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Brain drain, brain gain, and economic growth in China☆

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ABSTRACT

We have used Chinese provincial data (1980–2005) to examine the effects of permanent and temporary emigration on human capital formation and economic growth in source regions. First, we find that permanent emigration is conducive to the improvement of both middle and high school enrollment. In contrast, while temporary emigration has a significantly positive effect on middle school enrollment it does not affect high school enrollment. Moreover, the different educational attainments of temporary emigrants have different effects on school enrollment. Specifically, the proportion of temporary emigrants with high school education positively affects middle school enrollment, while the proportion of temporary emigrants with middle school education negatively affects high school enrollment. Finally, we find that both permanent and temporary emigration has a detrimental effect on the economic growth of source regions.

1. Introduction

Economists generally argue that international migration can retard the development of the source countries (Jagdish & Hamada, 1974; Beine et al., 2001).[1] As most emigrants are skilled laborers, their departure from source countries has often been described as a 'brain drain', a term first coined by the British Royal Society to describe the exodus of scientists from the UK to North America shortly after WWII (Gibson & McKenzie, 2011). More recently, this perception has been challenged. As reviewed by Doquier and Rapoport (2009), some argue that migration can have some positive effects including remittance of funds, incentives to undertake further schooling, and return migration after obtaining additional skills and that these factors may all contribute to the economic development of source countries.

One particular potential benefit of migration on source regions that has received increasing attention in the literature is an incentive effect on human capital formation. Described as a 'brain gain', this suggests that the emigration of skilled laborers may provide an incentive for those left behind to invest in human capital, which, according to the endogenous growth theory, is one of the key determinants for long-term economic growth. When decisions to invest in education are made in light of future

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[1] See Doquier and Rapoport (2009) for a survey on the 'brain drain' effect.

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migration opportunities, this kind of 'brain gain' is more likely to occur (Beine et al., 2008, 2011; Corrado & Stryszowski, 2009; Mayr & Peri, 2008).

Early cross-country studies have provided some macro-evidence for the existence of 'brain gain' (Beine et al., 2001, 2008, 2011; Clemens, 2007; Stark et al., 1997; Vidal, 1998). More recently, however, the debate on 'brain drain' and 'brain gain' has intensified with the accumulation of micro-evidence from household surveys or censuses that have allowed an examination of the causal mechanisms between migration and human capital formation in regions of origin. Five potential mechanisms have been proposed (Mckenzie & Rapoport, 2011): First, migrant remittances can help in alleviating the barriers of household credit constraint that may prevent households from sending their children for further schooling. Second, the prospects of skilled migration can increase the expected returns from education creating greater incentive for education. Some would call this a wage premium effect. Third, an existing network of skilled migrants can facilitate further migration by reducing transaction costs and risk by information sharing and informal support. Fourth, negative effects are likely from parental absence and the lack of parental care, support, and guidance. Fifth, further negative effects can occur if emigration increases the value of local child labor encouraging children to drop out of school. This has been termed the 'labor substitution effect'. Separating the influence of these five mechanisms can be difficult (Mckenzie & Rapoport, 2011).

Recent literature points to the positive effects of skilled migration on human capital formation.[2] Gibson and McKenzie (2011) have reviewed several studies supporting the benefits of 'brain gain'. Batista et al. (2012) reported that the educational level achieved by students in Cape Verde in 2006, was influenced by the potential for their future immigration. Specifically, a 10 percentage point increase in the probability of future migration improved the average probability of completing intermediate secondary schooling by 8 percentage points for those individuals not migrating before the age of 16 years. Clemens and Tiongson (2013) have utilized a regression discontinuity design method a break occurring in 2005 in a migration program to send skilled Filipino migrants to high-wage jobs in South Korea. They found that parental migration substantially increased the likelihood that their children would become enrolled in private schools and receive awards. Moreover, the benefits of parental remittances appeared to overcome any deleterious effects from the lack of parental care. Dinkelman and Mariotti (2014) similarly took advantage of a natural experiment in the migration of Malawians to South African mines in the 1970s. Using census data from Malawi in 1998, they were able to show that a greater exposure to international labor migration contributed to a 1.4–1.8% increase in the total years of education and a 2% increase in primary schooling attainment among age eligible cohorts. Their study also provides suggestive evidence for a 'labor substitution' effect on children's education especially in districts where child labor could be substituted for adult male labor. Theoharides (2014) examined the relationship between destination-specific migrant networks across local labor markets in the Philippines in 1993 and subsequent migration between 2004 and 2009. Theoharides concluded that the effect of remittances was dominant rather than the effect of premium wages because both female and male school enrollment responded similarly. Shrestha (2011) exploited an exogenous change in 1993 in the educational requirements for Nepalese Gurkha recruits into the British Army to show that for males, a rise in educational requirement increased the probabilities of completing primary and secondary school education. Chand and Clemens (2008) also found that incentives for Indo-Fijians to acquire education in order to emigrate after the 1987 coup in Fiji led to increases in 13th grade education and in Bachelor degrees but that these effects were not evident among the indigenous Fijians.

When job opportunities in regions receiving migrants are informal and low-skilled, incentive effects on education appear to actually be reversed. The availability of low-end jobs with minimal education requirements and relative high wages can lower incentives to invest in education. The net effect will depend on whether the positive influence of remittances is sufficient to counteract this disincentive. Evidence in the literature in regard to this has been equivocal. McKenzie and Rapoport (2011) found that living in a Mexican household where migration occurs lowers the chance of boys completing junior high school and of boys or girls completing high school. The observed decrease in schooling could be related to the ready immigration of boys and an increase in household responsibilities for the remaining girls. In a contrasting study also in Mexico, Hanson and Woodruff (2003) found that children in households where migration occurs complete significantly more years of schooling, an effect ranging from an additional 0.2 to 0.9 years. The effect was greatest for disadvantaged girls in households where the parents had low levels of education. Kandel and Kao (2001) found that international migration to the USA for menial jobs could be a double-edged sword: it improved children's academic performance at school but also dampened their aspiration for further college education.

Few studies have tried to distinguish the effect of permanent emigration from that of temporary emigration on human capital formation in source countries or to relate this to the varied education of the emigrants. As Beine et al. (2008) have pointed out, the recent debate on the advantages of 'brain gain' may be partly due to the absence of reliable cross-country data on international migration as stratified by educational levels.[3] Finally, even if the 'brain gain' effect exists, it does not automatically imply that emigration will have a positive effect on economic growth. For example, if human capital formation is emigration-oriented, the positive effect of human capital investment will not be fully earned by the source regions.

This paper examines the effects of both permanent and temporary emigration on human capital formation and economic growth in the source regions. To achieve this end, we take advantage of the availability of Chinese provincial data. These provide several benefits. First, they may avoid statistical inconsistencies that prevail in many cross-country regressions. Currently, China has 31 regions, each of which complies with the same statistical methodology.[4] Although we must then focus on domestic migration rather

[2] As shown in the section below, skilled migration may refer to different levels of education depending on the local context. In Malawi, skilled migration refers to the movement of individuals who have completed primary education whereas in the Philippines it requires at least a high school education (Dinkelman & Mariotti, 2014; Theoharides, 2014).

[3] This kind of migration data has become available only very recently (see Docquier & Marfouk, 2005).

[4] In the Chinese context, we define *regions* as units at the provincial level. These include 23 separate provinces, plus four municipalities directly ruled by the Central Government, and five autonomous regions. The terms 'provincial' and 'regional' are used interchangeably in this paper.

than international migration, China's provinces are large, each with an average population over 33 million, so that internal migration may mirror the effects of international migration in other countries in the world.

Second, in China it is easy to distinguish permanent emigration from temporary migration. In the Chinese context, the concepts of permanent vs. temporary migration are rooted in the *hukou* system (Fan, 2002; Sun & Fan, 2011).[5] The permanent migrants are those who have changed their registration place, whereas the temporary migrants are individuals whose residence place differs from the place of registration. According to Goldstein and Goldstein (1991), it is where individuals are registered, rather than the duration of stay, which defines individuals as permanent migrants or temporary migrants. Fan (2002) and Sun and Fan (2011) discuss that permanent migrants are sponsored by the state. They are highly educated and have more skills. On the contrary, temporary migrants are lowly educated and have less skills. They do not share the same institutional, economic, and social benefits as local residents. This dual-track migration system has also been characterized in the literature as *hukou* vs. non-*hukou*, plan vs. non-plan, formal vs. informal, or de jure vs. de facto migration. We use the term of permanent vs. temporary migration throughout of our paper.

