Does Human Capital Spillover Persist? Evidence from the Forced Migration by China's Send-down Policy

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Abstract

This paper tries to estimate the long-term effects of a temporary human capital shock, induced by a forced migration policy in Chinese history. From 1962 to 1979, the Chinese government forcefully relocated 17.92 million high school graduates from cities to rural villages, which was known as the Send-down policy. The immigration of educated youths increased the human capital stock in rural areas. However, this human capital shock retreated in the early 1980s, when most educated youths returned to cities after the policy ended. With a new county-level dataset of the educated youth immigration, we estimate the effects of the Send-down policy on the rural areas' human capital formation in the long-term. To account for the non-random placement of educated youths, we control for some pre-existing conditions for rural counties in our OLS estimation. Also, we exploit the variation within the pairs of contiguous counties. The benchmark estimates suggest that by 2010, one additional percentage of educated youths in the rural population increased the rural county's junior high school attainment rate by 0.33 percentage point. It also raised the senior high school attainment rate by 0.44 percentage point and college attainment rate by 0.35 percentage point. Our findings imply that a temporary human capital gain can persistently spillover in the long-term.

1. Introduction

Economists agree that human capital can benefit economic growth (Lucas, 1988; Glaeser, Scheinkman, and Shleifer, 1995; Shapiro, 2006; Iranzo and Peri, 2009). Moreover, a growing literature focuses on the spillover or externality of human capital, which can be via knowledge transfer, peer interactions, or other mechanisms (Marshall, 1890; Lucas, 1988; Acemoglu, 1996; Acemoglu 1998).

Marshall (1890) firstly pointed out that social interactions among workers in the same industry or location can create learning opportunities and enhance productivity. Incorporated to the economic growth model, the average level of human capital can contribute to the productivity of all factors (Lucas, 1988). The human capital externality can also come from the complementarity between physical and human capital (Acemoglu, 1996). As a group of workers increase education, rational firms would invest more physical capital, which will increase the productivity of all workers. The other discussions of the human capital externalities are about crime reduction or political involvement (Witte and Tauchen, 1994; Lochner and Moretti, 2002; Milligan et al., 2002;).

This paper will estimate the persistent spillover of a temporary human capital gain, induced by a forced migration policy in China. Throughout the 1950s, the Chinese government took aggressive policies to develop industrial sectors and urban economy.[2] The policies that favoured city economic growth boosted a massive rural-urban migration and increased the city population quickly. By the early 1960s, increasing unemployment and food shortage in cities became significant challenges facing the Chinese authority. The unemployment rate among the young generation just entering labour market was highest because the state-owned factories had no more quota to recruit new workers. So, to reduce the excess urban population, beginning in 1962, the government forcefully moved some unemployed high-school graduates from cities to rural areas. Since the rural areas were inferior to cities in living standard, this policy was then called the Send-down policy. The Send-down policy ended in 1980 when the new political leaders decided to reform the economic system and restore market. From 1963 to 1980, the government relocated 17.92 million youths from cities to rural areas. Shortly after 1980, most of the educated youths left the rural villages and returned to cities permanently.

The Send-down policy is a good natural experiment to test the human capital spillover and its persistence in the long-term. First, the policy explicitly targeted the high-school graduates in cities. Given that most rural residents were still illiterate by the early 1960s, the immigration of educated

[2] Such policies include the Five-year Plan and Great Leap Movement, which were all aimed at developing the heavy industries and catching up the developed countries. See background section for detail.

youths significantly increased the human capital stock of the rural destinations. Second, as the migrants had a limited choice of the destination, the policy distributed people without self-selection and independent of their economic motivation. Conditional on some pre-existing conditions relevant to the assignment rule, the remaining variation of immigration is more idiosyncratic and could serve the causal analysis. Third, the policy-driven human capital gain for rural areas was temporary because most educated youths returned to cities shortly after the policy ended. With the reversed shock, we can distinguish the persistence of human capital spillover and the spillover of a persistent shock. Very scarce studies try to isolate these two effects.

To measure the share of educated young immigrants in native rural population, we collect a new county-level dataset. With the populational education outcomes in 1990, 2000, and 2010, we estimate the effects of the Send-down policy on the rural areas' human capital formation in the long-term. As the government distributed the educated youths non-randomly, we control for a set of pre-existing heterogeneities that were relevant to the placement rule. Also, we control for the fixed effects of any pair of contiguous counties in our benchmark results to eliminate some endogenous unobservable. Counties located to each other tended to be similar geographically and economically. Moreover, they are more likely to integrate into a commodity and factor market. So, controlling for the contiguous county pair fixed effect should significantly increase the consistency of our estimates.

The benchmark estimates of this paper indicate positive and significant effects of the Send-down policy on the rural areas' human capital formation by 1990, 2000, and 2010. By 2010, one additional percentage of educated youths in the rural population increased the rural county's junior high school attainment rate by 0.33 percentage point. It also raised the senior high school attainment rate by 0.44 percentage point and college attainment rate by 0.35 percentage point.

Our findings can contribute to at least three strands of literature. First, our findings enrich the empirical studies on the human capital externality. The existing literature identifies the human capital externality by testing the causal effect of overall human capital stock on individual worker's wage via a Mincerian wage equation (Rauch, 1993). However, the regional unobservable factors in labour demand and supply can bias the OLS estimates (Moretti, 2004). The recent literature commonly exploits some exogenous variations or instrumental variables for overall human capital (Acemoglu and Angrist, 2000; Moretti, 2004; Cornelissen et al., 2017). Even the identification is valid, Ciccone and Peri (2002) proposed given the imperfect substitutivity between the skilled and unskilled workers, the change of relative supply of skilled workers will change the unskilled workers' wage even without externality. So, they introduced a constant-composition approach, which estimates the effect of average schooling on average wages across cities, holding the relative size of each skill group constant.

Other empirical studies test the human capital externality by the firms' productivity change, knowledge transfer or geographic agglomeration of patents (Moretti, 2002; Adams and Jaffe, 1996; Peri, 2002; Jaffe et al., 1993; Zucker et al., 1998).

Instead of exploring the change in school enrollment, our paper exploits the forced migration of educated people as a more exogenous source of human capital gain. Also, the absence of a competitive labour market in Chinese history helps us to rule out the market-based mechanisms proposed by Acemoglu (1996). One similar work is from Rocha et al. (2017). They look at the human capital gain caused by a state-sponsored settlement policy that attracted educated immigrants to a region in Brazil from the late 19th to early 20th century. They find that one century after the policy, municipalities receiving more educated settlers had higher levels of schooling and higher income. Though their findings suggest the persistence of a human capital shock, they cannot attribute the effects to spillover.

The second literature we can contribute to is the peer effects literature. Increasing empirical studies discuss peer effects on productivity or working effort (Falk and Ichino, 2006; Mas and Moretti, 2009; Lalive and Cattaneo, 2009; Bobonis and Finan, 2009). Peer effects can also be on individuals' school choice. Peer pressure and social norms regularly influence a child's education decision (Bernheim, 1994; Akerlof, 1997; Akerlof and Kranton, 2002; Glaeser and Scheinkman, 2003). Higher education of peers may bring informational externalities to the uneducated people, who observe the benefits of schooling via their peers' achievement (Bikhchandani et al., 1992). Peer interactions also generate complementarities between student learning and teachers' effort (Kremer et al., 2009). The human capital spillover among peers implies that the social multiplier of education spending may be higher than one. As most studies listed above focus on the contemporary peer effects, our paper tries to identify that in the long-term.

Finally, this paper also contributes to the specific literature on the Send-down policy. The existing economic studies on the Send-down policy are insufficient and mostly focus on the sent-down youths and their families. Zhou and Hou (1999) show that the sent-down youths suffered from the delayed marriage and child-bearing. Xie et al. (2008) find that the sent-down youths do not seem to benefit the policy. Li et al. (2010) find that the sent-down youths received more parental transfers in their later life, suggesting that parents behaved altruistically, showed favouritism, and exhibited guilt.

Due to the limited data on the immigration of educated youths, scarce studies evaluate the policy's impacts on the rural destinations. Kinnan et al. (2015) use inter-province migration data to show that the forced migration created lasting inter-province links, which can be an instrumental variable for the contemporary rural-urban migration. They find that improved access to migration leads to higher consumption level and lower consumption volatility for rural households. However, as this paper will

show, the inter-province migrants only accounted for 8% of all educated young migrants. Moreover, we show that the inter-province migration was endogenous, indicating that their identification might not be valid. Another study by Honig and Zhao (2015) tells a hostage story. They argue the arrival of educated youths provided the rural areas with access to equipment and technical training from the sending regions. The local officials had more bargaining power to request living and production materials from the sending cities. Though this story seems to be reasonable, they do not provide any quantitative evidence and only base the proposition on anecdotal cases of the educated youths from Shanghai.

To our best knowledge, this paper is the first to systematically evaluate the long-term effects of the Send-down policy on the rural areas. With the county-level immigration dataset, we can provide a more accurate and comprehensive picture of the Send-down migration. The rest of this paper is structured as follows. Section 2 gives a detailed background of the Send-down policy and its induced migration. Section 3 introduces the county-level immigration dataset and other relevant data sources. Section 4 discusses the identification strategy and the empirical results. Section 5 concludes.

2. Historical Background

2.1. The Send-down Policy

China became a communist country in 1949, and the new government proposed an ambitious agenda to develop the industrial sectors throughout the 1950s.[3] Increasing public investment pushed the industrial output to grow more than seven times from 1951 to 1960. Meanwhile, the increasing labour demand in cities motivated millions of people to move to cities, making the city population almost doubled.[4] The large city population became troubling after 1961 when the economy slowed down, and the labour demand shrank. The excess labour supply caused high unemployment in cities. The government prohibited free rural-urban migration in the late 1950s to reduce the city population. Also, the government sent 26 million unemployed rural migrants back to the countryside from 1960 to 1962.

