

How Does Central Authority Assign Provincial Leaders? Evidence from China

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Abstract

We analyze how central authority assigns provincial leaders to 31 provinces in post-reform China. Using data containing 198 provincial chief leaders from 1993 to 2007, especially 64 groups of rotated leaders, we find that the mode of central assignment depends on whether the central authority emphasizes efficiency or regional development balance. We show that positive assortative matching between leaders and provinces is implemented from early 1990s to early 2000s when central authority concerns more in improving national economic growth. After early 2000s, it turns to be negative assortative matching when central authority concentrates more in reducing regional disparity.

JEL Classification: D83; H11; H77

Key words: Promotion; Assignment; China

1 Introduction

The personnel control over provincial leaders is determined by central authority in China¹ (Huang, 1996, 2002). Central authority assigns provincial leaders to each province by considering the specific characteristics of provinces and leaders's abilities according to its objectives. In the economic development of China, provincial leaders are playing important roles (Chen, Li and Zhou, 2005; Li and Zhou, 2005). How central authority allocates provincial leaders to provinces is vital to the regional and national economic development in China.

Central authority manages the assignment of provincial leaders to provinces as a monopoly matchmaker. On one hand, the economic circumstances of each province, for example, the economic development, are considered by central authority. Different provinces have different characteristics. The regional differences in economic structure and economic development between provinces are large in China (Zhang, 2006; Demurger, 2001). On the other hand, central authority pays attention to the characteristics of leaders and leaders' effects on regional economy. Knowing the potential effects of leaders on regional economy, central authority assigns appropriate leader to each province by considering the characteristics of leaders and provinces based on its objectives in economic development. Roles of leaders in determining economic performance have drawn much attention

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¹The personnel control, including appointment and promotion of regional leaders, are considered as important instruments for central authority to induce regional leaders to follow central policy and decisions (See Maskin, Qian and Xu, 2000).

in the literature². Jones and Olken (2005) show that national leaders have significant effects on economic growth by identifying the difference before and after the replacement of national leaders. One potential problem is to identify the causative effect of leader on economic growth, because it might be the case that growth changes is the driving force for leader's replacement. To avoid such problem, Jones and Olken (2005) consider the deaths of national leaders while in office caused by exogenous shocks on the leadership, such as accident or illness, therefore, the change of leaders and the timing of this change is not related to the economic development. It is shown that the effect of leader is important. In another paper, Jones and Olken (2009) estimate the change of leadership caused by assassinations. They compare the cases where leaders were killed and leaders survived from the assassination. Whether a leader could survive is exogenous given the weapon used in the assassination. The result reflects that leaders have large and significant influences in autocratic nations. Li and Zhou (2005) find that Chinese provincial leaders compete for promotion by improving provincial economy.

How leaders with heterogeneous characteristics, especially different abilities, are assigned to provinces with different development levels by central authority is the main question in this paper. The allocation of leaders to provinces shares some similarities with matching theory (Jovanovic, 1979b, Becker, 1981; Damiano and Li, 2007; Terviö, 2008). Jovanovic (1979b) raises three assumptions for the matching model in labor market to interpret the job separations.. Firstly, workers produce different outputs cross jobs. Secondly, wage is flexible, and workers and employers could negotiate wages. Thirdly, there is information asymmetry in the two sides of matching market. The turnover happens when new information is accumulated under some circumstances. The model predicts that it is less likely to separate jobs as job tenure increases, because mismatch should have been found and deleted at an earlier stage. The predictions are consistent with empirical evidence. Allgood and Farrell (2003) try to understand the role of job-match heterogeneity in the CEO's turnovers empirically, especially the turnovers within the first five years. Their evidence is consistent with the predictions of Jovanovic (1979b). The possibility of turnover increases before the fifth year of the tenure and decreases afterwards. This explanation of turnovers does not deny the incentive problem and the problem of monitoring of CEOs, but add more understanding of CEO-firm match.

In terms of matching in marriage market, Becker (1973) proves that positive assortative matching maximizes the total output under the assumption that the matching types are complementary. He constructs a household production function and derives that it is complementary between traits of males and females based on the effects of these traits on household output when holding other traits fixed. In addition, he also gets negative assortative matching for some traits, for example wage rate, when the correlation for these traits between males and females are substitutes. The assumption of complementarity between matching types is important to the assignment result (Li and Suen, 2000; Tervio, 2008). Tervio (2008) uses a complementary production function to generate positive assortative matching between managers and firms, and this assignment is used to explore the differences in CEO pay, which depends on the distribution of firm size and CEO abilities. Damiano and Li (2007) apply this standard assumption that it is complementary in matching value function, to consider how intermediation as a monopoly matchmaker achieves efficient matching in the two-sided matching market using a schedule of entrance fees to sort different types of agents. Under this assumption, positive assortative matching achieves the maximized total matching value. Li and Suen (2000) apply the complementary production function to analyze the early matching market. They find higher expected workers would face greater risks of payoff in later matches, so that they match with lower expected types of job to avoid risks.

²From a micro level, Bertrand and Schoar (2003) explore the performance of 800 firms in US from 1969 to 1999 by identifying the personnel "style" of managers. They quantify to what extent that the variations in firm managing policies are due to the managers' fixed effects by identifying the manager-firm matched panel data. They find that CEO has significant effect on firm performance and different CEOs have different effects. However, this paper does not allow the estimation of the causal effects of managers on firm policies.

The matching between leaders and provinces is different from the literatures in the following ways. (1) Central authority determines the matching between leaders and provinces, and leaders should follow the central decisions. There is no free market for matching between leaders and provinces. (2) There is no negotiation about wages between provincial leaders and provinces or central authority. (3) Provincial leaders concern more on political promotion than wage. (4) There is no power of each province to take actions in attracting more capable leaders as firms' actions.

We develop one simple conceptual framework, in which the current output is generated based on the previous economic development level and the economic growth rate induced by current leader's ability, to show how central authority allocates leaders with heterogeneous abilities to different regions. We derive that it is complementary between previous economic level and the leader's ability in generating regional output. So efficiency requires that positive assortative matching should be made between leaders and provinces. But we differ from the literatures (Becker, 1981; Terviö, 2008) that the assignment is not implemented in a competitive labor market, but managed by central authority. Provincial leaders have to follow the decisions of central authority. Therefore, the assignment between leaders and regions depends on the objective of central authority. This objective function is the exogenous force that determines the assignment results by allowing for different characteristics of regions and leaders. Both efficiency and regional balanced development are concerned in the objective function of central authority but with different emphasis in different phases of economic development. Hence, given the complementarity between production factors, if efficiency is more emphasized, it requires positive assortative matching between leaders and regions (Becker, 1973, 1981). However, if balanced development among regions is more concerned by central authority, negative assortative matching would be made.

Leaders who have been rotated among provinces are used to look at the mode of central assignment. Central authority obtains the leader's ability from the economic performance in the previous province before she was rotated. Hermalin and Weisbach (1998) discuss the determinants of board in a bargaining process. They propose that board of each firm obtains CEO's ability from the realized earnings. The firm performance signifies the leader's ability. And CEO's bargaining power with the board comes from his perceived ability relative to the potential successor³. Similarly, in this paper, the provincial economic performance signifies the leader's ability. We are different from this paper in one important point that the provincial leaders have to follow the decisions of rotation rather than bargaining with the central authority. The average total productivity factor (TFP) growth rate over the tenure is derived to represent the leader's ability. Central authority allocates leaders to each province based on the leaders' perceived abilities and the provincial economic development level. The rotated leaders have worked in different provinces, and this could avoid the possible endogenous problems when estimating the correlations between the ability and economic development level.

In this paper, we find that the assignment result depends on the objectives of central authority in different phases of economic development. From early 1990s to early 2000s, the central job for the Party and government is to improve economic growth, and it is allowed that some regions could get rich in advance. As a result, central authority assigns provincial leaders with higher abilities to more developed regions to achieve larger production in the whole nation. After early 2000s, more attention is paid to reduce regional disparity⁴, central authority allocates leaders with higher abilities to less developed regions.

We contribute to the literatures by finding how assignment is done between leaders and

³Their model obtains several predictions about the relationship between CEO and board which are consistent with empirical findings. It extends the matching model of Jovanovic (1979) in the way of allowing endogenous monitoring decisions (See Hermalin and Weisbach, 1998). But they only focus on the monitor role of board over hiring and firing management and ignore other roles of board in firm management.

⁴Actually, the regional disparity in China turns to be larger since the outset of economic reform (Demurger, 2001, 2002; Jones et al, 2003). On average, coastal provinces grew faster than inland provinces. The negative assortative matching might be considered as one potential way to mitigate this problem.

provinces. Previous literatures on the political turnovers (Bo, 1996; Maskin et al, 2000; Li and Zhou, 2005; Chen et al, 2005) concentrate on how career incentives determine the local leader's behaviors in developing provincial economy⁵. They explore how central authority promotes and dismisses provincial leaders⁶ in the cadre evaluation system, and their economic performance is proved to be important for political turnovers. Bo (1996) studies the political mobility of Chinese provincial leaders systematically in the period between 1949 and 1994. He proposes that both economic performance and revenue contribution to central government are important factors in determining the political mobility, while the latter matters more than the former for leaders' promotion. The analysis covers both the periods before and after economic reform. After economic reform, the promotion criteria changes from political attitudes to actual achievement. He points out that provincial leaders try to achieve good performance to win recognition from central authority (See Bo, 1996). He raises the question of how economic performance affecting political mobility, and many literatures give more detailed research on this afterwards. To consider the case after economic reform, Li and Zhou (2005) find that the likelihood of promotion of provincial leaders could increase with their average economic performance over the tenure, and the likelihood of termination will decrease with their average economic performance using data from 1978 to 1995. This reflects that central authority uses personnel control as a tool to drive provincial leaders to generate higher economic growth rate. They show that provincial leaders are similar as middle-level firm managers whose turnovers are determined by firm headquarters. They contribute to the literatures identifying the roles of local government, for example in encouraging the growth of private firms (Qian and Weingast, 1997), induced by the reform of personnel management system. Maskin et al (2000) suggest that M-form structure could facilitate yardstick competition, and they provide evidence that leaders from regions with better performance is more possible to get promoted by showing positive correlation between changes of relative economic performance and the number of central committee members from each region using data from 1986 to 1991. Since mid-1990s, many deeper economic reforms, including fiscal reform have been undertaken. Chen, Li and Zhou (2005) extend these studies to cover a longer time period from 1979 to 2002. They provide further evidence for the career concerns of provincial leaders using same empirical method as Li and Zhou (2005). They show that political turnover is not only positively related to their own performance, but also related with the performance of the immediate predecessor negatively. Blanchard and Shleifer (2001) compare the development in China and Russia based on different effects of federalism and political centralization. They point out the importance of political centralization in the way that federalism plays great role in economic development, but this role relies on the political centralization, when centralization happens in China but not in Russia.