Third, we can readily examine the educational attainment of permanent and temporary migrants by using the Chinese census data. This has allowed us to compare the effects of emigrants with different educational levels on human capital formation and economic growth in the source regions. Fourth, the panel structure of the Chinese data set helps us in removing the cross-province heterogeneities.

Lastly and most importantly, China offers a source of interesting migration experiences for assessment. Until it was reformed in 1979, the *hukou* registration system strictly limited population mobility. At that time, the Chinese labor market was seriously segmented between rural and urban areas. However, since the loosening of these restrictions, over the last 30 years, China has been experiencing a large-scale migration from rural to urban and from inland to coastal areas. This probably constitutes the largest domestic labor migration in human history. For example, Sicular and Zhao (2002) showed that the magnitude of rural-to-urban migration more than doubled from 8.9 million in 1989 to 23.0 million in 1994. In addition, Cai (2003) estimated that in the population census of the year 2000 about 77.0 million migrants could be identified, accounting for more than 11% of the total labor force for that year. According to the Intercensal Population Survey of 2005, from the National Bureau of Statistics, the number of gross migrants reached about 150 million, of which 47 million were inter-provincial migrants (NBS, 2006). In 2012, this figure was reported to be around 163.4 million (Zhou et al., 2014).

Existing studies on the effect of migration on human capital formation in China have not to date matched the impressive size of the migrants. Most have focused narrowly on first round effects on children's education pointing to negative effects of parental migration on their children's school enrollment and performance, particularly when both parents were absent.[6] Very few studies have looked at broader spillover effects of migration on the next generation or cohort. One notable exception is the study by de Brauw and Giles (2008) which examined the effect of temporary migration on high school enrollment in rural China using the timing of ID card distribution to indicate migration. A negative relationship was found between temporary migration and high school enrollment. Our paper differs from theirs in three respects. First and most importantly, we have defined emigration rate and enrollment rate by age group, which is a major improvement. When emigrants are defined broadly to include young people of school age, emigration will automatically be seen to have a negative effect on school enrollment, which does not in turn have many economic behavioral implications. Second, we have examined the educational composition of the emigrants based on the level of school attainment in the source regions. Finally, we have examined not only effects on human capital formation but also on economic growth in the source regions.

We estimate both human capital formation and growth. For human capital formation, we used a within-group fixed effects model to eliminate cross-province heterogeneities that might bias Ordinary Least Squares (OLS) estimates. A fixed effects estimation suggested that permanent emigration has a positive effect on human capital formation in the source regions. In contrast, we found that the magnitude of temporary emigrants only has a significantly positive effect on middle school enrollment but does not significantly affect high school enrollment. More interestingly, the different educational attainments of the temporary emigrants have different effects on school enrollments. Specifically, the proportion of the temporary emigrants with high school education positively affects middle school enrollment, while that of the temporary emigrants with middle school education negatively affects high school enrollment. For the economic growth equation, we used a generalized method of moments (GMM) estimator. Conditional on the initial level of the per capita GDP, our system GMM estimates suggest that both permanent and temporary emigration can have a negative effect on the growth rate of per capital GDP in the source regions. Our results remain robust when we use a two-stage least square (2SLS) approach and when we used the historic migration rate for the contemporaneous migration rate, following the methods of McKenzie and Rapoport (2010) and Woodruff and Zenteno (2007), and a Bartik-style instrument, after Theoharides (2014).

The remainder of this paper is organized as follows: Section 2 describes the institutional background to migration in China; Section 3 specifies methods of analysis; Section 4 introduces our data sets and related variables; Section 5 presents estimated results and Section 6 discusses our conclusions.

[5] From the 1950s, the Chinese government has strictly implemented a *hukou* registration system whereby each citizen is issued a *hukou* designating his/her place of permanent residence. This is very difficult to change especially for those in the rural areas. Section 2 gives a detailed description of the institutional background of the *hukou* system and migration in China.

[6] See Zhou et al. (2014) for a review.

2. Background

2.1. The hukou system and migration in China

Since its establishment in 1949, China has adopted the Soviet model of prioritizing the development of heavy industries to achieve rapid industrialization. To implement this strategy, the Chinese government not only needed to pool many resources (e.g., suppressing the prices of rural products), but also had to limit population migration from rural to urban areas. A series of harsh regulations were implemented to intensify and artificially maintain this economically distorted system. Among these regulations, the *Regulations on Household Registration of the People's Republic of China* issued in 1958 was the most important; its target was to use the law pertaining to *hukou* to restrict the mobility of the Chinese population. [7]

Every citizen was given a *hukou* status, designating his/her legal place of residence. Two different types of *hukou* were issued: agricultural and non-agricultural. At first the non-agricultural *hukou* were held by urban residents, while the peasants in rural areas were assumed to be agricultural *hukou* holders. Given the limited resources at this stage, the Chinese welfare system only covered urban residents, that is, only those holding a non-agricultural *hukou* were allowed to access the various social facilities and social welfare services such as education, medical care, and old-age pensions during the pre-reform period. To protect the employment opportunities and the social welfare of urban residents, an easy solution was to bind such social welfare to one's *hukou* status. Thus, the *hukou* system became the base for achieving this target.

Evidence documents the dual segmentation of the Chinese labor market by the *hukou* system (see e.g., Knight & Song, 1999, 2005; Meng & Zhang, 2001). Under the strict *hukou* system, rural residents were confined to work locally for life regardless of whether low farm productivity induced surplus rural labor. At that time, the completion of college education was probably the only legitimate way to obtain a non-agricultural *hukou* for these agricultural *hukou* holders. Therefore, although rural laborers had a strong desire for better paying jobs in urban areas, rural-to-urban migration was unheard of before the Economic Reform. Apart from urban–rural segmentation, the *hukou* system also restricted the migration of urban residents. For example, they had no right to choose their jobs or to move freely between employment *units* or between urban areas.

Clearly, the urban–rural segmented system was economically inefficient. According to the calculations of Hu et al. (2002), the gross loss induced by the labor market segmentation from 1960 to 1978 amounted to 20%–60% of GDP. To improve economic efficiency, in 1978 the Chinese government reformed the old economic systems. When the *Household Responsibility System* was introduced in rural areas, agricultural productivity greatly improved, resulting in surplus rural labor. To transfer this surplus labor and increase the productivity and rural incomes, the government began to loosen its policies. In 1983, the government, for the first time, permitted skilled workers and craftsmen holding the agricultural *hukou* to engage in non-farm activities. In addition, in 1985, *Document No.1* of the Central Committee of the Party (CCP) began to allow farmers to search for jobs and establish businesses in nearby towns. However, because of the government's rationing and subsidies for food and other necessities which in these early stages of economic reform, were only available for non-agricultural holders living in urban areas, migration was limited to that occurring within local rural areas while migration from rural to urban areas or between provinces was not yet common (Cai, 2003). This situation was referred to as 'leaving the land but not the hometown' (*li tu bu li xiang*).

More significant changes occurred in the late 1980s after the government initiated a major reduction in its control of rural-to-urban migration; farmers were now permitted to work and to manage businesses in the cities as long as they managed to provide for themselves. The term '*rural migrant wave*' first emerged in 1989, reflecting this relaxation of policy. Indeed, the numbers of rural-to-urban migrants were estimated to have reached 8.9 million in that year (Sicular & Zhao, 2002). Furthermore, the end of food rationing in 1992 greatly reduced migration costs for agricultural *hukou* holders; also facilitating rural-to-urban migration. The volume of rural-to-urban migrants had more than doubled to 23 million by 1994. Based on the 2000 population census, Cai (2003) reported that there were about 77 million rural migrants within the urban areas although the number of temporary migrants was far bigger than that of permanent migrants. In the 2000 census, 74.4% of inter-county migrants appeared to be temporary migrants (Fan, 2008).

