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Does labor diversity cause agglomeration in Japan?: an NEG approach with a covariance structure analysis

Ryusuke Ihara* and Shizu Yamamoto†

Abstract

Using a simplified NEG model with homogenous capital and heterogeneous workers, this paper investigates the relation between labor diversity and agglomeration. The backward linkage (i.e. agglomeration caused by labor demand) implies that the agglomeration of capital leads workers to concentrate. The forward linkage (i.e. agglomeration caused by labor supply) implies that the increase in the number of workers enhances the degree of labor diversity, and causes agglomeration of capital. As a result of the circular causality, we show that labor diversity causes agglomeration when interregional commute cost is sufficiently low. In addition, a covariance structure analysis reveals the existence of the circular causality in Japan.

JEL Classification: R11, R12, J61

Key words: labor heterogeneity, new economic geography, circular causality, covariance structure analysis

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1. Introduction

Along with the progress of agglomeration and urbanization in the world economy, the concern with labor diversity has been growing for the last decades. The World Urbanization Prospects The 2009 revision reports that the share of urban population in the world population increased by 20%, while the International Migration Outlook (2011) reports that the net migration as a share of total population in OECD countries also increased by 50%, over the past two decades. From these two trends, we can read an interesting circular causality between agglomeration and labor diversity. The agglomeration economy has been studied in the context of the New Economic Geography (NEG) originating with Krugman (1991) and Fujita et al. (1999). Numerous studies have explained that economic activities (including firms, plants and workers) can benefit from agglomeration economies with the progress of globalization and the improvement of transportation technology. At the same time, agglomeration of workers from various countries and regions enhances labor diversity in cities. As Jacobs (1969) pointed out, labor diversity is the source of productivity in urban areas. The difference of values, cultures and way of thinking stimulates the creativity of workers and firms and improves their productivity. Therefore the increase in the degree of labor diversity attracts firms to the cities. As a result, a circular causality emerges: agglomeration of workers raises labor diversity and labor diversity stimulates agglomeration with the progress of globalization. The main purpose of this paper is to investigate the circular causality on labor diversity and agglomeration by theoretical and empirical analyses.

Numerous articles have studied the effect of labor diversity on productivity and agglomeration in recent years. For instance, Florida (2005) emphasized that regional creativity is explained by cultural heterogeneity and tolerance to it which are measured by various indices such as Gay index, Bohemian index, and so on. Ottaviano and Peri (2006) and Bellini and Pinelli (2009) respectively studied the effects of cultural heterogeneity on urban productivity in the United States and in Europe. Sparber (2008) explained that the effect of racial variety on economic development can be either positive or negative, and Sparber (2009) showed with the data of the United States that racial diversity has a positive effect on wages especially in legal services, computer

manufacturing, computer software, and other activities. Iranzo et al. (2008) and Navon (2009) also found that the diversity in skills and knowledge is beneficial for firms and plants.

The relation between agglomeration and labor diversity has been analyzed theoretically in the context of the NEG. Amiti and Pissarides (2005) used a skills circle presented by Salop (1979) to explain that the trade liberalization causes industrial agglomeration and interregional trade when labor is heterogeneous. Tabuchi and Thisse (2002) considered heterogeneous tastes about location choices and showed a bell-shaped distribution pattern. Ottaviano and Prarolo (2009) showed that multicultural cities emerge when communication between cities is easy. Berliant and Fujita (2008, 2011) investigated the process of knowledge creation and transfer, and explained multiple cultures raise creativity. While these studies demonstrate the importance of labor heterogeneity from a theoretical point of view, there have been few empirical studies that investigated the labor diversity in the context of NEG.

In order to work on the above issue, this paper first presents a simplified (i.e. minimal) NEG model with heterogeneous labor as a source of agglomeration, and then investigate it with a covariance structure analysis. The theoretical analysis shows that the basic story of the NEG (i.e. globalization causes agglomeration) is supported by our new model that is simpler and more tractable than the ordinary NEG models such as the two-sector model (with a manufacturing sector in Dixit-Stiglitz type monopolistic competition bearing interregional shipping costs and an agricultural sector in perfect competition bearing no shipping cost)¹. Furthermore, we show that covariance structure analysis is useful to describe the paths of causalities such as backward and forward linkages. Since at least this analytical method has not so far been applied in the empirical studies of the NEG literature, it is significant to examine the potential of this method to provide rich findings.

¹ It is more difficult than expected to simplify the NEG model while maintaining the basic story of the agglomeration caused by globalization (i.e. by the decrease in transport costs). For instance, if we consider a one-sector model where the dispersion force rests on land consumption, the distribution pattern becomes contrary to the above: the globalization causes the dispersion of economic activities (see e.g. Helpman, 1998, and Murata and Thisse, 2005). In order to keep the basic story of the NEG, we usually need some kind of manipulation such as introducing two sectors. See also Ottaviano and Thisse (2004).