We are consistent with their analysis in confirming the effects of central assignment over provincial leaders. However, in this paper, we consider the personnel control over provincial leaders from a more detailed perspective that how central authority allocates one leader to a province to fulfill its objectives in propelling economic development and keeping regional balance with leaders who have been rotated among provinces.

The remainder of the paper is organized as follows. In the following section, we provide general introduction to the institutional arrangement or personnel control for provincial leaders in China and the introduction about central objective in economic development. Section 3 provides the conceptual framework. Section 4 discusses the empirical methods. In section 5, we describe the data that is used in this paper. Empirical results of of central assignment is shown in section 6.

⁵Different methods are applied in the previous literatures for political turnovers. Bo (1996) applies multinomial logit model. Ordered probit model is used in Li and Zhou (2005) and Chen et al (2005).

⁶Since 1978, the cadre evaluation system has been reconsidered. In 1979, one document issued by Organization Department of Central Committee states that the evaluation system should be based on " political thought, organizational and leadership abilities, familiarity with substantive issues, and democratic work style, as well as actual achievement" (See Whiting, 2001). Central authority pays more attention on actual achievement instead of political attitudes.

Section 7 discusses extensions of the empirical analysis. In the final part, we conclude the paper.

2 Personnel control and central objectives

2.1 Personnel control over provincial leaders

Chinese government performs in a centralized structure which is a multidivisional-form hierarchy structure⁷ (Maskin et al, 2000). Central committee of the Party and State Council compose the highest kernel as decision makers. In particular, Central committee of the Party is the supreme decision-making body, and State Council is responsible for transferring strategic decisions into corresponding policies (Huang, 2002). Department of organization under the control of central committee is the primary agency for cadre management. Ministries and provinces are below State Council, and they are in the same bureaucratic rank. Provincial leaders are like the middle-level managers in a company with various departments (Li and Zhou, 2005). Provincial top leaders, party secretary, governors, vice governors and leaders for ministries are appointed by the Politburo⁸.

Central authority controls turnovers of provincial officials through appointment, promotion, rotation, termination, and cross-posting⁹ (Huang, 2002). Each turnover decision is not arbitrary, but based on a system of credentials and the performance of the candidates under consideration (See Huang, 2002). Local economic development has become one of the most important conditions to measure officials' performance (Li and Zhou, 2005). Actually, since the start of economic reform, improving economic development turns to be the central task of the party and government officials (Maskin et al, 2000).

Rotation of leaders among equally-ranked positions such as provinces or ministries is one important way of turnover. It is regulated that all leaders at county level or above should be rotated. Leaders at county level are rotated within prefecture, and leaders at prefecture level are rotated within province. Provincial leaders are rotated among provinces or between provinces and central departments. The official explanation for the rotation practice is to prevent factionalism by requiring leaders to work with new colleagues (Huang, 2002)¹⁰. Through regular and frequent rotations, leaders do not have large incentives to violate central policies as they could not gain interests associated with current positions, which they will leave in a short time. Besides, rotation could reveal information to the successor and central authority, which is helpful to get complete assessment to this leader. After rotation, central authority could collect more information of the leader who has just left the position. Moreover, rotation of leaders could be helpful to generate consistent

⁷In China, there are 31 provincial governments, 2400 county governments, about 30000 township governments, and around 40 ministries in the central department (Huang, 2002).

⁸Since 1983, it is regulated that cadres are managed by leaders immediately above them (Huang, 1996). So central department of organization is in charge of provincial leaders. And leaders lower than provincial leaders are managed by corresponding leaders in provincial level or lower levels.

⁹Cross-posting refers to the practice that an official is simultaneously posted to two positions. One is usually a seat on the Politburo, and the other position is in ministerial or provincial bureaucrats (See Huang, 2002).

¹⁰In 1962, Deng Xiaoping pointed out that rotation of leaders is one important form of managing leaders. Since early 1980s, central authority decided to rotate the leaders at county level. In 1990, one formal decision "Central Committee of the Communist Party's decision about Rotation Party Leaders and Government Leaders of China" required that leaders at the provincial level should be rotated among provinces or between provinces and central departments. If one leader worked in one region or department for too long time, they should be rotated among regions or departments. Rotation of leaders is important mechanism in cadre management. In 1999, a temporary rotation document "The Temporary Regulation for Rotation of Party Leaders and Government Leaders" was implemented and it gave detailed introductions about the requirement for rotation. And this document turns to be one formal regulation in 2006, "The Regulation for Rotation of Party Leaders and Government Leaders". Leaders who have been worked in one region for long time, leaders who need to increase working experiences to improve the leading abilities, or leaders who should avoid other colleagues, are all required to be rotated. For example, leaders who have been worked in one position for more than 10 years must be rotated. The rotation could be implemented among regions, departments, between regions and central department or state-owned enterprises.

development among regions, especially when more capable leaders are assigned to less developed regions. The successful experiences or useful lessons in one region could be easily introduced to other regions through leader's rotation. Finally, the rotation among provinces could increase the working experiences and skills of solving different problems for provincial leaders. The rotation among provinces is our main concern in this paper.

To understand the personnel control, it is necessary to connect it with the process of economic development. Naughton (2008) divides the economic reform in china into two periods. The first period is from 1978 to 1993, and second period is 1994 afterwards. In the first period, the reform is top-down, tentative, exploratory and focusing on a few key sectors (See Naughton, 2008). Policies are decentralization of power and devolution of resources. The main driving force for economic growth is state owned enterprises (SOE) and township and village enterprises (TVE). Fiscal contract system is implemented, and it regulates the amount of revenue contributed to central government. Local government could keep the remaining revenue. The budget revenue and SOE profits declines through the early 1990s, which signifies the inability to implement comprehensive reforms. Since 1994, the overall economic environment changes, and decisive decisions have been made and implemented quickly. Private firms are playing more important roles in economic development. A deeper and well-planned reform emerged after 1993 (See Naughton, 2008). The older leaders have left from the leadership, and more younger leaders come into the leadership, which is helpful to the implementation of new decisive policies. In 1992, the central government decides to build socialist market economy. Correspondingly, more reforms in fiscal and tax system are implemented. For example, fiscal contract system is replaced by tax assignment system which has increased the incentives of local government to improve economic growth and increased the fiscal capacity of central government. Similar as Naughton (2008), in this paper, we confine our analysis to this period after 1993.

2.2 Central objectives in economic development

Since the outset of economic reform, improving the economic growth has been the central job for the Party and government. More preferential policies are given to coastal regions than western and central regions (Chen and Fleisher, 1996; Demurger, 2001, 2002; Jones et al, 2003). Based on Demurger (2002), more supporting policies are given to coastal regions since 1978. In 1979, 3 special economic zones were built in Guangdong, and 1 special economic zone was set up in Fujian in 1980. 14 coastal cities were open and 10 economic and technological development zones were set up in 1985. 2 economic and technological development zones were set up in Shanghai in 1986. In 1990, Pudong new area was built in Shanghai. More preferential policies are given to these regions afterwards. The distribution principle was to give priority to efficiency with due consideration to fairness, encouraging some people and some regions to get rich in advance. In October 1992, adoption of building one socialist market economy was firstly raised in the 14th Communist Party Congress, which is considered as the end point of transition (see Naughton, 2008). The third Plenum of the 14th Congress in 1993 proposed the outlines of developing the market economy. Various deeper reforms in fiscal, tax, foreign trade and foreign exchange have been undertaken.

Those economic policies enlarge the regional disparity between eastern regions and inland regions. The Open-Door policy benefits eastern provinces to a large extent in the way of attracting more FDI and promoting international trade. Fiscal decentralization decreases the subsidies to the less developed provinces. Dual track prices lowers the prices of raw materials that are mainly produced in western and central provinces (See Demurger, 2002). Demurger (2001) reflects that large regional disparities exist in growth performance among provinces as economy develops in China. On average, coastal regions develop faster than inland regions. Similarly, Jones et al (2003) find that big variations exist in economic growth rates among geographic regions. Since late 1990s, central authority starts to pay attention to reduce regional disparity and some practical

actions are taken to develop western and central regions. For example, in 1999 the Grand Western Development Program¹¹ is raised to develop the less developed regions in western regions, and many related policies are implemented. From 2000 to 2008, 102 large projects have been implemented, and total investment amount is more than 1740 billion Yuan¹². In addition, Rejuvenation of Northeast Old Industrial Base is raised in 2003. From 2004 to 2006, the average GDP growth rate in northeastern region is 12.6%, which increases 2.6% from previous speed. Rise of Central China¹³ which is raised in 2004, and it is another important effort to make consistent developments in whole nation.

Since early 2000s, reducing development disparity is more concerned by the central authority. State Council (2000) raised that more tasks should be done to develop western and central regions, and increasing infrastructure investment in these regions is one of the most important tasks¹⁴. To build a Well-off Society in an all-round way was raised in 2002, and it is emphasized further afterwards. In the third plenum of 16th Party Congress in 2003, the framework of how to complete the socialist market economy was raised. It was the first time that all-round social progress is the developing strategy, and regional disparity is given more concern. Premier Wen Jiabao (2004) declared that "To attain the well-balanced regional development, we should continue to develop the western regions, rejuvenate the northeast old industrial base, speed up the central growth, and encourage eastern development". Current generation of leadership has paid much attention to decrease regional disparity and achieve regional harmonious development (Chen and Zheng, 2008). In 2003, after Wen Jiabao was elected to be premier, he pointed out that two of the most important jobs for central government is to achieve coordinated development between urban and rural areas, and to achieve coordinated development between eastern regions and inland regions. In the 17th Communist Party Congress in 2007, central authority continues to emphasize the importance of consistent development among regions, and keeping on building the Well-off Society.

In table A1 and A2, we provide the amount and increasing rate of fixed asset investment and central transfers to local government. From table A1 and figure 1, it is obvious to see that growth rate of fixed asset investment is greater in central and west regions than eastern regions since late 1990s, and it keeps increasing since 2004. Total amount of investment is larger in eastern regions because of the original development level and the preferential policies since 1978. In table A2 and figure 2, we compare the amount of central transfer to local government in different regions. We find the central government transfers more to central and west provinces than eastern regions since late 1990s, and the distance is turning to be larger since early 2000s. More transfers from central government are given to less developed regions to increase the economic growth in these regions. Similarly, the growth rate of central transfer in central and west regions is higher than eastern regions since 1995 with small exceptions in 2002 and 2003.

