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ORIGINAL PAPER

Hukou reform and labor market outcomes of urban natives in China

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Abstract

This paper investigates the causal effects of the relaxation of internal migration restrictions on labor market outcomes of urban natives in China, exploiting an "entry barrier" *hukou* reform. The prevalent view of China's *hukou* reform emphasizes its attraction for low-skilled workers, neglecting its considerable impact on high-skilled individuals. We find that the *hukou* reform cities attracted more high-skilled migrants. The greater availability of high-skilled migrants due to the *hukou* reform did not significantly affect the overall employment and income of urban natives. However, the reform did lead to employment shifts among urban natives, and these effects were most pronounced among high-skilled and medium-skilled urban natives. In addition, we find evidence that the reform attracted more self-employed individuals and private-owned enterprises (POEs), which stimulated local labor demand, especially for high-skilled workers.

Keywords *Hukou* reform · Labor market outcomes · Skill-biased effect · Employment shifts · Labor demand

JEL Classification J21 · J61 · J68 · O18

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1 Introduction

China has experienced mass internal migration in recent decades during the process of rapid economic growth and urbanization. As reported by the National Bureau of Statistics in China, 6.75 million people migrated in 1982, while the number increased to 247 million in 2015 and reached 376 million in 2020, exceeding the number of international migrants during the same period.[1] Consequently, China's internal migration has become an increasingly important academic and policy issue.

The impact of immigration on the labor market outcomes of natives has been widely debated in developed economies with no consensus. One common view is that immigrants can compete with natives, implying that increased immigration is a negative shock to natives (e.g., Altonji and Card 1991; Card 2001; Borjas 2003; Dustmann et al. 2017). Another view is that immigrants and natives are complementary, with natives benefiting from immigrants (Bodvarsson et al. 2008; Ottaviano and Peri 2012; Hong and McLaren 2015; Beerli et al. 2021). A third finds little or no impact of immigration on natives (e.g., Butcher and Card 1991; Card 2005; Manacorda et al. 2012). Ongoing debates call for more evidence.

In this paper, we use the Urban Household Survey (UHS) to study the impact of the relaxation of internal migration restrictions on the employment and income of urban natives, exploiting a *hukou* reform that began in 2001 in China.,[2][3] The *hukou* reform was adopted to relax the restrictions on internal migration, enabling migrants to gain eligibility for local urban *hukou* in selected prefectural cities (i.e., "entry barrier" *hukou* reform). Moreover, the *hukou* reform was rolled out on a city-by-city basis, allowing us to adopt the difference-in-differences (DiD) approach. This identification strategy compares the before-and-after changes in the outcomes of urban natives in reform cities with those in non-reform regions during the same period.

We aim to examine how the institutional policy change affected the internal migration and labor market outcomes of urban natives, emphasizing how individuals with different educational attainment respond. Existing evidence suggests that the impact of the *hukou* reform on the mobility of rural migrant workers was limited

[1] The data of migration in China is from http://www.stats.gov.cn/xxgk/jd/sjjd2020/202105/t20210513_1817408.html. In fact, internal migration is much more common than immigration, especially in developing countries (e.g., China, India, and Vietnam). The most recent estimate is that the number of international migrants was around 281 million in 2020, accounting for 3.6% of the global population (McAuliffe and Triandafyllidou 2021). The number of internal migrants was 740 million globally in 2009 (Esmer et al. 2009), which equates to 10.8% of the world population. During the period 1990 to 2005, the number of internal migrants was about 73.1 million in China, 42.3 million in India, and 12.7 million in Vietnam, accounting for 6.2%, 4.1%, and 21.9% of the total population in each country, respectively (Esmer et al. 2009).

[2] Note that we define urban natives based on legal *hukou* status. As a result, urban natives in our research include both permanent migrants (i.e., who have registered *hukou* in locals) and those natives since birth.

[3] The 2014 *hukou* reform is also widely studied (e.g., An et al. 2024; Chen and Fu 2023; Wang et al. 2023). However, we focus on the 2001 *hukou* reform and all statements on "*hukou* reform" throughout our paper refer to that unless otherwise stated.

(Sun 2021). Our textual analysis of the policy documents also shows that most cities imposed many restrictions on the implementation of the *hukou* reform. Therefore, we expect the high-skilled workers to be the affected group, as they are more likely to overcome the restrictions in most cases.

We first examine the impact of the *hukou* reform on migration. Contrary to the findings of previous studies focusing on rural–urban migration, we find that the *hukou* reform attracted more inflows of high-skilled migrants. We define high-skilled workers as those with college education and above, medium-skilled workers as those with senior high school education, and low-skilled workers as those with less than high school education. Further tests on the composition of migrants suggest that the high-skilled migrants are mainly young. Furthermore, we investigate the impact of the *hukou* reform on urban natives. Consistent with existing studies (e.g., Meng and Zhang 2010), our main result shows that the *hukou* reform had no significant impact on the employment and income of urban natives. However, the reform did lead to employment shifts from the non-private units to the private units among urban natives. Specifically, the *hukou* reform facilitated urban natives to shift from the formal sectors to the informal sectors, and from state-owned enterprises (SOEs) to non-state-owned enterprises (non-SOEs).

In addition, we examine whether the impact of the *hukou* reform is heterogeneous across urban natives' educational attainment, or whether there are skill-biased effects or not. The result shows that employment shifts due to the *hukou* reform occurred mainly among high-skilled and medium-skilled urban natives. Among medium-skilled natives, the earnings of employed workers declined significantly, while those of self-employed workers increased. However, the overall effects on household income are insignificant. Moreover, the heterogeneous analysis shows that the earnings of employed declined only for men and the earnings for self-employed increased only for women, suggesting that men were more likely to shift to be employed in private units, while women were prone to be self-employed.

