Assignment of provincial officials based on economic performance: Evidence from China☆

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A B S T R A C T

In China, the allocation of provincial officials reflects the tradeoff of the central authority between the economic growth and regional disparity. Before the early 2000s, the pattern of assignment is close to positive assortative matching between the official's ability and the local provincial endowment, which implies that the central authority's purpose is to maximize the aggregate outputs across provinces, and after the early 2000s, the pattern of assignment converges to negative assortative matching, which is well justified by the central authority's objective of minimizing the regional disparity. This paper contributes to the literatures by exploring the cadre management on the horizontal level.

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1. Introduction

In China, the central authority keeps a firm grasp on the turnovers of provincial officials (provincial party secretaries and governors) (Huang, 1996, 2002). On the one hand, the personnel control over provincial officials serves as one important tool for the central authority to induce the local officials to stand in the boss's shoes (see Maskin, Qian, & Xu, 2000). On the other hand, provincial officials play vital roles in the process of economic development when they compete for promotion (Chen, Li, & Zhou, 2005; Li & Zhou, 2005). Thus, the relationship between the Chinese political structure and economic development spawns a large body of studies recently.

Promotion enables provincial officials to climb up to a higher level of the political ladder, and in return, the perspective of promotion creates highly powered incentives for them to behave in the interests of the central authority (Maskin et al., 2000). Hence, incentive issues exist in this process. However, rotation, which is frequently used by the central authority, forces the officials at the same hierarchy level to work at different locations. The salience of this issue may not result from the incentive effect, but from its allocation effect, which is the matching between provincial officials and provinces.

In this paper, I try to explore the pattern of such horizontal movement of the provincial officials, and also identify the underlying reasons.

When assigning the provincial officials to different localities, the central authority usually takes the following two factors into consideration: the economic characteristics of provinces and the capacities of the officials.[1] However, the real pattern of the assignment also reflects the objective of the central authority. To account for this point, I develop a conceptual framework, in which the provincial output depends on provincial endowment and the leader's ability, and it is complementary between them. So efficiency dictates positive assortative matching between these two factors (Becker, 1973, 1981); that is, the official with higher ability is assigned to more developed province. On the other hand, the central authority, as a monopoly matchmaker, cares about not only the aggregate output of all provinces, but also the balanced development among all regions. I further find that, if these two concerns simultaneously enter the central authority's objective function, the optimal assignment would not be restricted to the positive assortative matching. Actually, any type of matching might be implemented, depending on which concern is emphasized. Particularly, the pattern of negative assortative matching reflects the central authority's desire of reducing the regional disparity (Fernandez & Rogerson, 2001; Mare Rober, 1991; Fernandez, Nezih, & John, 2005).

To test the pattern of matching between provincial officials and provinces, I firstly obtain the proxies for the traits of provincial officials and provinces. Economic performance reflects the provincial official's ability (Hermanlin & Weisbach, 1998). I use the differenced average total factor productivity (TFP) during the tenure as the measure for the official's ability, that is subtracting the average TFP growth before the leader in power from average TFP growth during his tenure, and then subtracting the differenced national TFP in the same periods. The trait of province is represented by index of provincial endowment or fixed effect. Secondly, in order to obtain the pattern of matching, I calculate the correlation coefficients and Spearman rank correlation coefficients between official's ability and provincial trait (Fernandez et al., 2005; Mendes, van den Berg, & Maarten, 2007; Mion & Naticchioni, 2009). However, these measures of correlations could be influenced by the extent of matching and the traits' distributions at the same time (Liu & Lu, 2006). In order to show the degree of matching and exclude possible variations in the traits' distributions, I build an alternative measure for the degree of assortative matching (Liu & Lu, 2006).

The correlation estimation between official ability and provincial trait would be biased if the official keeps working in the same province for two terms. Therefore, the empirical sample is confined to the rotated provincial officials, which includes chief leaders who are rotated, and also the vice leaders who are rotated and promoted from one province to another. As long as the provinces where the officials work before and after rotation are different, the aforementioned issue is absent. This sample selection could avoid the possible endogeneity problems in the correlation estimation.

The empirical result shows that from the early 1990s to the early 2000s, the central authority implements positive assortative matching between provincial officials and provinces. This reflects the fact that the central authority concentrates on maximizing aggregate national outputs. And the actual policies during this period are all supporting this objective. For example, some regions are encouraged to "get rich first", and preferential policies are given to special economic zones to improve the economic growth (Xu, 2010). On average, the growth rate is faster in coastal provinces than western or central provinces. After the early 2000s, negative assortative matching between officials and provinces is implemented. This shows that the central authority pays more attention to reduce regional disparity, because large regional disparity impedes the social stability and long-run economic growth (Zhang, 2006; Démurger, 2001; Démurger et al., 2002; Jones, Cheng, & Owen, 2003). Therefore, central authority has to consider the trade-off between equality and efficiency in different stages of economic reform in its objective function. The results are robust to various sensitivity tests.

I enrich the literature by analyzing the cadre management on the horizontal level in this paper. Previous literature explores turnovers of provincial officials in the cadre management on the vertical level and they have shown that provincial officials are more likely to be promoted if they can achieve better economic performance (Maskin et al., 2000; Bo, 1996, 2002; Li & zhou, 2005; Chen et al., 2005; Chan, 1996, 2006). The evidence shows that regional tournament competition gives strong incentives to provincial officials (Xu, 2010). Under this incentive framework, the central authority will promote the official with better performance as a reward and personnel control is used to motivate provincial officials to generate better economic performance (Blanchard & Shleifer, 2001). At the same time, Shih, Christoper, and Mingxing (2012) points out that social connection determines the chance of promotion. Jia, Masa, and David (2014) shows that social connection and performance are complementary for the selection of provincial leaders. Hence, provincial leader's appointment is a complex political decision, and economic permance is one of most important factors.[2]

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[1] Roles of leaders in determining economic performance have drawn much attention in the literature. Jones and Olken (2005, 2009) analyze the differences before and after the replacement of national leaders, and their results reflect that national leaders indeed impose significant effects on economic development, especially in autocratic nations. One potential problem is the identification of the causative effect of leaders on economy, because it might be the case that the growth change is the driving force for leader's replacement. To avoid such problem, Jones and Olken (2005) consider the deaths of these leaders while they are still in office caused by exogenous shocks, such as accident or illness, therefore, the change of leaders and the timing of this change is not related to the economic development. 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 (Jones & Olken, 2009). Li and Zhou (2005) show that regional officials in China compete for promotion by improving provincial economy. From a micro level, Bertrand and Schoar (2003) explore the performance of firms in US by identifying the personnel "style" of managers. They show that CEOs have unignorable effect on firm performance. Furthermore, different CEOs have different effects based on the manager-firm panel data.

[2] Government has issued formal document to illustrate the standards of cadre evaluation. One official document issued by Organization Department of Central Committee in 1979 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 economic achievement" (see Whiting, 2001). In the "Regulations of Selection and Appointment for Party and Government Leading Cadres",which is issued in 2014, in the regulation No. 27, the selection criterions for provincial leaders include economic performance, environment protection, social stability, cultural construction, social security, health, education, etc. Hence, economic performance is one of the important factors for the promotion of provincial leaders, which cannot be ignored.

Departing from the literature, I abstract away the incentive problems of provincial officials. This paper considers the matching between provincial officials and provinces. This analysis is closely related to the matching problem in the marriage market. When the production function shows complementarity between production inputs, Becker (1973) proves that positive assortative matching maximizes the aggregate value in the market and it is the efficient output. The complementarity between inputs is an important assumption for positive assortative matching (Li & Suen, 2000; Terviö, 2008).[3] For example, Damiano and Li (2007) apply this standard assumption to consider how intermediation as a monopoly matchmaker achieves efficient matching in the two-sided matching market.