3 Conceptual framework

We provide one simple framework to explain how central authority assigns regional leaders. There are N regions in the whole nation. Central authority rotates leaders with different abilities from one province to another based on its objectives in developing national economy.

Suppose there are two time periods, $t-1$, and t . The output Y_t^i at time t in region i is generated based on its previous output level Y_{t-1}^i and the growth rate g_t^i .

¹¹The main provinces that are covered by the Grand Western Development Program are Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shanxi, Gansu, Qinghai, Ningxia, Xinjiang, Inner Mongolia and Guangxi. Western regions take 71% of the total area of China.

¹²The data resource is: www.xinhuanet.com

¹³Central regions include 6 provinces, Shanxi, Henan, Hubei, Hunan, Anhui, Jiangxi.

¹⁴Besides infrastructure investment, other jobs are also emphasized, for example, strengthening agriculture development, increasing tourism, improving environment, restructuring industry, increasing other public investment, eg. education, public health, etc.

Figure 1 Increasing rate of investment in fixed asset in east regions, central and west regions from 1993 to 2009

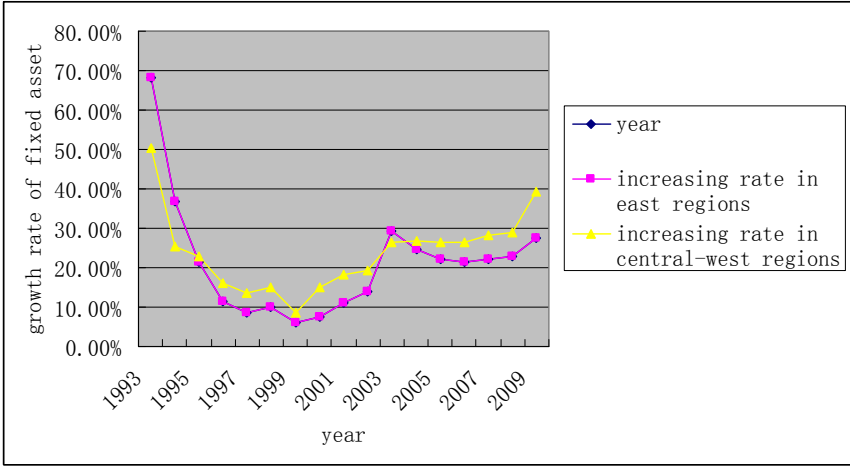
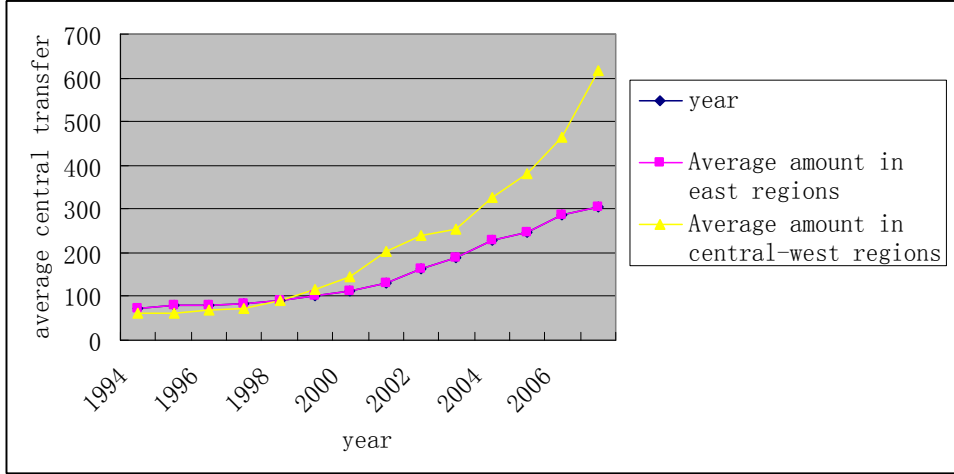


Figure 2 Average transfers from central government to local governments in east regions, central and west regions from 1994 to 2009



$$Y_t^i = Y_{t-1}^i(1 + g_t^i) \quad (1)$$

The growth rate of output in one region is a function of local leader's ability A and provincial endowment E .

$$g_t = g_t(A, E) \quad (2)$$

More capable leaders could generate higher speed of economic growth, and better endowment is helpful to achieve faster economic growth. The function g has this characteristic,

$$\frac{\partial g}{\partial A} > 0, \frac{\partial g}{\partial E} > 0$$

Obviously, the leader's ability will affect the total output of the region that is under her control by changing the economic growth rate.

$$Y_t^i = Y_{t-1}^i[1 + g_t^i(A, E_i)] \quad (3)$$

Equation (3) incorporates the analysis in equation (1) and (2), the economic output is based on the economic output in previous period and the growth rate generated by leader's ability and provincial endowment. Our purpose is to identify the assignment of leaders among provinces by looking at the leaders who have been rotated among provinces. For example, one leader used to work in province j , and then she was rotated to province i . Leader's ability A is obtained from the economic performance in the previous province j ($j \neq i$). There is no endogeneity problem for this obtained ability, and we will explain this more after the introduction of the method of obtaining abilities. The previous output Y_{t-1}^i has incorporated the previous leaders' effects, but this does not affect our analysis, because the effect of previous leaders is not related to the current rotated leader's effect. In addition, this assignment between provincial development and leader's ability is consistent with our data.

It is easy to find that, in equation (3) it is complementary between leader's ability A and the original output level, Y_{t-1}^i in the function of Y_t^i . If the output level of region i is better in the previous period $t - 1$, when a leader with higher ability is assigned to this region, larger output will be generated at t .

$$\frac{\partial^2 Y_t^i}{\partial A \partial Y_{t-1}^i} > 0$$

As the existence of positive cross-derivatives between leaders' ability and the previous output level, the efficiency in a frictionless matching market requires that positive assortative matching should be made (e.g., Becker, 1973, 1981; Li and Suen, 2000; Damiano, Li and Suen, 2005; Damiano and Li, 2007; Terviö, 2008). To generate the largest output, the most capable leader should be allocated to regions with the largest original output, Y_{t-1} , and the second most capable leader should be assigned to the region with second largest Y_{t-1} , and so on. Obviously, the regional disparity between better developed region and worse developed region is larger after positive assortative matching. This has been proved in the literatures, for example, Fernandez and Rogerson (2001), which states that increasing degree of assortative matching will generate larger income inequality. Mare (1991) agrees that more educational homogamy could increase the inequality for family and the inequality in social development of their offsprings.

Kremer (1997) does not find that changes in sorting could generate large income inequality which is presented by the standard deviation of children's education. Fernandez and Rogers (2001) extends the analysis of Kremer (1997) by considering the interaction of changes in the distribution of education or skills and changes in prices for skilled and unskilled labor. They prove that if the proportion of marriages with positive assortative matching is higher, the income inequality will

increase¹⁵. In both of these two papers, the degree of sorting between spouses is exogenously given (Fernandez, Guner and Knowles, 2005). However, Fernandez et al (2005) assume both sorting and inequality are endogenous, and they find that it is significant and positive relationship between the degree of marital sorting and the wage inequality.

The assignment in our case is not done in a frictionless or competitive market, but managed by the central authority, which behaves as a monopoly matchmaker. The matchmaker is Central Committee of the Communist Party, who controls the political turnovers and rotations of officials within the centralized structure of personnel control (Huang, 1996; Li and Zhou, 2005). The matchmaker's objective function is the exogenous force that determines the assignment results. Efficiency is concerned by the matchmaker. Economic growth is one of primary job for government since economic reform was started. At the same time, especially after late 1990s, matchmaker also considers the development balance among regions. Since large regional disparity affects social stability and long-run economic growth, to achieve balanced economic growth is one of the main policy considerations (Demurger, 2001). Economic development balance among regions could increase the motive power for the economic growth and improve the national ability of risk defence. Hence, the case is that both efficiency and regional balance are concerned in central objective.

Suppose $\gamma \in (0, +\infty)$, given the A and Y_{t-1}^i , the objective function of the matchmaker at t is,

$$Max[\sum_{i=1}^N Y_t^i - \gamma \sum_{i=1}^N (Y_t^i - \bar{Y}_t)^2] \quad (4)$$

The first part of the objective stands for efficiency, and the second part stands for reducing regional disparity. γ is the relative weight for regional balance, and the weight for efficiency is normalized to 1. \bar{Y}_t is the average output level for all regions at time t .

If γ is infinitely small or zero, only the efficiency consideration matters. Positive assortative matching would be implemented to achieve the largest total output given the complementarity between leader's ability and provincial economic development level. If γ is infinitely large, then the objective is to achieve regional development balance. Negative assortative matching between leaders and provinces will be implemented. Obviously, there exists two critical values γ^*, γ^{**} which could generate proposition 1. Note that $\gamma^* < \gamma^{**}$.

Proposition 1 *There exists γ^* and γ^{**} , if $\gamma \leq \gamma^*$, central authority as a matchmaker emphasizes more on efficiency. Positive assortative matching will be implemented. If $\gamma \geq \gamma^{**}$, central authority concerns more on regional balance. Negative assortative matching will be implemented. If $\gamma^* < \gamma < \gamma^{**}$, the assignment result is uncertain in the way of mixed results of positive assortative matching and negative assortative matching.*

Proof. We have obtained that it is complementary between leader's ability and the provincial economic development level before rotation.

$$\frac{\partial^2 Y_t^i}{\partial A \partial Y_{t-1}^i} > 0$$

To simplify the expression, we use the production function $Y = f(A, y)$. y is Y_{t-1}^i . We firstly analyze two extreme cases, $\gamma = 0$, and $\gamma = +\infty$. Then we discuss the cases in between.

(1) $\gamma = 0$

¹⁵In this calibrated model, the increased proportion of marriage with perfect sorting will decrease the fraction of children entering college or becoming skilled. Once the fraction of skilled workers or educated workers decreases, the wage of skilled workers will increase and the wage of unskilled workers will decrease, and this drives the wage inequality, and even the income inequality.

The problem in equation (4) turns to be maximizing the total output.

$$Max \sum_{i=1}^N Y_t^i$$

Assuming, $A_1 < A_2, y_1 < y_2$, then,

$$\frac{\partial[f(A_2, y) - f(A_1, y)]}{\partial y} = \frac{\partial\varphi(A_2, A_1, y)}{\partial y} > 0 \quad (5)$$

Because, $\frac{\partial\varphi(A_2, A_1, y)}{\partial y} = \frac{\partial[f(A_2, y)]}{\partial y} - \frac{\partial[f(A_1, y)]}{\partial y}$, and $\frac{\partial\varphi^2(A_2, A_1, y)}{\partial y \partial A_2} = \frac{\partial^2[f(A_2, y)]}{\partial y^2} > 0$. So $\frac{\partial\varphi(A_2, A_1, y)}{\partial y}$ is increasing in A_2 . If $A_1 = A_2$, $\frac{\partial\varphi(A_2, A_1, y)}{\partial y} = 0$. Since $\frac{\partial\varphi(A_2, A_1, y)}{\partial y} = 0$ for $A_1 = A_2$, and $\frac{\partial\varphi(A_2, A_1, y)}{\partial y}$ increasing in A_2 , equation (5) is proved.