Finally, we attempt to answer how the *hukou* reform affected urban natives from the labor demand side. The result shows that the *hukou* reform attracted more private-owned enterprises (POEs) or self-employed individuals, especially for the small-sized POEs. The increase in POEs, particularly in the medium and large-sized POEs, stimulated the local labor demand and significantly boosted the labor demand for high-skilled workers.

Our research has four contributions. First, this paper relates to the literature on the impact of immigration on the labor market outcomes of natives (Card 2001; Borjas 2003; Bodvarsson et al. 2008; Manacorda et al. 2012; Hong and McLaren 2015; Dustmann et al. 2017; Beerli et al. 2021). To date, most of the work has been carried out in developed countries. Unlike international migration, our paper focuses on internal migration in China, complementing existing studies on internal migration in developing countries (Strobl and Valfort 2015; Maystadt et al. 2016; El Badaoui et al. 2017; Kleemans and Magruder 2018) and several studies on the impact of internal migration in China on urban natives (Liu and Zhao 2009;

Meng and Zhang 2010; Shen and Yu 2011; Combes et al. 2015; Gao et al. 2015; Zhao 2020).[4]

Second, our research adds to the literature related to the *hukou* system in China. Different from existing studies focusing on the impact of labor mobility barriers caused by *hukou* system restrictions, our paper concerns the impact of changes in the *hukou* system.[5] In addition, instead of centering on the economic benefits due to *hukou* reform, such as increasing national GDP (Song 2021), improving productivity (Tombe and Zhu 2019; Gai et al. 2021), reducing trade-induced inequality (Fan 2019), promoting labor mobility (Sun 2021; Jin and Zhang 2023), and reducing the consumption volatility of rural households (Kinnan et al. 2018), we focus on more micro-level analysis of individuals. Moreover, unlike a recent study using CFPS data to measure the impact of the 2014 *hukou* reform on urban natives (An et al. 2024), we use the Urban Household Survey (UHS), which is representative of urban households in China, to assess the impact of the 2001 *hukou* reform on urban natives.,[6][7] More importantly, while most studies have focused on the impact of low-skilled migrants on low-skilled natives,our study is concerned with the responses of high-skilled urban natives due to *hukou* reform.

Third, this paper contributes to the literature on the reallocation effects in the local labor market. Emerging literature has investigated the relationship between employment-to-employment reallocation and wage growth (Moscarini and Postel-vinay 2017), the impact of trade liberalization shocks (Dix-Carneiro 2014; Costa et al. 2016; Dix-Carneiro and Kovak 2019) and immigration restriction (Boustan et al. 2010; Abramitzky et al. 2023) on employment adjustment in the local labor market. By contrast, our research provides new evidence on employment shifts under the specific local labor market institutional policy change (i.e., *hukou* reform) in China, which is relatively rare in studies related to *hukou* reform.

[4] Most of these studies used variations in the share of rural-to-urban migration across regions to examine the impact of internal migration on the labor market outcomes of urban natives (Liu and Zhao 2009; Meng and Zhang 2010; Shen and Yu 2011; Combes et al. 2015; Zhao 2020), and some other studies used the city scale (represented by urban population) to examine its impact on urban employment (e.g., Gao et al. 2015). This strand of literature mainly found negative (Liu and Zhao 2009), positive (Shen and Yu 2011; Combes et al. 2015; Gao et al. 2015; Zhao 2020) or little (Meng and Zhang 2010) impact of internal migration. Since almost all of them directly focused on the impact of migration share, neglecting the impact of policy changes (i.e., *hukou* reform in China), or only using cross-sectional data, thus they often faced with endogeneity issues.

[5] This strand of literature includes several perspectives, such as employment and wages (Zi 2020), wage structure (Dreger and Zhang 2017), job allocations (Ngai et al. 2018), consumption (Kinnan et al. 2018), trade-induced inequality (Zi 2018), and wage inequality (Whalley and Zhang 2007).

[6] The CFPS is a nationally representative social survey program that includes both urban and rural areas (Xie and Hu 2014). For example, the CFPS (2010) shows that the sample of urban and rural areas account for 46.38% and 53.62%, respectively. Therefore, the CFPS is less representative in terms of urban households compared to the Urban Household Survey (UHS) data, which is targeted on the survey of urban areas.

[7] The 2001 *hukou* reform we study is characterized by the relaxation of *hukou* entry barriers and attachments on many other requirements, such as education, occupation titles, investment, and housing purchase. The 2014 *hukou* reform studied by An et al. (2014) is carried out on a national scale based on the city-size categories. Therefore, the 2001 *hukou* reform in our research is more likely than the 2014 *hukou* reform to be merit-based. Please refer to An et al. (2024), Chen and Fu (2023), and Wang et al. (2023) for more detailed information on the 2014 *hukou* reform in China.

Finally, our research is related to the literature on the impact of immigration on firms' hiring responses (Wang et al. 2021; Imbert et al. 2022; Jin 2022). The effects of immigration on firms' entry and exit behaviors and productivity have been well documented in previous studies (Mahajan 2022), but little attention has been paid to the impact of reducing migration costs on firms in China (Imbert et al. 2022; Wang et al. 2021). In contrast to existing studies, this paper focuses on the impact of China's *hukou* reform on the entry behavior and hiring decisions of local firms and particularly demonstrates the changes in firms' demand for high-skilled workers, thus providing new insights into how *hukou* reform affects the local labor market.

The rest of this paper is organized as follows. Section 2 briefly reviews the policy background about China's *hukou* reform. Section 3 describes the data, sample, and descriptive statistics of the main variables used in this paper. Section 4 focuses on the econometric specification and identification strategy. Section 5 presents the main empirical results. Section 6 conducts robustness checks. Section 7 discusses possible interpretations from the labor demand perspective. Finally, Sect. 8 concludes.