The *hukou* system still has impacts on the availability of welfare for migrants, especially those from rural areas. This has led to the development of a two-track migration system designating *permanent* and *temporary* migrants (Sun & Fan, 2011). The first refers to the migrant workers who have legally obtained a *hukou* for the destination region and therefore may become assimilated into an urban area. The second refers to those migrants who work in destination regions without a *hukou* for this area. While the two groups share common features with internal migration in other countries (moving within location of common institutions, cultural heritage, and written language), they also resemble respectively the skilled immigrants versus the irregular or illegal immigrants described in international migration literature. Temporary migrants can still live in the urban areas but have little access to education or entitlement to job security, government housing, medical care or pensions. The loosening of the *hukou* system in urban China has not made the life of temporary migrants any easier because as with international migration, reforms have primarily aimed to cherry-pick the skilled and the wealthy migrants and to prevent rural migrants from accessing urban citizenship (Sun & Fan, 2011). This lack of formal access to social security means that the rural urban migrants must return to their rural homes when family needs arise or whenever misfortune strikes (Wang & Fan, 2006). The effect of the 2008/2009 global financial crisis provides a good example. Between late 2008 and April 2009, 45–70 million rural-to-urban migrants returned to their home villages either because they had lost their jobs in the crisis or because their re-entry into the urban labor market was delayed (Kong et al., 2010).[8]

[7] It should be noted that the *hukou* (household registration) system was indeed originally established in 1951; however, there was no strict limitation on migration at that time.

[8] This may lead one to think that the duration of their stay in urban areas differentiates permanent from temporary migrants. In fact it is not the case. Their precarious situation in urban areas and the resulting interrupted stay are primarily caused by their lack of urban *hukou*.

2.2. Chinese educational system

The educational system in China is centralized and can be classified into four layers (Fig. 1): primary school (six years), middle school (three years), high school (three years), and university (four years). There are several exceptions. For example, after finishing middle school, many students enter technical schools rather than high school. In China, high school provides a general education, and almost all high school graduates take the university entrance examination. Students who pass then enter universities, while the others enter the labor market. In contrast, technical schools develop students' professional skills, and almost all technical school graduates directly enter the labor market.

In 1986, China issued the Law of Compulsory Education, which prescribed that primary and middle school education is compulsory for all children. Nevertheless some areas, especially rural areas, took a considerable time to meet this standard. Even by the late 1990s, the law remained unenforced in some remote rural areas because tuition fees were expensive, hence unaffordable, for many poor families (Heckman & Yi, 2014). Educational development across the country thus became unbalanced, particularly in relation to higher education institutions (university level graduates). As Fan reported in 2008, most university graduates were employed in the coastal regions and not in the more inland areas of China; a phenomenon described as a 'brain drain'. Zhang et al. (2005) found that the number of students who went back to school substantially increased during the period of economic reform.

3. Empirical strategy

Following methods used for cross-country analysis of emigration (Beine et al., 2001), we have applied the two equations given below. The first is the human capital formation equation, which examines the effect of emigration on school enrollment. The second is the economic growth equation which estimates the effect of emigration on economic growth

$$\ln(\textit{school enrollment rate}_{it}) = \alpha_0 + \alpha_1 \cdot \textit{emigration rate}_{it} + X_{it}^1\alpha_2 + \eta_i + \tau_t + u_{it} \tag{1}$$

$$\textit{growth rate}_{it} = \beta_0 + \beta_1 \cdot \textit{emigration rate}_{it} + \beta_2 \cdot \ln\left(\textit{per capita GDP}_{i,t-1}\right) + X_{it}^2\beta_3 + \eta_i + \tau_t + \varepsilon_{it} \tag{2}$$

where the growth rate refers to the growth rate of (real) per capita GDP; X_{it}^1 and X_{it}^2 are the two vectors of the other control variables; u and ε are error terms; and α and β are the (vector) coefficients to be estimated. The subscripts i and t are the index province and year, respectively.

The vector of X_{it}^1 includes the educational input which is measured by the ratio of educational expenditure to local GDP, the share of agricultural population to the total population, and income inequality which is measured by the ratio of urban to rural income. These variables not only influence enrollment rate but also may be correlated with the emigration rate; hence, it is important to control for them. The vector of X_{it}^2 includes physical investment which is measured as the ratio of capital formation to local GDP, human capital stock which is measured by the proportion of secondary school graduates and high school graduates in the total population, degree of openness which is measured as the ratio of international trade to local GDP, and government size which is measured by the ratio of government expenditure to local GDP. Furthermore, in both equations, province dummies η_i are used to remove cross-province heterogeneities; year dummies τ_t also control for time period effects which are common across provinces.

The provincial fixed effects η_i may correlate both the dependent variable and the right-hand variables, and they are usually unobservable to researchers. Thus, omitting η_i could bias the OLS estimates. To deal with this problem, we have employed a fixed effects model to eliminate any cross-province heterogeneities in Eq. (1) above. For the dynamic regression of Eq. (2), if the real per capita GDP is first-order serially correlated, the fixed effects estimates may be biased because $cov(\Delta \ln)\textit{per capita GDP}_{l,t-1}, \Delta\varepsilon_{it} \neq 0$. Therefore, a GMM estimator was employed to deal with the possible endogeneity of the lagged dependent variable.

According to Bond et al. (2001), there are two GMM estimators. One is the earlier first-differenced GMM estimator developed by Arrellano and Bond (1991), in which the available lags of log ($\textit{growth rate}_{t-1}$), in this case, log ($\textit{growth rate}_{t-2}$) and log ($\textit{growth rate}_{t-3}$) if the lags exist, are used to instrument the first-difference of log ($\textit{growth rate}_{t-1}$) in the first-differenced equation. However, Bond et al. (2001) have argued that the first-differenced GMM estimator can be subject to weak instrument and finite sample biases. To address these issues, another GMM estimator—system GMM developed by Arellano and Olympia (1995) and Blundell and Bond (1998)—is preferred. The system GMM estimator utilizes all the available lags of the initial real per capita GDP as the instruments of the first difference of the lagged real per capita GDP in the differenced equation. This system also utilizes the lagged first difference of the real per capita GDP to instrument the initial real per capita GDP in the level equation to deal with the finite sample biases as Bond et al. (2001) have suggested. For this reason, in this paper we employ the system GMM model to estimate Eq. (2).

Migration may be endogenous in both the human capital formation equation (Eq. (1)) and the economic growth equation (Eq. (2)). The panel dataset allows us to employ the fixed effects model to effectively eliminate any bias that may arise from the unobservable time-invariant factors in both equations. However, the possibilities that can induce the endogenous issue of migration rates still exist. As Beine et al. (2003) noted, there may be a reverse effect in the human capital equation as educated laborers are more likely to migrate. Previous studies have suggested several possible candidates. For example, in a cross-country analysis, Beine et al. (2003) used population size, population density, racial tensions, and stock of migrants in Organization for Economic Co-operation and Development (OECD) countries to measure migration rates when they estimated the human capital formation equation.

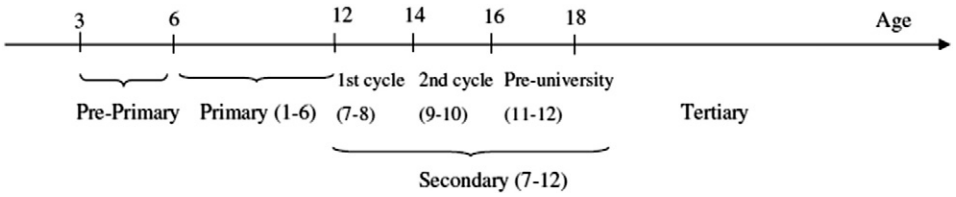

Fig. 1. Age of children and Chinese education system.

We use a 2SLS estimator to address this concern. Specifically, we use two instrumental variables for emigration rate. Following McKenzie and Rapoport (2010) and Woodruff and Zenteno (2007), the first instrumental variable is the lagged or historic migration rate. The second follows Theoharides (2014), in constructing a Bartik-style instrumental variable. We discuss the construction of these instrumental variables in Section 5 below.

4. Data

This paper uses the province-level panel data in China for our empirical analysis. As stated earlier these data have several advantages: firstly, they are more directly comparable as each region collects data similarly; secondly, permanent migration is readily distinguished from temporary migration; third, the educational composition of the emigrants is available; fourth, the panel structure helps eliminate province fixed effects and finally, the unprecedented magnitude and variation of domestic migration across provinces and time periods give us a precious opportunity to identify the effects of emigration in several dimensions.

Specifically, we have two datasets.[9] One is a panel of data (DATA8005) providing information at a provincial level on the variables of interest from 1980 to 2005. The permanent migration rate in DATA8005 is measured as the proportion of the emigrants in the local population making a change of *hukou* (regarded in the Chinese context as permanent migration). Furthermore, as a change in *hukou* is highly restricted, and college graduation is a major channel allowing this, permanent migration can also be regarded as the migration of highly educated or highly skilled laborers. This measure was directly collected from the *Comprehensive Statistical Materials of Population of the People's Republic of China: 1949–1985* as compiled by the National Bureau of Statistics, the Ministry of Public Security, and various *China Statistical Yearbooks*.