By the way, whilst there have been a considerable number of studies on labor diversity in the United States and Europe, sufficient attention has not yet been given to the labor diversity in Japan. There seem to be two reasons. The first reason is that the number of foreign workers in Japan is small and the government has taken a passive attitude to the immigrants from foreign countries². The second reason is that Japanese people tend to believe that they are ethnically homogeneous, thus show little interest in the diversity of workers especially in the aspect of races, culture and values. However, is it true that Japanese workers are homogenous and there is little effects on production process and agglomeration in Japan? Another purpose of this paper is to reveals the fact that has been overlooked in Japan. That is, by measuring the labor diversity, we find the effect on the productivity and agglomeration, with the Japanese prefectural data.

The remainder of this paper is organized as follows. In Section 2, we present a minimal two-region model incorporating homogeneous capital and heterogeneous workers. Capital is freely mobile between the regions, while workers are immobile but commute between the regions by paying commuting costs. In Section 3, we investigate the interregional commute (i.e. job choice) pattern of workers and the agglomeration of capital. Results show that capital agglomerates in a region with a larger share of residents thus the workers commute to the core region, when the interregional commute cost is lower than the benefit from labor diversity obtained in the core region. Section 4 presents a description of a covariance structure analysis with Japanese prefectural data, showing the existence of a circular causality based on labor diversity in Japan. Finally Section 5 concludes this paper.

2. The model

The model consists of two factors: homogenous capital, K ; and heterogeneous workers, L , which are characterized by the continuum of horizontally differentiated types of labor, $l(i)$. We consider the following production function of consumption

² The International Migration Outlook (2011) reports that the stock of foreign population as a percent of total population is 1.7% in Japan, in contrast to the US (6.9%), the UK (7.1%) and Germany (8.2%) in 2009. In addition, the share of foreign labor force in Japan is only 0.3%, in contrast to the UK (8.0%), Germany (9.4%) and France (5.8%) in 2008.

goods:

$$Y = K^{1-\alpha} \int_0^L l(i)^\alpha di, \quad (1)$$

where α is the expenditure share for workers. Assuming the symmetry in the labor amount of each worker, i.e. $l(i)=l$, and normalizing the price of good to unity, profit maximization yields the reward to capital, w^K , and the wage of workers, w^L :

$$w^K = (1 - \alpha)L \left(\frac{l}{K} \right)^\alpha, \quad (2)$$

$$w^L = \alpha \left(\frac{K}{l} \right)^{1-\alpha}. \quad (3)$$

The reward to capital is increasing in L because the production function exhibits increasing returns to scale in labor diversity³.

We introduce two regions: $r=1, 2$. Capital is assumed to be freely mobile between regions, and the amount of capital in region r is expressed as K_r . On the other hand, workers can not change the residential region, but can commute to the other region by paying the commuting cost, when the region of employment differs from the residential region. Assuming that each worker can not commute to two regions simultaneously (i.e. they can not provide labor service to two regions), we rewrite the rewards to capital and workers as

$$w_r^K = (1 - \alpha)\beta \frac{L_{(r)r}(l_{(r)r})^\alpha + L_{(s)r}(l_{(s)r}^\dagger)^\alpha}{K_r^\alpha}, \quad (4)$$

$$w_{(r)r}^L = \alpha\beta \left(\frac{K_r}{l_{(r)r}} \right)^{1-\alpha}, \quad (5)$$

$$w_{(s)r}^L = \alpha\beta \left(\frac{K_r}{l_{(s)r}^\dagger} \right)^{1-\alpha}, \quad (6)$$

³ The precise explanation is in e.g. Ether (1982) and Behrens and Sato (2006).

where $L_{(r)s}$ is the number of workers who reside in region r and take jobs in region s , and $l_{(r)s}^\dagger$ is the effective labor amount of workers in the labor-receiving region.

Considering the interregional commute, we assume that commuting costs take an “iceberg” form: $l_{(s)r}^\dagger = l_{(s)r} t$, $t = [0,1]$. By commuting from region s to region r , the initial amount of labor in region s , $l_{(s)r}$ shrinks to $l_{(s)r} t$. Therefore, parameter t is regarded as the ease of the interregional commute, and $1-t$ implies commute costs. Such an iceberg form implies that the disposable wage of the commuter also falls to $w_{(s)r} = w_{(s)r}^\dagger t$.