2 Policy background

The Chinese *hukou*, which means the household registration system, was formally created in 1958 as an institutional system used by the central government to manage the population nationwide and put restrictions on labor mobility. Each Chinese citizen's *hukou* was divided into two types: agricultural and non-agricultural. In addition, their *hukou* was divided into local and non-local. Agricultural and nonagricultural *hukou* reflect the initial occupation type, while local and nonlocal *hukou* are mainly based on the place of *hukou* registration (i.e., birthplace) (Song 2014). There are many criticisms against the division of *hukou*, regarding it as an unfair institution.

Hukou is closely linked to employment opportunities and public service, and there are significant differences between rural and urban areas in China.[8] It is often urban areas that have better job opportunities, higher wages, more convenient amenities, and higher quality of public services. As a consequence, rural migrants tend to move from their birthplaces to urban areas in pursuit of better employment opportunities, local amenities, and public services. However, labor mobility at the early stage is extremely restricted, with rural migrants hardly allowed to move across regions.

Restrictions on labor mobility only began to be gradually relaxed in the 1980s (Chan 2009). Starting from the mid-1990s, a few cities reformed the *hukou* system in the form of experiment to allow internal migration in small cities and towns. This *hukou* reform was expanded to potentially all counties in 2001 (Fan 2019). Despite

[8] The public services associated with *hukou* mainly include housing, education, and social security programs. For example, first, local urban residents are eligible for housing subsidies and have no restrictions on housing purchase transactions; second, their children could attend public schools with higher quality; finally, they also have access to benefits in social relief, social welfare, and social insurance.

the widespread removal of *hukou*-related restrictions in 2001, the impact on migration was limited due to the lower attractiveness of small- and medium-sized cities and towns compared to larger cities.

After 2001, prefectural governments gained decision-making autonomy to advance the urbanization strategy and facilitate mutual development between urban and rural areas, with a focus on *hukou* reform. This allowed prefectural governments to determine the extent of *hukou* reform, resulting in a gradual rollout on a city-by-city basis with varying intensities. The reform was designed to further attract migrant workers by abolishing both agricultural and non-agricultural *hukou* and relaxing *hukou* entry conditions (i.e., "unified *hukou*" reform and "entry barrier" reform). Specifically, the "entry barrier" reform allowed migrant workers to apply for local urban *hukou* as long as they met the requirements of "a legal fixed residence" and "stable income source."

In this paper, we focus on the impact of the "entry barrier" reform.[9] We identify over one hundred reform cities in the UHS sample covering 16 provinces. By reviewing the content of prefectural policy documents, we find that, despite the implementation of the "entry barrier" reform, most urban areas still have a mass of restrictions, such as educational attainment, occupation title, housing purchase, and investment.[10] This implies that the target of this *hukou* entry reform is likely to be high-skilled migrants, as they are more likely to meet these restricted requirements. In the context of this reform, a significant increase in the mobility of high-skilled workers would be expected. This is equivalent to imposing an exogenous labor supply shock on the urban labor market, which differs from previous studies that focused on the labor supply shock caused by rural migrant workers. Thus, urban natives may be affected by the arrival of high-skilled migrant workers.

3 Data and descriptive statistics

3.1 Data

The datasets in this paper mainly consist of two parts, including the collected policy documents related to *hukou* reform and the Urban Household Survey (UHS) conducted annually by China's National Bureau of Statistics (NBS).[11]

[9] At first, the policy mainly focused on how to achieve the integration of urban and rural *hukou*, which is reflected on the implementation of the *hukou* reform in some cities that have started to unify the agricultural and non-agricultural *hukou* (i.e., "unified *hukou*" reform). However, this shift does not mitigate the hindering effect of *hukou* on labor mobility across cities. Therefore, this paper mainly focuses on the impact of the "entry barrier" reform instead of the "unified *hukou*" reform.

[10] Among the *hukou* reform cities we collected, around 83.8% attached high-educated or high occupation title conditions, 65.8% covered investment constraints, 70.3% proposed housing purchase strictions. All in all, about 94.6% of the reform cities attached these constraints. Please refer to the Appendix B for more details on *hukou* reform.

[11] All the other datasets used in this paper are reported in Online Appendix B.

First, we compiled the *hukou* reform data from two official databases, the Peking University Law Information Database and the Baidu Search Engine Database, and several other official websites, including those of local prefectural governments, public security bureaus, and other authoritative news platforms (e.g., People's Daily Online, Sohu news, and Nanfang news). Based on these official websites, we searched keywords by any combinations of "*hukou*" (or *huji*) and "reform" (or *gaige*), having access to urban *hukou*, and relaxation of *hukou* entry conditions, and collected 145 policy documents including information about the *hukou* regulations disclosed by cities. The *hukou* reform status is identified by the following criteria, i.e., entry conditions for applying for local urban *hukou*. These conditions include the legal and fixed residence or stable income source mentioned in these public policy documents. The relaxation of *hukou* entry requirements is often referred to the "entry barrier" reform. Any city that implemented the "entry barrier" reform is identified as the reform city in our data.[12] We define the first reform time as the reform year according to the adoption or disclosure timing of policy regulations. As a result, 111 cities are identified as the reform groups adopting the *hukou* reform.[13]

Second, the Urban Household Survey (UHS) is collected from urban households in all prefectural cities of 31 provinces every year. Using the daily accounting method, each household surveyed is required to record detailed income and expenditure information on a daily basis. The record is collected quarterly by the surveyor (NBS 2006). Using the method of stratified random sampling, the number of households across cities we achieve is proportional to each city's urban population. Overall, the UHS is the official and reliable source of basic living indicators for urban households in China.

