Wage Inequality and Human Capital Formation

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Abstract

We investigate the effects of wage inequality between skilled and unskilled workers on human capital formation in a home country when the workers in the home country can migrate to a foreign country. In contrast to the previous analyses on brain drain, we pay attention to the fact that resources for human capital formation, such as education, are not necessarily supplied elastically and free. For this reason, we include a resource market in our model and consider its transactions explicitly. We show that even if workers have to pay pecuniary costs to form human capital, both skilled and unskilled workers in the home country always attempt to migrate when some of them can be accepted in a foreign country. We also show that brain gain and brain drain take place simultaneously. In particular, if wage inequality is larger in the foreign country than in the home country, skilled workers experience brain gain whereas unskilled workers experience brain drain. In contrast, if wage inequality is larger in the home country, skilled workers experience brain drain, whereas unskilled workers experience brain gain. Our results suggest that how migration possibilities affect human capital formation of different types of workers is closely related to differences in wage inequality between the home and foreign countries.

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1. Introduction

We investigate how wage inequality between skilled and unskilled workers in a home country and a foreign country affects human capital formation of the home country's workers when some of them can be accepted in the foreign country. For this purpose, we consider that the resources necessary for human capital formation, such as education, cannot always be supplied elastically and that workers generally cannot obtain such resources free of cost.

Wage inequality between skilled and unskilled workers has been a serious problem in many countries, especially in developing countries (Wood 1995, 1997; Marjit et al. 2001). Against our standard theoretical presumption, the recent liberalisation in trade did not necessarily alleviate it (Marjit and Beladi 2002; Marjit et al. 2004). On the contrary, in Latin America and South Asia, including India, trade liberalisation has increased wage inequality. Undoubtedly, trade is not the only factor that affects wage inequality. However, wage inequality does not seem to disappear easily.

This suggests that in an analysis on brain drain, we cannot ignore this reality because the analysis is often associated with skilled and unskilled labour and different wage inequalities in the labour-sending and labour-receiving countries. As shown by Yabuuchi and Chaudhuri (2007) and Beladi et al. (2008), migration and other factor motility affect wage inequality. However, we infer that wage inequality will also affect migration. But the effects of wage inequality on emigration and human capital formation have received little attention so far.

There can be two cases of wage inequality in a labour-sending country (often a developing country) and a labour-receiving country (often a developed country). One possibility is that wage inequality in the labour-sending country becomes smaller than that in the labour-receiving country as a result of, for example, trade liberalisation. Another possibility is that the labour-sending country would still have a larger wage inequality than the labour-receiving country. Therefore, we

assume these two cases and examine the effects of migration possibilities on human capital formation.

There is another weakness in previous studies on brain drain. Although the research has a long history, until now it has not paid sufficient attention to the fact that the supply of resources for human capital formation, such as education, cannot always meet the demand instantaneously and without cost.[1] Stark et al. (1997, 1998) assumed that an individual worker develops his human capital to maximise his utility derived from wages minus non-pecuniary costs of human capital

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[1] According to Docquier and Rapoport (2009), the research history comprises three *generations*. Although a survey of the research is not the aim here, a brief overview is as follows: The term "brain drain" gained wide usage in the late 1960s when the migration of skilled workers from developing to developed countries accelerated. The first-generation research, which includes Grubel and Scott (1966) and Berry and Soligo (1969), generally emphasized the benefits of free migration to the world economy. While the first-generation research assumed a competitive economy, Bhagwati and Hamada (1974), Hamada and Bhagwati (1975), and Bhagwati and Rogriguez (1975), which formed the second-generation research, introduced more realistic institutional settings and emphasized the negative effects of skilled emigration. After the mid-1990s the third-generation research, which includes Mountford (1997), Stark et al. (1997, 1998), and Beine et al. (2001, 2008), emerged. They took emigration of skilled workers to be beneficial not only to the labour-receiving country but also to the labour-sending country on the grounds that migration possibilities may send a positive signal and motivate others in the labour-sending country to acquire more resources, such as education. This will result in a larger average amount of acquired human capital of the labour-sending country. In the next section, we build a model in line with this argument.

formation. No constraint was assumed for human capital formation and no pecuniary costs were included.[2] Accordingly, we can assume that in their models the resource for human capital formation is being supplied to meet the demand instantaneously and without any pecuniary costs. These premises also apply to Mountford (1997) and Beine et al. (2001, 2008).