The factor distribution is described as follows. First, we note the share of capital locating in region 1 by θ :

$$\begin{aligned} K_1 &= \theta K, \\ K_2 &= (1-\theta)K. \end{aligned}$$

Second, λ represents the share of workers residing in region 1. The total number of workers residing in region r is given as

$$\begin{aligned} L_{(1)} &= \lambda L, \\ L_{(2)} &= (1-\lambda)L. \end{aligned}$$

In addition, letting n_r be the share of workers who have a job in the residential region, we have

$$\begin{aligned} L_{(1)1} &= n_1 L_{(1)}, & L_{(1)2} &= (1-n_1)L_{(1)}, \\ L_{(2)2} &= n_2 L_{(2)}, & L_{(2)1} &= (1-n_2)L_{(2)}. \end{aligned}$$

Finally, choosing a unit such that $l_{(r)r} = 1$, $L = 1$, and $K = 1$, we have the fundamental wage equations as follows:

$$w_1^K = (1-\alpha) \frac{n_1 \lambda + (1-n_2)(1-\lambda)t^\alpha}{\theta^\alpha}, \quad (7)$$

$$w_2^K = (1 - \alpha) \frac{n_2(1 - \lambda) + (1 - n_1)\lambda t^\alpha}{(1 - \theta)^\alpha}, \quad (8)$$

$$w_{(1)1}^L = \alpha \theta^{1-\alpha}, \quad (9)$$

$$w_{(1)2}^L = \alpha(1 - \theta)^{1-\alpha} t^\alpha, \quad (10)$$

$$w_{(2)2}^L = \alpha(1 - \theta)^{1-\alpha}, \quad (11)$$

$$w_{(2)1}^L = \alpha \theta^{1-\alpha} t^\alpha. \quad (12)$$

3. Location analysis

3.1 Job choice of workers

Workers can choose their jobs in each region, taking capital distribution as given. Comparing the wages (given by eqs. (9) and (10) for region 1 or given by eqs. (11) and (12) for region 2), they get the job which offers a higher wage.⁴ The comparison of wages in each region yields

$$w_{(1)1}^L > w_{(1)2}^L \quad \text{when} \quad \theta > \theta^\dagger \equiv \frac{t^{\alpha/(1-\alpha)}}{1 + t^{\alpha/(1-\alpha)}},$$

$$w_{(2)2}^L > w_{(2)1}^L \quad \text{when} \quad \theta < 1 - \theta^\dagger.$$

The resulting job choice pattern is summarized in Figure 1.

Figure 1. Job choice pattern

In domain (i), i.e. in the case of $1 - \theta^\dagger < \theta < \theta^\dagger$, workers obtain a higher wage when they choose the jobs in their residential region. Thus $n_1 = 1$, $n_2 = 1$. In domain (ii), i.e. in the case of $\theta > 1 - \theta^\dagger$, all the workers choose the jobs in region 1: $n_1 = 1$, $n_2 = 0$. That is, the workers residing in region 2 commute to region 1 because the interregional commute

⁴ We assume that the rewards to capital are equally distributed among workers, so we focus on the wage of workers.

costs is less than the benefit from the large amount of capital in region 1. Domain (iii) is the contrary to domain (ii): in the case of $\theta < \theta^\dagger$, all the workers choose the jobs in region 2: $n_1 = 0$, $n_2 = 1$. Summarizing the feature of the job choice, workers tend to choose jobs in the region with a larger share of capital when interregional commute is sufficiently easy.

3.2 Capital distribution

Considering that capital moves to a region with a higher reward, we find the equilibrium capital distribution. To start with, we derive the capital distribution in domain (i) in Figure 1. Substituting $n_1 = 1$ and $n_2 = 1$ into w_r^K and solving $w_1^K = w_2^K$ for θ , we have

$$\theta = \theta_D \equiv \frac{\lambda^{1/\alpha}}{\lambda^{1/\alpha} + (1-\lambda)^{1/\alpha}}. \quad (13)$$

Next, in domain (ii), substituting $n_1 = 1$ and $n_2 = 0$ yields $w_1^K > w_2^K = 0$ thus $\theta = 1$. Similarly, we get $\theta = 0$ by substituting $n_1 = 0$ and $n_2 = 1$ in domain (iii).