The Urban Household Survey contains detailed personal information of urban residents, including demographic characteristics, such as gender, age, and education, as well as employment and income, such as working status, sector, and earnings.[14] It also provides household-level characteristics, such as household size, housing area, housing ownership, and household income, including total income,

[12] Notably, only considering the *hukou* entry conditions might be not enough due to the complexity of *hukou* reform in China, although the "entry barrier" reform cities in our study are primarily targeted for high-skilled migrants. Therefore, we used several other criteria to conduct robustness checks (see Appendix BII.2). We are sincerely grateful for anonymous reviewers' invaluable suggestions.

[13] Table A1 in Online Appendix A reports the number of cities with the *hukou* reform by year and its comparison between this paper and Wang et al. (2021). Specifically, there were 83 *hukou* reform cities by 2005 while 65 in Wang et al. (2021). By 2007, we have identified 99 cities with *hukou* reform, which is 25 more than the number in Wang et al. (2021). The possible differences are from two sides. The first is the difference in provinces, only 10 provinces overlapped, namely, Shanxi, Jiangsu, Anhui, Shandong, Henan, Hubei, Guangdong, Chongqing, Sichuan, and Gansu, but the other 8 provinces used in this paper are not included in Wang et al. (2021). The second is the identification criteria. We do not exclude the cities with extra strict restrictions on the *hukou* reform. Table A2 in Online Appendix A reports the difference in reform cities for the overlapping provinces, with small distinctions. Furthermore, we conduct more discussions on the details of *hukou* reform in Online Appendix BII.

[14] The working status is divided into 15 different categories, including working in state-owned enterprises (SOEs), working in collective-owned enterprises, working in private-owned enterprises (POEs), being self-employed, retired, retired and re-employed, house working, students, etc. The sector of employment is recorded at 1-digit level, including at least 16 sectors, such as agriculture, forestry and fisheries, mining, manufacturing, construction and various services.

disposable income, and net family business income.[15] Because the working status and sector can be further classified as formal employment or informal employment, secondary sector or tertiary sector, this information enables us to investigate whether urban natives shift across sectors in response to the *hukou* reform. Unfortunately, we cannot track households and individuals over time, thus we have to rely on repeated cross-sectional data to examine the impact of the *hukou* reform.

The Urban Household Survey used in our paper covers 18 provinces and 191 cities. The provinces geographically scatter over the whole China and both the economically developed and less-developed areas, including Beijing, Shanxi, Liaoning, Heilongjiang, Shanghai, Jiangsu, Anhui, Jiangxi, Shandong, Henan, Hubei, Guangdong, Chongqing, Sichuan, Yunnan, Gansu, Zhejiang, and Shaanxi.[16] These provinces account for 75% of the urban population in 2008.

Since the *hukou* reform started in 2001, we use the UHS data from 1997 to 2009, covering both the pre- and post-reform periods. The UHS only covers urban residents, who have local *hukou* or non-local *hukou* but have lived in the city for more than 6 months. Rural migrants are not recorded before 2002. Although a few rural migrants with long-term fixed domiciles are included after 2002, they are underrepresented and only account for 0.7% of the UHS sample.[17]

The final working sample is drawn as follows: (1) Drop individuals with non-local *hukou* and a few foreigners (14,140 observations, accounting for 1.78%). (2) Drop the incapacitated and students (145,567 observations). (3) Drop those individuals who are the heads of public sectors such as state organs, parties, and government organs (13,780 observations) since their employment and income are less likely to be influenced by market rules (Dai et al. 2020).[18] (4) Drop those observations with abnormal coding of key variables (241,257 observations).[19] (5) Keep individuals aged 16–65 (185,254 observations dropped). (6) Drop those individuals whose working status are not clear, i.e., missing observations (14,034 observations). (7) Keep samples with at least one observation for each city before and after 2001 during 1997–2009 (panel data of 83 cities and 1079 city-year observations left).[20] (8) Drop the missing observations in the initial city-level conditions for our baseline DiD estimates. Finally, we obtained 13-year repeated cross-sectional data from 16

[15] The net family business income indicates the earnings earned by all family members from production and business activities. It equals to family business income minus production costs and taxes (UHS manual 2002).

[16] Zhejiang and Shaanxi are only recorded in the UHS before 2002.

[17] We directly drop these rural migrants since we are interested in urban natives.

[18] We also include all the employed, unemployed, and non-labor-force individuals in our analysis. The baseline results remain unchanged (see Tables A18-A22 and Figure A6 in Online Appendix A for more details). We are thankful for anonymous reviewers' invaluable suggestions.

[19] The abnormal coding of key variables includes family memberships number, gender coding number, and employment status coding number. We drop observations outside of regular ranges.

[20] The limited inclusion of only 83 cities is primarily attributed to the routinely rotation (typically every three years) of the city sample employed by the UHS, introducing variability in city inclusion. Consequently, some cities may have been surveyed in earlier years (e.g., 1997, 1998, and 1999) but are no longer part of the sample after 2000.

provinces and 77 prefecture-level cities, including 196,907 households and 429,386 individuals.[21]

3.2 Descriptive statistics

Table 1 reports the descriptive statistics of the main dependent variables over the sample period.[22] Panel A presents personal employment. The result in Panel A shows that approximately 72.9% of the individuals are employed, which is consistent with the result (71%) calculated by Dai et al. (2021). Additionally, approximately 56.7% of them are employed in the formal sector, and 16.3% are employed in the informal sector.[23] Similarly, the share of employment in SOEs is 42.8%, while the share of employment in non-SOEs is 30.1%. Those individuals who are working in the secondary sector and tertiary sector account for 24% and 48.2%, respectively. The shares of competitive and non-competitive service sectors are 18.2% and 30%, respectively, indicating that urban natives are more likely to engage in the service sector of public affairs.[24]