Then we could immediately obtained equation (6),

$$f(A_2, y_2) - f(A_1, y_2) > f(A_2, y_1) - f(A_1, y_1) \quad (6)$$

Now suppose there are more A and y , $A_1 < A_2 < \dots < A_n, y_1 < y_2 < \dots < y_n$, for all i that is not following this rank order, $(i_1, i_2, \dots, i_n) = (1, 2, \dots, n)$, according to Becker (1973), we have the following result.

$$\sum_{j=1}^n f(A_j, y_{i_j}) < \sum_{i=1}^n f(A_i, y_i)$$

To prove this, we assume the contrary case that there is a permutation not satisfying $i_1 < i_2 < \dots < i_n$. There is at least one i_{j_m} satisfying $i_{j_m} > i_{j_{m+1}}$, we could obtained that,

$$f(A_{j_m}, y_{j_{m+1}}) + f(A_{j_{m+1}}, y_{j_m}) > f(A_{j_m}, y_{j_m}) + f(A_{j_{m+1}}, y_{j_{m+1}})$$

However, this contrary case is not consistent with the optimality of i_1, \dots, i_n . So that positive assortative matching generates the largest output.

(2) $\gamma = +\infty$

The problem in equation (4) turns to be minimizing the regional disparity.

$$Min \sum_{i=1}^N (Y_t^i - \bar{Y}_t)^2]$$

Assuming, $A_1 < A_2, y_1 < y_2$, in order to prove that negative assortative matching could generate the result with least regional disparity, the problem is,

$$[f(A_1, y_1) - \frac{f(A_1, y_1) + f(A_2, y_2)}{2}]^2 + [f(A_2, y_2) - \frac{f(A_1, y_1) + f(A_2, y_2)}{2}]^2 > [f(A_1, y_2) - \frac{f(A_1, y_2) + f(A_2, y_1)}{2}]^2 + [f(A_2, y_1) - \frac{f(A_1, y_2) + f(A_2, y_1)}{2}]^2$$

To simplify the expression, we have,

$$[f(A_2, y_2) - f(A_1, y_1)]^2 > [f(A_1, y_2) - f(A_2, y_1)]^2$$

The left hand side is large than 0, while the right hand side is uncertain. We have two cases,

1) $f(A_2, y_2) - f(A_1, y_1) > f(A_1, y_2) - f(A_2, y_1)$

After reorganizing, we have,

$$f(A_2, y_2) - f(A_1, y_2) > f(A_1, y_1) - f(A_2, y_1) \quad (7)$$

And it is satisfied, because the left hand is positive, while the right hand side is negative.

2) $f(A_2, y_2) - f(A_1, y_1) > f(A_2, y_1) - f(A_1, y_2)$
 After reorganizing, we have,

$$f(A_2, y_2) - f(A_2, y_1) > f(A_1, y_1) - f(A_1, y_2) \quad (8)$$

And it is satisfied, because the left hand is positive, while the right hand side is negative.
 So that negative assortative matching could minimize the regional disparity for the case of two leaders and two regions.

Now we are ready to prove the following result. suppose there are more A and y , $A_1 < A_2 < \dots < A_n$, $y_1 < y_2 < \dots < y_n$, for all i that is not ranked in this way, $(i_1, i_2, \dots, i_n) = (n, n-1, \dots, 1)$,

$$\sum_{j=1}^n [f(A_j, y_{i_j}) - \frac{\sum_{j=1}^{n-1} f(A_j, y_{i_j})}{N}]^2 > \sum_{i=1}^n [f(A_i, y_{n+1-i}) - \frac{\sum_{i=1}^{n-1} f(A_i, y_{n+1-i})}{N}]^2$$

The above equation reflects negative assortative matching could general the output that minimizes the regional disparity.

To prove it, we assume the contrary case that the permutation is not satisfying $i_n < i_{n-1} < \dots < i_1$, so at least there is i_{j_m} , and $i_{j_m} < i_{j_{m+1}}$. Now we have,

$$[f(A_{j_m}, y_{j_m}) - \frac{f(A_{j_m}, y_{j_m}) + f(A_{j_{m+1}}, y_{j_{m+1}})}{2}]^2 + [f(A_{j_{m+1}}, y_{j_{m+1}}) - \frac{f(A_{j_m}, y_{j_m}) + f(A_{j_{m+1}}, y_{j_{m+1}})}{2}]^2 < [f(A_{j_m}, y_{j_{m+1}}) - \frac{f(A_{j_m}, y_{j_{m+1}}) + f(A_{j_{m+1}}, y_{j_m})}{2}]^2 + [f(A_{j_{m+1}}, y_{j_m}) - \frac{f(A_{j_m}, y_{j_{m+1}}) + f(A_{j_{m+1}}, y_{j_m})}{2}]^2$$

Similarly, we simplify the expression and reorganize it,

$$f(A_{j_{m+1}}, y_{j_{m+1}}) - f(A_{j_m}, y_{j_{m+1}}) < f(A_{j_m}, y_{j_m}) - f(A_{j_{m+1}}, y_{j_m})$$

or,

$$f(A_{j_{m+1}}, y_{j_{m+1}}) - f(A_{j_{m+1}}, y_{j_m}) < f(A_{j_m}, y_{j_m}) - f(A_{j_m}, y_{j_{m+1}})$$

However, the above two equations are not satisfied, because the left hand side is positive while the right hand side is negative.

Obviously, negative assortative matching could minimize the regional disparity.

(3) γ is in between

If γ is in between 0 and $+\infty$, obviously, there is one $\gamma^* > 0$, when $\gamma < \gamma^*$, the result is the same as $\gamma = 0$. There is one $\gamma^{**} > 0$, when $\gamma > \gamma^{**}$, the result is similar as $\gamma = +\infty$. When $\gamma^* < \gamma < \gamma^{**}$, the assignment is mixed.

We provide one numerical example to illustrate this. It is complementary between A and y . To make is simple, without loss of generality, we assume the production takes this form, $Y = f(A, y) = Ay$. In the following table, we provide one matrix when $n=3$. $A_1 = 4, A_2 = 6, A_3 = 8$, and $y_1 = 10, y_2 = 15, y_3 = 20$.

	A1	A2	A3
y1	40	60	80
y2	60	90	120
y3	80	120	160

Obviously, the positive matching refers the result in the diagonal line. $\sum A_i y_i = A_1 y_1 + A_2 y_2 + A_3 y_3 = 40 + 90 + 160 = 290$. The result for negative assortative matching is $\sum A_i y_j = A_1 y_3 + A_2 y_2 + A_3 y_1 = 80 + 90 + 80 = 250$. The result for mixed matching could be (1) $A_1 y_3 + A_2 y_1 + A_3 y_2 = 80 + 60 + 120 = 260$, (2) $A_1 y_2 + A_2 y_3 + A_3 y_1 = 60 + 120 + 80 = 260$, (3) $A_1 y_2 + A_2 y_1 + A_3 y_3 = 60 + 60 + 160 = 280$, or (4) $A_1 y_1 + A_2 y_3 + A_3 y_2 = 40 + 120 + 120 = 280$.

Based on equation (4), we calculate the objective amount. The output are different for positive assortative matching and negative assortative matching when γ is different. We consider three

The objective amount with different concentration of economic growth and regional disparity

γ	positive matching	negative matching	mixed matching (1)	mixed matching (2)	mixed matching (3)	mixed matching (4)
0.00001	289.93	250.00	259.98	259.98	279.93	279.96
1000	-7266377	-66416.7	-186407	-1866407	-6666387	-4266387
0.05	253.67	249.67	250.67	250.67	246.67	258.67

cases of γ . In the following table, in the first row it is the case when $\gamma^* = 0.00001$. It is obviously that positive assortative matching is generating the largest output. This is similar when γ is 0, and positive assortative matching is preferred. In the second row, it is the case when $\gamma^{**} = 1000$. Negative assortative matching could generate the largest output. This is similar with the case $\gamma = +\infty$. The choice of γ^* and γ^{**} depends on the specific number of A and y , and here we use 0.00001 and 1000 as an example. And in the last row when γ is between γ^* and γ^{**} , we take 0.05 as an example and we find that mixed matching with positive and negative assortative matching could generate the largest output.

Obviously, this numerical example proves our argument that positive assortative matching could generate the largest output when central authority concerns more on economic growth, and negative assortative is achieving output with least regional disparity when central authority gives more concentration on reducing regional disparity. Mixed matching with positive and negative assortative matching will be better when the concentration is between these two extreme cases. ■

As a result, positive assortative matching is implemented when central authority concentrates on largest output. And negative assortative matching between leaders and provinces is made when central authority concerns more in reducing regional disparity. Therefore, the assignment of leaders turns to be one tool or one form of effort for central authority to reduce regional disparity. According to the findings of Demurger et al (2002), the large regional inequality has induced less developed regional government to give policy responses in increasing infrastructure investment to catch up with the more developed regions.

To identify the central assignment over provincial leaders, we confine our analysis to the leaders who are rotated among provinces from time $t - 1$ to time t . We do not include leaders who only stay in one province during the time period. This is to exclude the possible endogeneity when considering how central authority assign leaders to provinces. If the leader has not been rotated among provinces any time, it is difficult to obtain her ability in developing economy. There are two reasons why we are focusing on rotated provincial leaders. Firstly, if the leader has been worked in central department and she is assigned to be a provincial leader afterwards. Based on the special function of each organ of central department, it is difficult to get her ability from the performance. Secondly, if the leader has been worked in one province as a vice leader, and then rotated to another province as provincial leader. It is still difficulty to get her ability. Vice leaders usually have different responsibilities over the provincial affairs. Therefore, her ability in developing economies could not be fully obtained if she is only responsible for one area which is not the economic area. The provincial leaders who are rotated among provinces provide us a good opportunity to look at the mode of assignment after obtaining the abilities of each provincial leader. Actually, leaders have other ways of turnovers than rotation, for example, promotion to central department of higher level. These leaders who are promoted to higher level might be more capable than the leaders who are rotated, so there might be some selection biases. However, this does not affect too much of our analysis in finding the mode of assignment over provincial leaders.