Finally, we compare the rewards to capital in the three domains to derive the equilibrium capital distribution:

$$w_1^K \Big|_{\theta=\theta_D} < w_1^K \Big|_{\theta=1} \quad \text{when} \quad t > t_1^* \equiv \frac{(\lambda^{1/\alpha} + (1-\lambda)^{1/\alpha})^\alpha - \lambda}{1-\lambda},$$

$$w_2^K \Big|_{\theta=\theta_D} < w_2^K \Big|_{\theta=0} \quad \text{when} \quad t > t_2^* \equiv \frac{(\lambda^{1/\alpha} + (1-\lambda)^{1/\alpha})^\alpha - (1-\lambda)}{\lambda}$$

$$w_1^K \Big|_{\theta=1} > w_2^K \Big|_{\theta=0} \quad \text{when} \quad \lambda > 1/2.$$

Note that $t_r^* = 2^\alpha - 1$ when $\lambda = 1/2$. As a result, the equilibrium distribution of capital is expressed in Figures 2 and 3. The thick lines in Figure 2 indicate the equilibrium distribution of capital for the case of $\lambda > 1/2$. Figure 3 shows the distribution pattern of capital relating to the distribution of workers. This figure explains that capital disperses

when distribution of workers is sufficiently equal among regions and interregional commute is sufficiently difficult. Consequently, we have the following proposition on agglomeration:

Figure 2. Distribution diagram for $\lambda > 1/2$

Figure 3. Distribution pattern in $t - \lambda$ plain

Proposition. *Suppose that region r has a larger share of workers. All the capital agglomerates in region r and thus all the workers choose the jobs in region r when the interregional commute is easy such that $t > t_r^*$.*

To see the meaning of the Proposition, let us focus on the circular causality of the backward and forward linkages in labor market. First, the backward linkage in this model implies the demand for workers causes the agglomeration of workers. When the share of capital amount in region 1, θ , is larger than the other, for instance, the wage of workers offered in region 1 is higher than that in the other region (see eqs. (9) and (10)). If θ is sufficiently large, the workers residing in region 2 have an incentive to commute to region 1 because the wage difference is larger than the commuting costs. In other ward, if the commuting cost is sufficiently low, workers choose the job in the region with larger share of capital. The forward linkage implies, on the other hand, the supply of labor services causes the agglomeration of capital through the effect of labor diversity. The increase in the number of workers in e.g. region 1 enhances the degree of labor diversity, and raises the capital reward in region 1 (see eqs. (7) and (8)). If the interregional difference in the number of workers is sufficiently large, or if interregional commute is sufficiently easy, capital agglomerates in region 1 because the positive effect of labor diversity on capital reward exceeds the negative effect of the increasing capital amount on it. Summarizing these results, the circular causality causes agglomeration of capital and concentration of workers (i.e. job location) when commute is sufficiently easy.

The Proposition explains the rise of cities along with the progress in the transportation facilities: the decrease in commuting costs unites regional labor markets, and the benefit from labor diversity stimulates the development of cities. Such a relation between agglomeration and transportation technology have been pointed out in the new economic geography. For instance, Fujita et al. (1999) and the numerous articles have explained the increasing tendency of agglomeration with decreased transportation costs of goods. This paper presents a similar result with another model, focusing on the effects of labor diversity and commuting costs.

Besides, we can regard the interregional commute cost as a negative effect of labor heterogeneity: an interregional *cultural adjustment cost*. In this context, the Proposition presents another implication. That is, workers in different regions can have different values, philosophies, dialects and languages. If workers cooperate with others with different cultures in some production process, such a interregional gap can bring about obstacles. However, such an interregional or international cultural gap tends to decrease because of the recent cultural globalization. Therefore, the decrease in the adjustment cost (i.e. the increase in t) leads economic activities to agglomeration.

4. The evidence from Japan

This section investigates the circular causality between the backward and forward linkages based on the labor diversity, by the covariance structure analysis using the data of all 47 Japanese prefectures.

In order to specify the model structure for covariance structure analysis, let us summarize the theoretical results in short. The backward linkage (i.e. agglomeration caused by labor demand) implies that the agglomeration of capital leads workers to concentrate through the rise in labor wage. The forward linkage (i.e. agglomeration caused by labor supply) implies that the increase in the number of workers in a region enhances labor diversity and the resulting rise in capital reward causes agglomeration of capital.

Constructing the path diagrams with the above linkages, Figures 4-1, 4-2, 5-1 and 5-2 show the standardized solutions in covariance structure analysis. Rectangle and

elliptical figures represent observed and unobserved variables, respectively. Single-headed arrows indicate causal relationships and adjacent numbers are the standardized regression coefficients. Numbers in italics are Squared Multiple Correlations (R^2). Double-headed arrows represent correlations, and e_i is a residual error.

The prefectural data used in the empirical analysis is as follows⁵. Capital agglomeration and capital reward are respectively measured by the number of firms and the average gross operating profit in each prefecture, from Establishment and Enterprise Census of Japan (2005). Labor agglomeration is defined as the number of employees in the working prefecture (for Figures 4-1 and 4-2) and as the number of employees in the residential prefecture (for Figures 5-1 and 5-2), from the Population Census (2005). Labor wage is the annual income from Basic Survey on Wage Structure (2005). Commute cost is defined as the average commute distance calculated from the Population Census (2005).