In 1962, the government began to send the unemployed high school graduates from cities to rural areas. Since the rural areas were "inferior" to cities, this policy was also known as the Send-down policy. People call the Sent-down high school graduates educated youths (*Zhiqing*) because they had much more education than the mass public. The policy became mandatory and more radical in 1968

[3] Such policies included the First and Second Five-Year Plan, as well as the Great Leap Movement.
[4] From 1951 to 1960, the urban population increased from 66.32 million to 130.73 million. While at the meantime, the rural population only increase 7% from 496.68 million to 531.52 million.

after the Cultural Revolution shut down the school system in 1966.[5] In 1968 and 1969, all the high school students who should graduate between 1966 and 1968 were mandatorily sent down, except for very few exemption.[6] After 1969, the government kept sending educated youths annually till the policy ended in 1980.

Figure 1 shows the cumulative share of educated youths sent down from 1963 to 1979. The sent-down migration fluctuated every year. Before 1967, only 10% of educated youths were sent. While by 1970, the policy enrollment rate had reached 40%, due to the massive sending in 1968 and 1969. The migration slowed down from 1971 to 1973 and revived in 1974. By 1977, the enrollment rate had hit 95%. Figure 1 also gives the share of rural counties receiving educated youths in the same period. 95% of rural counties with migration data had been enrolled by 1970.

To cut down the urban unemployment, the government would send down more educated youths when the city economy slowed down. Figure 2 shows the time-series correlation between the Send-down migration and a set of macroeconomic variables. It is evident that the migration always increased when the industrial sectors declined (panel a) and the labour demand shrank (panel b). Also, the enrollment rate of higher education was also negatively correlated with the Send-down migration (panel c) because colleges and professional schools can settle some educated youths who should be sent otherwise.

Decreasing the food demand in cities was another motivation of the Send-down policy. With a state monopolised grain market, the farmers must turn in most grain products except for a small amount to be self-sufficient. The government would reallocate the food and in most cases served the cities first. So, the enormous city population demand massive food reallocation, which would irritate the rural residents and provoke political objections. Sending down the educated youths can reduce the political objections of food reallocation and increase the agricultural labourers. So, as Figure 2 (panel d) shows, the Send-down migration tended to increase when the food production went down.

In 1978, the new political leader Deng Xiaoping took power and the economy gradually recovered. The government stopped sending more educated youths and allowed those in rural areas to return freely. From 1962 to 1979, the government sent down 17.76 million educated youths in total. By 1979, 14.9 million of them had returned to cities via different ways.

2.2. The Placement of Educated Youths

[5] The Cultural Revolution lasted from 1966 to 1976. From 1966 to 1970, all colleges stop admitting new students and most primary and high schools top giving classes. Occasional interruption to industrial productions and transportation were also common.

[6] Approximately 4.67 million educated youths were sent within 1968 and 1969.

Typically, a rural county could receive the educated youths from several origins. Figure 3 illustrates the immigration of educated youths with the Anfu County. Anfu was a rural county in Jiangxi Province. As the county chronicle documents, it received 3750 educated youths in total from 1957 to 1975.[7] 761 of the immigrants were from the towns within the county; 706 were from Ji'an, a neighbouring city; 583 youths came from Nanchang, the capital city of Jiangxi province. More noteworthy, the remained 1700 youths were from Shanghai, the most populated city in 1960s China. Even though for Anfu County about 50% of immigrants come from another province, nationwide 92% (16.49 million) of educated young immigrants were from within the province.

The government placed the educated youths by some rules. Since the educated youths could compete for food and other scarce living materials with the rural residents, the rural counties were usually reluctant to receive them. So, to place the educated youths, the provincial governments assigned a quota to each rural county, depending on its social and economic conditions. A policy guideline published by the central government in 1964 gave some rules:[8]

Regarding the sending directions, the government should first send the educated youths to the areas with sparse population, surplus arable land, high demand for labourer, diversified production, and stable income. The villages suffering severe natural disasters or already densely populated can be exempted; The villages of minority ethnics should only receive the educated youth of that ethnics.

Based on this guideline, the population density of the rural areas was the first condition to be considered. The rural areas with lower population density should be able to settle more agricultural labourers. Otherwise, sending the educated youths to the rural areas already densely populated can increase the idle labour and deteriorate the local food shortage. Second, the agriculture productivity mattered. With higher agricultural production, the more productive villages were able to feed more immigrants. Third, the government also consider ethnic homogeneity. Sending people to a place with similar ethnics and culture could facilitate their assimilation and reduce potential conflicts.

In practice, the geographic proximity might also be relevant. The provincial government tended to send more educated youths to the rural counties close to cities to save transportation costs. Moreover, sending people to a place close to home can avoid the long-distant separation of the teenagers from their families.

Figure 4 illustrates the inter-province migration of the educated youths from Beijing, Tianjin, and Shanghai, the three most populated cities in the 1960s. From 1962 to 1979, the three cities sent out

[7] As discussed before, the Send-down policy was initiated nationwide in 1962. Before that, the policy was implemented locally in some populated areas. The first record of Send-down migration can be traced to 1955.
[8] Source: *The Decision on Mobilize and Organize the Urban Educated Youth into Socialistic Production*, January 1964

1.24 million educated youths to other provinces. As the figure shows, besides the neighbouring provinces, the Liaoning, Jilin, Heilongjiang (all located in the Northeast), Xinjiang (in the Northwest), and Yunnan (in the Southwest) received most educated youths. As traditional border regions, these provinces had a tiny population and relatively vast arable land, which were perfect destinations for the educated youths. This pattern confirms the policy rules discussed above.

The same rules also applied to the within-province migration, which was more prevailing. In section 4, we will systematically test the relationship between multiple pre-existing conditions and the educated youth immigration. Overall we find that the rural counties with lower population density received more educated youths. Conditional on the population density, the counties with more agricultural population received fewer educated youths, and geographic locations mattered to some extent.

2.3. Rural Life and Human Capital Spillover

This immigration of educated youths increased not only agricultural labourers but also human capital to the rural areas. Compared with the native rural residents, the immigrants of high school graduates were significantly more educated. By 1964, 49% of Chinse were illiterate, and only 9.3% of the population ever attended a junior or senior high school.[9] These numbers were calculated for both cities and rural counties, indicating the actual illiteracy in rural areas should be much higher than that.

Once arriving at the rural areas, the local government settled the educated youths in three ways. First, before 1963 most educated youths were assigned to the state farms, which were owned and managed by the government. The educated youths got a stipend and food from the government. Then after 1964, the government began to assign the educated youths directly into the production teams, the most basic rural communities, which was known as *Chadui*.[10] Since 1964, *Chadui* turned to be the primary way to settle the educated youths. Without practical farming skills, the educated youths found it challenging to survive. The young settlers also felt hostility from the native since the two groups of people competed for food against each other. After 1974, the government established some farms specifically for educated youths and provided some subsidies. However, overall *Chadui* was still the primary settlement form throughout the whole period.

[9] See *Official Report of the Second Population Census of 1964*, National Bureau of Statistics. By June 30, 1964 the total population at age 13 or over was 473,360,217. The illiterate population was 233,267,947; the population just graduating junior high school was 32,346,788 and the senior high school graduates were 9,116,831.

[10] From 1958 to 1983, the rural communities of China were administrated in three levels. From up to down, they were the People's Commune, Production Brigades, and Production Team. On average, every production team was composed of 20 households and 100 people.

We emphasise that *Chadui* was the primary approach to the settlement because it made the educated youths interact with the rural residents sufficiently. It is impossible to observe any spillover of human capital without enough interactions between the immigrants and native people. The human capital can be spillover from the educated immigrants to the rural people via multiple ways. First, the educated youths directly transferred some knowledge and increased the local people's literacy. Besides farming, many educated youths acted as teachers in primary schools and illiteracy elimination classes. Some other immigrants became barefoot doctors and provided essential health services.[11] Other typical jobs of the educated youths included the accountants, machinery technicians, and weather forecasters. In Shaanxi Province, about 50% of the educated immigrants took the non-farming jobs.

The human capital can spillover implicitly as well. Peers modelling effects can be an essential way. Taking more complicated jobs and having access to better positions (i.e., state-owned factories, colleges, and military), the educated youths can inspire the rural residents with the benefits of getting an education. Such inspiration should be most likely to affect the rural people at the similar age of the educated youths. The human capital spillover can also result from a competition effect. Before the arrival of educated youths, the allocation of resources and working opportunities in rural areas did not depend on education, because most people were equally illiterate. However, the arrival of educated youths changed the rule and increased the competition for resources. So, to maintain the competitiveness, the rural residents can be motivated to get some education.

Many other channels can play a role in the human capital spillover from the educated young immigrants to the rural population. In this draft, we do not try to distinguish these channels. However, in the further studies, we are going to at least test some of the channels. More discussions on the channels can only be available with more microdata.

3. Data

3.1. Immigration of Educated Youths

Before this paper, all existing statistics on the educated youth migration were at national or provincial level. Without sufficient spatial variations, the aggregated data is not enough for policy evaluations. More importantly, as 92% of educated youths were placed within the province, the aggregate data cannot depict an overall movement of the Send-down migration.

[11] Barefoot doctors refer to those without formal medical training but having some medical skills. They can provide basic primary care, prescribe some Chinese medication, or even deliver birth.

To overcome the data limitation, I try to construct a new dataset on the educated youths' migration at the county level. The raw data are all from the rural counties' chronicles (*Xianzhi*), which were edited by the county governments.[12] For each county, I collect the total number of educated youths placed in that county by the Send-down policy. Also, for most counties, I also collect the starting and ending years of the educated youths' immigration into that county. Some counties further report the origins of the immigrating educated youths. Overall, we have 1668 rural counties in the benchmark sample, which covers 27 provinces across the country. By 1964, there were 2048 rural counties in China, and our sample has accounted for 80% of them.[13] In our sample, 1168 counties report at least one origin of the immigrating educated youths.

To measure the intensity of educated youths' immigration, I use the rural counties' agricultural population in 1964 as the denominator. I pick the year 1964 because the 1964 population census was the most recent census around the onset of the Send-down migration.[14] So, it should most accurately report the rural population just before the shock.[15] Also, it is safe to use the 1964 population because very few counties (186 counties) in our sample started receiving the educated youths before 1964. So, it should not be a serious concern that the immigrants would be double-counted in our measure.

I do not use the rural counties' total population as the denominator for multiple reasons. First, even for the most rural counties, there was a small portion of the non-agricultural population. They mostly resided in small towns and worked in service industries. The Send-down policy did not directly affect these people because the educated youths were all placed in villages. So, using the agricultural population as denominator can better measure the actual shock of Send-down migration on the rural communities. Second, for most rural counties, there were some educated youths sent from small towns to the surrounding villages within the county. Using total population as denominator can double count these within-county migrants and underestimate the real intensity of immigration.