In this paper, the main objective is to see the assignment of the provincial leaders between provinces. Given the complementarity between production inputs, if largest national output is emphasized by the central authority, positive assortative matching between officials and provinces will be implemented. On the other hand, if reducing regional disparity is emphasized, negative assortative matching will be implemented. The regional disparity between better developed regions and less developed regions turns to be larger after implementation of positive assortative matching (Fernandez & Rogerson, 2001; Mare Rober, 1991; Fernandez et al., 2005). Instead, negative assortative matching between officials and provinces could reduce the distance between better developed provinces and less developed provinces.

The remaining part of this paper is organized in the following way. In next section, I introduce the personnel control for provincial officials in China, the central and provincial objectives in economic growth. Section 3 proposes a conceptual framework and testing hypothesis. Section 4 discusses the empirical methods. In Section 5, I describe the dataset. Empirical results of central assignment and robustness checks are shown in Section 6. In the final part, I conclude this paper.

2. Personnel control and central objectives

2.1. Personnel control over provincial officials

The Chinese government behaves in a centralized structure. In this structure, subnational governments are subordinates to central government. The politburo standing committee is the supreme decision-making body, and the State Council transfers these decisions of politburo into executable policies (Huang, 2002). Department of organization is the executive institution for cadre management. Ministries and provinces are below the State Council, and they are in the same bureaucratic rank.

The central authority controls turnovers of provincial officials through appointment, promotion, rotation, termination, and cross-posting[4] (Huang, 2002). Each turnover decision is not arbitrary, but based on a system of standards (see Huang, 2002). Rotation of officials among equally-ranked positions is one important way of turnover. All officials at the county level and above should be rotated. Officials at provincial level are rotated between provinces, central departments and state-owned enterprises (SOE). Officials at the county level are rotated within prefecture or province, and officials at prefecture level should be rotated within province or between provinces. The rotation of officials could induce several effects. For example it could prevent factionalism by requiring officials to work in different places (Huang, 2002). Through frequent rotations, officials do not have large motivation to go against central policies as they could not gain interests related to current positions. Rotation would be helpful to improve the economic growth by duplicating economic form experiences (Xu et al., 2007). The successful experiences or useful lessons in one region could be easily introduced to other regions through official's rotation. In addition, rotation could increase the working experiences and skills of solving different problems for officials.

Personnel control is closely related with the process of the economic reform. Naughton (2008) divides the economic reform in China into two periods: from 1978 to 1993, from 1994 to nowadays. In the first period, the reform is "top-down, tentative, exploratory and focusing on a few key sectors" (see Naughton, 2008). The main driving force for economic growth is SOE and township and village enterprises (TVE) in this period. Fiscal contract system is implemented, and it regulates the amount of revenue contributed to central government. Local government could keep the remaining revenue. But the budget revenue and SOE profits decline through the early 1990s, and this shows that the reform is not comprehensive. Since 1994, "A deeper and well-planned reform emerged after 1993" (see Naughton, 2008). Private firms are playing more important roles in the economic development. The older generation of national leaders have left from the leadership, and younger generation comes into the leadership. Decisive decisions have been made and implemented quickly. In October 1992, the 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 for socialist market economy. Various deeper reforms in fiscal, tax, foreign trade and foreign exchange have been undertaken.

2.2. Central objectives in economic development

From the outset of the economic reform, improving the economic development has been the central job for the Party and government (Maskin et al., 2000; Xu, 2010). And the distribution principle is to give priority to economic efficiency with due

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[3] Terviö (2008) uses a complementary production function to generate positive assortative matching between managers and firms. This assignment is used to explore the differences in CEO pay, which depends on the distribution of firm size and CEO abilities. 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.

[4] Since 1983, it is regulated that cadres are managed by officials immediately above them (Huang, 1996). Cross-posting is 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).
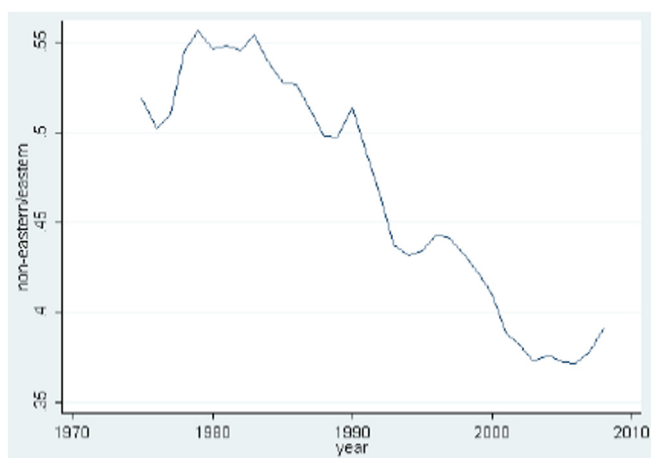
Fig. 1. Ratio of average real GDP per capita between inland regions and eastern regions.
Data source: China Statistical Yearbook, 1978–2009. Eastern region refers to Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan. Inland region refers to non-eastern region, which includes Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shannxi, Gansu, Qinghai, Ningxia, Xinjiang, Guangxi, Inner Mongolia, Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan.

consideration to fairness. More preferential policies are given to coastal regions than western and central regions (Chen & Fleisher, 1996; Démurger, 2001; Démurger et al., 2002; Jones et al., 2003).[5]

These economic policies enlarge the regional disparity between eastern regions and inland regions (Démurger, 2001; Jones et al., 2003; Xu, 2010).[6] The Open-Door policy benefits eastern provinces to a large extent in the way of attracting FDI and facilitating international trade. Fiscal decentralization decreases the subsidies to the less developed provinces, and dual track prices reduce the prices of raw materials that are mainly produced in western and central provinces (see Démurger et al., 2002).

In Fig. 1, I plot the ratio of average real GDP per capita between inland provinces and eastern provinces from 1975 to 2008 to see the regional disparity (Fleisher, Li, & Zhao, 2010). The ratio keeps decreasing since the early 1980s. In 1980, the ratio was 0.55, and it reduced to 0.39 in 2008. Fig. 2 shows the coefficient of variation of real GDP per capita (Renard, 2002; Fleisher et al., 2010). The variation coefficient increases quickly since the early 1990s. Large regional disparity reduces the economic and political stability, and even affect the unity of the nation (Xu, 2010). Without the development of the inland regions, there is no national development.

Reducing regional disparity is emphasized by the central authority since the early 2000s. The State Council (2000) raised that more tasks should be done to develop the western and central provinces, such as strengthening agriculture, upgrading industry, etc., and infrastructure investment in these regions is one of the main tasks. "To build a Well-off Society in an all-round way" was raised in 2002. In the third plenum of the 16th Party Congress in 2003, frameworks of completing the socialist market economy was raised, and regional disparity is given more concern. In addition, current generation of leadership has paid much attention to achieve regional harmonious development (Chen & Zheng, 2008). In 2003, after Wen Jiabao was elected to be the premier, he pointed out that two of the most important jobs for the central government are to achieve coordinated development between the eastern regions and inland regions, and to achieve coordinated development between urban and rural areas. Wen Jiabao (2004) declared that "To attain the well-balanced regional development, we should continue to develop the western regions, rejuvenate the northeastern old industrial base, speed up the central growth, and encourage eastern development." In the 17th Communist Party Congress in 2007, the central authority continues to emphasize the importance of harmonious development among regions to build the Well-off Society.

Practical actions are taken to develop the western and central regions. The Grand Western Development Program[7] is implemented in 2000 to develop the western regions. Rejuvenation of Northeastern Old Industrial Base is raised in 2003 to improve the development in northeastern regions. The Rise of Central China was raised in 2004, and it is an important policy to improve the development of central provinces. These programs have generated great achievements, for example, from 2000 to 2009, the average GDP growth rate in the western regions is 11.9%. From 2001 to 2008, central government provides about

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[5] 3 special economic zones were built in Guangdong in 1979, and 1 special economic zone was set up in Fujian in 1980. In 1985, 14 coastal cities were open and 10 economic and technological development zones were set up. 2 economic and technological development zones were set up in Shanghai in 1986. In 1990, Pudong new area was built in Shanghai.