The measurement of labor diversity is an important problem especially in Japan. In the recent empirical studies using the data of the U.S. or the EU, labor diversity is measured by demographic (i.e. racial and cultural) or occupational (i.e. skills and knowledge) aspects. However, it is difficult to find demographic data on racial or cultural diversity in Japan (except the number of resident foreigners) since the Japanese have tendency to emphasize their homogeneity. Therefore, this paper measures the “labor diversity” by the elements such as the diverse values and tastes among workers, as well as the differences in the constitution of workers including occupation and the commute from other prefectures. The following six indices are adopted to construct the “labor diversity factor (unobserved variable).” The first four indices demonstrate the diversity in residents’ values and tastes: (i) Newspaper index is defined as the subscription share of not the top selling but the subsequent newspapers in each prefecture, taken from the Newspaper report, Japan Audit Bureau of Circulations (2007). (ii) Car index is the share of automobile companies excepting the big five

⁵ In order to investigate the commuting pattern only, the county-level regional data is more appropriate than prefectural data. However, there are not county-level datas on the cultural and taste diversity of residents in Japan. In addition, in order to distinguish the cultural difference within Japan, counties are too small and broader area classification such as prefecture is desirable.

(Toyota, Nissan, Honda, Mitsubishi and Mazda) in motor vehicle registration, which is taken from Toyota No Gaikyo (2005). (iii) Voting index is given as $1 - \text{HHI}$, where HHI is the Hirschman-Herfindahl Index of the votes for political parties in the election of the House of Councilors in 2007. (iv) Foreign travel index is the share of residents who had foreign travel in each prefecture, taken from the annual report of statistics on legal migrants (2005). The last two indices represent the labor diversity brought by the constitution of workers. Supposing that white-collar workers are the specialists in their jobs thus have heterogeneous skills and knowledge, we define (v) White-collar index as the share of “Professional and technical workers”, “Managers and officials”, and “Clerical and related workers” in the Population Census (2005). While the above indices explain the diversity of *residential* workers in each region, the final index adds the diversity given by the workers commute from *other prefectures*: (vi) Commute index is the number of prefectures where the workers commute from, which is taken from the Population Census (2005). This index implies that the workers from different regions have different values and different ways of thinking.

Figure 4-1. Backward linkage (Model 1)

Figure 4-2. Backward linkage (Model 2)

Figure 5-1. Forward linkage (Model 1)

Figure 5-2. Forward linkage (Model 2)

Figures 4-1 and 4-2 show the backward linkage: agglomeration caused by labor demand; and Figures 5-1 and 5-2 show the forward linkage: agglomeration caused by labor supply. The model 1 (for Figures 4-1 and 5-1) describes the whole paths supposed in this paper (i.e. including the negative effects of commute costs), but the model does not fit well: RMSEA is 0.315 and 0.118 respectively, and the coefficients of Commute cost are not significant. One of the possible causes is that the commute cost is less important as dispersion force than other factors (e.g. land use) which are not considered in this paper. Therefore, we take up model 2 (for Figures 4-2 and 5-2) which focuses on the very circular causality.

In Figure 4-2, Capital agglomeration has a significant and positive effects on Labor agglomeration directly and indirectly through Labor wage, and those paths explain 90% of the observed variance in Labor agglomeration. The indirect path indicates the backward linkage supposed in this paper: the increase in the number of firms (i.e. the amount of capital) raises the wage level (the coefficient is 0.64), and the rise of wage level leads workers to concentrate in the region (0.23). The direct effect means the number of jobs is influenced by the capital agglomeration regardless of wage level (0.79). This path suggests the existence of other factors unrelated to this model (e.g. the downward wage rigidity).

Figure 5-2 shows the existence of the forward linkage with a good model fit (GFI=0.907, RMSEA=0.051, and almost all the coefficients are significant at 1%)⁶. First, Labor agglomeration has a positive and significant effect on the latent Labor diversity (0.91). We can see the main constitutions of Labor diversity are Car index (0.69), White-collar index (0.76) and Foreign travel index (0.86). The remaining indices of Newspaper, Voting and Commute are related to Labor diversity not strongly but moderately: the coefficients are positive and significant (0.51, 0.31, and 0.47 respectively). Furthermore, Labor diversity has a positive and significant effect on the Capital reward (0.87) and finally leads capital to concentrate in the region (0.89). These empirical analyses supports the theoretical result that labor diversity causes agglomeration through the circular causation, by using Japanese prefectural data.