However, such assumptions are not realistic. In a short period, resources used for human capital formation, such as education, cannot be supplied elastically with changes in demand. If a large number of people are willing to attend school, it will take some time before all of them can attend school. It goes without saying that this is because the supply of education cannot be increased in a short period. In such a case, we naturally consider that demand will be equalized to supply given changes in the price of the resource. If this is the case, it will be difficult to rule out the market for the resource and pecuniary costs related to human capital formation.

Therefore, we incorporate into the model the resource market and consider transactions of the resource explicitly.

Once the resource market and its transactions are introduced in the analysis, even if skilled and unskilled workers' wages are given independently, human capital formation for these two types of workers becomes interdependent through the resource market. This is another advantage of including the resource market.

We will derive the following results: When skilled and unskilled workers in the home country have migration possibilities to a foreign country, both always have an incentive to migrate even if they need to pay pecuniary costs to form human capital. If the wage inequality between skilled and unskilled workers is larger in the foreign country than in the home country, migration

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[2] Stark et al. (1998, footnote 1) stated explicitly that they disregard direct outlays in connection with human capital investment.

possibilities raise the average acquired human capital of skilled workers in the home country, but lower the average acquired human capital of unskilled workers in the home country. In other words, the skilled workers experience brain gain and unskilled workers experience brain drain. In contrast, if wage inequality is larger in the home country than in the foreign country, skilled workers experience brain drain and unskilled workers experience brain gain.

The remainder of this paper is organised as follows: Section 2 models a two-country economy with skilled and unskilled workers. We assume that the home country and the foreign country have different wage inequalities and that there is a resource market for human capital formation in the home country. We also assume that some of the home country's workers can migrate to the foreign country. Section 3 examines the effects of wage inequality on human capital formation of the home country's workers. Section 4 presents concluding remarks.

2. The Model

We assume two countries, a home country and a foreign country. The foreign country has a larger capital stock than the home country. There are skilled and unskilled workers in both countries. Both types of workers in the home country have migration possibilities to the foreign country. Migrants do not send remittances to the home country. Firms in the foreign country do not distinguish between skilled (unskilled) native workers and skilled (unskilled) migrant workers. This implies that skilled (unskilled) native and skilled (unskilled) migrant workers are paid the same wage in the foreign country. Moreover, we assume that there is no unemployment in either country.

In the home country, there are $\mu\overline{N}$ skilled workers and $(1-\mu)\overline{N}$ unskilled workers, where μ, $0 < \mu < 1$, is a constant and denotes the fraction of skilled workers in the initial labour endowment before migration. $\overline{N}$ is a positive constant and denotes the initial labour endowment. We assume

that skilled and unskilled workers have the same migration possibility θ, $0 < \theta < 1$, that is given exogenously and defined as the probability for an individual skilled (unskilled) worker to be accepted as a (an) skilled (unskilled) migrant into the foreign country, although in the benchmark case, they are assumed to have no migration possibilities, i.e. $\theta = 0$.

The productivity of an individual worker depends on capital stock, innate talent, and acquired human capital. Since the capital stock is assumed to be larger in the foreign country, a worker is more productive in the foreign country than in the home country if he has the same level of innate talent and acquired human capital in the two countries. By nature, a skilled worker can be considered more talented than an unskilled worker. Accordingly, we assume that a skilled worker has higher productivity than an unskilled worker if he is equipped with the same level of capital stock and acquired human capital. Needless to say, by capturing more resources, an individual worker forms more human capital and, other things being equal, the worker with more acquired human capital is more productive.