[6] Inland regions include central and west provinces. The items of "inland regions", "non-eastern regions" and "central and west regions" are interchangeable. Eastern regions include 11 provinces, which are Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan. Central regions include Shanxi, Henan, Hubei, Hunan, Anhui, Jiangxi.

[7] The mains provinces that are covered by the Grand Western Development Program are Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shannxi, Gansu, Qinghai, Ningxia, Xinjiang, Inner Mongolia and Guangxi. These western regions take 71% of the total area of China.

Fig. 2. Coefficient of variation for provincial real GDP Per capita.
Data source: China Statistical Yearbook, 1978–2009.

60 billion financial support to reduce poverty in the western regions. In addition, from 2004 to 2006, the average GDP growth rate of provinces in the northeastern region is 12.6%, which increases 2.6% from previous growth rate.[8]

In Fig. 3, I provide the growth rate of fixed asset investment in eastern and inland regions (Chen & Groenwold, 2010). Obviously, growth rate of fixed asset investment is greater in the central and west regions than eastern regions since the late 1990s, and this growth rate keeps increasing since 2004. In Fig. 4, I compare the amount of central transfer to local government in eastern and non-eastern regions. The central government transfers more to inland provinces than eastern regions since the late 1990s, and this distance of central transfer between eastern and inland regions is turning to be larger since the early 2000s. Central transfer starts in 1994, when tax assignment system replaced fiscal contract system. The main purpose of central transfer is to balance regional disparity in the income of local government, and make sure that the local governments could provide enough social services.

Lastly, I plot the average growth rate of GDP per capita in inland and eastern regions from 1993 to 2008 in Fig. 5. Since 2002, this growth rate is much faster in non-eastern regions. While before 2002, the eastern regions grow faster for most of the years. To some extent, various actions to promote the development of inland provinces are effective.

2.3. Provincial targeted objectives and policies

In this part, we look at the provincial objectives in economic development. Each year the provincial government issues "Report on the Work of the Government", and make the objectives of economic growth, fixed investment, export and import, CPI, public budget revenues, etc. In order to achieve these objectives, various policies, such as encouraging innovation, adjusting the economic structure, upgrading the industrial structure, increasing urbanization, and so on. Each province makes policies based on its own characteristics. For example, in 1993, Guangdong province expects that its GDP growth rate was 12.8%, Guizhou was 9%, and Henan was 10%. In 2008, the expected GDP growth rate for the three proinves turns to be 9%, 10% and 11%. Based on different expected growth rate, various policies are taken to achieve these objectives.

In Fig. 6, we pick up three provinces from western region, central region and eastern region, which is Guizhou, Henan and Guangdong. We can see that the expected GDP growth rate in Guangdong is quite high in the begining and dropped in the early 2000s, and even lower than the Guizhou and Henan. The expected growth rate is relatively stable in Henan and Guizhou.

In 2000, Guangdong expected its economic growth would be 8.5%, and export would be 2%. To achive these goals, the government increases fixed investment, encourage foreign direct investment, upgrade the technology, increase the urbanization, and strengthern the cooperation with western provinces, etc. In 2008, Guangdong expects the growth rate of economic growth to be 9%, export and import to be 10%, fixed investment to be 15%, disposable income to be 9%. In order to achieve these goals, the govenment plans to increase the enterprises' innovation abilities, increase the investment in infrastructure, develop the industrial agglomeration, expand advanced manufacture industries, and transform and upgrade traditional industries, etc. Between 2003 and 2007, the average GDP growth rate is 14.5%, and the average fixed investment is 19.3%. In 2000, Henan's expected growth rate was 8% and fixed investment growth rate was 12%. In 2008, the expected economic growth in Henan province was 11%, the growth rates of fixed investment and foreign direct investment were 18% and 25%. To achieve these objectives, the government intended to optimize and upgrade the industrial structure, set up modern industrial system, encourage merge and acquisitions, promote industrial agglomeration, increase the fixed investment in infrastructure, accelerate the process of urbanization. Between 2003 and 2007, the total fixed investment is 2004 billion RMB and the annual urbanization rate is 1.7%. Finally, for Guizhou province, in 2000, its expected growth rate was 8% and fixed investment growth rate was 12%. In 2008 the government expected its economic growth rate was 10%. They concentrated

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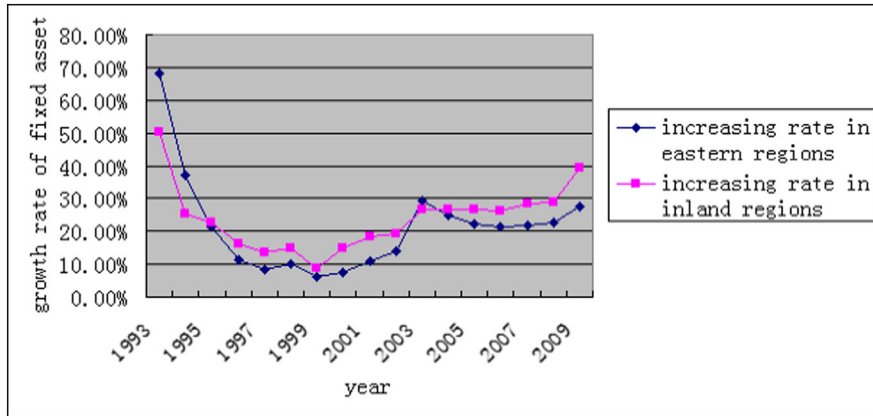[8] The data resource is: www.xinhuanet.com

Fig. 3. Increasing rate of investment in fixed asset in eastern region and inland region from 1993 to 2008.
Data source: China Statistical Yearbook, 1993–2008. Eastern region refers to Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan. Inland region refers to non-eastern region, which includes Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shannxi, Gansu, Qinghai, Ningxia, Xinjiang, Guangxi, Inner Mongolia, Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan.

on fixed investment, especially transportation and irrigation systems, accelerating the industry restructuring, nurturing the leading industries, and increasing the agricultural productivities and so on. Between 2003 and 2007, The ratio for three industries was adjusted to 15.7:42.5:41.8, annual increase rate of foreign direct investment was 25.3%, and the highway construction increases fast.

3. Conceptual framework and testing hypothesis

3.1. Conceptual framework

I assume that it is complementary between official's ability and provincial endowment, and the economic efficiency in a frictionless market requires that positive assortative matching should be made (Becker, 1973, 1981; Li & Suen, 2000; Damiano, Li, & Suen, 2005; Damiano & Li, 2007; Terviö, 2008). In order to generate the largest national output, the most capable official should be allocated to the province with the largest economic output or richest endowment and the second most capable official should be assigned to the region with second largest economic output, and so on. Obviously, the regional disparity between better developed region and less developed region is larger after positive assortative matching (Fernandez & Rogerson, 2001; Mare Rober, 1991; Fernandez et al., 2005).