With the data on the number of immigrating educated youths' and 1964 agricultural population, I calculate the percentage of educated youths in native agricultural population for each county, as our main measure of the Send-down immigration's intensity. Figure 5 shows the county-level variation of the immigration intensity across the country. Like the inter-province migration pattern, the rural

[12] From the county chronicles, Jin and Jin (2014) compiled all the chapters relevant to the Send-down policy into a history archive.
[13] We exclude Tibet in this calculation, since basically Tibet was exempted from the Send-down policy except for a very limited number of educated young Tibetans returning to their rural hometown during that period.
[14] China conducted population census in 1953, 1964, 1982, 1990, 2000, and 2010.
[15] The due time of the census is June 30, 1964. And the educated youth were normally sent in the second half of the year.

counties in Liaoning, Jilin, Heilongjiang, and Xinjiang received significantly more educated youths than areas. We also find that the rural counties neighbouring large cities (i.e., Beijing, Tianjin, and Shanghai) received more educated youths than elsewhere, mostly due to the proximity rule.

The county-level variation also supports our argument that the inter-province migration data cannot accurately measure the shock of educated youths' immigration. Yunnan, a southwestern province, was a major destination of the educated youths from Shanghai. Our county-level data indicates that the rural counties in Yunnan had a very low immigration intensity, possibly because of a large native agricultural population or very few educated youths immigrating within the province. Figure 5 also confirms that even within a province, there remains much county-level variation that we can leverage. Table 2 (panel A) gives some summary statistics on the educated youths' immigration for our sample.

3.2. Pre-event Heterogeneity

As we discussed before, many ex-ante conditions of rural counties could affect the educated youths' placement and should be controlled. Though the county-level data in the 1960s were quite limited, I try to collect some relevant demographic and geographic variables. Firstly, from the 1964 population census, I calculate the population density for every county, which was the key consideration for the educated youths' placement. Then I calculate the percentage of agricultural people in the total population. Conditional on the general population density, a higher percentage of the agricultural population can indicate a more populated agricultural sector.

To control the proximity of a rural county to cities, I gauge the geographic distance from each county to its corresponding provincial capital city.[16] For the within-province migration, provincial capital was usually the major sending regions. I also gauge the distance from each county to the three largest cities in the country (Beijing, Tianjin, and Shanghai), because they were major sources of the inter-province migrating educated youths. Besides proximity, I also control the geographic longitude and latitude for that county. Table 2 (panel b) provides the summary statistics on these geographic variables.

3.3. Education Attainment: 1990 - 2010

As the main form of human capital, school education is our sole focus in this paper. To measure the contemporary education outcomes for a rural county, I calculate the rates of school attainment for

[16] The county map GIS data comes from the dataset *The Administrative Boundary Maps: 1949-2014*, copyrighted by All China Marketing Research Co., Ltd.

the contemporary population. The school attainment rates include all levels of education, from primary school to college. Also, I also include adults' literacy rate as an outcome variable given the very high illiteracy of the elderly cohorts. Data on the school attainments are all from the population census of 1990, 2000, and 2010. I include the census of all three years to examine the persistent effects of the Send-down migration.

Specially, the adult literacy rate and the rates of school attainment are constructed as follow:

$$\text{adult literacy rate} = \left(\frac{\text{Literate Population at Age 15 or over}}{\text{Population at Age 15 or Over}}\right) * 100\%$$

$$\text{primary school rate} = \left(\frac{\text{Population Ever Attending Primary Schools}}{\text{Population at Age 6 or Over}}\right) * 100\%$$

$$\text{junior high school rate} = \left(\frac{\text{Population Ever Attending Junior High Schools}}{\text{Population at Age 10 or Over}}\right) * 100\%$$

$$\text{senior high school rate} = \left(\frac{\text{Population Ever Attending Senior High Schools}}{\text{Population at Age 15 or Over}}\right) * 100\%$$

$$\text{college rate} = \left(\frac{\text{Population Ever Attending Colleges}}{\text{Population at Age 20 or Over}}\right) * 100\%$$

The rates of school attainment are derived from the population ever attended the schools at a specific level divided by the total population at eligible ages. So, a person with a higher education level will be counted in the attainment rates of all lower education levels as well. For example, a college graduate should be counted in all the attainment rates listed here. Such measurements can ensure that a higher attainment rate for any school level indicates a better education performance.

It is also noteworthy that in our measurements, the eligible ages of the population in the denominators may not exactly match the actual school ages. For example, children normally are enrolled in junior high schools at age 12. However, we use the population at age 10 and over as the denominator of junior high school attainment rate. That is because the available population census in 1990 and 2010 only report the aggregate population for every four age cohorts (i.e., the population at age 1-4, 5-9, 10-14, and so on). So, the best thing we can do is to use a neighbouring age as a substitute.

Table 3 gives some summary statistics on the contemporary education outcomes from 1990 to 2010. The attainment rates of schooling at all levels increased quickly from 1990 to 2010, implying the young cohorts are much better educated. Specifically, the average literacy rate among adults increased

from 72% to 93%, and the attainment rate of primary schools increased from 74% to 93%. Secondary education also quickly developed. The attainment rates of junior and senior high school both doubled. The college attainment is still low, but it had grown tenfold from 0.9% in 1990 to 9.5% in 2010.

4. Empirical Results

4.1. Immigration of Educated Youths and Pre-existing Conditions

As we proposed before, many pre-existing conditions of the rural county can affect the immigration of educated youths. To estimate the causal effects of the Send-down migration, we should control for the conditions affecting the outcomes by other channels. Based on the policy guideline, we explicitly test the correlation between some observable pre-existing conditions and the Send-down immigration. We regress the share of immigrants in rural population on the rural county's population density, the share of the agricultural population, the distance to the provincial capital, and the distance to Beijing, Tianjin, and Shanghai. We also control for the longitude and latitude of the county. All regressions included prefecture fixed effects.

Table 4 presents the results and confirms the policy rules indicated by the guideline. The first column takes the share of all immigrants as dependent variables, and the estimates show that the population density of rural counties negatively affected the share of immigrants. Also, conditional on the overall population density, the counties with a higher share of agricultural people tended to receive fewer immigrants. The rural counties closer to provincial capital received more immigrants, confirming that the proximity mattered.

The second and third columns separate the immigrants by their origins. We find that the overall population density and the distance to provincial capital did not affect the within-county immigration significantly. However, these two variables negatively affected the immigration from outside the county. Moreover, the share of agricultural population negatively affected the immigrants from inside the county but had zero effects on the immigrants from outside the county.

These results are reasonable and consistent with the rules we discussed before. When the provincial government assigned the educated youths from outside the county, it evaluated the county's overall ability to bear the immigrants and did not care the demographic structure within the county. Also, because 92% of immigration occurred within the province, the capital city was the most important origins of the immigrants from outside the county. So, the proximity to the capital city should be significantly negative in column 3 and insignificant in column 2. Finally, the share of the agricultural

population negatively affected the within-county immigration, indicating that the county authority would send fewer educated youths from the towns if the rural villages were already densely populated.

To conclude the results from Table 4 confirms the placement rules indicated by the policy guideline. However, the results also show that these pre-existing conditions indeed were closely correlated with the immigration of educated youths. So, in the next section, we will control for all the listed variables in our OLS estimates. These results also imply that many unobservable conditions can bias our estimates, and we should address that.

4.2. Human Capital Spillover – OLS Estimates

Before we formally test the human capital spillover of the Send-down immigration, Figure 6 presents a simple correlation between the share of immigrants and the attainment rates of all educational levels in 2010. All coefficients are significant and positive. To identify the causal effects, we firstly focus on the following specification:

$$y_{ict} = \beta_0 + \beta_1 * immgrt_{ic} + \beta_2 * immigrt_{ic} * Year_{2000} + \beta_3 * immigrt_{ic} * Year_{2010} + \beta_4 * Year_{2000} + \beta_5 * Year_{2010} + X_{ic}\gamma + \varphi_c + \pi_{ct} + \upsilon_{ic}$$

The outcome variable y_{ict} is the attainment rates of a specific educational level in the county i of the prefecture c and at year t. The variable $immgrt_{ic}$ is the share of educated young immigrants in the rural population of 1964. $Year_{2000}$ and $Year_{2010}$ are the dummy variables for the year 2000 and 2010 respectively. X_{ic} is a set of pre-existing conditions, including the rural county's population density, the share of agricultural population, the distance to the provincial capital, and the distance to the three largest cities. The control variables also include the geographic coordinates of that county. φ_c denotes the prefecture fixed effects, π_{ct} is the year-specific prefecture fixed effects and ϵ_{ic} is the error term.

Based on that specification, it is easy to derive the marginal effects of the immigrants' share on the educational outcomes in 1990, 2000, and 2010. The estimate β_1 is the marginal effects on the outcomes in baseline year 1990. The marginal effects on the outcomes in 2000 and 2010 are the linear combination of the coefficients $\beta_1 + \beta_2$ and $\beta_1 + \beta_3$ respectively. Table 5 reports the ordinary least squares estimates of the specification above. Moreover, Figure 7 plots the marginal effects of the Send-down immigration on the educational outcomes in 1990, 2000, and 2010.

We find that the marginal effects on all outcomes except for the college attainment rate are positive and significant in 1990. One more percentage point of the immigrants' share increased 0.42

percentage point of the adults' literacy rate. Marginal effects on the attainment rates of primary schools, junior high schools and senior high schools were 0.39 percentage point, 0.63 percentage point and 0.3 percentage point respectively.

Then the marginal effects on the adults' literacy rate, primary school attainment, and the junior high school attainment decreased from 1990 to 2010. By 2010, the marginal effects on literacy rate and the primary school attainment had been zero, and the effects on the junior high school attainment had dropped to 0.4 percentage point. However, the marginal effects on the attainment rates of the senior high school and college had increased from 1990 to 2010. By 2010, their marginal effects had increased to 0.5 and 0.39 percentage point respectively.