To ensure that the model reflected these considerations, we included the following assumptions: An individual skilled worker acquires human capital by $\ln e_S$ if he captures the resources by e_S (> 1). Needless to say, under this assumption acquired human capital increases with its resources. He earns $h_S \ln e_S$ in the home country and $f_S \ln e_S$ in the foreign country, which is determined to be equal to the skilled native workers' wages in that country w_S^*, where $h_S < f_S$, implying that capital is more abundant in the foreign country.[3] An individual unskilled worker

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[3] In general, wages in the labour-sending country will not be independent from emigration, and wages in the labour-receiving country will not be independent from immigration. However, to avoid complicating the analysis, we consider that effects of emigration and immigration on wages are not significant, and assume that wages in the home country are independent from emigration

forms human capital by $\ln e_U$ by capturing the resource by $e_U\ (>1)$. He earns $h_U \ln e_U$ in the home country and $f_U \ln e_U$ in the foreign country, which is determined to equal the unskilled native workers' wages in that country w_U^*, where $h_U < f_U$. We also assume that $h_U < h_S$ and $f_U < f_S$ since skilled workers (migrants) are more talented than unskilled workers (migrants).

We define the home country's wage inequality between skilled and unskilled workers as $h_S \ln e_S / h_U \ln e_U$, and the foreign country's wage inequality as w_S^* / w_U^*. Under these definitions, wage inequality is larger in the home country than in the foreign country if

$$\frac{h_S}{h_U} > \frac{f_S}{f_S},$$

and wage inequality is larger in the foreign country than in the home country if

$$\frac{h_S}{h_U} < \frac{f_S}{f_S}.$$

Both skilled and unskilled workers in the home country attempt to capture the same resource to develop human capital. However, as mentioned, it is difficult for the supply of the resource to instantaneously meet demand. We assume that the home country's total supply of the resource remains unchanged throughout the analysis and denote it with a positive constant $\overline{E}$, which is given exogenously. We also assume that the resource price p is determined competitively in the resource market. The resource is traded at the equilibrium price.

There is an argument against these assumptions. It goes without saying that education is the most important resource for human capital formation, but it is often financed by taxes and we do not pay its costs directly, although Commander et al. (2004) pointed out that in the last decade

and wages in the foreign country are independent from immigration. We also assume that human capital accumulated in the home country does not 'depreciate' even after migration.

there has been an increase in the provision of private educational services in many developing countries. The price of such services does not seem to be adjusting demand and supply. This is true for primary and secondary education. However, we must note that primary and secondary education is usually compulsory. As a result, there will be no differences between skilled and unskilled workers in receiving these levels of education. In the context of our model, the same duration of primary and secondary education can be included in both e_S and e_U, purchased at a resource price of zero. The difference in the demand for education will emerge for tertiary education, which is becoming more market-oriented (Johnstone et al., 1998).[4] Accordingly, the demand for tertiary education will be more price-dependent and given the market price, skilled and unskilled workers will demand different amounts of tertiary education. This will cause e_S and e_U to have different values. These observations allow us to assume a resource market that allocates the resource among the skilled and unskilled workers according to the price.

Under migration possibilities for both types of workers, an individual skilled worker in the home country demands the resource to maximise his net earnings $W_S^{\tilde{S},\tilde{U}}$ that are equal to skilled workers' expected wages minus pecuniary costs for realising such wages, i.e.

$$W_S^{\tilde{S},\tilde{U}} = \theta f_S \ln e_S + (1-\theta) h_S \ln e_S - p e_S.$$

Similarly, an individual unskilled worker in the home country demands the resource to maximise his net earnings $W_U^{\tilde{S},\tilde{U}}$ that are equal to unskilled workers' expected wages minus pecuniary costs for realising such wages, i.e.

$$W_U^{\tilde{S},\tilde{U}} = \theta f_U \ln e_U + (1-\theta) h_U \ln e_U - p e_U.$$

In contrast to Stark et al. (1997, 1998), non-pecuniary costs are not included by implicitly

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[4] According to Dahlman and Aubert (2001) and Zeng and Wang (2007), private provision for tertiary education has been growing rapidly in China.

assuming that such costs are fixed.

3. The Brain Gain and the Brain Drain

In this section, we examine the effects of migration possibilities on human capital formation of skilled and unskilled workers. In particular, we examine whether skilled and unskilled workers in the home country increase or decrease their average acquired human capital when some of them are accepted in the foreign country.

As a benchmark, we first deal with the case where neither type of worker has migration possibilities, i.e. $\theta = 0$. An individual skilled worker demands the resource to maximise his net earnings $h_S \ln e_S - p e_S (\equiv W_S^{S,U})$, and skilled workers' total demand for the resource is $(h_S / p) \mu \overline{N}$, which decreases with the resource price. Similarly, an individual unskilled worker demands the resource to maximise his net earnings $h_U \ln e_U - p e_U (\equiv W_U^{S,U})$, and unskilled workers' total demand for the resource is $(h_U / p)(1 - \mu) \overline{N}$, which also decreases with the resource price.