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's objective function is the exogenous force that determines the assignment results. Economic growth is one of the primary jobs for government since the economic reform started. At the same time, especially after the late 1990s, matchmaker also considers the development balance among regions. Large regional disparity reduces social stability, long-run economic growth and the national ability of risk defense (Démurger, 2001; Xu, 2010). Hence, both national output and regional balance are concerned in the central objective function.
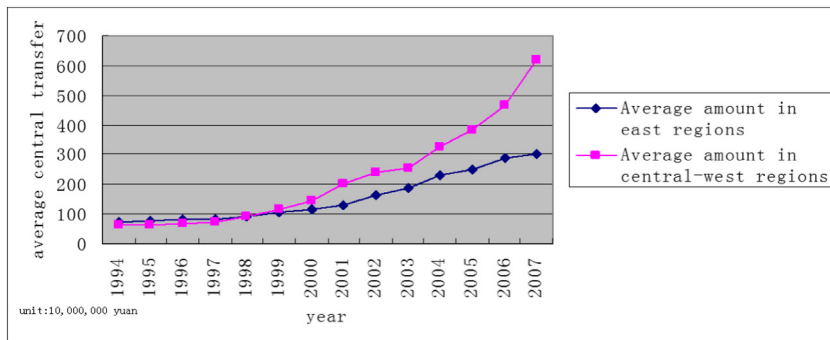
Fig. 4. Average transfer from central government to local governments in eastern regions, central-western regions from 1994 to 2009.
Data source: Finance Yearbook of China, 1994–2009. Eastern region refers to Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan. Central-west region refers to non-eastern region, which includes Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shannxi, Gansu, Qinghai, Ningxia, Xinjiang, Guangxi, Inner Mongolia, Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan.
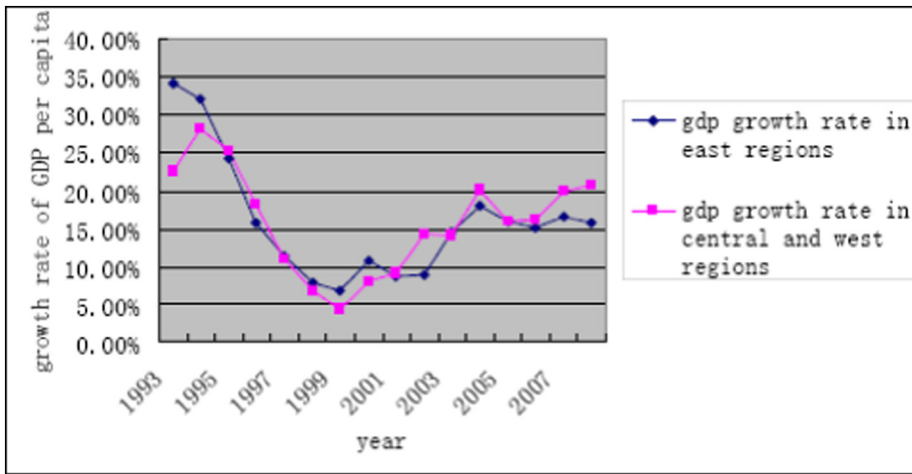
Fig. 5. The growth rate of GDP per capita in eastern, central and western regions from 1993 to 2008.
Data source: China Statistical Yearbook, 1993–2008. Eastern regions refer to Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan. Central and western region refers to non-eastern region, which includes Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shannxi, Gansu, Qinghai, Ningxia, Xinjiang, Guangxi, Inner Mongolia, Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan.

Suppose $\gamma \in 0,1]$, and Y is a function of provincial leader's ability A and provincial endowment E, which are complementary. The objective function of the matchmaker at t is:

$$V_t = \underset{(A,E)}{Max} \left[\gamma \sum_{i=1}^{N} Y_t^i - (1-\gamma) \sum_{i=1}^{N} \left(Y_t^i - \overline{Y}_t \right)^2 \right], \tag{1}$$

V_t measures the total value for the objective function at time t, Y_t^i is the economic output of province i at time t. $\overline{Y}_t$ is the average output in all provinces. The first part of the objective function stands for the largest national output and the second part stands for reducing regional disparity. γ measures the relative weight. In this model, the value of γ is exougeously determined, which reflects the development strategy of the central authority.

3.2. Testing hypothesis

Central government takes both national economic output and regional balance into consideration, but the concentration is different in different time periods. I propose the fowllowing hypotheses:

1. If γ is equal or close to 1, the objective of central government is to achieve the largest national output, positive assortative matching between provincial officials and provinces will be implemented.
2. If γ is equal or close to 0, the objective of central government is to minimize regional disparity, negative assortative matching between provincial officials and provinces will be implemented.
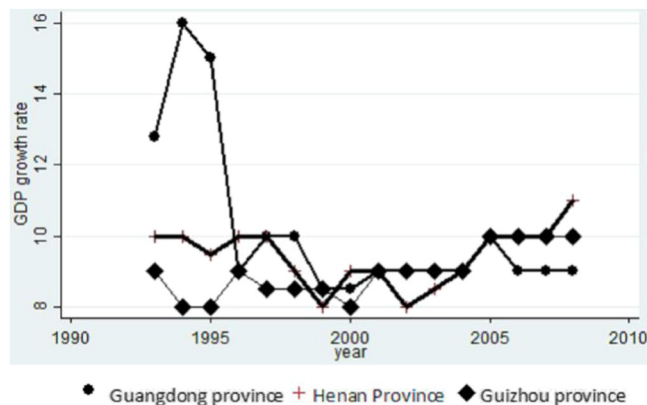

Fig. 6. The GDP growth rate (%) in different selected provinces.
Data source: China Statistical Yearbook, 1993–2008.

Table 1
The general statistics of TFP growth rate from 1985 to 2008.

Province	Province code	Mean	Median	Standard deviation	Variance	Min	Max
Beijing	11	7.07%	5.64%	6.69%	0.45%	0.47%	33.65%
Tianjin	12	1.24%	1.16%	3.30%	0.11%	−6.98%	7.55%
Hebei	13	4.80%	4.56%	4.09%	0.17%	−1.73%	15.75%
Shanxi	14	4.47%	5.86%	5.64%	0.32%	−5.82%	17.82%
Inner Mongolia	15	5.23%	4.45%	4.16%	0.17%	−3.31%	14.66%
Liaoning	21	3.56%	4.17%	4.38%	0.19%	−3.85%	11.66%
Jilin	22	4.35%	4.91%	4.96%	0.25%	−4.14%	20.41%
Heilongjiang	23	3.00%	3.19%	2.72%	0.07%	−3.65%	7.14%
Shanghai	31	4.06%	3.65%	4.15%	0.17%	−3.82%	14.26%
Jiangsu	32	5.96%	5.25%	4.86%	0.24%	−2.26%	16.46%
Zhejiang	33	7.32%	7.04%	5.32%	0.28%	−1.96%	18.42%
Anhui	34	3.91%	4.61%	5.65%	0.32%	−9.22%	13.54%
Fujian	35	6.01%	4.09%	6.46%	0.42%	−5.43%	17.27%
Jiangxi	36	5.27%	5.44%	3.67%	0.13%	−4.84%	12.59%
Shandong	37	6.18%	6.07%	3.84%	0.15%	−0.78%	17.26%
Henan	41	5.32%	5.01%	3.75%	0.14%	−1.03%	12.75%
Hubei	42	3.42%	3.93%	6.18%	0.38%	−19.32%	15.60%
Hunan	43	4.05%	4.70%	3.83%	0.15%	−4.82%	10.44%
Guangdong	44	8.18%	7.10%	4.18%	0.18%	1.34%	17.20%
Guangxi	45	5.73%	6.44%	3.68%	0.14%	−1.35%	11.18%
Hainan	46	3.58%	2.84%	3.77%	0.14%	−0.59%	9.38%
Sichuan	51	5.25%	4.95%	2.87%	0.08%	0.85%	11.93%
Guizhou	52	4.41%	2.84%	3.75%	0.14%	0.24%	14.26%
Yunan	53	3.41%	2.53%	3.98%	0.16%	−2.08%	11.69%
Shannxi	61	5.44%	4.93%	3.03%	0.09%	−0.45%	11.33%
Gansu	62	4.20%	4.75%	4.18%	0.17%	−6.18%	17.29%
Qinghai	63	2.94%	2.65%	3.63%	0.13%	−3.90%	10.69%
Ningxia	64	3.89%	2.83%	4.11%	0.17%	−3.16%	14.61%
Xinjiang	65	5.14%	4.77%	3.86%	0.15%	−0.69%	13.42%
National average		4.79%	4.48%	4.57%	0.21%	−19.32%	33.65%

Data source: China Statistical Yearbook, 1993–2008.