Panels B and C present individual and household-level income information, respectively. The result in Panel B shows that the average annual total personal income is 13,754 yuan (around 1661 USD). The earnings for the employed and self-employed are 11,225 yuan (around 1356 USD), of which the earnings for the employed are 10,447 yuan (around 1262 USD), accounting for 76% of the total personal income. This indicates that earnings for the employed are the main source of income for urban natives. In addition, the average earnings for the self-employed are only 777.4 yuan (around 93.9 USD). The result in Panel C shows that the mean disposable income per capita, disposable income per laborer, and earnings for employed per laborer are 10,063 yuan (around 1215 USD), 13,677 yuan (around 1652 USD), and 10,577 yuan (around 1277 USD), respectively. The net business income per laborer is only 809.7 yuan (around 98 USD), indicating that urban

[21] Given that the proportion of our sample cities is small, we recognize that our findings would probably be limited. Nevertheless, our results are still valid and instructive due to the representativeness of the UHS sample and robustness results by using an alternative unbalanced sample (see Table A14 in Online Appendix A).

[22] We also report the descriptive statistics of explanatory and control variables in Table A3 in Online Appendix A.

[23] Hart (1973) was the first to define formal employment and informal employment, arguing that one is employed with formal earnings and the other is self-employed. The key is whether the labor force is employed permanently and whether it is paid a fixed salary. Following this rule, this paper defines those individuals who are working in state-owned enterprises, collective-owned enterprises, and other mixed economy units as "formal employment." In contrast, we define those individuals who are self-employed, working in the private-owned enterprises, retired and re-employed and those categorized as the other employment as "informal employment."

[24] SOE employment refers to persons employed in the SOEs, while non-SOE employment includes those employed in the non-SOEs. The secondary sector refers to various sectors, such as mining, manufacturing, and construction, except agriculture and service sectors. The tertiary sector covers all service sectors, excluding agriculture and secondary sectors. Among tertiary sectors, we define those sectors, such as wholesale and retail trade, accommodation, catering, and other social living services, as living service sectors (competitive service sectors). Thus, the others are categorized as non-competitive service sectors.

households are relatively less likely to engage in self-employment than other form of employment during the sample period.

Figure 1 shows the number and share of all reform cities by year during the sample period. Figure 1 shows that most cities implemented reform in 2003 and 2004, with numbers of 15 and 10, respectively. The number of reform cities was 5 in both 2001 and 2002 and then increased significantly in 2003 and 2004. However, the number began to decline, except in 2007 when the number of reform cities slightly rose to 4 and then continued to decrease to 1 and 2 in 2008 and 2009, respectively. Overall, there are 46 cities with the *hukou* reform, leaving 31 non-reform cities (i.e., the never-treated group).[25] By 2004, the cumulative number of reform cities accounted for about 40% of the total number of sample cities, and the number reached 60% by 2009.

4 Specification and identification strategy

4.1 Econometric specification

We use a multiple-group and multiple-period difference-in-differences (DiD) framework to identify the causal effects of the *hukou* reform on the labor market outcomes of urban natives. Ideally, we can make causal inferences by comparing the before-after differences in employment and income of urban natives in reform cities with the differences for the same individuals in the absence of the *hukou* reform. Obviously, we cannot observe the counterfactual at the same time. However, the non-uniform *hukou* reform was rolled out on a city-by-city basis, allowing us to adopt the DiD approach. Exploiting the rollout variation of the reform, we first define the reform cities as the treatment group and the non-reform cities as the control group. We then compare the before-after changes in the outcomes of urban natives in the reform cities with the corresponding changes in the non-reform cities during the same period. Specifically, we estimate the following equations:

$$Y_{ict} = \alpha_0 + \alpha_1 Hukou_{ct} + \theta X_{ict} + \zeta X_{hct} + \lambda_c + \xi_t + \varepsilon_{ict} \tag{1}$$

$$Y_{hct} = \beta_0 + \beta_1 Hukou_{ct} + \zeta X_{hct} + \lambda_c + \xi_t + v_{hct} \tag{2}$$

The subscripts i, h, c, and t represent individuals, households, cities, and years, respectively. Y_{ict} is the dependent variable, including employment status and income at the individual level. $Hukou_{ct}$ is the key explanatory variable, which is a dummy variable indicating whether the *hukou* reform was implemented in city c and year t. $\boldsymbol{X_{ict}}$ and $\boldsymbol{X_{hct}}$ are a set of time-varying control variables at the individual and household levels, respectively. For example, individual-level control variables include age, gender, and educational attainment. Household-level control variables include

[25] We disclose the information on the lists of *hukou* reform cities in Table A23 in Online Appendix A. The lists include all province names, city names, and their reform years.

Table 1 Summary statistics: main dependent variables

Variable	Mean	SD
Panel A: Personal employment (Obs. = 429,386)		
Employed	0.729	0.444
Formal employment	0.567	0.496
Informal employment	0.163	0.369
SOE employment	0.428	0.495
Non-SOE employment	0.301	0.459
Secondary sector	0.240	0.427
Tertiary sector	0.482	0.500
Competitive service sector	0.182	0.386
Non-competitive service sector	0.300	0.458
Panel B: Personal income (Obs. = 429,386; unit: *yuan*)		
Total income	13,754 (8.671)	13,988 (2.402)
Earnings for employed and self-employed	11,225 (7.123)	13,891 (3.933)
Earnings for employed	10,447 (6.728)	13,188 (4.141)
Earnings for self-employed	777.4 (0.470)	5780 (2.028)
Panel C: Household income (Obs. = 196,907; unit: *yuan*)		
Disposable income per capita	10,063 (8.830)	9673 (0.953)
Disposable income per laborer	13,677 (9.145)	13,022 (0.939)
Earnings for employed per laborer	10,577 (7.963)	11,095 (3.036)
Net business income per laborer	809.7 (0.785)	4800 (2.470)

The statistics in parentheses in Panels B and C give log income, and all the income indicators are deflated by the CPI

household size, housing area per capita, housing ownership, and years of education per capita. λ_c and ξ_t represent the city fixed effects and year fixed effects, respectively. The former is used to control for the interference of some unobservable factors that do not change over time at the regional level, such as regional systems and cultural characteristics, while the latter is used to control for some macroeconomic and environmental factors that do not vary across individuals. ε_{ict} is the error term.