For the resource market to be in equilibrium, the total demand for the resource must be equal to its supply:

$$\frac{h_S}{p} \mu \overline{N} + \frac{h_U}{p}(1 - \mu) \overline{N} = \overline{E},$$

and the resource price is determined as follows:

$$p = \alpha \{ h_S \mu + h_U (1 - \mu) \} (\equiv p^{S,U}),$$

where $\alpha \equiv \overline{N} / \overline{E}$ is assumed to be sufficiently small so that net earnings and the average acquired human capital are positive.

By substituting resource price into net earnings, we derive net earnings of an individual skilled worker and an individual unskilled worker under no migration possibilities:

9

$$W_S = h_S \left[\ln \frac{h_S}{\alpha \{ h_S \mu + h_U (1-\mu) \}} - 1 \right] (\equiv W_S^{S,U}), \tag{1}$$

$$W_U = h_U \left[\ln \frac{h_U}{\alpha \{ h_S \mu + h_U (1-\mu) \}} - 1 \right] (\equiv W_U^{S,U}). \tag{2}$$

Accordingly, in the benchmark case, the average acquired human capitals of skilled workers and unskilled workers are, respectively,

$$\ln \frac{h_S}{\alpha \{ h_S \mu + h_U (1-\mu) \}} (\equiv AAHC_S^{S,U}), \tag{3}$$

$$\ln \frac{h_U}{\alpha \{ h_S \mu + h_U (1-\mu) \}} (\equiv AAHC_U^{S,U}). \tag{4}$$

The average acquired human capital is larger for skilled workers than for unskilled workers since an individual skilled worker demands more resources than an individual unskilled worker.

We next deal with the usual case where both types of workers have migration possibilities, i.e. $\theta > 0$. From $\partial W_S^{\tilde{S},\tilde{U}} / \partial e_S = 0$, we find that skilled workers demand the resource by $[\{ \theta f_S + (1-\theta) h_S \} / p] \mu \overline{N}$, and from $\partial W_U^{\tilde{S},\tilde{U}} / \partial e_U = 0$, we find that unskilled workers demand the resource by $[\{ \theta f_U + (1-\theta) h_U \} / p] (1-\mu) \overline{N}$.

The resource price is determined as follows:

$$p = \alpha [\{ \theta f_S + (1-\theta) h_S \} \mu + \{ \theta f_U + (1-\theta) h_U \} (1-\mu)] (\equiv p^{\tilde{S},\tilde{U}}).$$

The resource price is higher when migration possibilities are non-zero, i.e. $p^{\tilde{S},\tilde{U}} > p^{S,U}$. This is because migration possibilities raise the total demand for the resource.

Under non-zero migration possibilities, an individual skilled worker and an individual unskilled worker have the following net earnings:

$$W_S = \{ \theta f_S + (1-\theta) h_S \} \left[\ln \frac{\theta f_S + (1-\theta) h_S}{\alpha [\{ \theta f_S + (1-\theta) h_S \} \mu + \{ \theta f_U + (1-\theta) h_U \} (1-\mu)]} - 1 \right] (\equiv W_S^{\tilde{S},\tilde{U}}). \tag{5}$$

10

$$W_U = \{\theta f_U + (1-\theta)h_U\}\left[\ln\frac{\theta f_U + (1-\theta)h_U}{\alpha[\{\theta f_S + (1-\theta)h_S\}\mu + \{\theta f_U + (1-\theta)h_U\}(1-\mu)]} - 1\right](\equiv W_U^{\tilde{S},\tilde{U}}). \quad (6)$$

Accordingly, the average acquired human capital for skilled and unskilled workers are, respectively,

$$\ln\frac{\theta f_S + (1-\theta)h_S}{\alpha[\{\theta f_S + (1-\theta)h_S\}\mu + \{\theta f_U + (1-\theta)h_U\}(1-\mu)]}(\equiv AAHC_S^{\tilde{S},\tilde{U}}). \quad (7)$$

$$\ln\frac{\theta f_U + (1-\theta)h_U}{\alpha[\{\theta f_S + (1-\theta)h_S\}\mu + \{\theta f_U + (1-\theta)h_U\}(1-\mu)]}(\equiv AAHC_U^{\tilde{S},\tilde{U}}). \quad (8)$$

As in the benchmark case, the average acquired human capital is larger for skilled workers than for unskilled workers.