4. Emprical method

4.1. Sample selection

In the empirical analysis, I will identify how officials with different abilities are allocated to each province. Firstly, I calculate official's ability, A. TFP reflects the production efficiency (Acemoglu, 2009; Barro & Sala-i-Martin, 2004; He et al., 2013). This efficiency is closely related to provincial officials, because the economic reform increases the autonomy of provincial governments (Qian & Xu, 1993; Qian & Weingast, 1997). The economic strategies and policies are managed by local officials, and the differences in strategies among provinces could induce larger differences in development. Tan (2002) proves that the growth difference between provinces, especially the provincial disparity, is a function of provincial officials' roles. The abilities of regional officials are important in improving regional economy (see Tan, 2002).

The calculated provincial TFP growth rate from 1985 to 2008 is shown in Table 1.[9] The average TFP growth rate is 4.79%, and this is similar with Li (2009) who obtains an average of 4.65% between 1984 and 2006. Islam, Erbiao, and Hiroshi (2006) show that it is between 2.95% and 4.06% with different methods in China from 1978 to 2002. In Hu and Khan (1997), they find that TFP growth rate between 1979 and 1994 is 3.9%. Chow and Li (2002) shows that it is 2.6% from 1978 to 1998, which is slightly higher than other studies.

Average TFP growth rate during the tenure of each official, $TFP_{average}$,

$$TFP_{average} = \frac{\sum_{t=1}^{T} TFP_{ti}}{T}, \tag{2}$$

where T is the number of years that one official has been worked in one province, i refers to province. For example, if one official stays in one province for one year, $T = 1$; if she stays in this position for two years, $T = 2$ and so on. N is the number of years that the former official has been worked in province i.

$$DID \; TFP_{average} = \left(\frac{\sum_{t=1}^{T} TFP_{ti}}{T} - \frac{\sum_{t-N}^{t-1} TFP_{ti}}{N} \right) - \left(\frac{\sum_{t=1}^{T} TFP_t}{T} - \frac{\sum_{t-N}^{t-1} TFP_t}{N} \right), \tag{3}$$

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[9] The detailed calculation of TFP is in the appendinx. I thank Kui-Wai Li for sharing the data of human capital. The data is from "http://fbstaff.cityu.edu.hk/efkwli/ChinaData.html".

Average performance over the tenure is less noisy and puts weight on the average term instead of short term shocks. The provincial leader's ability is measured by differenced TFP, that is the differenced provincial TFP minus the differenced national TFP within the same periods. By doing this, I can examine the effect of specific policies that this provincial leader has introduced, and how these policies drive the provincial TFP. Thus the difference-in-difference TFP growth rate has eliminated the effect of central policies and effect of previous leaders who had worked in the current province before the leader.

4.2. Sample selection

To identify the assignment over provincial officials, I confine our analysis to officials who have been rotated among provinces (He et al., 2013). I include the chief leaders who are rotated, and also the vice leaders who are rotated and promoted to be chief leaders from one province to another. To look at the rotated provincial officials, suppose one official who used to work in province j at time $t-1$, was rotated to province $i(j \neq i)$ at time t. The calculated $DIDTFP^j_{average}$ might be affected by endowments or other noises in province j, E^j. However, because endowment E^j and E^i are not related, and it is impossible for one official to impose her effect on the province that she has never been. The relationship between $DIDTFP_{average}$ and provincial endowment could truly tell the result of assignment between provincial officials and provinces (Wooldridge, 2002). If one official has been rotated more than once, I treat this official as a different person and similar method applies.

I have to admit that when the central authority makes the decision of rotation from province j to i, both the variables of the provinces, including the endowments, are considered. Hence, the correlation between E^j and E^i might not be 0. This underlying relationship between the endowment E^j and E^i could not be alleviated within our framework.

4.3. Test of matching

I use correlation coefficients, Spearman rank correlation coefficients, regression coefficients and the degree of matching between $DIDTFP_{average}$ and provincial endowment to see the result of central assignment (Fernandez et al., 2005; Mendes et al., 2007).[10]

Correlation coefficient indicates both the direction and degree of correlation of variables. It varies from -1 to 1. Larger positive correlation coefficients reflect that the positive assortative matching is stronger (Mendes et al., 2007). Correlation is different from causality, because it only reflects the association of variables on the two sides. I give no judgment of the dependent or independent variables. Spearman correlation correlations reflect the correlation coefficients between the two sides of ranked variables. The direction of correlation is shown by the sign of Spearman correlation coefficients. When there are no prominent outliers, correlation and rank correlation coefficients are consistent. Spearman correlation coefficient has several characteristics. Firstly, it is less sensitive to the outliers than correlation coefficient, because the variables have been transferred to ranks. Spearman rank correlations could be 1 if the two sides of matching are monotonically related, when the correlation coefficient is not 1. Secondly, Spearman rank correlation does not require linearly related variables on the two sides of matching, and there is no assumptions of the distribution for the variables. It applies to variables which are difficult to measure.

In addition, I build one measure for degree of matching similar as Liu and Lu (2006).[11] I use the median value to divide traits on the two sides of matching into (0,1). Variables larger than the median value is 1, 0 otherwise. Suppose there are N officials and N provinces on the two sides, there could be four types of matching outcomes, $(i,j), i=0,1$ and $j=0,1. i$ and j are representing the types of officials and provinces. N^A_1 is the number of officials who have higher abilities than the median value, and N^y_1 is the number of provinces whose economic output is larger than the median amount. (1,1) and (0,0) are positive assortative matching results, and (1,0) and (0,1) are negative assortative matching results. $N_{1,1}$ is the number of matching with type (1,1). According to Liu and Lu (2006), the degree of matching is measured by the relative distance between assortative matching result and perfectly random matching result:

$$P = \begin{cases} \dfrac{N_{1,1} - Q^-}{\min(N^A_1, N^y_1) - Q^-}, & \text{if } N_{1,1} \geq Q \\ \dfrac{Q^+ - N_{1,1}}{Q^+ - \max(0, N^A_1 - N^y_1)}, & \text{if } N_{1,1} < Q \end{cases}, \tag{4}$$

$Q = \frac{N^A_1 N^y_1}{N}. Q^-$ is the largest integer which is smaller than Q or it could be equal to $Q. Q^+$ is the least integer which is bigger than Q or it could be equal to Q.

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[10] Different methods are applied in previous literatures to test assortative matching, for example, between workers and firms. Mendes et al. (2007) summarize three measures of testing assortative matching. Firstly, it is the traditional correlation coefficient. Secondly, the rank correlation coefficient, which could mitigate the effects of extreme value on the correlation coefficients. Thirdly, the regression coefficient between the two sides is used. In the marriage market, Mare (1991), Kremer (1997), and Fernandez et al. (2005) look at the correlation of education level between spouses to find the result of mating. Fernandez and Rogers (2001) use the proportion of marriages with positive assortative matching as measure for the degree of matching.

[11] They propose one new measure for the degree of matching in marriage market. It divides the education level of man and woman into two groups: high and low with index 1 and 0 respectively. It is 1 if one person has a post secondary education or above, 0 otherwise. They argue that both the degree of matching and the changes of traits' distributions could affect the ordinary correlation coefficient. It is difficult to identify whether changes in correlation coefficients is induced by the degree of matching or changes in traits' distributions. And their measure could truly reflect the degree of matching and exclude the changes in the distribution of trait on the two sides matching.

The sign of the measure of assortative matching is represented by:

$$R = \begin{cases} P, \text{if } N_{1,1} \geq Q \\ -P, \text{if } N_{1,1} < Q \end{cases}.$$

(5)

This degree of assortative matching could accommodate the changes in traits distribution. Different measures in different time periods could reflect the changes in the degree of matching. Liu and Lu (2006) proves that this measure could generate consistent result with correlation coefficients between the two sides of matching (Kremer, 1997). Finally, note that I am lack of an objective standard to divide the level of official's ability as high and low because median value changes in different time periods. Therefore, this might induce some inconsistencies between this measure and the correlation coefficients. In addition, the degree of matching is built on one dichotomous trait (education) on the two sides of matching in Liu and Lu (2006). While in our case, I can not use one objective standard to divide the traits.