4.3. Contiguous County Pair Fixed Effects

The ordinary least squares estimates can be upward or downward biased, depending on the way the error terms correlated with the immigrants' share and outcome variables. For example, the rural counties with higher income may receive more educated young immigrants. If the persistent income difference also directly affected current education outcomes, the OLS estimates could be upward biased. To address this endogeneity problem, we improve the identification by including the contiguous county pair fixed effects. Following is the baseline regression in this draft.

$$y_{icpt} = \beta_0 + \beta_1 * immigrt_{icp} + \beta_2 * immigrt_{icp} * Year_{2000} + \beta_3 * immigrt_{icp} * Year_{2010} + \beta_4 * Year_{2000} + \beta_5 * Year_{2010} + X_{icp}\gamma + \varphi_c + \pi_{ct} + \theta_p + \upsilon_{icp}$$

The added subscript p is the index of the pair of contiguous counties. Compared with the simple OLS estimates, this specification can eliminate all unobservable shared by two contiguous counties from the error term. We think this specification can give more consistent estimates because the contiguous rural counties had many unobservable in common. For example, the natural endowments, demographic conditions, and market potential should be similar within the pair of contiguous county. Moreover, the contiguous counties are more likely to integrate into a common labor market, where the wage and education premium are determined. Controlling for the contiguous county pair fixed effect, the remained error term should be much more random.

Table 6 reports our benchmark results. We find similar direction and statistical significance of the coefficients. However, the magnitudes of the coefficients are significantly smaller than the OLS estimates, confirming our prediction that OLS can overestimate the real effects. By 2010, an additional one percentage point of the immigrants' share increased the junior high school attainment rate by 0.3

percentage point. The marginal effects on the attainment rates of the senior high school and college were 0.43 and 0.34 percentage point respectively.

In our baseline regression, we use the full sample of 1637 contiguous counties across the country. These counties made up 6088 county pairs. Alternatively, we can focus on the county pairs across provincial borders. As we introduced before, the government relocated 92% of educated youths within the province. So, for the pair of contiguous counties located in different provinces, the immigrants' share can be primarily determined by the overall pre-existing conditions in their province. If we assume that the other endogenous unobservable continuously changed across the provincial border, the variation of immigrants' share across the border can help us to identify the causal effects. We can also implement the strategy with the prefecture border counties.

Figure 8 shows the spatial distribution of our subsample of province border counties and prefecture border counties. Table 7 gives some descriptive statistics on the subsample of counties on province and prefecture borders. As we can see, compared with the non-border counties, the border counties did not receive significantly more or fewer educated youths. However, the pre-existing conditions for the border counties were somewhat different.

Figure 9 plots the marginal effects, estimated from the subsample of province border counties and prefecture border counties. We also plot the full sample estimates for comparison. Again, we find similar directions and statistical significance of the marginal effects. However, the standard errors for the subsample of province border counties are much larger, which can be due to a much smaller sample size.

5. Conclusion

This paper tries to examine whether the Send-down policy in China from 1962 to 1979 had any long-lasting impacts on the rural areas' human capital formation. As the immigrants in rural areas were mostly high school graduates, their arrival brought significant human capital gains to the rural destinations. Taking the Send-down migration as a natural experiment, we try to test the human capital spillover in the long-term.

Conditional on a set of pre-existing conditions, the estimates from the simple ordinary least squares and an improved approach of contiguous county pair fixed effect suggest a positive and significant human capital spillover. By 1990, one additional percentage point of the immigrants' share increased the adult literacy rate by 0.38 percentage point and increased the primary school attainment rate by 0.35 percentage point. These marginal effects diminished to zero by 2010. For the high school

education, by 1990 one additional percentage point of the immigrants increase the attainment rates of junior and senior high schools by 0.49 and 0.19 percentage point respectively. These effects changed to 0.33 and 0.43 percentage point by 2010. By 1990, we do not find any significant effects on the college attainment, but the marginal effects increased to 0.34 percentage point in 2010.

Our findings provide suggestive evidence for the persistent spillover of human capital. However, we should be cautious to conclude. Many other confounding channels must be ruled out to verify the positive and significant effects were due to the human capital spillover at least to some extent. First, we should further test whether the temporal presence of the educated youths permanently changes the rural areas' productivity. If the there is some persistent productivity gain from the educated youth immigration, the productivity difference can mostly explain the education outcomes. Second, we should also test the hostage story, proposed by Honig and Zhao (2015). If the arrival of educated youths also brought a massive inflow of physical capital, then the increased physical capital stock in rural areas can also directly change the educational outcomes.

We can also verify the human capital spillover by estimating the cohort-specific marginal effects of the Send-down policy. If we find the positive and significant effects only for the cohorts interacting with the educated youths in their school ages, that can further rule out that the productivity change or physical capital gain dominated the effects.

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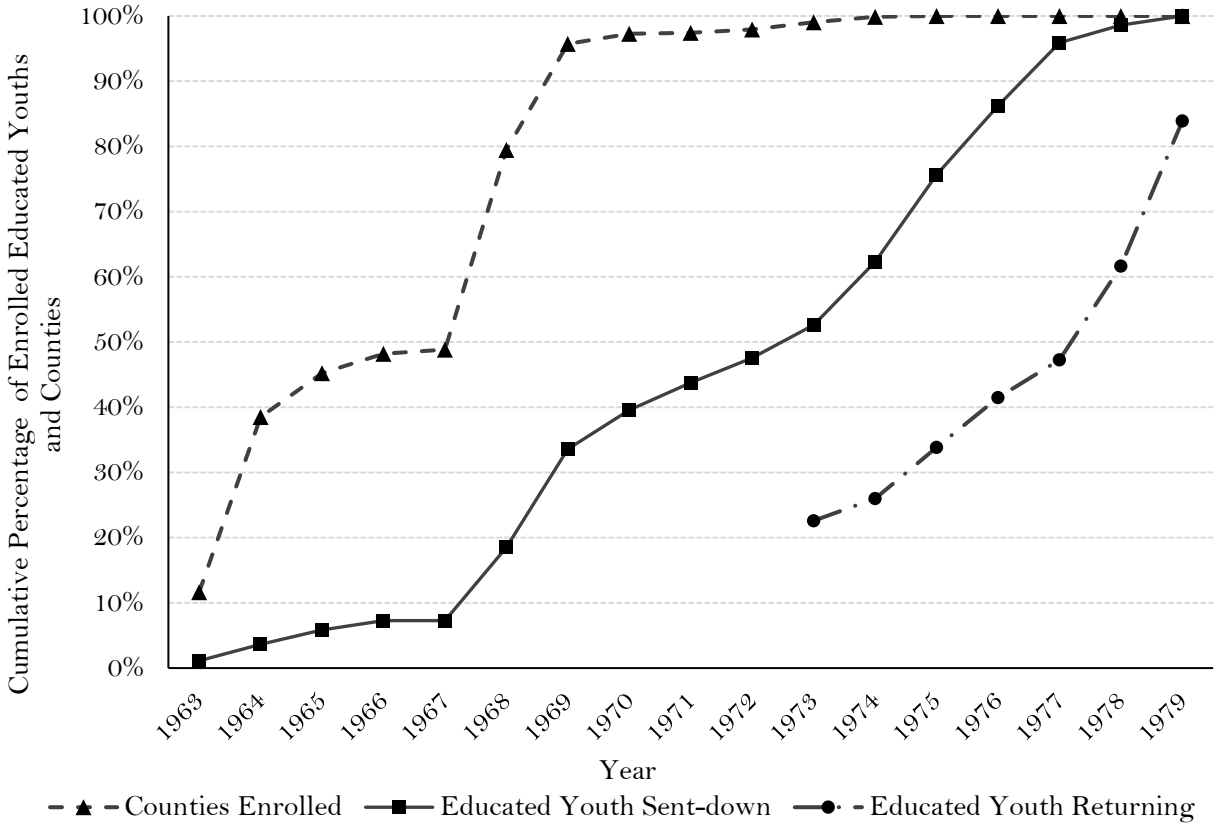
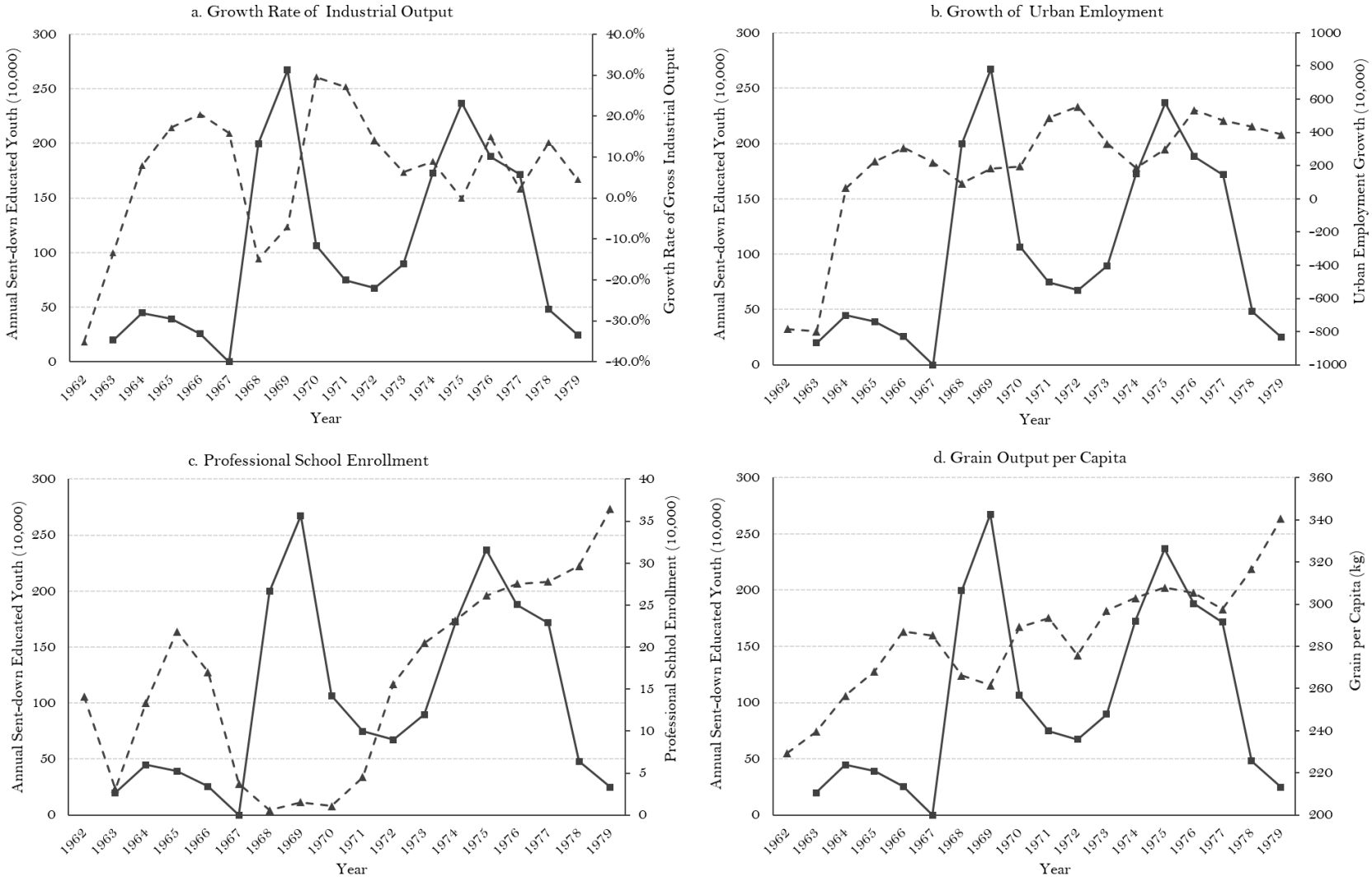
Figure 1 Cumulative Percentage of Enrolled Educated Youths and Counties: 1963 - 1979



