = f^N - (1 - G(\bar{y}^N)) \frac{B}{u'(c^N)} + p_2^N k^N.$$

Using (13) and (14), the above equation can be rewritten as

$$b^N = p_1^N \int_{\bar{y}^N} y dG(y) + p_2^N k^N.$$

Equilibrium payroll subsidies  $t_e^N$  can be obtained by substituting the above equation into (B1) or (B2) such as

$$t_e^N = G(\bar{y}^N) p_1^N \bar{y}^N - p_2^N k^N.$$

## Appendix C

Total differentiation of (14) gives

$$\frac{\partial f^N}{\partial \bar{y}^N} = \frac{\partial p_1^N}{\partial x_1^N} \frac{\partial x_1^N}{\partial \bar{y}^N} \int_{\bar{y}^N} (y - \bar{y}^N) dG(y) - p_1^N (1 - G(\bar{y}^N)).$$

Because  $\bar{y}^N < 0$ ,  $\partial p_1 / \partial x_1 < 0$ ,  $\partial x_1 / \partial \bar{y} > 0$ ; then,  $\partial f^N / \partial \bar{y}^N < 0$ .

## Appendix D

The Lagrangian of the government's program is

$$\begin{aligned} \Gamma = & \sum_i [(1 - G(\bar{y})) u(w + \hat{r}k_i) + G(\bar{y})(u(b + \hat{r}k_i) - B)] l_i \\ & + \lambda^I \left\{ f \left( \int_{\bar{y}} y dG(y), k^I \right) - [(1 - G(\bar{y})) w + G(\bar{y}) b] - \hat{r}k^I \right\}, \end{aligned}$$

where  $\lambda^I$  is the Lagrangian multiplier. The first-order condition with respect to  $k^I$  is

$$\frac{\partial \Gamma}{\partial k^I} = 0 \iff \frac{\partial f(x_1, x_2)}{\partial x_2} - \hat{r} = 0. \quad (\text{D1})$$

Since all countries are symmetric, all governments choose the same  $k^I$ ; then  $r = \partial f(x_1, x_2) / \partial x_2$ , which implies that  $r = p_2$ .

The first order conditions with respect to  $w$  and  $b$  are, respectively,

$$\begin{aligned}\frac{\partial \Gamma}{\partial w} = 0 &\iff \sum_i u'(w + \hat{r}k_i) l_i - \lambda^I = 0, \\ \frac{\partial \Gamma}{\partial b} = 0 &\iff \sum_i u'(b + \hat{r}k_i) l_i - \lambda^I = 0.\end{aligned}$$

Because of  $u'' < 0$ , this condition holds if and only if  $c^I = w = b$  where

$$c^I = f\left(\int_{\bar{y}^I} y dG(y), k^I\right) - p_2^I k^I.$$

The first order condition with respect to  $\bar{y}$  is

$$\begin{aligned}\frac{\partial \Gamma}{\partial \bar{y}} = 0 &\iff -\sum_i [u(w + \hat{r}k_i) - u(b + \hat{r}k_i) + B] l_i + \lambda^I \left\{ -\frac{\partial f(x_1, x_2)}{\partial x_1} \bar{y} + w - b \right\} \\ &+ \lambda^I \left( \frac{\partial f(x_1, x_2)}{\partial x_2} - \hat{r} \right) \frac{\partial k^I}{\partial \bar{y}} = 0.\end{aligned}\tag{D2}$$

Using  $c^I = w = b$  and (D1), (D2) can be rewritten as

$$\bar{y}^I = -\frac{BL}{\lambda^I p_1^I},$$

where

$$\lambda^I = \sum_i u'(c^I + \hat{r}k_i) l_i.$$

## Appendix E

We prove  $\bar{y}^I > \bar{y}^N$  by contradiction. Suppose that  $\bar{y}^I \leq \bar{y}^N$ . From  $\bar{y}^I < 0$  and  $\bar{y}^N < 0$ ,  $x_1^I \leq x_1^N$ . Because  $k^I = k^N$ ,  $p_1^I \geq p_1^N$  and  $f\left(\int_{\bar{y}^I} y dG(y), k^I\right) \leq f\left(\int_{\bar{y}^N} y dG(y), k^N\right)$ . The market clearing conditions, (8) and (21), imply that

$$\sum_i (c^I + \hat{r}k_i) \frac{l_i}{L} \leq c^N.$$



Using the Jensen's inequality, we obtain the following inequality

$$\sum_i u' (c^I + \hat{r}k_i) \frac{l_i}{L} > u' (c^N).$$

In combinatoin with  $p_1^I \geq p_1^N$ , the above inequality can be rewritten as

$$-\frac{B}{\sum_i u' (c^I + \hat{r}k_i) l_i p_1^I} > -\frac{B}{u' (c^N) L p_1^N}.$$

Using (13) and (24), the above inequality means that

$$\bar{y}^I > \bar{y}^N,$$

which contradicts  $\bar{y}^I \leq \bar{y}^N$ .

## Appendix F

To implement (22), from (3), capital taxes  $t_k^I$  must be

$$t_k^I = 0.$$

To implement (24), from (2) and (4), the layoff tax must satisfy the following condition:

$$\begin{aligned} f^I &= -p_1^I \bar{y}^I + \frac{p_1^I \int_{\bar{y}^I} y dG(y) - G(\bar{y}^I) f^I}{1 - G(\bar{y}^I)} \\ &= p_1^I \int_{\bar{y}^I} (y - \bar{y}^I) dG(y). \end{aligned}$$

Next, we characterize the equilibrium payroll subsidies  $t_e^I$  and unemployment benefits  $b^I$ . From (2) and the insurance condition  $w^I = b^I$ , (24) can be rewritten as

$$b^I + t_e^I = f^I - \frac{BL}{\sum_i u' (c^I + \hat{r}^I k_i) l_i}. \quad (\text{F1})$$

Now, the budget constraints of the government (9) can be rewritten as

$$(1 - G(\bar{y}^I)) t_e^I = G(\bar{y}^I) (b^I - f^I). \quad (\text{F2})$$

Combining (F1) and (F2), unemployment benefits  $b^I$  are

$$b^I = f^I - (1 - G(\bar{y}^I)) \frac{BL}{\sum_i u'(c^I + \hat{r}^I k_i) l_i}.$$

Using (24) and (25), the above equation can be rewritten as

$$b^I = p_1^I \int_{\bar{y}^I} y dG(y).$$

Equilibrium payroll subsidies  $t_e^N$  can be obtained by substituting the above equation into (F1) or (F2) as

$$t_e^I = G(\bar{y}^I) p_1^I \bar{y}^I.$$