In the empirical analysis, leader's ability in developing provincial economy could not be observed directly, but reflected from the economic performance in the previous province at $t - 1$. One provincial leader's ability is fixed during her career (Hermanlin and Weisbach, 1998). From equation (2), we know the growth rate of g_{t-1}^j reflects the combination of leader's ability and the endowment of E^j in province j .

$$g_{t-1}^j = g(A, E^j)$$

Then the leader's ability could be obtained by identifying the economic growth rate g_{t-1}^j in region j at time $t - 1$.

Hermanlin and Weisbach (1998) argue that firm's performance is one signal of CEO's ability. We follow this argument that economic performance in each province signifies the leader's abilities. We use TFP growth rate to measure the contributions that provincial leaders have made in the output growth of province j . TFP is the part in the production that is not explained by inputs, and it reflects the efficiency of production. The economic reform since 1978 increases the autonomy of provincial governments, and they have more power in managing local economy. The role of leaders and the quality of provincial leadership could be reflected from the economic performance in each province. The economic strategies and policies are closely related to local leaders, and the differences in strategies among provinces could induce larger differences in development¹⁶. Tan (2002) proves that the growth differences between provinces, especially the provincial disparity is a function of provincial leader's role. The abilities of regional leaders are important in improving regional economy (See Tan, 2002). The provincial TFP differences in economy are related to the variations in provincial physical technology, which is due to the policies and strategies in technology development implemented by local governments¹⁷.

The Cobb-Douglas function form is used as the production function to obtain TFP. K is capital input, L is labor input. θ_i is the elasticity of output with respect to each input, K and L .

$$TFP_{t-1,t}^j = \ln\left(\frac{Y_t^j}{Y_{t-1}^j}\right) - \theta_K \ln\left(\frac{K_t^j}{K_{t-1}^j}\right) - \theta_L \ln\left(\frac{L_t^j}{L_{t-1}^j}\right)$$

The estimated ability using TFP might be affected by endowments that are not fully considered by inputs. Given the assumption that if infrastructure endowment is better, entrepreneurs will generate more R&D activities and produce more technological progress, TFP growth rate could be a function of infrastructure endowment (Demurger, 2001). Luckily the rotated leaders could be used to mitigate this problem. At time $t - 1$, the leader worked in region j ($j \neq i$), and she is rotated to region i at t . After the assignment, the output level at region i is achieved, $Y_t^i = Y_{t-1}^i[1 + g_t^i(A, E^i)]$. To explore the assignment, we look at the relationship between A and Y_{t-1}^i . Y_{t-1}^i includes the effect of endowment E^i , and A is obtained from the previous economic growth rate g_{t-1}^j which might be affected by endowment in province j E^j . However, it does not affect our analysis using the data of rotated leaders because E^j and E^i are not related. It is impossible for one leader to impose her effect on the region that she has never been. The relationship between A obtained from g_{t-1}^j and Y_{t-1}^i could truly tell us the mode of assignment between leaders and regions. How the assignment is imposed depends on the objectives of the central authority.

At the same time, we have to admit that the assignment from province j to province i might not be random but controlled by central authority. The central assignment itself could reflect some potential relationship between the two provinces involving leadership changes. So when central authority makes the decision of rotation, both the effects of E^j and E^i have already been

¹⁶Tan (2002) compares the development strategy in Fujian and Jiangxi. He proves the importance of leaders in improving local economy by adopting coherent strategies towards provincial economy.

¹⁷Hall and Jones (1999) proved that the income differences among countries are due to differences in TFP and the differences in TFP are related to the variations in physical technology.

considered. So the correlation between E^j and E^i might not be 0. In addition, when making fixed capital investment, central authority would consider the endowment of each province before investment based on national planning and management. However, this potential relationship between the endowment E^j and E^i could not be alleviated within our framework.

4 Empirical method

In this part, we explore how provincial leaders are allocated to each province from the correlation coefficients between leader's ability and the economic development level in each province before rotation is taken place. Similar as Fernandez et al (2005), we use correlation coefficient and Spearman Rank correlation coefficients between leader's ability and provincial development level to measure the mode of central assignment.

Different methods are applied in previous literatures to test assortative matching, for example, between workers and firms. Mendes, Van den Berg and Lindboom (2007) summarize three measures of testing assortative matching. Firstly, the traditional correlation coefficient between firm-specific productivity and the proportion people who have higher education. Secondly, the rank correlation coefficient between the two sides, and this could mitigate the effects of extreme value on the correlation coefficients. Thirdly, the regression coefficient between the two sides is used. Identification of the correlation coefficient is widely used in the literatures.

To measure the sorting between the two sides of the matching, fixed effect of workers and firms are both considered. Postel-Vinay and Robin (2006) measure the firm quality using the log of value added per worker, and they find that it is positive correlation between firm quality and worker's skill which is measured by worker's individual fixed effect. Mion and Naticchioni (2009) consider the correlation between individual fixed effect and firm size to look at whether it is positive assortative matching between the two sides. They show that it is positive assortative matching between firm size and skills of workers presented by individual fixed effects. This further proves that it is complementary between workers' skills and firm size. And this is consistent with our analysis that it is complementary between leaders' ability and provincial development level. There are exceptions in the findings. Abowd et al (2004) find that it is slightly positive between firm quality and worker's skills in US, and it is negative in France. Firm quality is presented by the firm fixed effect, and worker's skill is represented by worker's individual fixed effect.

In marriage market, Mare (1991) looks at the correlation of education level between spouses and tries to find the sources for the mode of mating since 1930s in US. Kremer (1997) uses the correlation between education level of male and female in each family to measure the degree of matching. Fernandez and Rogers (2001) use the proportion of marriages with positive assortative matching to measure the degree of assortative matching. Similarly as Kremer (1997), Fernandez et al (2005) uses the Pearson correlation and Spearman rank correlation coefficients in skills or years of education between spouses to measure the degree of marital sorting. Liu and Lu (2006) compare the results of correlation coefficients and the fraction of perfectly sorting. They propose one new measure for the degree of sorting based on the trait taking the value of (0,1) by dividing the education level of each man and woman into high and low types based on whether they have a post secondary education or above. They use the relative distance of actual matching outcome to the perfectly random matching outcome to measure the degree of sorting. However, in our paper, we do not have an objective standard to divide the level of leader's ability as high and low, so we could not obtain dichotomous measure for the trait. In addition, our primary job is to look at whether the central assignment is positive or negative assortative matching between leaders and provinces rather than measuring the specific degree of sorting within each type of assortative matching groups.

Ability is measured by the TFP growth rate over the tenure of each leader. We use Cobb-

Douglas production function to generate TFP¹⁸.

$$Y = AK^\alpha L^\beta$$

Where, $\alpha > 0$, $\beta > 0$. Y is the total production, L is labor input, and K is capital input. A measures the technology improvement. Taking logarithmic form, we have,

$$\ln Y = \ln A + \alpha \ln K + \beta \ln L$$

After first difference to the production function, TFP growth rate $TFP_{t-1,t}$ could be obtained,

$$TFP_{t-1,t} = \ln\left(\frac{Y_t}{Y_{t-1}}\right) - \alpha \ln\left(\frac{K_t}{K_{t-1}}\right) - \beta \ln\left(\frac{L_t}{L_{t-1}}\right) \quad (9)$$

Literatures have used different measures for capital and labor (Jorgenson, 1967; Young, 1995). The capital stock is estimated using the perpetual inventory method with geometric depreciation (Holz, 2006) in this paper.

$$K_t = \frac{I_t}{P_t} + (1 - \delta)K_{t-1}$$

I_t is the investment at time t , P_t is the investment index at time t ¹⁹, δ is the depreciation rate. Suppose that the initial year of capital stock K_0 is 1957²⁰, and $K_0 = I_0/(g_0 + \delta_0)$, where I_0 is the investment for the initial year, δ_0 is the depreciation rate in the initial year, which is 0.03 before 1978. g_0 is the growth rate for capital around initial year. We usually take the average growth rate for four or five years around the initial year. The depreciation rate is 0.04 for 1978-1992, 0.05 for 1993-2008 (Islam and Dai, 2007). All the capital is transferred into the real capital based on the constant price of 1990. We take capital investment as a whole rather than dividing them into different groups because of the data limitation.

Labor input is the average labor income of rural areas and urban areas. We do not use the average wage level and the number of employees in the yearbook, because they are confined in urban areas, and this underestimates the proportion of labor inputs in GDP. Instead, we use the average labor income in rural and urban areas. The number of working population in rural areas and urban areas in each province are the total population multiply the proportion of working population between 15 and 64 to total population in 2000, which is based on the population survey in 2000.

Under the assumption of perfect competition and constant returns to scale of capital, the share of capital is one minus the share of labor, θ_L . θ_L is the total nominal labor income in rural areas and urban areas divided by nominal GDP of each year. The average share of labor input is about 42% from 1978 to 2008 for all the provinces. As long as both capital inputs and labor inputs are obtained, we could use equation (9) to calculate the TFP growth rate. The calculated TFP growth from 1978 to 2007 is shown in table A3. Islam, Dai and Sakamoto (2006) have calculated

¹⁸The translogarithmic function form could also be used as the production function (Young, 1995) to obtain TFP.

$$Y = \exp[\alpha_0 + \alpha_K \ln K + \alpha_L \ln L + \alpha_t \cdot t + \frac{1}{2}B_{KK}(\ln K)^2 + B_{KL}(\ln K)(\ln L) + B_{Kt} \ln K \cdot t + \frac{1}{2}B_{LL}(\ln L)^2 + B_{Lt} \ln L \cdot t + \frac{1}{2}B_{tt} \cdot t^2]$$

¹⁹The price index for investment comes for the statistical yearbook for the time period 1991-2008. For the period before 1991, it comes from "The gross domestic product of China, 1952-1995". There is no record for the investment index in Tibet.

²⁰Because of the data limitation, if there is no statistics for 1957, we use the first year that is recorded in the statistics. For example, in Hainan, the first year is 2000. In Chongqing, the first year is 1997.

the TFP growth rate in China between 1978 and 2002. And they find the TFP growth rate is between 2.95% and 4.06% with different methods. We have found that the average TFP growth rate between 1978 to 2007 is 3.78%, and it is 4.49% for the period of 1978 to 2002.

If one leader has been rotated more than once, we could still obtain her ability by drawing the average TFP growth rate over the tenure. Working in different provinces might generate different TFP growth rates, but the ability is the same. We use average TFP growth rate during the tenure of each leader in the previous province before rotation, $TFP_{average}$ as the measure of the unobserved ability of provincial leaders in improving economic growth. TFP_t is the annual TFP growth rate at time t .

$$TFP_{average} = \frac{\sum_{t=1}^T TFP_t}{T}$$

We use the years that leaders have been in the current post until the considered year as tenure, T . For example, if the leader has been a governor or secretary for one year, $T = 1$; after another year, $T = 2$ and so on. Average performance over the tenure is less noisy and puts weight on the average term instead of short term shocks.