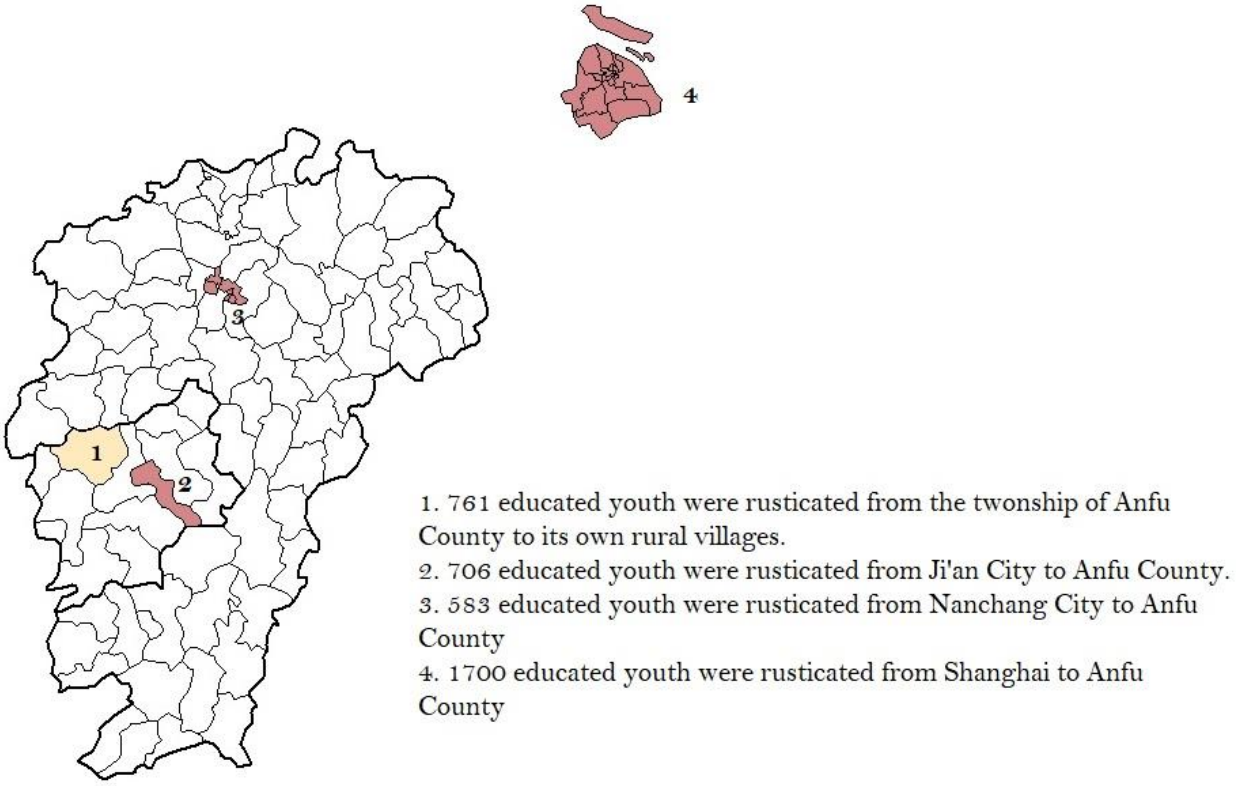
Note: The data on the sent-down educated youths comes from the official reports of Central Agency of Educated Youth, and published by *The Whole Story of China' Send-down Movement*, edited by Hongzhang Gu (2009). The number of educated youths from 1963 to 1966 is estimated from total number of sent-down population and the share of educated youths among them. The data on enrolled counties comes from *The Collection of Historical Archive on Send-down Movement*, edited by Jin & Jin (2014); The starting year for each county is compiled from each county annual; We have 1753 counties with non-missing records on the starting year in our sample.

Figure 2 Annual Flow of Sent-down Educated Youth and Macroeconomic Conditions



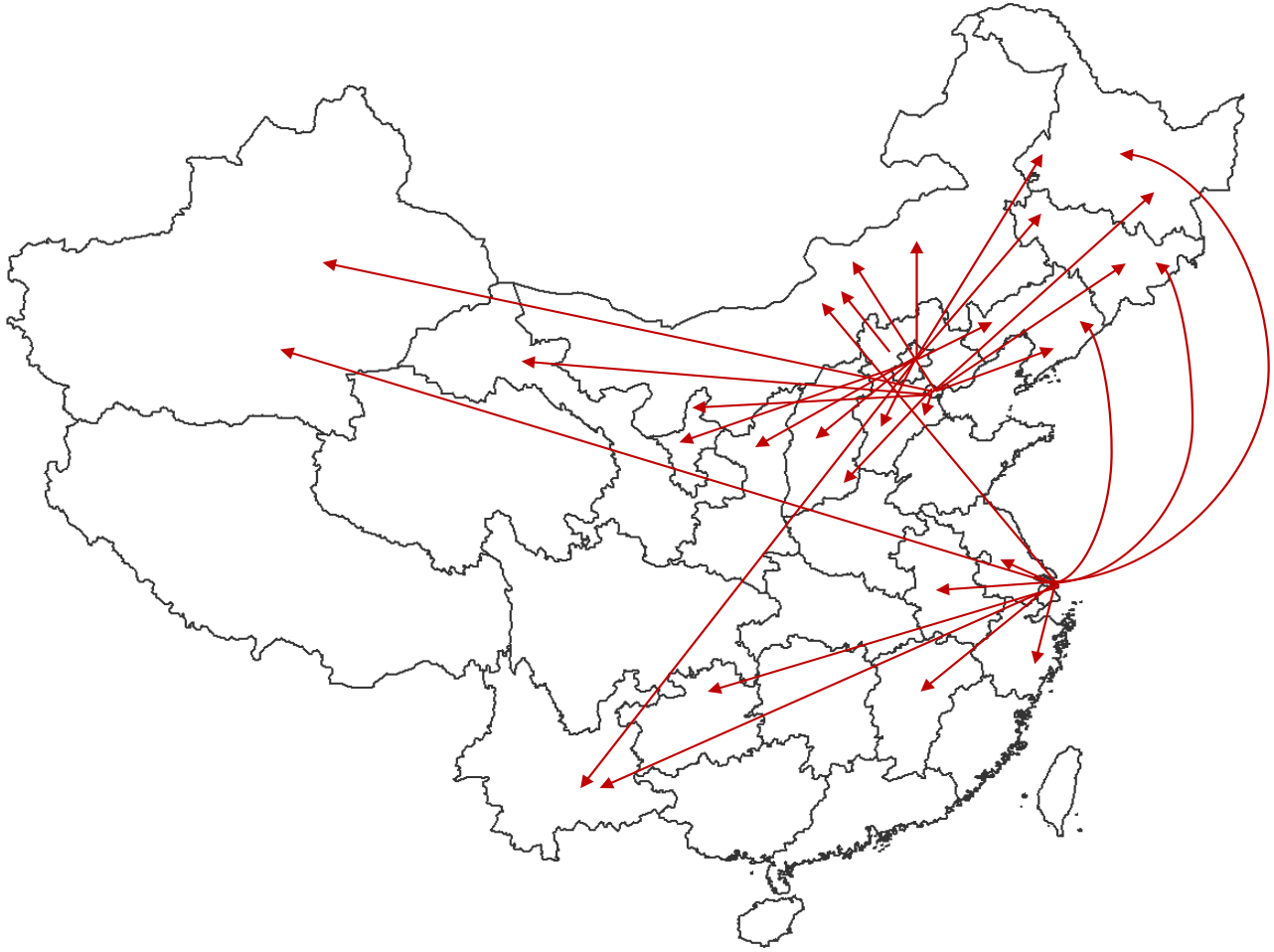
Note: The solid line for each graph refers to annual flow of sent-down educated youths, and data comes from Gu (2009); the dash line in each graph refers to the corresponding macroeconomic variable: the growth rate of industrial output, growth of urban employment, professional school enrollment, and the grain output per capita. Data of macroeconomic variables come from the All China Data Center.