The school enrollment measure pertinent to this paper is the usual enrollment ratio of middle school to high school. This was calculated as: $school\ enrollment\ rate = enrolls_m / graduates_{m-1}$, where $enrolls_m$ is the number of students enrolled in the mth education level, and $graduates_{m-1}$ is the number of students that graduated from the $(m-1)$ th education level. For example, the high school enrollment rate of province i in year t is calculated as the ratio of the total enrollment in high schools over the number of middle school graduates in province i and year t. The raw data on enrollments and graduates were collected from various issues of the *Educational Statistical Yearbook of China*. It should be noted that the middle schools here include both regular middle schools and vocational middle schools, while high schools include regular high schools, vocational high schools, and secondary technical schools.

Other economic and demographic variables used in the DATA8005 were mainly collected from the *Comprehensive Statistical Data and Materials on 50 Years of New China*, plus various *China Statistical Yearbooks*, and *China Population Statistical Yearbooks*. It should be noted that there was a significant adjustment in regional real GDP after the first China economic census in 2004. We have used these adjusted real GDPs (at the constant price of 1978) to compute the growth rates.

Following Islam (1995) and others, we separated the data into five 5-year sub-periods to implement panel data analysis of human capital formation and economic growth. This means that all the right-hand variables of the equations are five-year averaged except for the variable of initial output level in the economic growth equation. Therefore, this panel contains information on 29 provinces for the period 1980–2005 with five-year intervals.[10]

The use of DATA8005 has two advantages. One is that we can track a long time period of migration, school enrollment, and economic growth. In fact, the period from 1980 to 2005 almost exhausted the whole period after the economic reform in China. The other advantage is that we can clearly define permanent migration by exploiting the change of *hukou*. However, we cannot check the effect of the educational composition of emigrants on human capital formation and economic growth. We also cannot examine the effect of temporary migration given this data set.

The second dataset (DATA9000) used in this paper complements DATA8005 in both respects mentioned above. DATA9000 directly computes migration using the 1990 and 2000 Chinese population censuses.[11] Specifically, the temporary migration rate is measured as the proportion of people aged 20–40 who changed their residence in the past five years over the total population of the same age group in the source regions.

One advantage of DATA9000 is that it contains detailed information on the educational composition of emigrants. Specifically, three educational emigration rates (middle school, high school, and college level) are calculated to estimate the compositional effects

[9] For a systematic comparison of the two data sets, see Appendix A.

[10] Tibet is excluded due to incomplete information, while Chongqing is excluded because it was part of Sichuan before 1997.

[11] Since its establishment in 1949, China has had a total of five population censuses. However, only the 1990 and 2000 censuses contain identifying variables of migration.

of emigration on the dependent variables of interest. These three variables are defined as the proportion of middle school emigrants, high school emigrants, and college graduates out of the total emigrants. The share of migrants with only primary education or lower is used as the base group, which is dropped from both equations.

Using the census data, we can also assign another measure of human capital formation for province *i* in year *t*. In detail, the school enrollment ratio rate here is measured as the proportion of students at a related educational level to the total population at the normal graduation age. For example, given that the normal graduation age in primary school is 12, the enrollment ratio in middle school is the proportion of students in year one in middle school to the total population aged 12 in province *i* and year *t*. It should be noted that the normal graduation age of primary school can either be 12, 13, or 12 and 13. Therefore, we have three different measures for the middle school enrollment. The same age treatment is used for senior high school at the age of 15, 16 or 15 and 16.

As noted, we deliberately define the migration rate and enrollment rate by different age groups. If emigration rate is defined on the age group including the young people of school age, emigration implies an automatically negative effect on school enrollment, which does not have many economic behavioral implications. Let us take an extreme case for illustration. Assuming that both migration rate and enrollment rate are defined in the same age group of 17–18, the dependent variable of the enrollment rate measures the number of students who remain in school. In contrast, the independent variable of emigration measures the number of students who drop out of school and work outside. Therefore, the relationship between the dependent variable and the independent variable would reflect a similar fact that people drop out of school to emigrate or because of emigration itself, rather than the effect of emigration on human capital investment. In this paper, we are interested in whether the emigration of one group *induces* the human capital investment of another (younger) group.

In DATA9000, we also collected other control variables listed in both vectors of X^1 and X^2. In contrast to DATA8005, the other control variables are time point valued to be consistent with the definition of migration and enrollment rates, which is based on the 1990 and 2000 censual years.

The statistical descriptions of the variables of DATA8005 and DATA9000 are shown in Tables 1 and 2, respectively. Data show that the average growth rate of real per capita GDP is about 8% with a standard deviation of 3.4% over the period of 1980–2005. Comparing the two datasets, one can easily find that on average, the temporary emigration rate (about 34%) more than doubled the permanent emigration rate (about 16%), which is consistent with the usual casual observations. However, school enrollment rates in DATA9000 are much lower than those in DATA8005. For example, whichever normal graduation age is adopted, the middle school enrollment in DATA9000 is always lower than that in DATA8005. As for the composition of emigration rates, Table 2 shows that most of the migrants are less well educated. This is consistent with the casual observation that many migrants are educated only to middle school level or below.

5. Results

In this section, we analyze the effects of emigration on both human capital formation and economic growth in the source regions by exploring the available panel data of China's provinces. Initially, we present the estimation results of Eqs (1)–(2) specified in Section 3 using permanent migration data (DATA8005), and then turn to use the temporary migration data (DATA9000) for both checking robustness and further analysis.

5.1. The effect of permanent emigration

5.1.1. The effect of permanent emigration on school enrollment

As mentioned earlier, we use two different measures of school enrollment rates, middle school enrollment rate and high school enrollment rate, as substitutes for human capital formation. Accordingly, in Table 3, we first report the estimates of the effects of emigration on middle school enrollment using the permanent migration data (DATA8005).

Table 1
Summary statistics of the variables.

Variable	Obs.	Mean	Std. dev.	Min	Max
Permanent emigration rate (1/1000)	200	16.483	5.496	4.790	35.186
Real per capita GDP growth rate	199	0.080	0.034	−0.008	0.187
ln (real per capita GDP)	228	6.774	1.049	4.817	9.920
Government expenditure / GDP	144	0.135	0.056	0.046	0.328
Education expenditure / GDP	143	0.032	0.012	0.014	0.074
Rural population / total population	116	0.723	0.139	0.339	0.886
Fixed investment / GDP	145	0.329	0.099	0.154	0.723
Middle school enrollment rate	144	0.840	0.131	0.534	1.012
High school enrollment rate	144	0.452	0.127	0.219	0.903
Income inequality (urban real per capita income / rural real per capital income)	116	2.520	0.617	1.310	4.494
International trade / GDP	143	0.197	0.278	0.009	1.624

Notes: (1) Data source: DATA8005 (see Appendix A for details); (2) the permanent emigration rate is defined as the proportion of emigrants with a change of *hukou* relative to the local population; (3) school enrollment ratios are the usual enrollment ratio of middle school and high school (see Section 4 for details); (4) all variables are five-year averaged except for ln (real per capita GDP).

Table 2
Summary statistics of the variables.

Variable	Obs	Mean	Std. dev.	Min	Max
Temporary emigration rate (1/1000)	61	34.424	32.517	7.829	166.647
Share of temporary emigrants with middle school education	61	39.353	11.574	15.796	64.656
Share of temporary emigrants with high school education	61	18.227	5.967	6.750	34.639
Share of temporary emigrants with college education	61	10.994	10.265	1.466	48.303
Middle school enrollment rate 1: age group 12	61	0.637	0.289	0.000	0.984
Middle school enrollment rate (2): age group 13	61	0.723	0.234	0.000	0.984
Middle school enrollment rate (3): age groups 12 and 13	61	0.699	0.252	0.000	0.984
High school enrollment rate (1): age group 15	61	0.205	0.206	0.000	0.890
High school enrollment rate (2): age group 16	61	0.275	0.196	0.000	0.845
High school enrollment rate (3): age groups 15 and 16	61	0.248	0.200	0.000	0.849
Income inequality	58	2.411	0.608	1.140	4.280
Education expenditure / GDP	57	0.030	0.010	0.006	0.057
Rural population / total population	61	0.730	0.146	0.330	0.932
ln (real per capita GDP)	58	7.265	0.731	6.013	9.439
Fixed investment / GDP	58	0.323	0.104	0.162	0.606
Average schooling years	61	4.897	1.227	1.017	7.818

Notes: (1) Data source: DATA9000 (see Appendix A for details); (2) the temporary migration rate is directly computed from the 1990 and 2000 population censuses The temporary migration rate is defined as the proportion of emigrants aged 20–40 years out of the total population of the same age who migrated out the source regions during the past five years; (4) school enrollment ratios are measured as the proportion of students at the given grade of education relative to total population at the normal graduation age.