5. Data

Provincial officials in 31 provinces in China from 1978 to 2008 compose the data in this paper. I focus on the time period after the 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 and "a deeper and well-planned reform emerged after 1993" (see Naughton, 2008). The information of provincial officials comes from one book published in Chinese "The Documentation of Administration in the People's Republic of China (2003)", and the websites http://www.xinhuanet.com/ and http://www.chinavitae.com/. These data provide detailed information of officials, for example, the age, gender, education, working experiences, and the date of joining the Party, and so on. Moreover, the date of taking and leaving office in each position is also included. The data of economic performance for each province comes from the statistical yearbook and "The gross domestic product of China, 1952–1995". I transfer all GDP per capita into real level based on the constant price of 1990.

Some officials might hold two positions at the same time, for example, governor and vice secretary. I take the higher position which reflects the true power of the official. In total, there are 344 chief provincial officials since 1978. In Table 2, I list the general statistics about the variables. For example, the average tenure in each position is 3.22 years, and more than 20% officials have the experiences of working in the central department.

In the sub sample of rotated provincial officials, I include the chief leaders who are rotated, and also the vice leaders who are rotated and promoted from one province to another. It is likely that central authority not only rotates the chief leaders, but also allocates able officials from lower ranks to higher ranks in another province. After identifying destinations and origins of these rotated officials, there are 77 rotated officials from 1993 to 2008. Generally, provincial governor and party secretary do not change simultaneously to avoid the instability of leadership. The officials who have been rotated from central department, SOE or other institutions are not included, and the vice provincial officials who have been rotated between provinces are also excluded. As a result, the number of rotated officials is a few in each year. Most people are rotated among provinces only once and a few officials have been rotated for twice or three times.

Table 2
General statistics for chief provincial officials.

Variable	Mean	Std. dev	Min	Max	N
Promotion	0.054	0.226	0	1	1184
Termination	0.076	0.264	0	1	1184
Annual GDP growth rate	0.096	0.060	−0.223	0.467	1173
Average TFP growth rate over the tenure	0.049	0.039	−0.089	0.335	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

Data source: The book "The Documentation of Administration in the People's Republic of China (2003)", and the websites "http://www.xinhuanet.com/" and "http://www.chinavitae.com/".
The observation unit is provincial official-year. Promotion is 1 if one official is promoted in one year, 0 otherwise. Termination is 1 if one official is retired or demoted, 0 otherwise. 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 officials are older than 65, 0 otherwise. Education is 1 if official's education is college or higher, 0 otherwise. Central is 1 if the official has worked in central department, 0 otherwise. SOE is 1 if one official has worked as the official of SOE, 0 otherwise. Years of party are the number of years since the official joined the Party. Origin of Shanghai is 1 if the official has worked in Shanghai, 0 otherwise. Communist Youth League is 1 if the official has worked in the leading positions in communist Youth League, 0 otherwise. Home is 1 if the official worked in the province where she was born, o otherwise. Tenure is the number of years an official has been in the position.
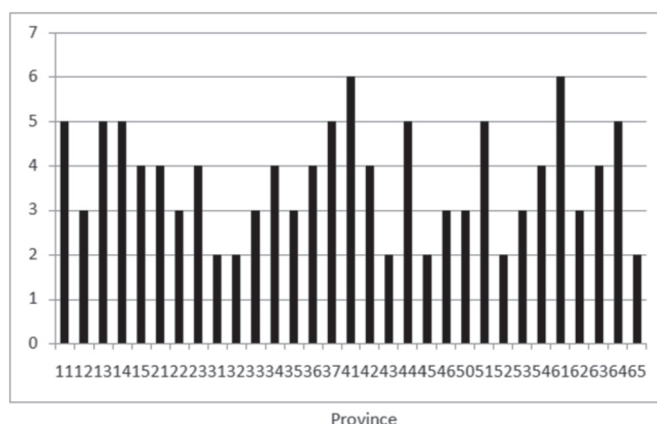
Fig. 7. Number of rotations in each province after 1993.
Data source: one book published in Chinese "The Documentation of Administration in the People's Republic of China (2003)", and the websites "http://www.xinhuanet.com/" and "http://www.chinavitae.com/". Rotation means provincial leaders rotated from other province to this province, or provincial officials rotated from this province to another province. Numbers in the horizontal axis refers to the provincial code, which can be found in Table 1.

In Fig. 7, I compare the number of rotations for officials in each province from 1993 to 2008. Hubei and Shanxi are the provinces which have the largest number of rotations, 6 times. While Xinjiang and several other provinces have only two rotations during the time period from 1993 to 2008.

The rotation in one province includes two directions — official rotated from other province to this province and official rotated from this province to another province. Generally, Hebei has the largest number of officials rotated from other provinces, 5 times. Instead, Guangxi, Xinjiang, Fujian, Jilin and Jiangsu only have one rotation from other provinces. For the number of officials who are rotated from this province to other provinces, Jinlin and Tibet ranks first with 6 times. Tianjin, Shanxi, Sichuan, Guizhou only have one rotation to other provinces during this period.

In summary, rotation is one important form of management over provincial officials, and I will look at how the rotation is implemented among provinces in the next section.

6. Empirical result

6.1. How is provincial chief official being rotated?

I look at the assignment between provincial endowment E^i and ability. Each province has different endowment. To show these differences, I build one index of provincial endowment E by adding the standardized values of the following five components with equal weight (Cai & Treisman, 2005). (1) Natural resources, it is measured by provincial share of raw materials production in 1993. Logarithmic form is taken to this share because the variance for the distribution of natural resources is large.[12] (2) The geographical distance to Shanghai is used to measure the geographical advantage of each province. It takes negative sign in the calculation. (3) Human capital, which includes the proportion of people with higher education in school or university in 1993, and the number of patents in 1993. (4) Infrastructure construction, which includes the proportion of railways that were paved in 1993 and the proportion of highways that were paved in 1993.[13]

After obtaining the provincial endowment E with the method of Cai and Treisman (2005), correlation coefficients, Spearman rank correlation coefficients, and regression coefficients are applied to look at the assignment between officials and provinces. Because of the data limitation, there is only few observations in each year, so I do not obtain the annual assignment result. The analysis is based on the data of five overlapping years. In Table 3, I find that before early 2000s, most of the coefficients are positive, and this reflects that positive assortative matching is implemented. More capable officials are allocated to more developed provinces, and less capable officials are allocated to less developed provinces. From 1998 to 2002 and from 1994 to 1998, all the coefficients are significant and larger than the coefficients in other time periods. Large regional disparities, which reduces the social stability and long run economic growth, is a driving force for the central authority to concern more in achieving balanced development among provinces. After early 2000s, it turns to be negative assortative matching. Because of the small

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[12] Natural resources include the production of crude oil, coal, diesel, kerosene, power, hydro power, natural gas, gasoline, thermal power, fuel, coke. Each type of resources has the same weight. I add the sum of the proportion for each type of resource, and take log for this proportion. Similar distribution exists if I firstly take log to each share and sum them afterwards.

[13] Most of the items I used are similar as Cai and Treisman (2005). They use the "number of research and development organizations" as one part for human capital, and I use the number of patents instead. For the infrastructure, they consider the number of buses for every 1000 people, but I do not include this because of data limitation.

Table 3
The correlation coefficients between officials' abilities and provincial endowment with five-year overlapping data.