Figure 3 An Illustration of Educated Youth Assignment – Anfu County



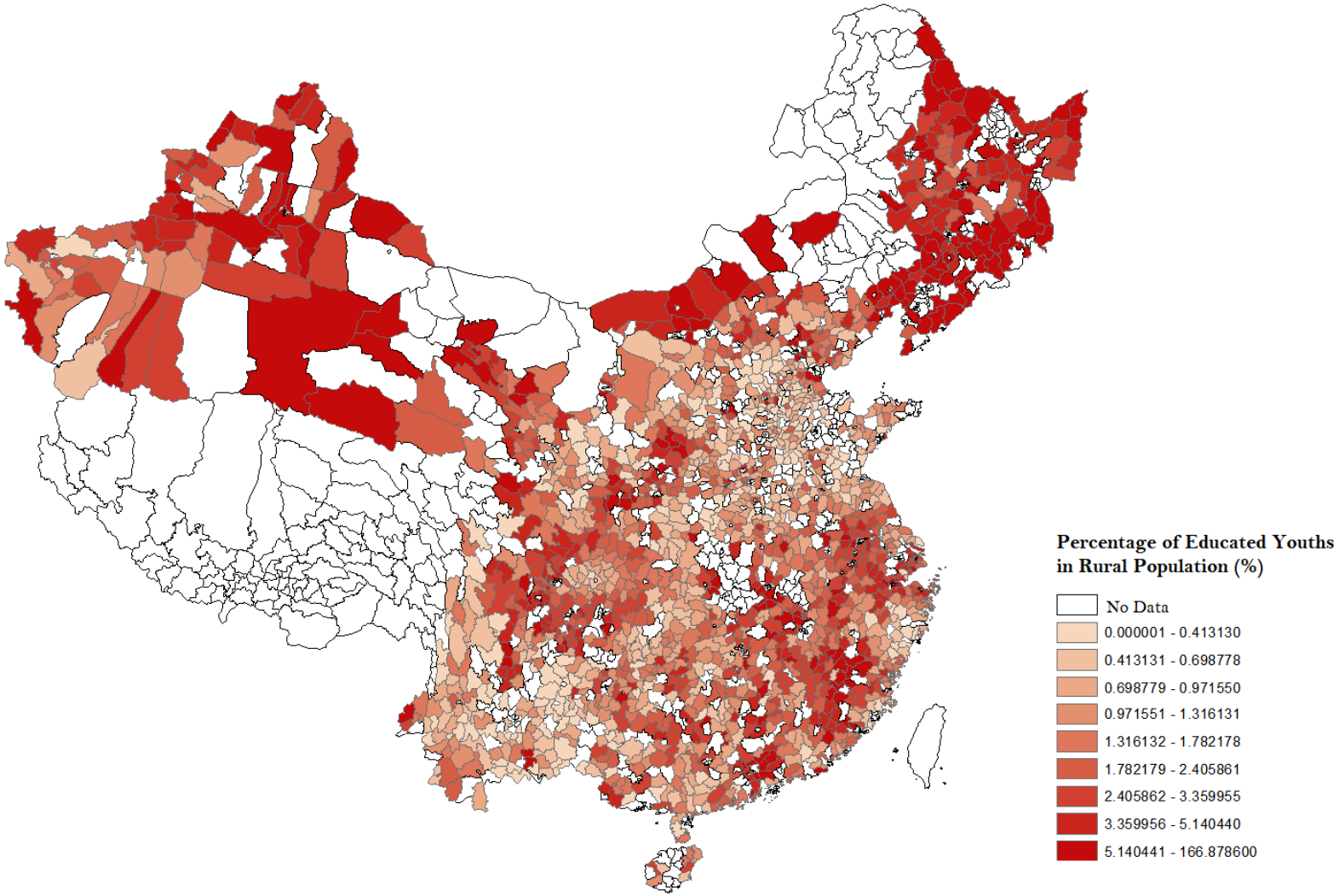
Note: The polygon marked by number 1 is Anfu county, and the polygon marked by number 2 is Ji'an city. Both Anfu and Ji'an city are administrated by the prefecture of Jinggangshan. The polygon marked by number 3 is Nanchang, the provincial capital city of Jiangxi. And the polygon marked by number 4 is Shanghai. Migration data comes from the *County Annals of Anfu County* (1995).

Figure 4 Illustration of Inter-Province Migration of Educated Youths: 1962 - 1979



Note: Data comes from Gu (2009). The graph only shows the inter-province migration from Beijing, Tianjin, and Shanghai, which accounted for 87% of all inter-province educated youths migration. The graph is for illustrative purpose.

Figure 5 The Percentage of Educated Youths in Rural Population



Note: Data comes from the county record of educated youth migration compiled by Jin and Jin (2014). The educated youth include both those migrating from the township and outside the counties. The color group is based on the ten percentiles.

Table 1 Descriptive Statistics of Send-down Migration and Ex-Ante County Heterogeneities

	Panel A. Send-down Migration				
	Mean	Std. Dev.	Min	Max	*N*
Starting Year to Receive E.Y.	1,966	2.99	1,950	1,975	1,687
Ending Year to Receive E.Y.	1,978	2.04	1,960	1,981	1,678
Total Number of E.Y.	5,739	7,323	29	77,103	1,668
Number of E.Y. from outside the County	2,735	4,695	0	67,091	1,168
% Educated Youths in Rural Population	2.82	5.92	0.03	166	1,658
% Educated Youths from outside Count in Rural Population (%)	1.34	3.21	0.00	51.54	1,161
	Panel B. Ex-ante County Heterogeneities				
	Mean	Std. Dev.	Min	Max	*N*
Population Density, 1964 (1000 People per Sq. Km)	0.19	0.17	0.000	2.15	1658
Share of Agriculture Population, 1964 (%)	91.35	8.10	20.67	98.79	1658
Distance to Province Capital (100 Km)	1.61	1.43	0	11.42	1668
Distance to Beijing (100 Km)	11.59	6.40	0	33.17	1668
Distance to Shanghai (100 Km)	12.01	6.95	0	41.10	1668

Note: all the summary statistics are calculated at county level. The data of 1964 comes from the population census of 1964, and geographic information comes from the historical administrative boundary of China.

Table 2 Descriptive Statistics of Education Outcomes: 1990 - 2010

	1990	2000	2010
Adult Literacy Rate (%)	72.13 (15.25)	87.92 (11.63)	93.27 (7.583)
Primary School Enrollment Rate (%)	74.20 (15.19)	87.38 (12.19)	93.17 (7.720)
Junior High School Enrollment Rate (%)	34.40 (12.13)	51.84 (16.59)	64.39 (15.65)
Senior High School Enrollment Rate (%)	9.721 (4.933)	17.19 (11.39)	23.56 (12.88)
College Enrollment Rate (%)	0.979 (0.995)	4.282 (5.677)	9.521 (8.717)
Graduate School Enrollment Rate (%)	-	0.0749 (0.361)	0.278 (0.907)
Average Years of Schooling	-	7.250 (1.497)	8.564 (1.449)

Note: Data comes from the population census in 1990, 2000, and 2010. Summary statistics are calculated at county level.

Table 3 Percentage of Educated Youths in Rural Population by Province: 1962 - 1979

Province	Province Report		In-sample County Chronicles	
	Percentage of Educated Youths in Rural Population	Rank	Percentage of Educated Youths in Rural Population	Rank
Liaoning	24.22	1	8.46	2
Shanghai	15.94	2	3.51	5
Heilongjiang	14.73	3	5.17	4
Beijing	12.07	4	9.00	1
Jilin	9.73	5	7.15	3
Xinjiang	7.36	6	3.43	6
Jiangxi	3.50	7	2.39	11
Neimenggu	3.09	8	3.08	8
Ningxia	3.07	9	1.78	17
Hubei	3.03	10	2.89	9
Qinghai	2.93	11	3.18	7
Guangdong	2.90	12	2.41	10
Shaanxi	2.71	13	2.13	14
Anhui	2.63	14	2.03	15
Fujian	2.57	15	2.37	12
Zhejiang	2.43	16	1.92	16
Sichuan	2.40	17	2.16	13
Gansu	2.40	18	1.42	21
Jiangsu	2.26	19	1.53	20
Guangxi	2.10	20	1.55	19
Shanxi	2.01	21	1.16	22
Hunan	1.87	22	1.70	18
Yunnan	1.83	23	0.87	26
Hebei	1.81	24	1.13	23
Guizhou	1.48	25	1.08	25
Henan	1.45	26	1.08	24
Shandong	0.97	27	0.81	27

Note: the province report comes from Gu (2009), and the rural population is defined by the agriculture population and comes from the Population Census of 1964. The city of Tianjin is included in the Hebei Province.

Table 4 The Percentage of Educated Youths in Rural Population and County Ex-Ante Conditions

	All Educated Youths	Educated Youths from Inside the County	Educated Youths from Outside the County
	(1)	(2)	(3)
Population Density in 1964	-0.134**	-0.0272	-0.135**
	(0.0550)	(0.0295)	(0.0535)
Percentage of Agricultural population in 1964	-0.147***	-0.104***	-0.00884
	(0.0220)	(0.0176)	(0.00984)
Distance to Province Capital	-0.256**	-0.0533	-0.205*
	(0.115)	(0.0821)	(0.115)
Distance to Metropolitans	Yes	Yes	Yes
Longitude & Latitude	Yes	Yes	Yes
Prefecture F.E.	Yes	Yes	Yes
N	1641	1152	1149
R^2	0.668	0.592	0.537

Note: the population density in 1964 is in the unit of 1000 persons per square kilometers; share of agriculture population is in percentage points. All regressions exclude the county outliers with dependent variables distributed at the top 1%. Standard errors are clustered in prefecture level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure 6 The Density of Educated Youth Immigrants and Education Outcomes in 2010