Table 3
Permanent emigration on middle school enrollment.

	Dependent variable: ln (middle school enrollment rate)							
	All regions				Coastal regions excluded			
	Panel A. Fixed effects estimates							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Permanent emigration rate	0.010*	0.008*	0.005	0.005	0.015**	0.013*	0.008	0.008
	(0.005)	(0.005)	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)	(0.008)
	Panel B. 2SLS estimates							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Permanent emigration rate	0.057***	0.051***	0.051*	0.060	0.081**	0.089**	0.180	0.198
	(0.018)	(0.018)	(0.030)	(0.041)	(0.033)	(0.045)	(0.225)	(0.287)
ln (education expenditure / GDP)	No	Yes	Yes	Yes	No	Yes	Yes	Yes
ln (income inequality)	No	No	Yes	Yes	No	No	Yes	Yes
ln (rural population / total population)	No	No	No	Yes	No	No	No	Yes
# of observations	144	142	115	115	90	88	71	71
# of regions	29	29	29	29	18	18	18	18

Notes: (1) Data source: DATA8005 (see Appendix A for details); (2) Table 1 presents the summary statistics; (3) robust standard errors are in parentheses; (4) the instrument variable used in panel B for contemporaneous permanent emigration rate is the lagged permanent emigration rate; (5) * significant at 10%; ** significant at 5%; *** significant at 1%; (6) all regressions include year dummies.

Columns (1)–(4) in Panel A show the fixed effects estimates using the whole sample including all regions in China. Column (1) only includes the involved variables of emigration and time dummies. It also shows that the emigration rate has a positive effect on middle school enrollment and that this effect is statistically significant. We add some controls that may influence the enrollment rate and emigration rate step by step. These controls include public education expenditure ratio, urban–rural income inequality, and the proportion of agricultural population. The first two variables are used to control possible credit constraints for schooling. The last variable is controlled for because there exists a big gap in educational attainment between rural and urban areas. Results show that the coefficient of emigration rate is still statistically significant at the 10% level after controlling for the public education expenditure ratio in Column (2), although the estimated magnitude is lower than that in Column (1). The next two columns show that the emigration rates still have positive effects on middle school enrollment; however, the coefficients become statistically insignificant after controlling for more variables reflecting income inequality and rural population.

In Columns (5)–(8) in Panel A, the coastal regions are excluded from our analysis because these provinces are usually migrant-receiving regions, which, to some extent, are similar to developed countries based on cross-country analysis.[12] Despite this fact, we find that emigration rates cause middle school enrollment to increase, with a coefficient of around 0.01. The coefficients shown in Columns (7) and (8), after controlling for the inequality and share of agricultural population, are marginally significant at the 10% level.

[12] The coastal regions are Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan. The 2000 census shows that these coastal regions are net immigration regions. In other words, the number of immigrants is larger than the number of emigrants in these regions.

Panel B of Table 3 reports the 2SLS estimates. Considering that permanent emigration rates might be an endogenous variable, we use the lagged values as the instrumental variable. This practice is quite standard in the migration literature (e.g., McKenzie & Rapoport, 2010; Woodruff & Zenteno, 2007).[13] The 2SLS estimates are qualitatively similar to the fixed-effects estimates, although the magnitudes of the 2SLS estimates are bigger than the fixed-effects estimates.

Table 4 presents the estimation results for the effects of permanent emigration on high school enrollment in the source regions. Columns (1)–(4) of Panel A show the full sample estimates. In Columns (5)–(8) of Panel A, we have restricted the analysis to the sub-dataset without the coastal regions. Column (1) includes only the emigration rate and period dummies. One may see that the emigration rate has a statistically significant coefficient, with a magnitude of 0.017. This means that on average, one permillage increment in the emigration rate increases the high school enrollment rate by 1.7%. We then add the public education expenditure ratio to the regression model, giving a statistically significant coefficient of emigration with a smaller magnitude of 0.016. Column (3) includes income inequality, showing that the emigration rate still has significantly positive effects on high school enrollment at the 10% level. Column (4) controls all the three variables. The result shows that the coefficient of the emigration rate remains positive, although both its magnitude and significance level have declined slightly.

Columns (5)–(8) repeat the exercise as in Columns (1)–(4) by using a sub-sample dataset, which excludes the 11 coastal regions. Column (5) shows that the emigration rate has a statistically significant positive coefficient with a magnitude of 0.018. When adding the public education expenditure ratio, the emigration rate remains statistically significant. We further control the other two variables in a step-by-step procedure as shown in Columns (7) and (8); both regressions show that the effect of emigration on high school enrollment is strong that it can control these variables. In addition, the estimated coefficient is positive and statistically significant at the 10% level, although the coefficients have slightly declined. In Panel B of Table 4, we report the 2SLS estimates. The results are qualitatively the same. Moreover, the changes of the magnitudes of the estimates are very small.

Comparing Table 4 with Table 3, we find that the estimated effect of emigration on high school enrollment is larger than its effect on middle school enrollment. To sum up, the estimated results in both Table 3 and Table 4 show that emigration does have a positive effect on school enrollment even if some of the coefficients are not statistically significant. The results presented here suggest a positive effect of permanent emigration on human capital investment in the source regions.

5.1.2. The effect of permanent emigration on economic growth

We now report the effects of emigration on growth in Table 5. Following the literature we reviewed, we have adopted the system GMM estimator to carry out these regressions. Columns (1)–(4) in Table 5 report the two-step system GMM estimates. The permanent emigration rates are instrumented by the lagged values. Column (1) includes the emigration rate, investment ratio, initial output level, and period dummies. It also shows that the three variables have statistically significant coefficients at the 1% level. Emigration rate has a negative impact on economic growth rate, with a magnitude of −0.004. This means that one permillage increase in the emigration rates will decrease the growth rate of that province by 0.4%. The negative coefficient of the initial output level implies that there is a convergence in the output per capita between regions.

The results of the diagnostic tests for the GMM model are reported in the second panel of Table 5. Applying the Arellano-Bond test for autocorrelation in first difference errors, we find that the test for AR(1) rejects the null hypothesis of no first-order autocorrelation. In contrast, the result of the Arellano-Bond test for AR(2) shows that the null hypothesis of no second-order autocorrelation cannot be rejected. These results support the requisition of implementing the GMM estimation. Furthermore, we conduct a Sargan overidentifying test to examine the validity of the additional instruments.[14] It is difficult to find an instrument variable which is very convincing. However, as the Sargan test results in the reported tables indicate, the IVs pass the test of over-identifying restrictions (i.e. the test results confirm that the IVs can be excluded from the equations of main interest). The p-values for the Sargan test suggest that these instruments are statistically valid.

We add some controls to the basic growth regression in Columns (2)–(4). Column (2) includes the enrollment rates of middle school and high school, both of which are used to represent human capital. According to the endogenous growth theory, these two variables are expected to have positive effects on the growth rate. Column (3) includes the budget expense ratio and the degree of openness. Budget expense ratio is used to represent government size, which is usually argued to have detrimental impacts on growth. The degree of openness is expected to have beneficial impacts on economic growth. Both regressions show that the coefficients of the emigration rates change slightly yet still have a high level of significance. Column (4) suggests that we have full control over all the variables. Accordingly, the results are still robust and statistically significant at the 1% level. The coefficients of the other variables have predictable signs, although some are insignificant. Furthermore, the Sargan tests suggest that there is no explicit evidence to reject the validity of instrumental variables used in GMM regressions. The Arellano-Bond tests suggest that the requisition of implementing the GMM estimation suffices.

To examine whether the GMM estimates are biased, Bond et al. (2001) proposed a suggestive method. They argued that the OLS estimate of $\ln(\textit{per capita GDP}_{t-1})$ is usually biased upwards, while the within-group estimate of $\ln(\textit{per capita GDP}_{t-1})$ is biased downwards. Therefore, these estimates provide the upper and lower bounds for the robustness check of the system GMM.[15] Following

[13] We are not able to construct a Bartik-style instrument for permanent emigration rates because the variable of permanent emigration rates is from statistic yearbooks. We discuss the construction of a Bartik-style instrument for temporary emigration rates below.