We look at how assignment is done through central authority's allocation. Taking similar method as Mion and Naticchioni (2009), Fernandez et al (2005) and Van den Berg and Lindboom (2007), we explore the assignment mode between leader's abilities and of economic development in each province. We use the level of real GDP per capita one year before the provincial leader is rotated to measure the economic development of each province. The correlation and rank correlation between average TFP performance during the tenure of the rotated leaders in previous province and the GDP per capita one year before the rotation reflect the direction and assignment of provincial leaders to provinces.

Both Pearson correlation and Spearman correlation are applied in our analysis. Pearson correlation coefficient indicates both the direction and degree of correlation of variables. Spearman correlation reflects the Pearson correlation coefficients between the two sides of ranked variables. The direction of correlation is shown by the sign of Spearman correlation coefficients between variables. The Pearson correlation and Spearman correlation are highly correlated (Fernandez et al, 2005). Especially, when there is no prominent outliers, these two correlation coefficients are similar. On the other hand, the Spearman correlation coefficient is less sensitive to the outliers than Pearson correlations, because the variables have been transferred to ranks. In addition, the Spearman correlations could be 1 if the variables are monotonically related, when the Pearson coefficient is not 1.

5 Data

The data used in this paper covers the provincial leaders in 31 provinces in China from 1993 to 2007. We focus on the time period after socialist economy was officially adopted in 1992. It is considered as the end point of transition when building one socialist market economy was raised in 1992 (See Naughton, 2008). The information of provincial leaders comes from one book published in Chinese "*The Documentation of Administration in the People's Republic of China* (2003)", and the website "<http://www.xinhuanet.com/>". These data sets provide detailed information of leaders, for example, the age, gender, education, past working experiences, date of joining the Party. More importantly, they track down the date of taking and leaving office in each province, and the following arrangement for each leader, which includes promotion, termination, lateral move or other arrangement. The data of economic performance for each province from 1992 to 2007 comes from the statistical yearbook, and "*The gross domestic product of China, 1952-1995*" for data from 1978 to 1991. We use GDP deflator to transfer all GDP per capita into real GDP per capita based on the constant price in 1990.

We focus on the top-ranking leaders who are rotated between provinces. Some leaders might hold two positions at the same time, for example governor and vice secretary. We take the higher position which reflects the true power of the leader. In total, there are 344 chief provincial leaders since 1978. From 1993 to 2007, there are 198 chief leaders and 1184 leader-year observations²¹. In table 1, we list the general statistics about the variables that we are interested.

To look at the assignment of leaders to provinces, we use one sub sample of the total data, which includes leaders who are rotated among provinces, and exclude leaders who are promoted, staying at the original positions, or retired. The rotated leaders include both provincial governors and provincial secretaries. In this sub sample, most people are rotated among provinces only once and a few leaders have been rotated for twice or three times. After identifying destinations and origins of these rotated leaders, there are 64 groups of leaders who worked in different provinces before and after rotation since 1978, and 292 provincial leader-year observations. We focus on the rotations happen from 1993 to 2007, and it turns to be 49 groups of rotated leaders. The rotation before 1993 is only a few. In 1990, there is formal regulation²², which requires that leaders should be rotated among provinces or between provinces and central departments. It intends to increase the working experiences of leaders and improve their abilities of dealing with problems. At the same time, this rotation could be helpful to eliminate corruption. Generally, provincial governor and party secretary do not change at the same time to keep the stability of leadership in the original province. As a result, the number of rotations is not many in each year.

In figure 1, we compare the number of rotations for leaders in each province from 1993 to 2007. Hebei is the province which has the largest number of rotations, 6 times. Liaoning and Qinghai are the second largest provinces of rotations, 5 times. While Xinjiang have no rotations during the time period from 1993 to 2007.

The rotation includes two directions—flowing in and flowing out. Generally, Hebei has the largest number of leaders flowing in, which is 4 times. Guangdong, Henan, Liaoning and Beijing are the second largest provinces, which are 3 times. Instead, Guangxi, Hainan, Guizhou, Xinjiang and Qinghai do not have leaders flowing in. Most of these provinces are autonomous regions with different races, which need special experiences in management. Inside leader are more familiar with local affairs than outsiders who have been working in other provinces.

For the number of leaders rotated to other provinces, Qinghai, Gansu and Henan ranks first with 4 times. Four chief leaders have worked in these provinces and then rotated to other provinces. All these three provinces are less developed provinces, working in these provinces could increase the leader's ability and experiences in dealing problems in less developed regions. Xinjiang, Inner Mongolia, Tianjin, Heilongjiang, Shanghai, Sichuan, Yunnan and Guangdong do not have leaders flowing out to other provinces. For some special provinces, e.g. Xinjiang, Inner Mongolia, Yunnan and Heilongjiang, the stability of provincial leaders is important for the social stability of these provinces in the national frontier²³. Leaders in these provinces are more likely to get promotion, for example, in the form of cross-posting, or get retired after the term. Leaders in Shanghai are more than seven times to be promoted than leaders in other provinces (See Bo, 1996). Many leaders are promoted to higher positions or get retired rather than being rotated to other provinces²⁴. This is similar for the municipality of Tianjin, although its promotion possibility is lower than Shanghai. Guangdong is in the frontier of economic reform. More advanced economic policies and economic experiments are implemented in Guangdong since the beginning of economic reform. Economic

²¹We focus on leaders who have been rotated from 1993 to 2007. Some leaders may have started their job in each province before 1993, but the time of rotation takes place after 1993.

²²"Central Committee of the Communist Party's Decision about Rotating Party Leaders and Government Leaders of China" was issued in 1990.

²³For example, since 1978, there are 8 leaders who have worked in Xinjiang. 1 is promoted, 5 are tired, and 2 are still working there. In Inner Mongolia, 9 leaders are tired, and 2 are still working there. Among 14 leaders who have worked in Heilongjiang, 1 is promoted, 8 are tired, and 5 are still working there.

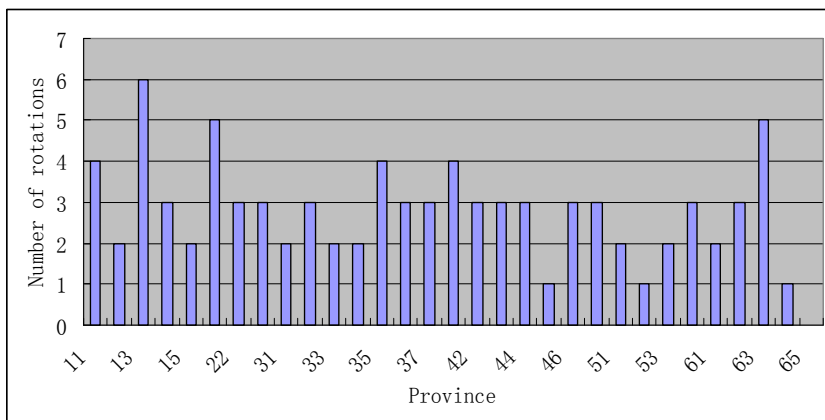
²⁴Among the 14 leaders who have worked in Shanghai since 1978, 50% were promoted to higher position in the central government, 36% were get retired, and 14% are still working in Shanghai as chief leaders.

Table 1 General statistics for the variables for the leaders who are rotated after 1993

Variable	Mean	Std.		Min	Max	N
		Dev				
promotion	0.053	0.224		0	1	1184
termination	0.079	0.270		0	1	1184
Annual GDP growth rate	0.096	0.060		-0.223	0.467	1173
Average TFP growth rate over the tenure	0.038	0.040		-0.054	0.249	1152
Average GDP growth rate over the tenure	0.122	0.066		-0.07	0.772	1132
age	58.509	4.376		42	68	1179
age65	0.068	0.252		0	1	1184
education	0.825	0.380		0	1	1168
central	0.212	0.409		0	1	1184
SOE	0.027	0.162		0	1	1184
Years of Party	34.722	7.664		6	52	1167
Origin of Shanghai	0.025	0.157		0	1	1184
Communist Youth League	0.0870	0.282		0	1	1184
home	0.319	0.466		0	1	1184
tenure	3.215	2.650		0	15.833	1184

The observation unit is provincial leader-year. Promotion is 1 if one leader is promoted in one year, 0 otherwise. Termination is 1 if one leader is retired or demoted, 0 otherwise. Annual GDP growth rate is the GDP growth rate annually. Average TFP growth rate is the average TFP growth rate over the tenure. Average GDP growth rate over the tenure is the average GDP growth rate during the tenure. Age65 is 1 if leaders are older than 65, 0 otherwise. Education is 1 if leader's education is college or higher, 0 otherwise. Central is 1 if the leader has worked in central department, 0 otherwise. SOE is 1 if one leader has worked as the leader of SOE, 0 otherwise. Years of party are the number of years since the leader joined the Party. Origin of Shanghai is 1 if the leader has worked in Shanghai, 0 otherwise. Communist Youth League is 1 if the leader has worked as member in communist Youth League, 0 otherwise. Home is 1 if the leader worked in the province where she was born, 0 otherwise. Tenure is the number of years a leader has been in the position; it increases as the number of years.

Figure 1 Number of rotations in each province after 1993



experiment might be an opportunity for one’s career if other provinces could follow. Knowing this, more ambitious leaders could initiate more economic reforms (Xu, 2009). From data, we find that leaders in Guangdong are more likely to get promoted instead of being rotated²⁵.

In general, the direction of rotation could be related to economic factors, political factors, and ethnic factors. We focus on how leaders are matched with provinces by central authority from the economic development perspective.

6 How is provincial chief leader being rotated?

In this part, we look at provincial chief leaders who have been rotated among provinces. Central authority allocates leaders based on their abilities and economic development level at $t - 1$ to achieve the desired economic growth at t . In this part, we use $TFP_{average}$, average TFP growth rate during the tenure of each leader in the previous province before rotation, to measure of the unobserved ability of provincial leaders in improving economic growth. We use three method of testing matching in Mendes et al (2007) to test the correlation between leader’s ability and the economic development before rotation is done. The economic development is represented by real GDP per capita one year before the rotation. The matching results depend on the objectives of central authority.

The principles and regulations to manage provincial leaders are changing over time based on the policy focus and composition of central authority. The corresponding changes in the style of managing provincial leaders reflect the different central concentration in economic efficiency and regional development balance. The correlation coefficients are listed in table 3. Because of the data limitation, there are only one observation or no observations in some years, so the correlation coefficients are missing for some years. But we could still infer the trend of rotation. From 1993 to 2007, we find that central authority does not follow one constant way in allocating provincial leaders because of changes in objective function.