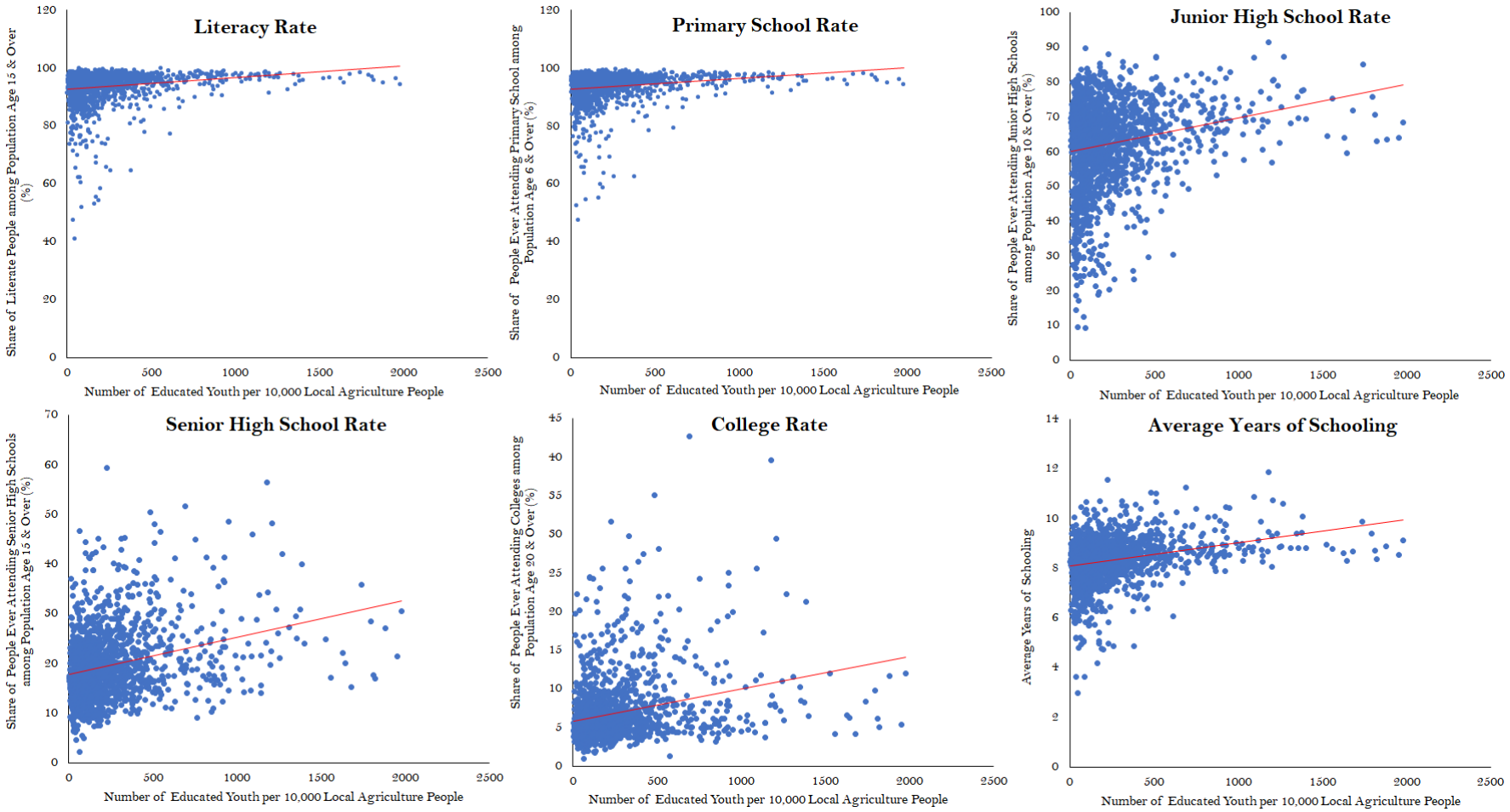


Table 5 OLS Estimates - Educated Youth Immigrants and Education Outcomes: 1990 - 2010

	Literacy Rate	Primary School	Junior High School	Senior High School	College
Percentage of Educated Youths in Rural Population	0.442***	0.394***	0.635***	0.307**	0.0410
	(0.121)	(0.115)	(0.145)	(0.0977)	(0.0377)
Percentage of Educated Youths in Rural Population * $Year_{2000}$	-0.241***	-0.228***	-0.0435	0.122*	0.111***
	(0.0719)	(0.0607)	(0.0614)	(0.0476)	(0.0258)
Percentage of Educated Youths in Rural Population * $Year_{2010}$	-0.400***	-0.347***	-0.206**	0.186*	0.333***
	(0.0985)	(0.0952)	(0.0745)	(0.0875)	(0.0764)
$Year_{2000}$	10.78***	10.29***	13.79***	10.21***	5.000***
	(0.638)	(0.538)	(0.545)	(0.422)	(0.229)
$Year_{2010}$	16.95***	15.47***	28.33***	24.40***	16.81***
	(0.873)	(0.844)	(0.661)	(0.776)	(0.678)
Population Density in 1964	5.301***	5.028***	9.462***	2.163	1.536
	(1.120)	(1.048)	(2.659)	(1.779)	(0.896)
Percentage of Agricultural Population in 1964	-0.138**	-0.125**	-0.271***	-0.215***	-0.0803***
	(0.0475)	(0.0442)	(0.0568)	(0.0460)	(0.0231)
Distance to Provincial Capital	-1.308**	-1.349**	-1.364**	-0.270	-0.148
	(0.454)	(0.446)	(0.509)	(0.227)	(0.0879)
N	4898	4898	4897	4897	4897
R^2	0.872	0.870	0.899	0.760	0.737

Note: All regressions control for the distance to three largest cities (i.e., Beijing, Tianjin, and Shanghai), longitude, latitude, prefecture fixed effect, and prefecture-year fixed effects. All specifications exclude the 1% of counties with highest intensity of the educated youth immigration. Standard errors are clustered at prefecture level and reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure 7 Marginal Effects of Educated Youths Immigration on Education Outcomes – OLS Estimates

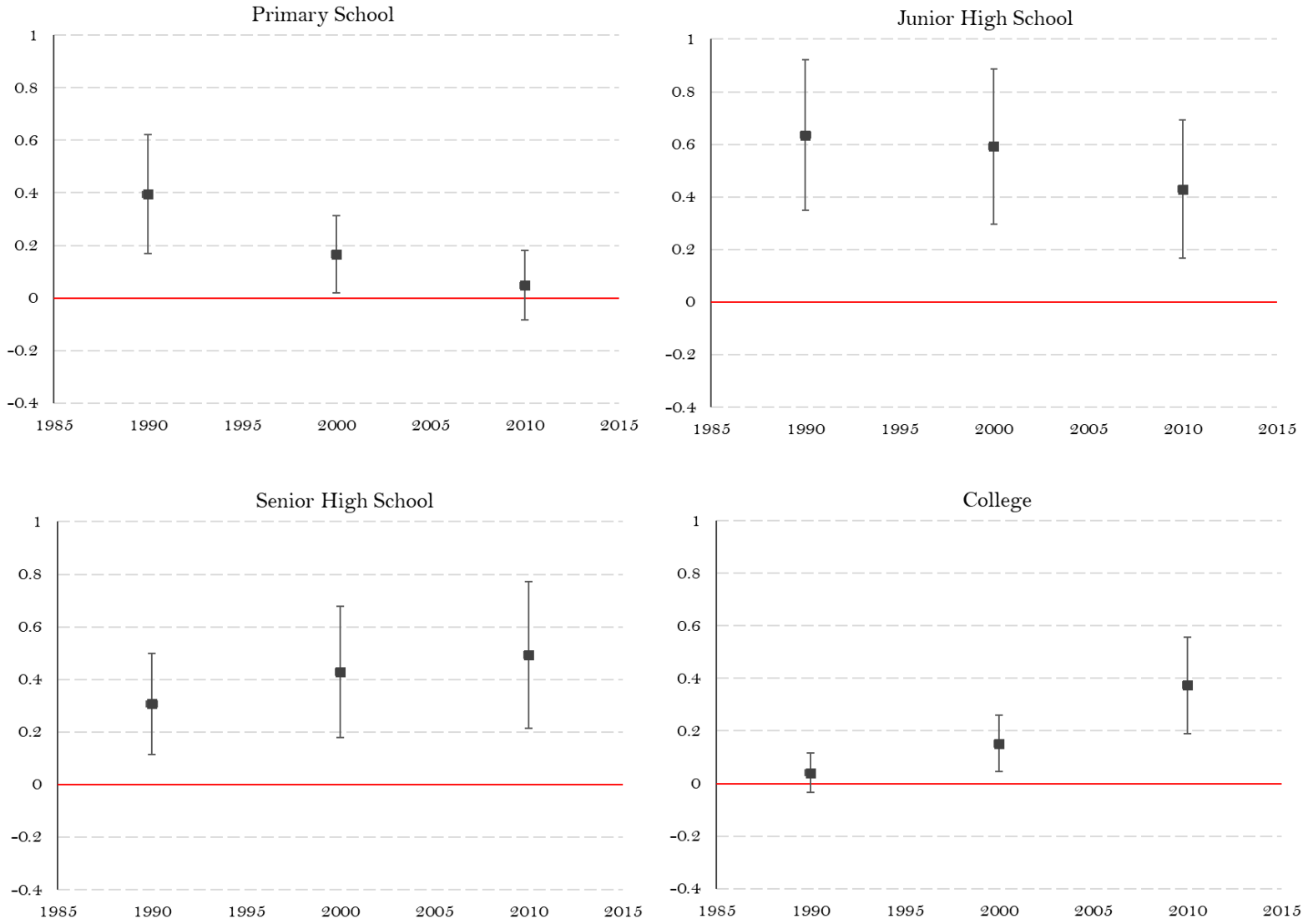
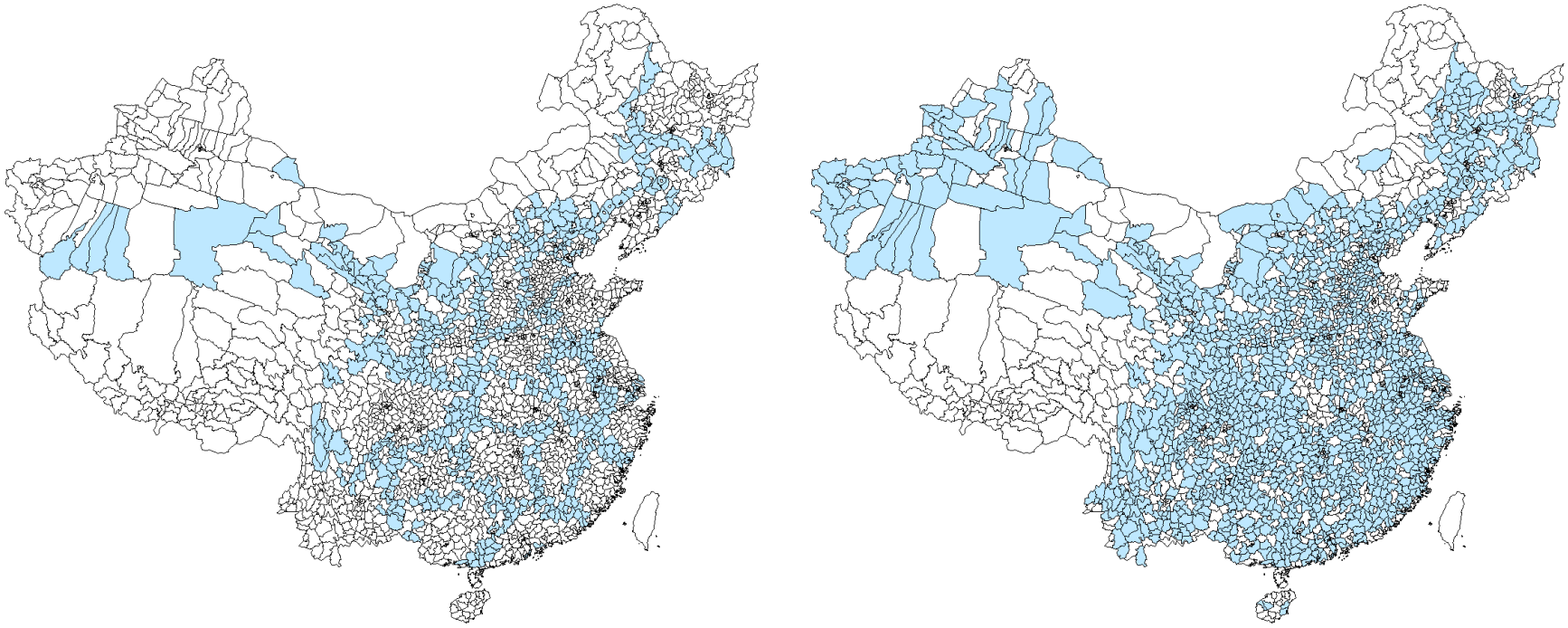