[14] The Sargan test is a test of over-identification restrictions. The joint null hypothesis is that the excluded instruments are correctly excluded from the structural growth equation, and the structural equation is correctly specified. Under the null hypothesis, the test statistic is asymptotically distributed as chi-squared with a degree of freedom equal to the number of over-identify restrictions. For further discussion, see for example, Hayashi (2000, pp. 227–228, 407, 417).

[15] For further discussion, see Bond et al. (2001).

Table 4
Permanent emigration on high school enrollment.

	Dependent variable: ln (high school enrollment rate)							
	All regions				Coastal regions excluded			
	Panel A. Fixed effects estimates							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Permanent emigration rate	0.017**	0.016**	0.012*	0.010	0.018**	0.014*	0.012*	0.010*
	(0.007)	(0.008)	(0.007)	(0.006)	(0.007)	(0.007)	(0.006)	(0.006)
	Panel B. 2SLS estimates							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Permanent emigration rate	0.012*	0.013	0.003	0.004	0.036***	0.037***	0.048***	0.048***
	(0.007)	(0.008)	(0.008)	(0.006)	(0.006)	(0.007)	(0.009)	(0.013)
ln (education expenditure / GDP)	No	Yes	Yes	Yes	No	Yes	Yes	Yes
ln (income inequality)	No	No	Yes	Yes	No	No	Yes	Yes
ln (rural population / total population)	No	No	No	Yes	No	No	No	Yes
# of observations	144	142	115	115	90	88	71	71
# of regions	29	29	29	29	18	18	18	18

Notes: (1) Data source: DATA8005 (see Appendix A for details); (2) Table 1 presents the summary statistics; (3) robust standard errors are in parentheses; (4) the instrument variable used in panel B for contemporaneous permanent emigration rate is the lagged permanent emigration rate; (5) * significant at 10%; ** significant at 5%; *** significant at 1%; (6) all regressions include year dummies.

their procedure, we also conduct these two regressions. The results are presented in Columns (5) and (6). In comparing the coefficient in Column (4) with that in Columns (5) and (6), it is clear that the coefficient of ln(*per capita GDP*$_{t-1}$) in Column (4) stands between the coefficients in Columns (5) and (6). This indicates that the system GMM estimates are reliable.

5.2. The effect of temporary emigration

As stated in the Introduction, although permanent migration in China may resemble international migration, this measure can only provide the gross migration rate. To obtain the composition of the migration rates, temporary migration data imputed from the census can provide us with an alternative.

The census data allows us to separate gross migration into several groups by educational level, allowing an investigation of the compositional effect of migration on human capital formation and economic growth. Furthermore, the 1990 census recorded total

Table 5
Permanent emigration on economic growth.

	Dependent variable: real per capita GDP growth rate					
	SYS-GMM	SYS-GMM	SYS-GMM	SYS-GMM	POLS	FE
	(1)	(2)	(3)	(4)	(5)	(6)
ln (real per capita GDP$_{t-1}$)	−0.037***	−0.019**	−0.055***	−0.045*	−0.025***	−0.083***
	(0.004)	(0.009)	(0.019)	(0.025)	(0.007)	(0.011)
Permanent emigration rate	−0.005***	−0.003***	−0.003**	−0.003**	−0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ln (fixed investment / GDP)	0.092***	0.087***	0.134***	0.108***	0.013	0.021*
	(0.009)	(0.017)	(0.027)	(0.034)	(0.009)	(0.011)
ln (middle school enrollment rate)		−0.079***		−0.002	0.016	0.019
		(0.023)		(0.040)	(0.020)	(0.022)
ln (high school enrollment rate)		−0.002		0.002	0.016	0.034**
		(0.043)		(0.042)	(0.011)	(0.013)
ln (government expenditure / GDP)			−0.057***	−0.045**	−0.024***	−0.001
			(0.012)	(0.019)	(0.007)	(0.008)
ln (international trade / GDP)			0.015**	0.018*	0.010***	−0.001
			(0.008)	(0.011)	(0.004)	(0.007)
AR(1) test	0.002	0.003	0.001	0.004		
AR(2) test	0.885	0.901	0.870	0.771		
Sargan test	0.273	0.389	0.491	0.549		
# of observations	144	142	144	142	142	142
# of regions	29	29	29	29	29	29

Notes: (1) Data source: DATA8005 (see Appendix A for details); (2) Table 1 presents the summary statistics; (3) absolute value of *t* or *z* statistics in parentheses; (4) * significant at 10%; ** significant at 5%; *** significant at 1%; (5) all regressions include year dummies; (6) AR (1) test and AR (2) test denote Arellano-Bond test for zero autocorrelation in first difference errors. Sargan test denotes the test of over-identifying restrictions for additional instruments in level equations. P-values for AR(1), AR(2), and Sargan tests are reported. (7) There are 29 regions in the regressions.

migration from 1985 to 1990, while the 2000 Census recorded total migration from 1995 to 2000. As discussed in Section 2, large-scale migration between regions occurred during these two periods; so that census-based data provides us with a better understanding of the migration during this time. As both censuses recorded only cross-province migration over a five-year period, the migration rate imputed from the census data is regarded as temporary migration.[16] However, using the census data also has disadvantages. China has had five censuses since 1953, but only two of them (1990 and 2000) provide migration information. Given this, we have migration rates at only two time points. For this reason, it is impossible to run GMM regressions for the economic growth equation.

5.2.1. A Bartik-style instrument

Temporary emigration might be an endogenous variable in either the human capital formation or the economic growth equations. To address this concern, we have constructed a Bartik-style instrument following Theoharides (2014)[17]:

$$D_{pt} = \sum_i M_{it} \frac{M_{pi0}}{M_{i0}}$$

where D_{pt} is the predicted number of emigrants in province p and year t. M_{it} is the number of emigrants to destination province i and year t in China. $\frac{M_{pi0}}{M_{i0}}$ is the share of emigrants at a baseline year from province p to province i out of the total emigrants from province p.

This instrument uses the province-specific historic migrant networks across provinces to construct a migration demand index. Specifically, $\frac{M_{pi0}}{M_{i0}}$ is a proxy variable of historical migration networks which should be orthogonal to the contemporaneous socioeconomic environment in the sending province. So, D_{pt} is the predicted number of emigrants. However, all censuses prior to census 1990 do not have information on migration. To address this concern, we use the old permanent emigrants in census 2000 to proxy for the historical network. Specifically, M_{pi0} is the number of people whose age is 50 years and above whose *hukou* are located in province i but who were born in province p; M_{i0} is the total number of people whose age is 50 and above whose *hukou* are located outside of province p but who were born in province p.

5.2.2. The effect of temporary emigration on school enrollment

Table 6 presents the estimated effects of emigration rates on middle school enrollment using temporary migration data (DATA9000). Panel A reports the fixed-effects estimates. We first run the regression for the full sample, and the results of which are given in Columns (1)–(3). Column (1) shows that the emigration rate has a positive effect on middle school enrollment, although this effect is statistically significant only at a marginal level. The composition of emigration by educational level also has positive coefficients on middle school enrollment. In addition, we find that the effect of emigration on middle school enrollment increases with the share of highly educated emigrants. The coefficients on the share of college-educated temporary emigrants out of the total temporary emigrants are consistently significant at the 1% level. These coefficients mean that compared with the base group (emigrants with either primary education or illiteracy), emigration of workers with high educational attainment will help increase middle school enrollment. Furthermore, the higher the education level, the stronger such an effect will be. For example, the temporary emigration rate of workers with college education has a stronger effect on promoting middle school enrollment than that of a high temporary emigration rate on high school education.

As discussed in Section 3, the normal graduation age is 12, 13, or both. Therefore, in Column (2), we use another middle school enrollment, which assumes that 13 is the normal graduation age. We still find positive coefficients from all these emigration variables. The coefficients on the variable for the proportion of temporary emigrants with college education and the variable of total temporary emigrants change little in magnitude. In contrast, for the variables for the proportion of temporary emigrants with middle school and high school education, notable changes in magnitude have been observed. This indicates that the coefficients on the variables of shares of temporary emigrants with middle school and high school are somewhat sensitive to the selection of normal graduation age, which determines the variation of the dependent variable.