In the beginning period from 1993 to 1997, leaders with better TFP performance are assigned to more developed regions to increase the speed of the economic reform. Central authority concentrates in promoting economic growth since socialist market economic is officially adopted in 1992.

²⁵There are 14 leaders who have worked in Guangdong since 1978. Among them 57% leaders are promoted, 21.5% are retired, and 21.5% are still staying Guangdong as chief leaders.

Table 3 Correlation between ability (average TFP over tenure) and provincial economic development one year before rotation

year	correlation	spearman rank correlation	regression of ability on provincial economic development	n
1993	0.9040**	0.7	1.036**	5
1994				1
1995				1
1996				0
1997	1.000	1.000	0.314	2
1998	-1.000	-1.000	-28.630	2
1999	-1.000	-1.000	-2.425	2
2000				1
2001	0.9013*	1***	1.535*	4
2002	-0.712	-0.738	-0.931	4
2003	-1.000	-1.000	-0.193	2
2004	-1.000	-1.000	-3.455	2
2005	1.000	1.000	0.616	2
2007	-0.004	0.186	-0.001	12

* significant at 10%, ** significant at 5%, *** significant at 1%.

This is true until 2001 with some exception in 1998 and 1999. From 1993 to early 2000s, more capable leaders are assigned to more developed regions, because more concern is given to economic growth in central authority's objective function. In 1998, it is negative assortative matching. Only two rotations are implemented in 1998. Two leaders who have been worked in Jilin and Henan are rotated to Zhejiang and Guangdong. However, the difference between GDP per capita one year before rotation in Zhejiang and Guangdong is small. This rotation could not provide enough evidence to support negative assortative matching in 1998. Similarly, in 1999, leaders who have been working in Fujian and Qinghai are rotated to Chongqing and Shanxi. The differences in real GDP per capital one year before rotation in Chongqing and Shanxi are not big. Obviously, this is no strong evidence that it is negative assortative matching in 1999.

After 2002, when central authority concerns more in reducing regional disparity, leaders with higher abilities are assigned to less developed provinces. So that the allocation could be mixed with positive and negative assortative matching. Actually, large regional disparities exist in the economic performance since economic reform (Demurger, 2001). This disparity is a driving force for central authority to concern more in achieving balanced development. In addition, in 2002, the general secretary of the Communist Party, the premier, and the members of standing committee of the political bureau are replaced by a new generation of leaders. The change of members in central authority is accompanied by policies changes in managing provincial leaders and the effects on economic development (Jones and Olken, 2005, 2009). Since 2002, negative assortative matching is implemented. And this is consistent with the central policies in emphasizing the development of inland regions since early 2000s. Obviously the direction of rotation reflects the central objectives in developing national economy. Although the correlation coefficients are not significant after 2002, this provides some evidence that the assignment has changed from positive assortative matching to mixed assignment with positive and negative assortative matching, and this is induced by the change of central concentration. This result is consistent with our argument in proposition 1.

In table 4, we use five years overlapping data to look at the correlation coefficients between ability and economic development before rotation. We find that the spearman rank correlation coefficients are positive and significant from 1993 to 1997, and it is positive from 1997 to 2001. This is consistent with our explanation that before early 2000s, central authority concerns more on economic growth. It is negative in the period of 1999-2003, 2000-2004 and 2001-2005. We believe this is driven by the negative assortative matching after 2002. From 2002 to 2006, the spearman rank coefficients are negative and significant. Central authority assigns more capable leaders to less developed regions to reduce regional disparity.

To get robust result, we list the correlation coefficients based on different time periods before and after 2001 when central authority gives different emphases on economic growth and balanced development. The result is shown in table 5. These correlation coefficients prove our proposition 1 that when central authority concerns more on efficiency before early 2000s, positive assortative matching is implemented. When central authority concerns more in reducing regional disparity, negative assortative matching is implemented since early 2000s, and it is significant for each period after 2002. The correlation coefficient from 1993 to the years after 2002 is negative, and this is mainly driven by the negative assortative matching after 2002.

In general, from early 1990s to early 2000s, central authority assigns provincial leaders with higher abilities to more developed provinces to achieve higher economic growth rate. After early 2000s, more capable leaders are allocated to less developed regions to reduce regional disparity. We follow the regressions of column 3 in table 3 by adding the dummy of period, which is 1 if year is 2002 or afterwards, and 0 otherwise. In table 6, we find that the coefficient for the dummy is -3.10, which is significant. This confirms that after early 2000s, the allocation between leaders and provinces is different from the period from 1993 to early 2000s.

We have compared the growth rates of real GDP per capita in eastern and inland regions. It shows that the average growth rate is higher in eastern regions than inland regions before early

Table 4 The correlation coefficients between ability of each leader (average TFP over tenure) and GDP per capita one year before rotation with five-year overlapping data

year	correlation	spearman rank correlation	regression of ability on provincial economic development	n
1993-1997	0.443	0.600*	0.380	9
1994-1998	0.249	0.143	0.232	6
1995-1999	0.446	0.393	0.585	7
1997-2000	0.206	0.250	0.397	7
1997-2001	0.365	0.500	0.816	11
1998-2002	-0.075	0.094	-0.146	13
1999-2003	-0.306	-0.132	-0.300	13
2000-2004	-0.384	-0.234	-0.512	13
2001-2005	-0.288	-0.123	-0.326	14
2002-2006	-0.482	-0.597*	-0.613	11
2003-2007	-0.314	-0.280	-0.165	19

* significant at 10%, ** significant at 5%, *** significant at 1%.

There is no rotation in 1996, so there is no correlation for the period 1996-2000

2000s. After 2002, the growth rate is higher in inland regions than eastern regions. The growth rate of real GDP per capita is consistent with our analysis to central authority's emphasis in allocating leaders to provinces. In table 7, we list the average growth rate of GDP per capita in eastern and inland regions since 1993.

The assignment of provincial leaders to each province reflects the change of central concentration on economic development and regional development balance. If central authority focuses more on efficiency, it could be more possible that leaders with higher abilities are assigned to more developed provinces. On the other hand, if central authority concentrates more in keeping regional balance in economic development, provincial leaders with higher abilities are more likely to be allocated to less developed provinces. The assignment of leaders is closely related to the process of economic reform and development. The economic reform has come into the track of building socialist market economy since early 1990s. The regulation over provincial leaders is serving for the economic development in the way that more capable leaders are rotated to more developed regions. After early 2000s, when regional disparity turns to be larger, central authority concerns more in reducing regional disparity among regions. More capable leaders are assigned to less developed regions to reduce regional disparity.

7 Extension

In this part, we look at the assignment of leaders in different regions, eastern regions and inland regions. Central authority pays attention to the different economic development levels in different regions when assigning leaders to provinces. In table 8, we list the correlation coefficients between leader's ability and provincial real GDP per capita one year before rotation in eastern regions and

Table 5 The correlation coefficients between ability of each leader (average TFP over tenure) and GDP per capita one year before rotation with increasing annual data

year	correlation	spearman rank correlation	regression of ability on provincial economic development	n
1993-1994	0.508	0.486	1.009	6
1993-1995	0.535	0.464	1.018	7
1993-1997	0.443	0.6*	0.380	9
1993-1998	-0.027	0.046	-0.029	11
1993-1999	0.122	0.126	0.183	13
1993-2000	0.048	0.108	0.082	14
1993-2001	0.066	0.071	0.141	18
1993-2002	-0.164	-0.158	-0.316	22
1993-2003	-0.329	-0.218	-0.416	24
1993-2004	-0.3563*	-0.252	-0.503*	26
1993-2005	-0.3469*	-0.287	-0.505*	28
1993-2006	-0.3436*	-0.262	-0.513*	29
1993-2007	-0.410***	-0.456***	-0.288***	41
2002-2003	-0.662	-0.754*	-0.323	6
2002-2004	-0.543	-0.779**	-0.617	8
2002-2005	-0.462	-0.608*	-0.528	10
2002-2006	-0.482	-0.597*	-0.613	11
2002-2007	-0.335	-0.407*	-0.176	23

* significant at 10%, ** significant at 5%, *** significant at 1%.

There is no rotation in 1996, so there is no correlation for the period 1993-1996

Table 6 The regression of ability on the independent variable of time dummy

Dependent variable: ability measured by TFP over the tenure	
Independent variables	coefficient
real GDP per capital before rotation	-0.161 (-0.11)
dummy	-3.101** (-1.27)
R square	0.28
N	41

** significant at 5%

Dummy=1 if year of rotation is 2002 or afterwards, and 0 otherwise

Table 7 The average GDP growth rate in eastern and inland regions

year	1993-1997	1993-2001	2002-2007
Eastern	9.22%	8.61%	12.88%
Inland	8.90%	8.51%	14.65%
Difference (Eastern-inland)	0.32%	-0.10%	-1.77%

Eastern regions include Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan. Other provinces belong to Inland regions

inland regions.

Because of the data limitation, in some years there is only one observation or no observations. Results in eastern regions show that from 1993 to 1997, it is positive assortative matching between leaders and provinces. During this period central authority concerns more in economic growth, so positive assortative matching appears. After 1997, it is negative assortative matching, and it is significant and negative for the correlation coefficients between 1993 to 2007. After early 2000s, both negative assortative matching and positive assortative matching are existing in eastern regions. Negative assortative matching is significant from 2002 to 2003, and from 2002 to 2004. And for the period from 2003 to 2007, it is positive assortative matching. Because eastern regions are more active and powerful in generating better economic performance, central authority relies more on eastern regions to keep economic growth.

On the other hand, the assignment results in inland regions are a little different from eastern regions. It is negative assortative matching between leaders and provinces in inland regions for all the years except between 2003 and 2004. Given the lagged development in inland regions, large regional disparity exists between eastern and inland regions. To reduce the regional disparity in inland regions, more negative assortative matching is implemented. From 1993 to 1999, the negative assortative matching is significant, and similar for the period 1993 to 2007.

Therefore, central authority takes different strategies in improving economic growth and reducing regional balance by assigning leaders to provinces for different regions. In eastern regions more emphases are put on economic growth and in western and central regions more emphases are put on reducing regional disparity.

Once the rotation is implemented, the rotated leaders go to new provinces. How is the effect of rotation? Could leaders generate better economic performance? The correlation between leaders' abilities and the change in TFP growth rate in the provinces involving rotations could show some indications of the rotation effect. In table 9, we list the correlation between leaders' abilities and change of TFP growth in each province after rotation. Obviously, the measure of ability does not change. And the measure for provincial economy is the difference in average TFP growth rate three years after rotation and three years before rotation.