We are now in a position to compare the usual case with the benchmark case to derive the effects of migration possibilities on human capital formation. Inspection of Equations (7) and (3) shows that

$$sign(AAHC_S^{\tilde{S},\tilde{U}} - AAHC_S^{S,U})$$

$$= sign\left[\frac{\theta f_S + (1-\theta)h_S}{\alpha[\{\theta f_S + (1-\theta)h_S\}\mu + \{\theta f_U + (1-\theta)h_U\}(1-\mu)]} - \frac{h_S}{\alpha\{h_S\mu + h_U(1-\mu)\}}\right],$$

$$= sign(h_U f_S - h_S f_U),$$

and inspection of Equations (8) and (4) shows that

$$sign(AAHC_U^{\tilde{S},\tilde{U}} - AAHC_U^{S,U})$$

$$= sign\left[\frac{\theta f_U + (1-\theta)h_U}{\alpha[\{\theta f_S + (1-\theta)h_S\}\mu + \{\theta f_U + (1-\theta)h_U\}(1-\mu)]} - \frac{h_U}{\alpha\{h_S\mu + h_U(1-\mu)\}}\right]$$

$$= sign(-h_U f_S + h_S f_U).$$

These equations suggest that if

$$f_S/f_U > h_S/h_U \quad (\Leftrightarrow h_U f_S - h_S f_U > 0),$$

11

then, (9)

$$AAHC_S^{\tilde{S},\tilde{U}} > AAHC_S^{S,U} \text{ and } AAHC_U^{\tilde{S},\tilde{U}} < AAHC_U^{S,U}.$$

According to Equation (9), if wage inequality is larger in the foreign country than in the home country, the average acquired human capital of skilled workers is larger under non-zero migration possibilities than under zero migration possibilities, whereas the average acquired human capital of unskilled workers is smaller under non-zero migration possibilities than under zero migration possibilities. Thus, under non-zero migration possibilities, it is likely that the skilled workers experience brain gain and the unskilled workers experience brain drain.

Whether the brain gain and the brain drain materialise depends on whether workers in the home country actually attempt to migrate to the foreign country. Even with non-zero migration possibilities, workers do not attempt to migrate if they cannot obtain larger net earnings by doing so. By comparing Equations (5) and (1) and Equations (6) and (2), we find that if $f_S/f_U > h_S/h_U$, $W_S^{\tilde{S},\tilde{U}} > W_S^{S,U}$, whereas we cannot determine which of $W_U^{S,U}$ and $W_U^{\tilde{S},\tilde{U}}$ is larger. Accordingly, skilled workers certainly attempt to migrate, but unskilled workers may not attempt to migrate since unskilled workers do not necessarily obtain larger net earnings by migration. However, even if $W_U^{S,U} > W_U^{\tilde{S},\tilde{U}}$ is possible, they will attempt to migrate to the foreign country because their net earnings would be much smaller if they choose to remain in the home country when skilled workers are attempting to migrate, i.e. $W_U^{\tilde{S},\tilde{U}} > W_U^{\tilde{S},U}$, where $W_U^{\tilde{S},U}$ is the net earning of an individual unskilled worker who does not attempt to migrate when skilled workers are attempting to migrate.[5] Thus, both types of workers certainly attempt to migrate.

Therefore, if the foreign country's wage inequality is larger than that of the home country, skilled workers experience brain gain and unskilled workers experience brain drain. This result is

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[5] $W_U^{\tilde{S},U} = h_U \ln h_U / \alpha[\{\theta f_S + (1-\theta)h_S\}\mu + h_U(1-\mu)] - h_U.$

independent from the value of θ.