Table 6 C.C.P. Fixed Effect Estimates - Educated Youth Immigrants and Education Outcomes: 1990 - 2010

	Literacy Rate	Primary School	Junior High School	Senior High School	College
Percentage of Educated Youths in Rural Population	0.384***	0.350***	0.491***	0.196***	-0.0198
	(0.0500)	(0.0473)	(0.0701)	(0.0542)	(0.0258)
Percentage of Educated Youths in Rural Population * $Year_{2000}$	-0.232***	-0.223***	-0.0315	0.118***	0.109***
	(0.0261)	(0.0216)	(0.0228)	(0.0159)	(0.00850)
Percentage of Educated Youths in Rural Population * $Year_{2010}$	-0.405***	-0.357***	-0.159***	0.240***	0.367***
	(0.0320)	(0.0302)	(0.0284)	(0.0334)	(0.0296)
$Year_{2000}$	10.68***	10.17***	13.72***	10.49***	5.196***
	(0.272)	(0.249)	(0.283)	(0.577)	(0.560)
$Year_{2010}$	16.95***	15.52***	28.09***	24.35***	17.01***
	(0.355)	(0.334)	(0.477)	(0.953)	(1.307)
Population Density in 1964	5.477***	5.418***	9.294***	3.397***	2.256***
	(0.760)	(0.613)	(1.530)	(0.883)	(0.493)
Percentage of Agriculture Population in 1964	-0.139***	-0.121***	-0.333***	-0.277***	-0.110***
	(0.0192)	(0.0181)	(0.0262)	(0.0207)	(0.0104)
Distance to Provincial Capital	-1.105***	-1.064***	-0.892***	-0.0779	-0.0989
	(0.225)	(0.212)	(0.293)	(0.183)	(0.0806)
Marginal Effects in 2000	0.152***	0.127***	0.459***	0.314***	0.089***
	(0.042)	(0.040)	(0.071)	(0.060)	(0.028)
Marginal Effects in 2010	-0.021	-0.007	0.331***	0.436***	0.347***
	(0.040)	(0.039)	(0.068)	(0.064)	(0.039)
Number of Counties	1637	1637	1637	1637	1637
Pairs of Contiguous Counties	6088	6088	6088	6088	6088
R^2	0.938	0.941	0.963	0.888	0.840

Note: All regressions control for the distance to three largest cities (i.e., Beijing, Tianjin, and Shanghai), longitude, latitude, prefecture fixed effect, prefecture-year fixed effect, and the contiguous county pair fixed effect. All specifications exclude the 1% of counties with highest intensity of the educated youth immigration. Standard errors are two-way clustered at contiguous county pairs and county level. They are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure 8 The Border Counties in China



Province Border Counties

Prefecture Border Counties

Note: The county boundaries are based on the map of 1968. The maps only highlight the border counties with non-missing data on the educated youth migration.

Table 7 Summary Statistics for Counties on Prefecture and Province Borders

	Non-Border Counties (1)	Prefecture Border Counties (2)	Province Border Counties (3)	Group Difference (2) − (1)	Group Difference (3) − (1)
Percentage of Educated Youths in Rural Population	2.466	2.389	2.264	-0.0769	-0.202
	(3.057)	(2.594)	(2.542)	(0.33)	(0.82)
Population Density, 1964 (1000 People per Sq. Km)	0.256	0.179	0.147	-0.0778***	-0.109***
	(0.249)	(0.168)	(0.147)	(4.12)	(5.68)
Share of Agriculture Population, 1964 (%)	91.30	91.73	91.92	0.432	0.625
	(7.619)	(7.092)	(7.279)	(0.73)	(-0.99)
Distance to Province Capital (100 Km)	1.922	1.539	1.841	-0.383***	-0.0814
	(1.513)	(1.384)	(1.182)	(3.26)	(0.67)
Distance to Beijing (100 Km)	11.61	11.56	10.08	-0.0529	-1.537**
	(7.688)	(6.254)	(5.440)	(0.09)	(2.53)
Distance to Shanghai (100 Km)	12.01	11.90	10.81	-0.108	-1.198*
	(7.769)	(6.791)	(5.160)	(0.18)	(1.97)
Longitude of County Centroid	147452.6	121161.6	217139.2	-26290.9	69686.7
	(800337.5)	(751601.7)	(600038.0)	(0.42)	(-1.09)
Latitude of County Centroid	2484547.8	2493506.5	2544156.3	8958.7	59608.5
	(807792.0)	(726095.4)	(662525.8)	(-0.14)	(-0.91)

Note: the province border counties are all naturally prefecture border counties. So, the counties in column (3) are all included in column (2). The standard deviations are reported for the summary statistics by groups. t-statistics are reported in parentheses for last two columns. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 9 Marginal Effects of Educated Youths Immigration on Education Outcomes – C.C.P. Fixed Effect Estimates

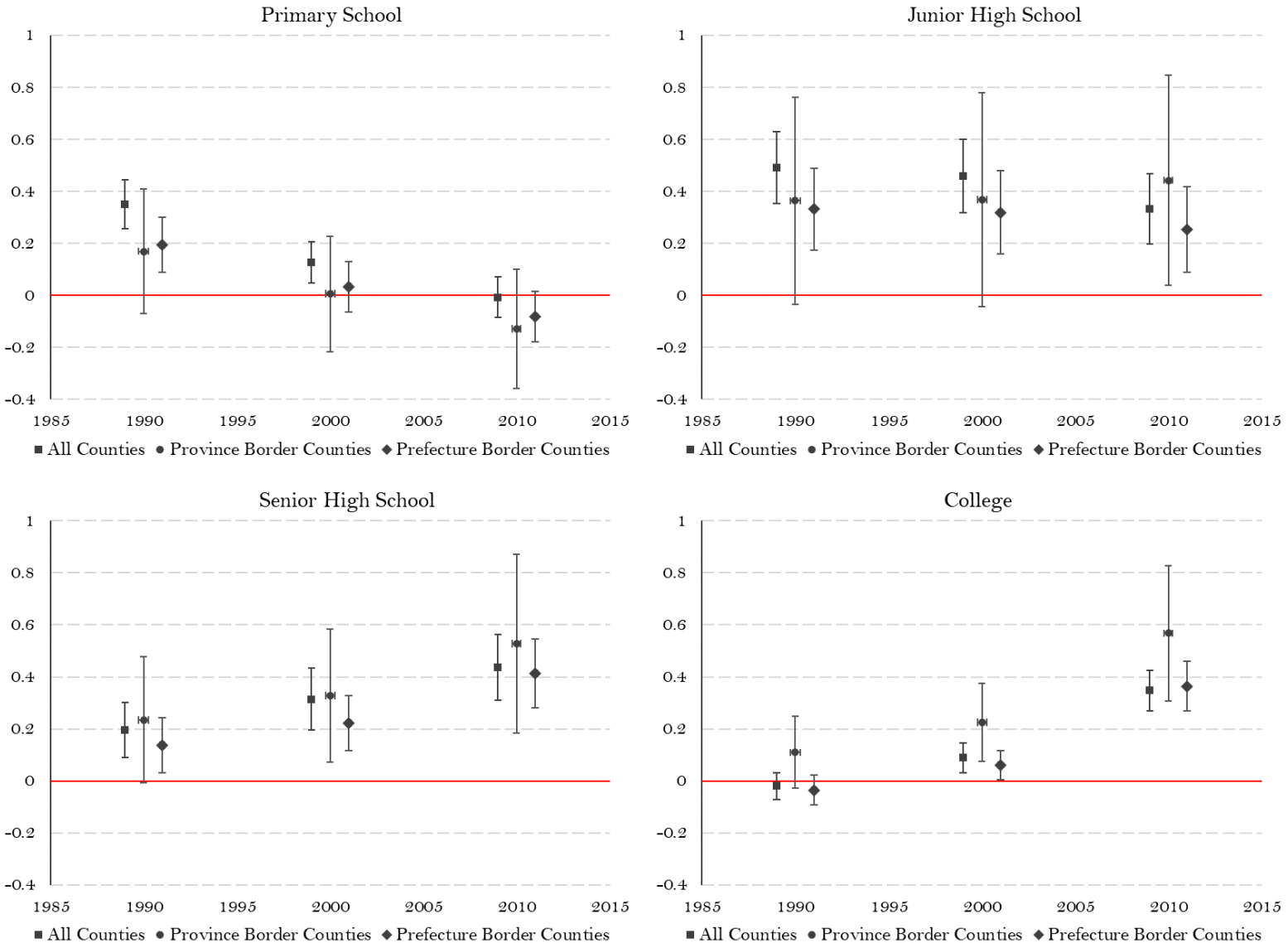


Figure 10 Marginal Effects of Educated Youth Immigration on Education Outcomes by Sending Origins