5. Conclusion

This paper described a simple two-region model and investigated the effect of labor diversity in the circular causality. The theoretical results show that workers tend to choose their jobs in the region with a larger share of capital when interregional commute is sufficiently easy. Furthermore, the inflow of commuting workers increases the degree of labor diversity in the labor-receiving region, and causes agglomeration of

⁶ We use the number of employees in the residential prefecture as labor agglomeration in Figures 5-1 and 5-2. Since the labor diversity is mainly measured by the data of *residents*, the relation between labor diversity and labor agglomeration gets worse if we use the number of employees in *working prefectures* as labor agglomeration.

capital. The main result is similar to that of the NEG literature: The emergence of agglomeration along with the recent globalization (i.e. the progress in transportation technologies and the decrease in cultural adjustment costs). However, this paper shows that such a result is obtained by not only the ordinary framework (e.g. a two-sector model with the Dixit-Stiglitz type monopolistic competition) but also a simpler and more tractable model with labor heterogeneity as a source of agglomeration.

In addition, the covariance structure analysis with Japanese prefectural data confirms that the circular causality based on labor diversity exists in Japan. So far a considerable number of studies on the diversity in workers and cultures has been made in the United States and Europe. For instance, Florida (2005) showed the regional diversity and tolerance are related to regional productivity and industrial location by using indices such as Gay index, Bohemian index, and so on. And numerous empirical studies investigated the effect of labor diversity on productivity. On the other hand, sufficient attention has not been given to this issue in Japan because the Japanese people tend to believe their racial and cultural homogeneity. However, we can easily observe differences in e.g. cultures, values, dialects among people from other prefectures or regions. Hence there should be the effect of labor diversity on economic activities even in Japan. This paper revealed the following fact that had been overlooked so far. The diversity in workers in Japan affects productivity of firms and companies, and the circular causality in the NEG leads economic activities to agglomeration.

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Figure 1. Job choice patterns