For most of the time periods before 2001, it is positive assortative matching between ability and the change in TFP growth, which reflects that more capable leaders could generate faster TFP growth rate. And the correlation coefficients are significant from 1993 to 1998 and afterwards until 2001. After 2002, most of the assignments are negative assortative matching. So the correlation coefficients between ability and the change of TFP before and after rotation are negative. However, most of them are not significant because of the existence of the mixed assignment of both positive assortative matching and negative assortative matching. Therefore, to generate faster TFP growth rate, more efforts should be put rather than assigning leaders among provinces.

Table 8 The correlation coefficients between ability of each leader (average TFP over tenure) and GDP per capita one year before rotation in different regions

year	Leaders worked in eastern regions after rotation				Leaders worked in inland regions after rotation			
	correlation	spearman rank correlation	regression of ability on provincial GDP	N	correlation	spearman rank correlation	regression of ability on provincial GDP	N
1993-1994					-0.832	-0.500	-3.190	3
1993-1995					-0.791	-0.400	-2.852	4
1993-1997	0.407	0.500	0.234	5				
1993-1998	-0.117	-0.214	-0.149	7				
1993-1999					-0.878**	-0.771*	-4.868**	6
1993-2000					-0.319	-0.321	-2.311	7
1993-2001	-0.226	-0.333	-0.304	8	-0.454	-0.382	-2.843	10
1993-2002	-0.431	-0.532*	-0.778	12				
1993-2003	-0.631**	-0.633**	-0.682**	13	-0.441	-0.300	-2.834	11
1993-2004	-0.622**	-0.654**	-0.713**	14	-0.169	-0.042	-1.246	12
1993-2005					-0.323	-0.279	-1.407	14
1993-2006					-0.217	-0.111	-0.944	15
1993-2007	-0.601***	-0.737***	-0.330***	21	-0.390*	-0.307	-1.277*	20
2002-2003	-0.785	-0.872*	-0.430	5				
2002-2004	-0.738*	-0.812*	-0.419*	6				
2002-2007	-0.391	-0.433	-0.104	13				
2003-2004	-1.000	-1.000	-0.165	2	1.000	1.000	16.844	2
2003-2005					-0.283	-0.600	-1.275	4
2003-2006					-0.220	-0.300	-1.086	5
2003-2007	0.132	0.201	0.025	9	-0.354	-0.115	-1.500	10

* significant at 10%, ** significant at 5%, *** significant at 1%.

Table 9 The correlation between ability of each leader (average TFP over tenure) and the difference in TFP growth rate in the rotated provinces before and after rotation

Year	correlation	spearman rank correlation	regression difference in TFP growth rate on ability	N
1993-1994	0.508	0.657	0.338	6
1993-1995	0.502	0.679*	0.437	7
1993-1997	0.243	0.417	0.347	9
1993-1998	0.536*	0.536*	0.666*	11
1993-1999	0.637* *	0.637* *	0.705* *	13
1993-2000	0.640* *	0.609* *	0.628* *	14
1993-2001	0.403 *	0.430*	0.326*	18
1993-2002	0.198	0.162	0.160	22
1993-2003	0.156	0.161	0.117	24
1993-2004	0.148	0.160	0.099	26
1993-2005	0.119	0.108	0.076	28
1993-2006	0.051	0.061	0.033	29
1993-2007	0.150	0.195	0.096	41
2002-2003	0.144	0.174	0.082	6
2002-2004	-0.206	0.084	-0.074	8
2002-2005	-0.188	0.000	-0.067	10
2002-2006	-0.450	-0.232	-0.204	11
2002-2007	-0.005	0.212	-0.003	23

* significant at 10%, ** significant at 5%, *** significant at 1%.

The difference in TFP growth rate is the average TFP growth rate three years after rotation minus the average TFP growth rate three years before rotation.

8 Summary

In this paper, we discuss the central management over provincial leaders through assignment of leaders to provinces. How to match provincial leaders and provinces is a sophisticated project and it is determined by the central authority's objectives. With the sample of Chinese provincial chief leaders who are rotated among provinces, we find that the assignment of provincial chief leaders to provinces is closely related to the managing policy of central authority and economic reform process. From early 1990s to early 2000s, positive assortative matching between leaders and provinces is implemented. Central authority allocates more capable leaders to more developed regions. After early 2000s, negative matching between leaders and provinces is implemented. Provincial leaders with high abilities are allocated to less developed provinces. Based on the different economic development levels in eastern and inland regions, more positive assortative matching is implemented in eastern regions, and more negative assortative matching is implemented in inland regions.

There is no free market for the provinces and provincial leaders to match with each other, but through the central selection and rotation, both central authority and provincial leaders are playing great role in developing regional economy in China.

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Table A1 The average amount and increasing rate of fix asset investment in east and central-west provinces

year	increasing rate in east regions	increasing rate in central-west regions	Average investment in east regions	Average investment in central-west regions
1979	17.18%	8.41%	28.82	16.47
1980	23.02%	21.56%	35.57	20.22
1981	26.34%	1.82%	44.63	21.37
1982	25.06%	34.27%	55.62	27.96
1983	12.59%	18.36%	62.28	33.04
1984	30.31%	36.18%	79.28	43.24
1985	47.57%	44.48%	115.94	61.17
1986	17.53%	10.27%	138.47	66.65
1987	20.99%	15.04%	171.89	77.27
1988	24.78%	18.09%	216.02	91.50
1989	-3.04%	-5.73%	197.06	84.42
1990	9.67%	10.79%	213.22	92.52
1991	26.11%	24.32%	266.06	114.07
1992	52.24%	35.19%	406.96	155.08
1993	68.13%	50.38%	677.86	233.79
1994	36.96%	25.43%	911.91	300.27
1995	21.30%	22.93%	1111.48	365.56
1996	11.39%	15.98%	1250.66	431.23
1997	8.50%	13.73%	1355.95	485.74
1998	10.11%	14.83%	1488.16	553.51
1999	6.00%	8.55%	1575.48	581.92
2000	7.53%	14.92%	1704.77	657.21
2001	11.13%	18.37%	1897.65	760.89
2002	14.10%	19.34%	2198.50	892.58
2003	29.42%	26.57%	2921.83	1123.21
2004	24.72%	26.68%	3673.77	1444.17
2005	22.22%	26.52%	4529.70	1863.45
2006	21.33%	26.43%	5484.25	2386.19
2007	22.01%	28.34%	6573.75	3124.10
2008	22.88%	28.99%	7977.69	4066.95
2009	27.45%	39.18%	9978.70	5786.69

Data resources: China Statistical Yearbooks The unit of amount is 100 million. East regions include Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. Other provinces belong to central and west regions.

Table A2 The increasing rate and average amount of transfers from central government to local government in east and central-west regions

year	Growth rate in east region	Growth rate in central-west regions	Average amount in east regions	Average amount in central-west regions	Total amount in east regions	Total amount in central-west regions
1994			73.5234	60.63213	1180	1210
1995	7.78%	15.57%	79.1013	63.36358	1270	1270
1996	2.38%	21.09%	80.512	69.20784	1290	1380
1997	4.68%	8.73%	83.5074	73.23904	1340	1460
1998	8.97%	25.27%	91.5245	91.04689	1460	1820
1999	11.24%	30.20%	103.0955	117.1374	1650	2340
2000	13.68%	26.21%	113.944	146.2272	1820	2920
2001	13.72%	41.13%	129.1905	202.5069	2070	4050
2002	33.04%	18.02%	162.3418	237.762	2600	4760
2003	14.97%	5.62%	187.0148	253.2976	2990	5070
2004	25.12%	28.30%	228.3756	326.1502	3650	6520
2005	2.26%	19.08%	247.092	382.4431	3950	7650
2006	14.02%	21.32%	288.0007	465.7916	4610	9320
2007	13.20%	32.87%	303.9037	617.1592	4560	12300

The unit of amount is 100 million

East regions include Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. Other provinces belong to central and west regions.

Data resource: Finance Yearbook of China

Table A3 The general statistics of TFP growth rate from 1978 to 2007

province code	mean	median	standard deviation	variance	min	max
11	5.01%	4.62%	3.89%	0.15%	-3.67%	11.70%
12	3.69%	1.69%	5.30%	0.28%	-3.80%	18.98%
13	3.01%	1.29%	4.59%	0.21%	-6.60%	13.64%
14	3.09%	2.24%	4.58%	0.21%	-4.25%	16.01%
15	3.81%	3.52%	4.44%	0.20%	-3.45%	14.36%
21	3.54%	2.79%	4.62%	0.21%	-6.08%	13.29%
22	3.67%	2.37%	4.89%	0.24%	-4.40%	14.40%
23	2.68%	2.01%	3.46%	0.12%	-1.91%	9.84%
31	4.99%	4.69%	3.80%	0.14%	-2.04%	15.44%
32	5.35%	3.60%	5.09%	0.26%	0.02%	20.90%
33	5.10%	4.70%	4.56%	0.21%	-0.71%	12.82%
34	2.82%	1.43%	4.33%	0.19%	-4.94%	13.53%
35	2.88%	1.49%	15.82%	2.50%	-73.26%	29.00%
36	3.37%	3.22%	6.50%	0.42%	-20.43%	14.67%
37	4.61%	3.54%	4.09%	0.17%	-1.53%	12.28%
41	3.33%	2.80%	4.94%	0.24%	-4.01%	12.84%
42	2.69%	2.22%	3.77%	0.14%	-2.86%	11.40%
43	2.23%	1.41%	3.93%	0.15%	-6.01%	14.33%
44	7.94%	7.16%	4.49%	0.20%	0.97%	17.85%
45	0.28%	1.15%	5.05%	0.26%	-17.93%	9.56%
46	8.15%	8.11%	7.51%	0.56%	-3.04%	33.79%
50	5.01%	7.23%	7.17%	0.51%	-7.27%	15.53%
51	2.57%	2.89%	4.31%	0.19%	-10.36%	10.35%
52	2.28%	0.93%	6.07%	0.37%	-9.77%	20.79%
53	1.02%	-0.27%	4.17%	0.17%	-3.24%	15.91%
54	9.34%	10.30%	6.97%	0.49%	-9.65%	22.55%
61	3.81%	2.43%	4.58%	0.21%	-5.90%	17.81%
62	3.37%	3.31%	5.05%	0.25%	-13.13%	13.53%
63	1.11%	0.88%	4.70%	0.22%	-14.18%	13.89%
64	2.81%	1.89%	4.42%	0.20%	-3.08%	12.96%
65	3.89%	2.97%	3.49%	0.12%	-3.03%	11.59%
Total average	3.78%	2.89%	5.86%	0.34%	-73.26%	33.79%