Year	Correlation	Spearman rank correlation	Regression of ability on provincial endowment	n
1993–1997	0.014	−0.029	0.010	20
1994–1998	0.380*	0.251*	0.411*	20
1995–1999	0.278	0.037	0.310	18
1996–2000	0.290	0.046	0.295	15
1997–2001	0.333	0.207	0.383	18
1998–2002	0.363*	0.249	0.410*	23
1999–2003	−0.245	−0.221	−0.304	20
2000–2004	−0.248	−0.263	−0.300	20
2001–2005	0.086	−0.047	0.083	22
2002–2006	0.047	−0.044	0.042	20
2003–2007	−0.011	−0.091	−0.011	25
2004–2008	−0.120	−0.071	0.120	27

*Significant at 10%, **significant at 5%, ***significant at 1%.
Data source: China Statistical Yearbook, 1993–2008. The book "The Documentation of Administration in the People's Republic of China (2003)", and the websites "http://www.xinhuanet.com/" and "http://www.chinavitae.com/". Provincial endowment refers to the endowment index calculated by the author. The provincial leader's ability is measured by differenced TFP in Eq. (3).

Table 4
The bootstrap regression result.

Dependent variable: provincial ability measured by DID TFP		
Independent variables	(1)	(2)
Provincial endowment index	0.153	
	(0.136)	
Interaction of dummy and provincial endowment index	−0.157	
	(0.273)	
Provincial fixed effect		0.065
		(0.081)
Interaction of dummy and provincial fixed effect		−0.114*
		(0.131)
Dummy	0.456	0.006
	(0.781)	(0.010)
N	74	74

**Significant at 5%, *significant at 10%.
Data source: China Statistical Yearbook, 1993–2008. The book "The Documentation of Administration in the People's Republic of China (2003)", and the websites "http://www.xinhuanet.com/" and "http://www.chinavitae.com/". Provincial endowment refers to the endowment index calculated by the author. The provincial leader's ability is measured by differenced TFP in Eq. (3). Provincial fixed effect refers to the fixed effect obtained from the Eq. (6). Dummy = 1 if year of rotation is 2003 or afterwards, and 0 otherwise.

sample in each time period, regression coefficients are only used as references for the correlation coefficients, and all of the regression coefficients are following same trend as correlation coefficients.[14] In 2003 the General Secretary of the Communist Party, the Premier, and the members of the standing committee of the political bureau are replaced by a new generation of national officials. The change of members in the central authority is accompanied by policies changes in managing provincial officials (Jones & Olken, 2005, 2009).

To further identify the difference of assignment before and after the early 2000s, I regress the official's ability $DIDTFP_{average}$ on endowment by adding the dummy of time period, which is 1 if year is 2003 or afterwards, and 0 otherwise. Due to the small sample size, I apply bootstrap in the regression, and standard errors are clustered due to the heteroscedasticity. In Column 1 of Table 4, the interaction item between the time dummy and provincial endowment is significant, −0.157, and this further proves the change of direction in assignment from positive assortative matching to negative assortative matching.

The assignment of provincial officials to each province reflects the change of central concentration on the aggregate economic output and regional development balance. According to the results, before the early 2000s, positive assortative matching is implemented when central authority intends to achieve the largest output in the whole nation. After the early 2000s, the central authority concerns more in reducing regional disparity among regions by implementing negative assortative matching. Reducing the regional disparity is also helpful to the national economic growth in the long run. Therefore γ could be endogenous in the way that regional disparity decreases the sustainability of economic growth. In this case, central authority implements negative assortative matching as one way to reduce regional disparity.

One point to note is that changes in assignment after early 2000s should be modest, as the coefficients are not be quite significant because of the small sample. However, obviously, central authority notices the necessity of reducing regional disparity, and the negative coefficients prove this. There is a trend of allocation from positive assortative matching to negative assortative matching.

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[14] I use the same methods to obtain the results with two years overlapping data, three years overlapping data, and four years overlapping data. The results are similar.

Table 5
The correlation coefficients between officials' abilities and provincial fixed effect with five-year overlapping data.

Year	Correlation	Spearman rank correlation	Regression of ability on provincial endowment	n
1993–1997	0.234	−0.227	−0.085	20
1994–1998	0.158	0.002	0.075	20
1995–1999	0.140	0.095	0.067	18
1996–2000	0.145	−0.076	0.063	15
1997–2001	0.326	0.258	0.149	18
1998–2002	0.361*	0.296	0.155*	23
1999–2003	0.097	0.199	0.046	20
2000–2004	0.099	0.181	0.046	20
2001–2005	0.091	0.141	0.045	22
2002–2006	−0.056	−0.084	−0.032	20
2003–2007	−0.187	−0.121	−0.135	25
2004–2008	−0.001	0.065	−0.001	27

*Significant at 10%, **significant at 5%, ***significant at 1%.
Data source: China Statistical Yearbook, 1993–2008. The book "The Documentation of Administration in the People's Republic of China (2003)", and the websites "http://www.xinhuanet.com/" and "http://www.chinavitae.com/". Provincial fixed effect refers to the fixed effect obtained from the Eq. (6). The provincial leader's ability is measured by differenced TFP in Eq. (3).

Table 6
The degree of matching between officials' abilities and provincial characteristics with five-year overlapping data.

Year	Degree (1)	Degree (2)	n
1993–1997	0.125	−0.167	20
1994–1998	0.200	0.200	20
1995–1999	−0.125	0.001	18
1996–2000	0.167	0.200	15
1997–2001	0.200	0.400	18
1998–2002	0.333	0.500	23
1999–2003	−0.111	0.500	20
2000–2004	−0.125	0.667	20
2001–2005	0.200	0.500	22
2002–2006	0.200	0.250	20
2003–2007	−0.111	−0.111	25
2004–2008	0.143	−0.100	27

Data source: China Statistical Yearbook, 1993–2008. The book "The Documentation of Administration in the People's Republic of China (2003)", and the websites "http://www.xinhuanet.com/" and "http://www.chinavitae.com/".
The degree of matching is obtained by applying the equation of the measure of Eq. (4). The dichotomous trait is divided by whether it is larger or smaller than the median value. It is 1 if the trait is larger than the median value, and it is 0 otherwise. For the provincial characteristics, we use provincial endowment and provincial fixed effect. Degree (1) refers to the degree of matching between officials' abilities and provincial endowment, and degree (2) refers to the matching between officials' abilities and provincial fixed effect.

6.2. Alternative explanation

To empirically obtain E, I take another method which is similar with fixed effect model as Mendes et al. (2007) to measure the time-constant provincial characteristics using the matched official-province data. Fixed effect model is used by many studies (Postel-Vinay & Robin, 2006; Mendes et al., 2007; Abowd & Kramarz, 2004; Andrews, Thorsten, & Richard, 2006). Mendes et al. (2007) obtain firm-specific productivity for each firm and look at its relationship with workforce skills in each firm. Abowd and Kramarz (2004) use firm fixed effect to represent firm quality, and worker's individual fixed effect to present worker's skill. In our case, similar as Mendes et al. (2007), I obtain the provincial time-constant characteristics from fixed effect model.

Following Barro (1999), Mankiw, Romer, and Weil (1992); He (2012), and He, Sun, and Zou (2013) I analyze the following equation to obtain provincial fixed effect:

$$g_{it} = \alpha + \ln GDP_{t-1} + \beta X_{1_{it}} + \theta X_{2_{it}} + u_i + \delta_t + \varepsilon_{it}, \tag{6}$$

the subscript i and t represent province and time. g_{it} is the GDP per capita growth rate in each province i at time t. $\ln GDP_{t-1}$ is included to capture conditional convergence. $X_{1_{it}}$ includes the provincial economic characteristics, which are investment in fixed asset, education, the working population, and the degree of openness.[15] $X_{2_{it}}$ includes the official's characteristics, which are education, age, central working experiences, and gender. δ_t is the time effect. u_i is the provincial fixed effect.

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[15] Investment is the accumulation rate of investment in fixed asset; the degree of openness is the share of the sum of provincial export and import divided by provincial GDP; working population is represented by the growth rate of working population between 15 and 64 in each province. Education is growth rate of educated people with higher education in each province.

Table 7
The correlation coefficients between officials' abilities and provincial endowment with five-year overlapping data from 1986 to 1992.