Therefore, we repeat the regression by assuming that both 12 and 13 are the normal graduation ages of primary school pupils. We expect that the estimated coefficients on the variables of shares of temporary emigrants with middle school and high school education would stand between those in Columns (1) and (2). The result reported in Column (3) supports this prediction. Column (3) also shows that the variable of the proportion of temporary emigrants with college education still has a statistically significant coefficient, and the magnitude of the coefficient has made a small increase. At the same time, the gross emigration rate still exhibits a positive effect on the increase of middle school enrollment, as seen in Table 3.

Columns (4)–(6) in Panel A of Table 6 repeat the regressions by restricting the sample within the western and central regions of China. The results show some changes. Each of the three regressions that use three measures of the middle school enrollment, respectively, reveals that the coefficients of emigration rates with middle school education become negative, but these negative coefficients are statistically insignificant. In addition, the coefficients of emigration rates with high school education and the gross emigration rates are statistically significant. In terms of the magnitude of the coefficients, the results suggest that the relative importance of the composition of the emigration rates has changed to some extent. For example, compared with the data in Columns (1)–(3), the emigration of workers with college education is relatively less important in promoting the middle school enrollment in the source regions.

[16] To comply with the definition of temporary emigration, we have excluded the emigrants who have had a change of *hukou*.

[17] We thank a referee's suggestion on the construction of a Bartik-style instrument.

Table 6
Temporary emigration and middle school enrollment.

	Dependent variable: middle school enrollment rates					
	Coastal regions included			Coastal regions excluded		
	MID 1	MID 2	MID 3	MID 1	MID 2	MID 3
	Panel A: Fixed effects estimates					
	(1)	(2)	(3)	(4)	(5)	(6)
Share of temporary emigrants with middle school education	0.377	0.588	0.541	−0.519	−0.171	−0.344
	(0.451)	(0.449)	(0.488)	(0.458)	(0.445)	(0.472)
Share of temporary emigrants with high school education	0.937	0.241	0.498	2.594**	1.871*	2.239**
	(0.818)	(0.688)	(0.771)	(0.997)	(0.901)	(1.005)
Share of temporary emigrants with college school education	1.211***	1.269***	1.317***	0.575	0.853	0.785
	(0.405)	(0.404)	(0.405)	(0.695)	(0.563)	(0.601)
Temporary emigration rate	1.083	1.099*	1.172	2.269***	2.102***	2.299***
	(0.672)	(0.633)	(0.689)	(0.669)	(0.673)	(0.724)
	Panel B: 2SLS estimates					
	(1)	(2)	(3)	(4)	(5)	(6)
Share of temporary emigrants with middle school education	0.369	0.586	0.534	−0.576	−0.230	−0.410
	(0.453)	(0.433)	(0.467)	(0.552)	(0.476)	(0.523)
Share of temporary emigrants with high school education	0.939	0.241	0.499	2.701**	1.985*	2.365*
	(0.831)	(0.794)	(0.856)	(1.322)	(1.140)	(1.252)
Share of temporary emigrants with college school education	1.208**	1.268**	1.314**	0.572	0.849	0.781
	(0.528)	(0.504)	(0.544)	(0.751)	(0.647)	(0.711)
Temporary emigration rate	1.111	1.106	1.196	2.449**	2.292**	2.510**
	(0.928)	(0.886)	(0.955)	(1.175)	(1.013)	(1.113)
# of observations	57	57	57	35	35	35
# of regions	29	29	29	18	18	18

Notes: (1) Data source: DATA9000 (see Appendix A for details); (2) Table 2 presents the summary statistics; (3) standard errors are in parentheses; (4) * significant at 10%; ** significant at 5%; *** significant at 1%; (5) all regressions include year dummies, ln (education expenditure / GDP), ln (income inequality), and ln (rural population / total population); (6) we use a Bartik-stype instrument for temporary emigration rate in Panel B; (7) middle school enrollment rates are calculated as the proportion of middle school students relative to the total population of the same age group (age of 12, 13, or 12–13). MID1: age 12 is assumed as the normal graduation age of primary school, MID2: age 13 is assumed as the normal graduation age of primary school; MID3: 12 or 13 is assumed as the normal graduation age of primary school pupils.

Table 7
Temporary emigration and high school enrollment.

	Dependent variable: high school enrollment rates					
	Coastal regions included			Coastal regions excluded		
	HIG 1	HIG 2	HIG 3	HIG 1	HIG 2	HIG 3
	Panel A: fixed effects estimates					
	(1)	(2)	(3)	(4)	(5)	(6)
Share of temporary emigrants with middle school education	−0.935**	−0.530**	−0.678**	−0.775***	−0.367**	−0.536***
	(0.435)	(0.224)	(0.288)	(0.179)	(0.146)	(0.147)
Share of temporary emigrants with high school education	0.638	0.190	0.299	−0.160	−0.497	−0.390
	(0.857)	(0.484)	(0.597)	(0.329)	(0.414)	(0.350)
Share of temporary emigrants with college school education	−1.315**	−0.850***	−1.002***	−0.824***	−0.635***	−0.726***
	(0.570)	(0.246)	(0.326)	(0.273)	(0.205)	(0.233)
Temporary emigration rate	0.700	0.419	0.542	1.492	0.603	0.952
	(0.770)	(0.384)	(0.498)	(0.984)	(0.377)	(1.333)
	Panel B: 2SLS estimates					
	(1)	(2)	(3)	(4)	(5)	(6)
Share of temporary emigrants with middle school education	−0.940*	−0.488**	−0.646**	−0.741***	−0.342*	−0.507**
	(0.517)	(0.231)	(0.298)	(0.240)	(0.196)	(0.208)
Share of temporary emigrants with high school education	0.639	0.183	0.293	−0.225	−0.544	−0.444
	(0.949)	(0.424)	(0.546)	(0.575)	(0.468)	(0.499)
Share of temporary emigrants with college school education	−1.316**	−0.836***	−0.991***	−0.822**	−0.634**	−0.724**
	(0.602)	(0.269)	(0.347)	(0.326)	(0.266)	(0.283)
Temporary emigration rate	0.716	0.278	0.435	1.383	0.525	0.861
	(1.058)	(0.473)	(0.609)	(1.511)	(0.416)	(1.443)
# of observations	57	57	57	35	35	35
# of regions	29	29	29	18	18	18

Notes: (1) Data source: DATA9000 (see Appendix A for details); (2) Table 2 presents the summary statistics; (3) standard errors are in parentheses; (4) * significant at 10%; ** significant at 5%; *** significant at 1%; (5) all regressions include year dummies, ln (education expenditure / GDP), ln (income inequality), and ln (rural population / total population); (6) we use a Bartik-stype instrument for temporary emigration rate in Panel B; (7) middle school enrollment rates are calculated as the proportion of middle school students relative to the total population of the same age group (age of 12, 13, or 12–13). MID1: age 12 is assumed as the normal graduation age of primary school, MID2: age 13 is assumed as the normal graduation age of primary school; MID3: 12 or 13 is assumed as the normal graduation age of primary school pupils.

To address the potential endogeneity of emigration in the human capital formation equation, we use a 2SLS estimator. Panel B of Table 6 reports the 2SLS estimation results of the effects of temporary emigration on middle school enrollment rates. We find that the results reported in Panel A are robust as to the usage of the instrumental variable method.

Table 7 presents the estimation results of the effects of temporary emigration on high school enrolments. Panel A reports the fixed effect estimates. We find that the coefficients of emigration rates of emigrants with middle school education now become negative; such coefficients are statistically significant at a high level. When we focus on the sample that excludes the coastal regions, the coefficients of emigration rates with middle school education are still statistically significant and negative. This means that the share of temporary emigrants with only middle school education will significantly reduce high school enrollment. The results are qualitatively the same when we use the 2SLS estimation as reported in Panel B.

Based on Tables 6–7, we conclude that not only the total volume of emigrants but also their educational composition affects human capital investment in the source regions.

5.2.3. The effect of temporary emigration on economic growth

We now investigate the relationships between temporary emigration by educational level and economic growth using the temporary migration data. We only have observations for two time points; thus, OLS and 2SLS regressions are adopted. Table 8 shows the regression outcomes. Panel A reports the OLS estimates. For the first three columns, we run the regressions using the full sample. In Column (1), the growth rate is regressed on the emigration rates based on the initial output level. The emigration rate of emigrants with middle school education is found to be positively correlated with the growth rate; in contrast, the other two emigration rates are always negatively correlated with the growth rate. This means that compared with the base group (emigrants with only primary school education or those who are illiterate), the emigration of workers with middle school education will foster the growth of the source regions, while the emigration of workers with high school education or better will be detrimental to the growth of the sending regions. The gross emigration rate here is found to have a predictable negative effect on growth, which is consistent with the findings in Table 5. The positive and statistically significant coefficient of the lagged per capita GDP suggests that there is a divergence between Chinese regions for the period of 1990–2000.