Similarly, the dependent variable Y_{hct} is the outcome variable which is measured by disposable income per capita, disposable income per laborer, earnings for employed per laborer, and net business income per capita. ν_{hct} is the error term, and all other variables are the same as in Eq. (1). The coefficients on $Hukou_{ct}$, $\alpha_{1,}$ and β_1 capture the effects of the *hukou* reform on the employment and income of urban natives. All standard errors are clustered at the city level.

4.2 Identification strategy

The DiD estimation is based on the difference between the before-after changes in the outcomes of the treated group (i.e., reform cities) and the corresponding changes in the control group (i.e., non-reform cities). The validity of our

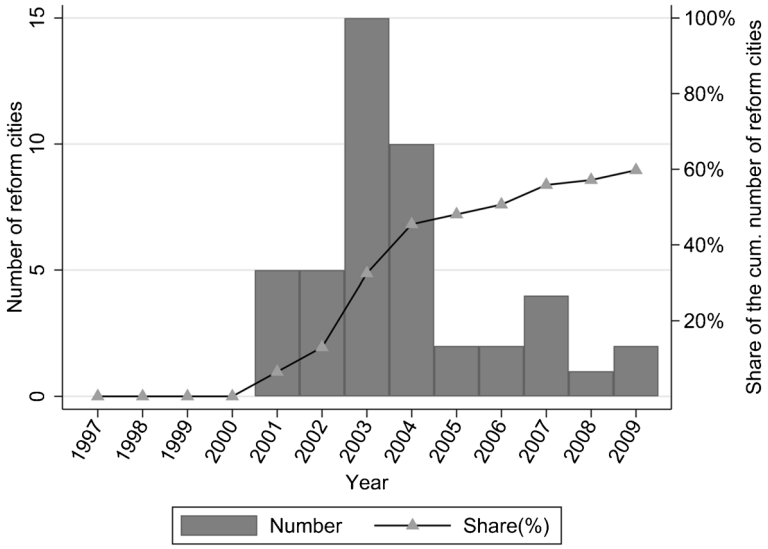

Fig. 1 The number and share of reform cities by year. *Notes*: The histogram and the line graph indicate the number of reform cities and the cumulative share of the number of reform cities, respectively. The share is defined as the cumulative number of reform cities by year over the total number of cities in our working samples. The number of prefecture-level cities in our working samples is 77, of which there are 46 reform cities between 2001 and 2009

identification depends on the parallel trend assumption. It is assumed that the average outcomes of urban natives in reform cities follow the same trend as those in non-reform cities. However, since the *hukou* reform was implemented in different years, the cities may not be randomly selected. Therefore, the pre-reform differences between reform and non-reform cities would no longer make them comparable. If the pre-determined factors of the *hukou* reform are also correlated with the outcomes we are interested in, i.e., employment and income, then our DiD estimators may be biased.

To address the endogeneity problem, we first control for individual- and household-level characteristics, such as gender, age, years of education, household size, housing area per capita, house property types, and years of education per capita, to exclude some observable factors that may affect the employment or income of urban natives. Furthermore, we control for city fixed effects to exclude some potentially unobserved time-invariant factors that might affect the labor market outcomes of urban natives. The year fixed effects control for common shocks that may be attributed to the general increase in demand arising from rapid economic development, e.g., the macroeconomic environment factors in a given year that have the same impact on all urban natives.

In addition, since the initial city-level characteristics that affect the *hukou* reform and employment or income of urban natives may be year-specific, we further control for prefecture-level initial conditions interacted with year dummies, which allow us to control for the effects of some unobservable time trends at the city level on the

urban natives in our main specifications. Following Wang et al. (2021), we choose several city-level initial outcomes, such as log local GDP per capita, the share of the non-agricultural population, the share of secondary sector employment, log local fiscal expenditure per capita, and log local average wage, to capture some general impacts of rising labor demand due to regional economic development, changes of industrial structure, and so forth.[26]

Another issue is the credibility of two-way fixed effect (TWFE) estimators, which has been addressed in numerous recent studies. For instance, Goodman-Bacon (2021) and de Chaisemartin and D'Haultfœuille (2020) point out that staggered DiD estimators (i.e., two-way fixed effects estimators) are likely to be unreliable due to the negative weighting problem under the condition that heterogeneous treatment effects exist. Given this, many scholars have also discussed solutions to heterogeneous treatment effects. Most of them have dealt with the so-called "bad control group" problem (i.e., earlier adopters served as the control group). We also draw on the practice of related research to re-examine the DiD estimated results in the benchmark section. Specifically, we conduct an event study approach to plot the newly staggered DiD estimators in the figures (see Sect. 6.1).

Furthermore, we need to rule out other potential confounding factors for casual inference, as our sample period spans from 1997 to 2009, when there were many other important policies, e.g., SOE reform, trade liberalization (WTO), minimum wage policy, and higher education expansion policy. To do this, we further control for SOE reform effects by including city-level SOE reform intensity interacted with year dummies in our baseline specifications. As for the others, we further extend our empirical framework by controlling for prefecture-level tariff rates lagged by one year, city-year-level minimum wages, and higher education expansion intensity to eliminate the threat of confounding policies to our identification (see Sect. 6.2).