In contrast, if

$$f_S / f_U < h_S / h_U \ (\Leftrightarrow h_U f_S - h_S f_U < 0),$$

then,   (10)

$$AAHC_S^{\tilde{S},\tilde{U}} < AAHC_S^{S,U} \text{ and } AAHC_U^{\tilde{S},\tilde{U}} > AAHC_U^{S,U}.$$

According to Equation (10), if wage inequality is larger in the home country than in the foreign country, it is likely that skilled workers decrease the average acquired human capital and unskilled workers increase the average acquired human capital given non-zero migration possibilities. This suggests that skilled workers may experience brain drain and unskilled workers may experience brain gain.

To examine whether brain gain and brain drain actually occur, we compare net earnings. We find that $W_U^{\tilde{S},\tilde{U}} > W_U^{S,U}$, whereas $W_S^{S,U} > W_S^{\tilde{S},\tilde{U}}$ as well as $W_S^{S,U} < W_S^{\tilde{S},\tilde{U}}$ are possible. Accordingly, unskilled workers certainly attempt to migrate, but skilled workers do not always attempt to migrate. However, we also find that $W_S^{\tilde{S},\tilde{U}} > W_S^{S,\tilde{U}}$, where $W_S^{S,\tilde{U}}$ is the net earning of an individual skilled worker who does not attempt to migrate when unskilled workers are attempting to migrate.[6] As in the previous case, workers who lose by not attempting to migrate will attempt to migrate. Thus, both types of workers certainly attempt to migrate.

Therefore, if the home country's wage inequality is larger than that of the foreign country, unskilled workers experience brain gain and skilled workers experience brain drain. This result is also independent from the value of θ.

When there is no difference in wage inequality between the two countries, i.e. $f_S / f_U = h_S / h_U$, both types of workers attempt to migrate. However, neither brain gain nor brain drain occurs. In

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[6] $W_S^{S,\tilde{U}} = h_S \ln h_S / \alpha [h_S \mu + \{\theta f_U + (1-\theta) h_U\}(1-\mu)] - h_S.$

other words, if

$$f_S / f_U = h_S / h_U \ (\Leftrightarrow h_U f_S - h_S f_U = 0),$$

then,

$$W_S^{\tilde{S},\tilde{U}} > W_S^{S,U} \ \text{and} \ W_U^{\tilde{S},\tilde{U}} > W_U^{S,U},$$

$$AAHC_S^{\tilde{S},\tilde{U}} = AAHC_S^{S,U} \ \text{and} \ AAHC_U^{\tilde{S},\tilde{U}} = AAHC_U^{S,U}.$$

To summarise the results derived in this section, even if workers have to pay pecuniary costs to obtain the resource to develop human capital, both skilled and unskilled workers attempt to migrate to the foreign country. If the home country's wage inequality is smaller, skilled workers experience brain gain and unskilled workers experience brain drain. In contrast, if the home country wage inequality is larger, unskilled workers experience brain gain and skilled workers experience brain drain.

4. Concluding Remarks

Migration possibilities affect the incentive structure of workers and change their human capital formation. Although it has been considered that emigration of skilled workers has negative impacts on the labour-sending country, recent studies have found that skilled workers' emigration may increase average acquired human capital of the labour-sending country. In other words, the labour-sending country may experience brain gain as well as brain drain.

To examine the effects of migration possibilities on human capital formation in a more realistic situation, we explicitly took account of differences in wage inequality in the labour-sending and labour-receiving countries and the limited availability of the resource for human market formation. Previous analyses on the brain drain have paid little attention to these facts, which seem to strongly affect skilled worker emigration and human capital formation.

We found that both skilled and unskilled workers always attempt to migrate to the foreign

14

country even if they have to pay pecuniary costs to obtain the resource and that how the brain gain and the brain drain occur depends on differences in wage inequality between home and foreign countries.

Our analysis can be extended in several directions by modifying the assumptions. We assumed that the resource market is competitive. As a first attempt to introduce the resource market, such an assumption is appropriate, but in reality, the resource is allocated in a non-competitive manner. If we change the assumption of the competitive resource market, the results are likely to be different. We also assumed that the resource is financed privately. We can extend the analysis by assuming that a part of the resource is financed publicly. The results would also be affected depending on how workers pay taxes and how the government provides the resource. Moreover, we assumed that the budget constraint of an individual worker is not binding and that his net earnings are always positive. We can include the case where an individual worker cannot demand the resource as much as he wants at the market price given the budget constraint. Incorporating such a case will significantly improve our analysis.

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