Year	Correlation	Spearman rank correlation	Regression of ability on provincial endowment	n
1986–1990	0.142	−0.276	−0.117	16
1987–1991	0.369	0.080	0.318	17
1988–1992	0.509	0.315	0.439*	14
1989–1993	0.226	0.018	0.133	18
1990–1994	0.371	0.263	0.247	19
1991–1995	0.369	0.270	0.261*	20
1992–1996	0.069	0.095	0.044	17

*Significant at 10%, **significant at 5%, ***significant at 1%.
Data source: China Statistical Yearbook, 1986–1992. The book "The Documentation of Administration in the People's Republic of China (2003)", and the websites "http://www.xinhuanet.com/ " and "http://www.chinavitae.com/ ". Provincial endowment refers to the endowment index calculated by the author. The provincial leader's ability is measured by differenced TFP in Eq. (3).

Using the rotated officials as the sample, the provinces before and after rotation are different. I can apply the correlation coefficients to look at the matching between officials and provincial time-constant fixed effects. Results of five-year overlapping data are shown in Table 5. The correlation coefficients and regression coefficients are positive and significant from 1998 to 2002. The trend in assignment changes in the early 2000s. After the early 2000s, the correlation coefficients turn to be negative. The assignment is changing from positive assortative matching to negative assortative matching in early 2000s.

The explanation of results should be modest as many coefficients are not significant because of the small sample. But I believe the pattern of matching is consistent with the trend that central concentration is changing from maximizing national output to reduce regional disparity.

To further identify the difference of assignment before and after the early 2000s, I regress the official's ability $DIDTFP_{average}$ on provincial fixed effect by adding the dummy of time period, which is 1 if year is 2003 or afterwards, and 0 otherwise. Due to the small sample size, I apply bootstrap in the regression. In Column 2 of Table 4, the interaction item between the time dummy and provincial fixed effect is negative, −0.114, and this further proves the change of direction in assignment from positive assortative matching to negative assortative matching.

6.3. Robust check

In this part, I look at the degree of assortative matching between officials and provinces based on Eq. (1) to infer the change of γ. The dichotomous traits of $DIDTFP_{average}$ and provincial characteristics are divided into two groups. If the trait is larger than the median value, it is 1, and 0 otherwise.

The degree of matching for five years overlapping data is shown in Table 6. Degree (1) uses the median values of abilities and provincial endowment as the standard to divide the traits into two groups. Degree (2) uses the median values of abilities and provincial fixed effect as the standards. Before the early 2000s, most measures for the degree of assortative matching are positive. This reflects that the central authority gives more concerns to the national aggregate outputs in its objective function. The degree of matching shows the distance of actual matching to random matching when it is positive assortative matching. Since the late 1990s, most of the degrees of matching are turning to be negative.

Most of the degrees in column (1) and (2) are consistent. There are some differences in the degree of matching because the standards of dividing traits on the two sides of matching into 0 and 1 are different, and this could generate different number of observations for each type of trait. Compared to Table 3, the general trend of assignment, which changes from positive assortative matching to negative assortative matching, shows similar pattern in Table 6.

It starts to be negative in the period 1999–2003, followed by some positive assortative matching or random matching afterwards until the period after 2003 when it turns to be negative assortative matching. This might be induced by the different methods of calculation. The method in calculating the degree of assortative matching in Liu and Lu (2006) uses one exogenous standard to divide the traits of matching. In Table 6 I use the median value of each period as the standard to divide the traits.

Table 8
The correlation coefficients between officials' abilities and provincial fixed effect with five-year overlapping data from 1986 to 1992.

Year	Correlation	Spearman rank correlation	Regression of ability on provincial endowment	n
1986–1990	−0.327	−0.440	−0.114	16
1987–1991	−0.045	−0.214	−0.017	17
1988–1992	0.174	0.094	0.078	14
1989–1993	0.244	0.068	0.083	18
1990–1994	0.324	0.109	0.151	19
1991–1995	0.308	0.157	0.153	20
1992–1996	−0.185	−0.143	−0.087	17

*Significant at 10%, **significant at 5%, ***significant at 1%.
Data source: China Statistical Yearbook, 1986–1992. The book "The Documentation of Administration in the People's Republic of China (2003)", and the websites "http://www.xinhuanet.com/" and "http://www.chinavitae.com/". Provincial fixed effect refers to the fixed effect obtained from the Eq. (6). The provincial leader's ability is measured by differenced TFP in Eq. (3).

Table 9
The bootstrap regression result from 1986 to 2008.

Dependent variable: ability measured by DID TFP		
Independent variables	(1)	(2)
Provincial endowment index	0.201	
	(0.108)	
Interaction of dummy and provincial endowment index	−0.204	
	(0.319)	
Provincial fixed effect		0.044
		(0.061)
Interaction of dummy and provincial fixed effect		−0.093
		(0.131)
Dummy	0.112	0.002
	(0.596)	(0.010)
N	94	94

**Significant at 5%, *significant at 10%.
Data source: China Statistical Yearbook, 1986–2008. The book "The Documentation of Administration in the People's Republic of China (2003)", and the websites "http://www.xinhuanet.com/" and "http://www.chinavitae.com/". Provincial endowment refers to the endowment index calculated by the author. The provincial leader's ability is measured by differenced TFP in Eq. (3). Provincial fixed effect refers to the fixed effect obtained from the Eq. (6). Dummy = 1 if year of rotation is 2003 or afterwards, and 0 otherwise.

Obviously, these median values varies in different periods. The absence of objective standard for each time period in dividing the trait might induce the inconsistency.

Moreover, in order to make sure that the empirical results are not suffering from the sample selection bias, I extend the time period from 1986 to 1992.[16] There are 99 rotated officials from 1986 to 2008 in the sample. The correlation coefficients between provincial officials and provincial endowment are shown in Table 7, and results between officials and provincial fixed effects are in Table 8. We can see that for most of the time periods, the coefficients are positive. And this is consistent with our hypothesis that before early 2000s, the central authority place more capable officials to more developed provinces, i.e. it is positive assortative matching between provincial officials and provinces. Table 9 shows the bootstrap regression result, and the regression results are similar as the findings in Table 4.

7. Summary

In this paper, I discuss the central management over provincial officials through rotation between provinces. How to assign officials to provinces is a sophisticated project. It is determined by the central authority's objectives. With the sample of Chinese provincial chief officials who are rotated among provinces and vice leaders who are rotated and promoted from one province to another, I find that the assignment of provincial chief officials to provinces is changing with the policy concentration of the central authority.

Both traditional correlation coefficients and degree of assortative matching are applied to look at the direction of assignment. The results suggest that from the early 1990s to the early 2000s, positive assortative matching is implemented in the way that the central authority allocates more capable officials to more developed regions, and less capable officials are assigned to less developed provinces. During this period, the central authority concentrates on maximizing the national aggregate output. However, after the early 2000s, negative assortative matching is implemented as more concerns are given to reduce regional disparity.

The empirical evidence is supportive to the theoretical expectation of assortative matching. At the same time, I have to admit that the results are not quite strong because of the sample for rotated officials is small and many coefficients are not quite significant. These results show a general trend of matching provincial leaders by the central government.

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[16] We look at the empirical result from 1986 to 1992 for three reasons. Firstly, the number of observations for each 5-year time period before 1986 is less than 10, which is too small. Secondly, the rotation of officials was firstly raised in 1986 in "Central Committee of the Communist Party's Notice of Cadre Assignment and Promotion on the basis of the Party's Principles". In this file, it officially proposed that rotation is one important way of cadre management for the first time. In 1990, one formal decision "Central Committee of the Communist Party's Decision about Rotation Party Leaders and Government Leaders of China" required that officials at provincial level should be rotated among provinces or between provinces and central departments. Thirdly, the economic reform was initially started in 1978. Since the central authority decides to assign the provincial officials based on their abilities in developing the economy, it needs several years to observe the provincial officials abilities.

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