5 Empirical results

5.1 Effects on migration

To examine the impact of the *hukou* reform on urban natives, we first need to test whether the *hukou* reform has an impact on migration and what changes have occurred in the composition of migrants. This is the key to examining how natives are affected by the labor supply shock due to the *hukou* reform. Theoretically, a large inflow of migrants would compete with urban natives for job opportunities. We use

[26] The potential differences between our reform and non-reform cities due to various observational characteristics and unobserved determinants of *hukou* reform would make them not comparable to each other, though we have taken steps to address the endogeneity issue. To mitigate this concern, we followed Wang et al. (2023), who had explored three key factors (i.e., economic, political, and sociocultural elements) impacting the adoption of *hukou* reform, to employ the PSM-DID method to conduct a re-estimation of *hukou* reform impact on the employment and income of urban natives. The relevant results are not reported but available upon request. We are very grateful for anonymous reviewers' insightful feedback and suggestions.

educational attainment to proxy for the skills. Those people who have obtained college education and above are defined as high-skilled workers, those with senior high school education are defined as medium-skilled workers, and those with less than senior high school education are defined as low-skilled workers. Of course, we also draw on An et al. (2024) to test for changes in the composition of migrants by age and gender groups.

Based on the 1% sample of the 2000 population census and the 20% sample of the 2005 mini-census data, we calculate the change and distribution of the work-related migrants in reform and non-reform cities in urban China.[27] We divide the migrants into three education levels (i.e., college and above, senior high school, junior and below) and two types of *hukou* (i.e., agricultural and non-agricultural), see Table A4 in Online Appendix A for details. Table A4 in Online Appendix A shows that the share of migrant workers in reform cities is lower than that in non-reform cities, except for the high-skilled and non-agricultural *hukou* migrants. This disparity can be attributed to the relatively easier inflow of high-skilled and non-agricultural *hukou* migrants to reform cities. Additionally, after the reform, the share of migrants across all groups increases in reform cities compared to non-reform cities, aligning with our intuitive expectations. For instance, the share of college and above and non-agricultural *hukou* migrants increased by 0.1 and 0.18 percentage points, respectively.

We further conduct a regression analysis and find a similar result in Table 2. The result is consistent with Chen et al. (2022), who also found the promotion effects of relaxing internal migration restrictions on high-skilled migrant workers. Specifically, our result indicates a significant increase of 0.106 percentage points (23.6% relative to the mean) in the share of college and above migrants in reform cities compared to non-reform cities following the relaxation of internal migration restrictions. Meanwhile, the share of non-agricultural *hukou* migrants experienced a 0.145 percentage point increase (10.39% relative to the mean), albeit with insignificant coefficient. Conversely, other shares exhibited declines. These results suggest that the reform indeed attracted a greater influx of high-skilled migrants to reform cities post-reform. Moreover, these results are consistent with studies conducted in developed countries (Beerli et al. 2021; Doran et al. 2022), revealing that more friendly policies towards the high-skilled migrants would result in more inflows of skilled migrants. According to the skill complementarity theory, with more inflows of high-skilled migrant workers, the labor demand for low-skilled workers may also

[27] Consistent with Tian (2022), we define an individual as a migrant if the person lives in current residential area more than 6 months but registered elsewhere, or the person lives in current residential area less than 6 months, registered elsewhere, and out of registration area more than 6 months. Our study centers on urban areas as we emphasize rural–urban or urban-urban migration. Additionally, we narrow our focus to work-related migration, given its predominant contribution (30%-50%) to overall migration and since we mainly focus on labor market impact. Furthermore, we define various migrants according to distances, demographic characteristics (e.g., *hukou*, education, age, and gender), and years of relocating in locals. Consequently, our study covers work-related migration across various distances, including within-prefecture-and-cross-county (district) migrants, across-prefecture-and-within-province migrants, and across-province migrants. Please see Online Appendix BI.7 for more details on the definitions of migrants.

Table 2 The effects of *hukou* reform on work-related migration by education attainments

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var	Share of migrants (%)					
Sample	All	College and above	Senior high school	Junior and below	Agricultural *hukou*	Non-agricultural *hukou*
Hukou reform × Post2005	−0.477 (0.636)	0.106* (0.056)	−0.092 (0.121)	−0.491 (0.520)	−0.622 (0.576)	0.145 (0.117)
No. of cities	329	329	329	329	329	329
Observations	658	658	658	658	658	658
R-squared	0.344	0.407	0.310	0.317	0.341	0.249
Mean of dep. var. (%)	5.268	0.450	1.042	3.776	3.873	1.395

This table reports the 2 × 2 DiD estimation results based on the population census data, and all the constants are not reported. Using the 2000 and 2005 population censuses, we restrict the time of migration to urban areas to the last 4 years. The number of reform cities in our DiD estimation is 89, which implies that the number of control cities is 240. Following Fan (2019), we control for year fixed effects and city-level administrative division fixed effects in all specifications. We also control for the log total urban population and some city-level initial conditions, including log local GDP per capita, the share of non-agricultural population, the share of second-industrial employment, log local fiscal expenditure per capita, and log local average wage interacted with the year dummy "Post2005" ("Post2005" equals to 1 if the year is 2005). We exclude prefectures of "The Tibet Autonomous Region" as we do not have data for these cities. As a result, we drop 14 prefectures, and there are 329 cities left. Robust standard errors are clustered at the city level in all specifications. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

increase. Nevertheless, the number of rural migrants did not increase significantly during 2000–2005, which is supported by the findings of Sun (2021).