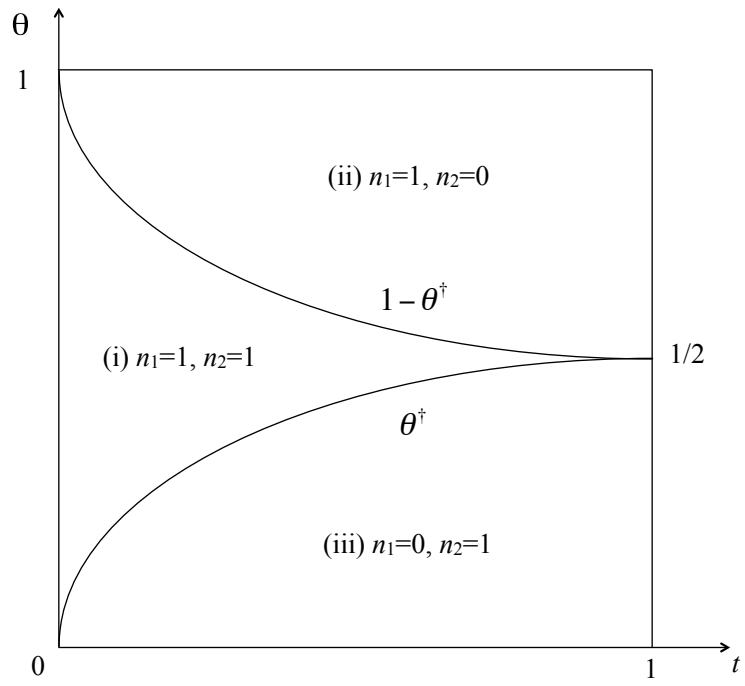


Figure 2. Distribution diagram for $\lambda > 1/2$

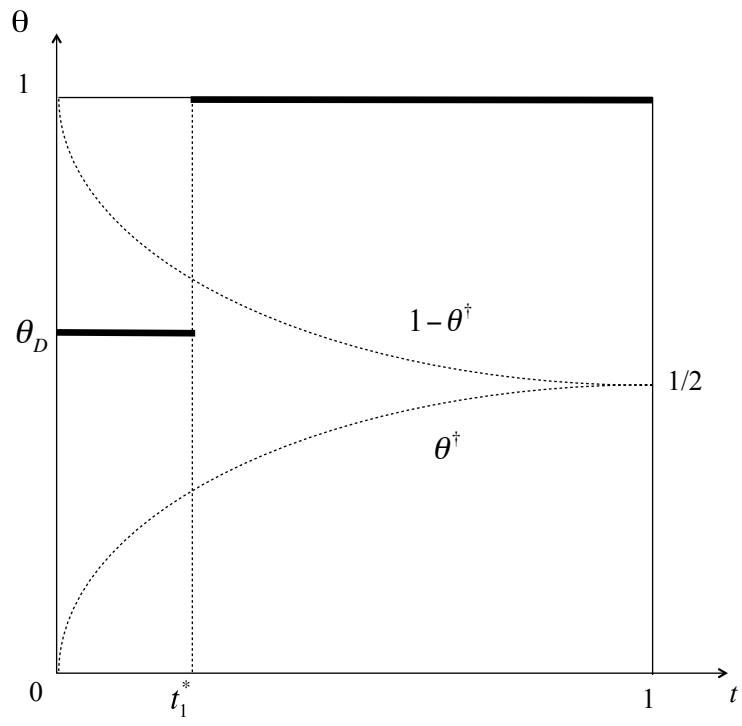


Figure 3. Distribution pattern in $t - \lambda$ plain

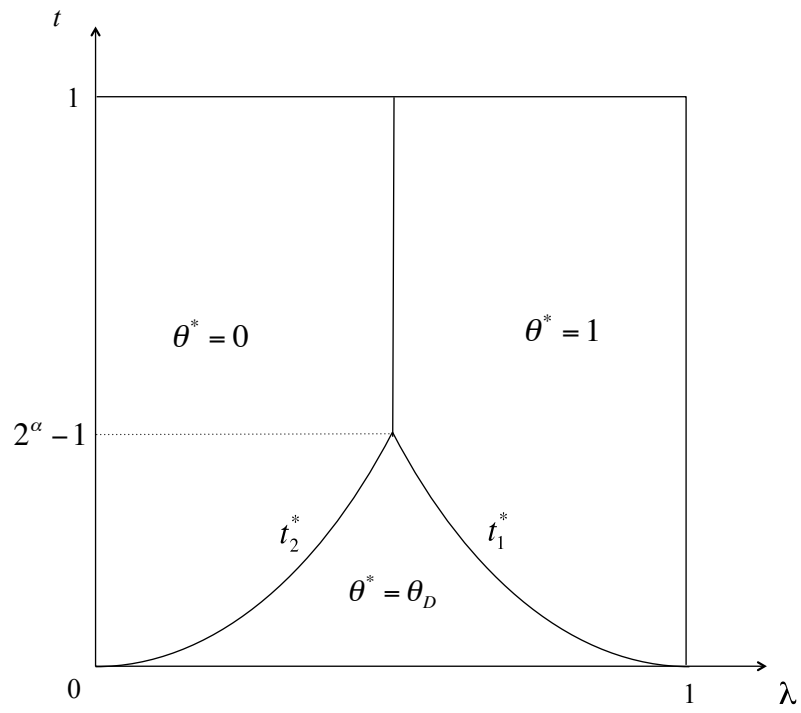


Figure 4-1. Backward linkage (Model 1)

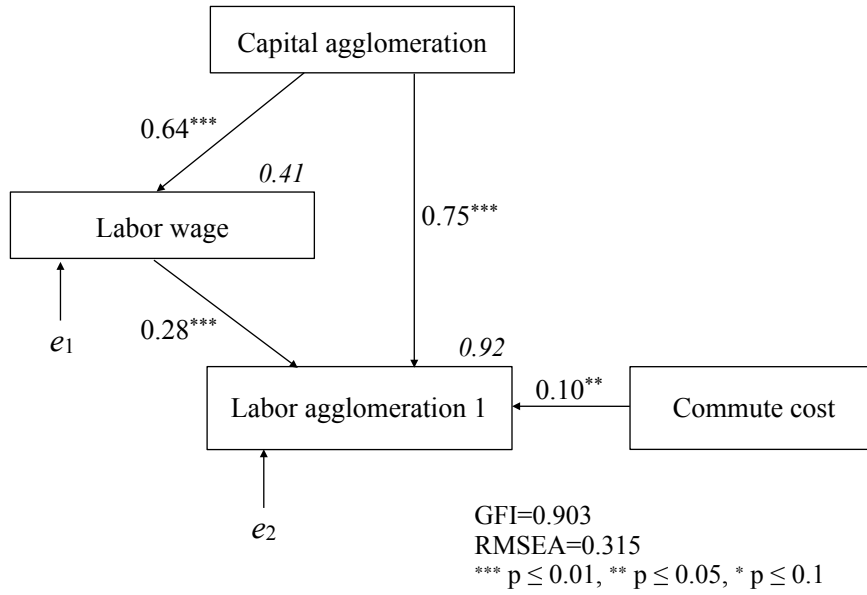
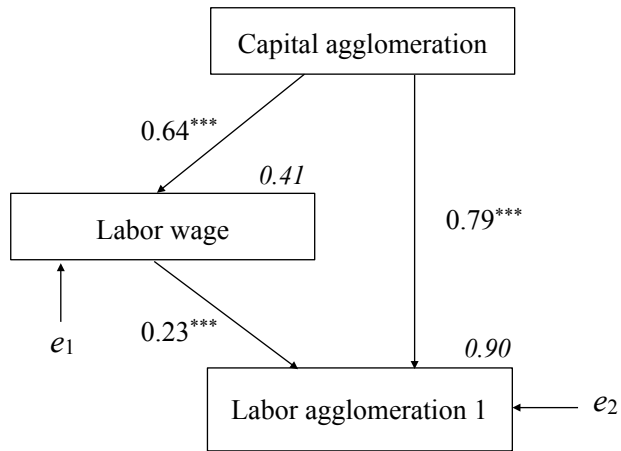