We then add some controls to the regressions in Columns (2) and (3). The first is the initial investment rate, which usually needs to be included in the growth regression model according to the growth theory. The second control is the initial average schooling, which is the proxy of human capital. According to the new growth theory, the initial level of human capital is often conducive to growth. Column (2) shows that there is no significant change in terms of the estimated coefficients after including the initial investment ratio. The negative sign of the coefficient of the initial investment ratio is inconsistent with the theoretical expectation, but it is statistically insignificant. The basic results remain even after controlling for the initial level of human capital, as shown in Column (2).

However, the results in Columns (4)–(6) display a dramatic change after we drop the coastal regions from our analysis data. First, the coefficient of the initial output level now becomes negative as the growth theory is asserted, although this negative coefficient is

Table 8
Temporary emigration and economic growth.

	Dependent variable: real per capita GDP growth rate					
	Coastal regions included			Coastal regions excluded		
	HIG 1	HIG 2	HIG 3	HIG 1	HIG 2	HIG 3
	Panel A: OLS estimates					
	(1)	(2)	(3)	(4)	(5)	(6)
Share of temporary emigrants with middle school education	0.122**	0.116**	0.113*	0.060	0.054	0.039
	(0.049)	(0.051)	(0.058)	(0.043)	(0.044)	(0.062)
Share of temporary emigrants with high school education	−0.042	−0.027	−0.029	0.002	0.016	0.012
	(0.060)	(0.068)	(0.072)	(0.055)	(0.059)	(0.062)
Share of temporary emigrants with college school education	−0.070	−0.073	−0.076	0.058	0.052	0.045
	(0.064)	(0.066)	(0.073)	(0.056)	(0.058)	(0.063)
Temporary emigration rate	−1.393**	−1.234*	−1.238*	−1.070*	−0.849	−0.854
	(0.578)	(0.659)	(0.676)	(0.517)	(0.595)	(0.621)
	Panel B: 2SLS estimates					
	(1)	(2)	(3)	(4)	(5)	(6)
Share of temporary emigrants with middle school education	0.125**	0.134**	0.127*	0.062	0.059	0.043
	(0.058)	(0.061)	(0.069)	(0.043)	(0.045)	(0.063)
Share of temporary emigrants with high school education	−0.048	−0.071	−0.075	−0.000	0.008	0.005
	(0.071)	(0.082)	(0.087)	(0.056)	(0.061)	(0.064)
Share of temporary emigrants with college school education	−0.133	−0.122	−0.128	0.047	0.040	0.034
	(0.080)	(0.080)	(0.088)	(0.061)	(0.061)	(0.066)
Temporary emigration rate	−3.125***	−3.204***	−3.191***	−1.291*	−1.212	−1.177
	(0.967)	(1.052)	(1.068)	(0.675)	(0.774)	(0.795)
# of observations	29	29	29	18	18	18

Notes: (1) Data source: DATA9000 (see Appendix A for details); (2) Table 2 presents the summary statistics; (3) absolute values of robust t statistics in parentheses; (4) * significant at 10%; ** significant at 5%; *** significant at 1%; (5) all regressions include year dummies, ln (real per capita GDP_{t-1}), ln (fixed investment / GDP), and ln (average schooling years); (6) we use a Bartik-stype instrument for temporary emigration rate in Panel B.

statistically insignificant. This implies that there could be a 'club convergence' in the western and central regions in China.[18] Second, all three compositions of the emigration rates become positively and statistically not significantly correlated with the growth rates. Only the impact of the gross emigration rate on growth rate remains unchanged, still exhibiting a negative effect on growth. Columns (5) and (6) reveal that the main results in Column (4) remain. In Panel B of Table 8, we carry out the 2SLS estimation. The results are qualitatively the same as those reported in Panel A.[19]

In summary, the estimates in Table 8 do not seem sufficiently robust. One possible reason is that the sample is limited and very small inducing sensitive results. Alternatively, temporary migration may not be a suitable measure in the context of this growth analysis because it contains a large 'floating population' who often return to their hometowns even if they were listed as the residents of the destination regions during the census period. Therefore, we argue that this kind of migration has an ambiguous effect on the growth of the sending regions.

6. Discussion and conclusion

The impact of emigration on the well-being of the source regions is still hotly debated in the literature. This paper argues that the impact of emigration on the well-being of the source regions depends not only on the type of emigration (temporary versus permanent) but also on the educational attainment of the emigrants. By exploring Chinese provincial data from 1980 to 2005, we examined the effects of emigration on both school enrollment and economic growth of the source regions. Unlike previous studies, this study distinguishes the effects of temporary emigration from those of permanent emigration.

We found that permanent emigration improves enrollment in both middle and high schools. In contrast, we found that the magnitude of temporary emigrants only has a significantly positive effect on middle school enrollment but does not have a significant effect on high school enrollment. More interestingly, different educational attainments of temporary emigrants have different effects on school enrollments. Specifically, the share of temporary emigrants with high school education positively affects middle school enrollment, while the share of temporary emigrants with middle school education negatively affects high school enrollment.

Combining the results from both permanent and temporary migration, we found that the educational level of the migrants is positively associated with school enrollments.[20] As discussed in the subsection of the background on China's educational system, high school level provides a general education during which little technical or professional skills are developed. The almost exclusive objective of anyone studying in high school is to prepare for further education and then to take the university entrance examination, although the admission rate to universities is low. Thus, with more people migrating out after university education, more students will be encouraged to study high school and eventually take their university entrance tests. In contrast, with more people migrating out with a low level of education, say, middle school level, more students will prefer to enter the labor market directly for employment rather than enter high schools. This is something like a demonstrative or incentive effect.

We have also estimated the effect of both permanent and temporary emigration on economic growth. We find that that both permanent and temporary emigration has a detrimental effect on the economic growth of the source regions. The results suggest that a positive brain gain effect cannot fully compensate for the negative brain drain effect on the economic growth in source regions.

In summary, the empirical results of this paper imply that when designing or evaluating migration policies, not only the classification into permanent or temporary migration should be considered but also the educational composition of the migrants. Furthermore, the fact that emigration affects school enrollment and human capital formation suggests that we should study not only economic aspects but also human development aspects.

Appendix A. Comparing the two data sets: DATA8005 vs. DATA9000

DATA8005

Period: 1980–2005

Intervals: 5 years

Source: All variables are collected from *Comprehensive Statistical Materials of Population of Peoples' Republic of China: 1949–1985* and from various issues of the *China Statistical Yearbooks, Educational Statistical Yearbook of China,* and *China Population Statistical Yearbooks.*

Migration type: Permanent migration

Description: This data set contains only the information on migrants whose *hukou* has been changed. As discussed in the Background section, migrants who have had a change of *hukou* are regarded as permanent migrants in the Chinese context.

[18] 'Club convergence' means that the *per capita* incomes of countries identical in their structural characteristics converge with one another in the long run provided that their initial conditions are similar (Galor, 1996). In other words, countries or regions with similar initial conditions cluster into different groups and converge to different steady states.

[19] Although results suggest that highly skilled temporary migration is related to a decrease in schooling performance at home, it is worth noting that temporary migrants with higher education are very particular and rare. Sun and Fan (2011) show that they only account for 1.3% of all temporary migrants. Therefore they should not change the interpretation of our main results.

[20] In China, even after the economic reform, obtaining a university degree remains the only way to achieve permanent migration or to change one's *hukou* for a long period, especially for those born in rural areas. Thus, although we have no information on the educational composition of the permanent migrants, the majority of permanent migrants have higher educational attainment.

DATA9000

Period: 1990–2000

Intervals: 10 years

Source: Variables relating to migration and school enrollments are directly generated from the 1990 and 2000 censuses of population (1% sample). Other socioeconomic variables are taken from the statistical book *Comprehensive Statistical Materials of Population of Peoples' Republic of China: 1949–1985* and from the various issues of *China Statistical Yearbooks*.

Migration type: Temporary migration

Description: Temporary migrants are those who have changed their residences during the last five years. The main advantage of DATA9000 is that it allows the classification of the migrants into different education groups. We can explore the different effects of the different educational attainments of temporary emigrants on the human capital formation and economic growth in the source regions.

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