Figure 4-2. Backward linkage (Model 2)



*** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$

Figure 5-1. Forward linkage (Model 1)

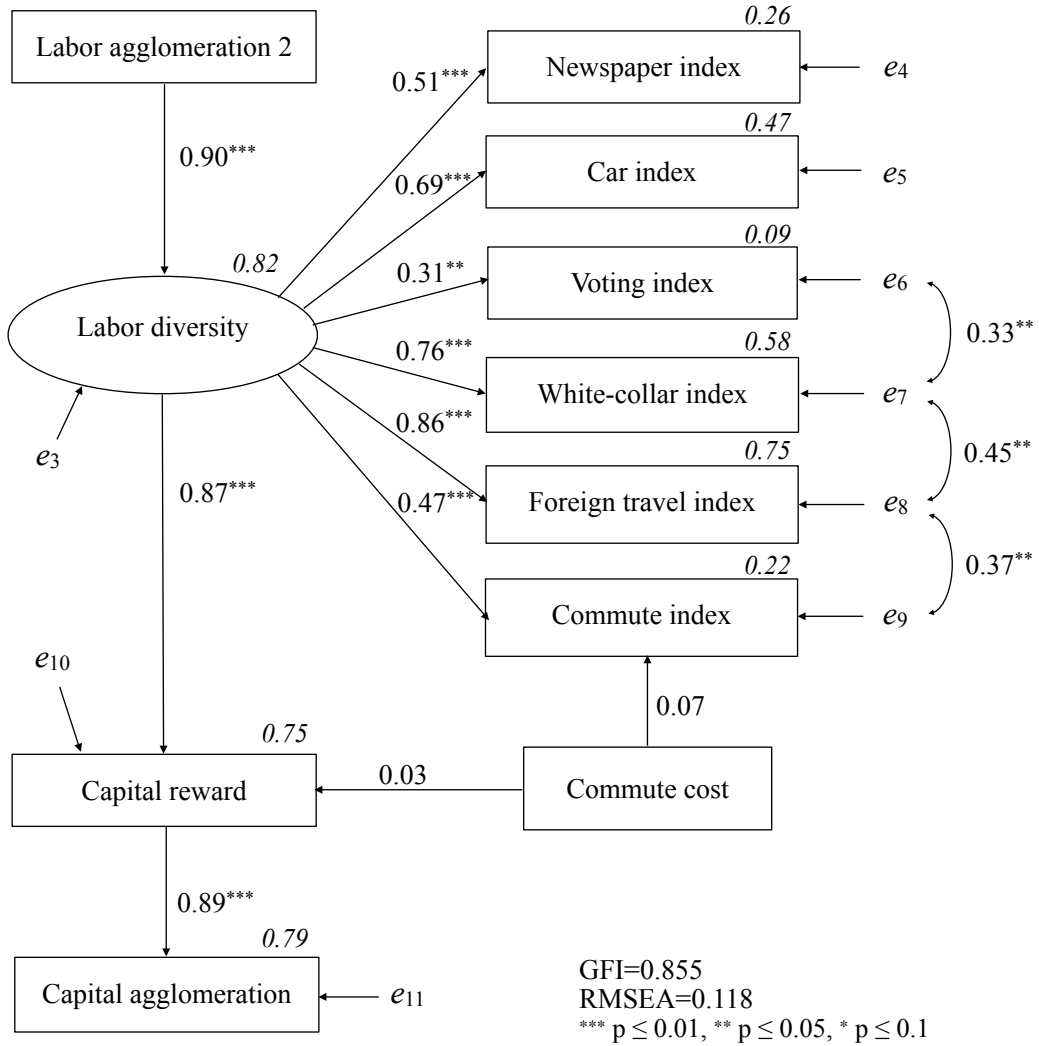


Figure 5-2. Forward linkage (Model 2)