To figure out the compositional characteristics of migrants, we further examine the impact of the *hukou* reform on the changes in the composition of migrants by age and gender, following An et al. (2024). Tables A5 and A6 report the DiD estimation results by educational attainment, age, and gender groups.[28] The result in Table A5 reveals a notable surge in college and above migrants by 0.081 percentage points (34.3% relative to the mean) due to the *hukou* reform, alongside a rise in non-agricultural *hukou* migrants by 0.054 percentage points (9.2% relative to the mean), despite the insignificant coefficient. Notably, there is no significant increase in the 30–49 and 50–65 age groups, suggesting that the reform led to a significant increase in the number of high-skilled and non-agricultural *hukou* migrants primarily for the younger cohorts. The result in Table A6 shows noteworthy increases in the share of male college and above and non-agricultural *hukou* migrants by 0.063 and 0.042 percentage points (21% and 4.9% relative to the mean), respectively. Conversely, the share of female college and above and non-agricultural *hukou* migrants witnessed significant increases of 0.043 and 0.103 percentage points, respectively. Notably, the estimates of 0.063 and 0.043 for both genders are remarkably close, suggesting little difference in the inflows of high-skilled migrants between males and females. These results are similar to those of Zhou (2021), who found that the merit-based *hukou* reform had a positive correlation with the migrant flows for both genders in large cities and that the relaxation of migration policies attracted more single migrants (especially high-educated migrants).[29]

In summary, the aforementioned results suggest that the *hukou* reform has attracted more high-skilled young labor. Moreover, the high-skilled migrants for both genders show similar increases, potentially affecting the same composition of urban natives in terms of education, age, and gender.

5.2 Effects on employment

We first estimate the impact of the *hukou* reform on the employment of urban natives. Table 3 reports the estimated effects of the *hukou* reform on whether the urban natives are employed. The result in Table 3 shows that the *hukou* reform had no significant impact on the overall employment of urban natives. Also, when we further differentiate skill levels (i.e., junior and below, senior high school, and college and above), we find that the probability of employment of high-skilled and medium-skilled urban

[28] We also divide migrants by migration distance and report the result in Table A7 in Online Appendix A. The result presented in Table A7 confirms the surge in high-skilled migrants, mainly attributed to within-prefecture or across-prefecture inflows.

[29] Note that the merit-based *hukou* reform mentioned in Zhou (2021) is the same as that in Fan (2019). Specifically, the merit-based *hukou* reform refers to the reforms favoring high-skilled migrants, including requirements on job prospects and stability, residence conditions, and contribution to the social security system. Similarly, in this paper, we define those reform cities whose regulations attaching requirements on higher education, occupational or talent titles, making investment, or house purchasing as merit-based reform cities. Please see detailed information in Online Appendix BII.1.2.

Table 3 The effects of *hukou* reform on employment

	(1)	(2)	(3)	(4)
Dep. var	Employed			
Sample	Full sample		Junior and below	
Hukou reform	−0.002 (0.008)	−0.003 (0.006)	0.008 (0.012)	0.002 (0.010)
Observations	429,303	429,303	149,878	149,878
R-squared	0.252	0.253	0.292	0.293
Sample	Senior high school		College and above	
Hukou reform	−0.006 (0.007)	−0.005 (0.007)	0.001 (0.007)	−0.000 (0.007)
Observations	162,770	162,770	116,655	116,655
R-squared	0.140	0.141	0.131	0.132
No. of cities	77	77	77	77

This table reports the DiD estimation results based on the full sample and sub-samples by educational attainment, and all the constants are not reported. All specifications control for city and year fixed effects, and controls include both individual-level and household-level characteristics such as age, gender, years of education, household size, log housing area per capita, house property dummies, and mean years of education per household. We control for city-level initial conditions, including log local GDP per capita, the share of non-agricultural population, the share of second-industrial employment, log local fiscal expenditure per capita, and log local average wage, interacted with year dummies; SOE reform intensity interacted with year dummies. SOE reform intensity is represented by the city-level difference in the share of SOE employees between 1997 and 2001. We also control for province trends in the even columns. Robust standard errors are clustered at the city level in all specifications. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

natives decreased, while the employment likelihood of low-skilled urban natives increased. However, the estimates are statistically insignificant for all skill groups. These results are consistent with several previous studies (Butcher and Card 1991; Card 2005; Manacorda et al. 2012), which found little impact of immigration on the labor market outcomes of natives in developed economies. Moreover, our results are closely related to Meng and Zhang (2010), who found no significant effects of internal migration on the employment and wages of urban natives. They argue that the lack of substitution effects of internal migration is due to labor market segregation and demand expansion resulting from economic growth. Similarly, we argue that our non-significant results are likely to be driven by both substitution effects and demand expansion effects, as demand effects may offset the adverse effects of the substitution effects. We do not find significant substitution effects on overall employment, as there may also be pooling effects across all skill groups.

Furthermore, to explore what would have happened to the urban natives, we then classify employment into different categories. Table 4 reports the composition effects of the *hukou* reform on the employment of urban natives. The result in Table 4 shows that the probability to be employed in the formal sector for urban natives declined significantly by 2.1 percentage points (equivalent to 3.8% relative to the mean), while the informal employment increased by 1.8 percentage points, reflecting an 11% rise relative to the mean. Similarly, we find that urban natives were less likely (a decline of 2.4 percentage points) to be employed in SOEs but had a greater chance (an increase of 2.1 percentage points) of transitioning to non-SOEs (5.6% and 7%

Table 4 The composition effects of *hukou* reform on employment

	(1)	(2)	(3)	(4)
Dep. var	Formal employment		Informal employment	
Hukou reform	−0.017 (0.012)	−0.021** (0.009)	0.015* (0.008)	0.018** (0.007)
Observations	429,303	429,303	429,303	429,303
R-squared	0.243	0.245	0.076	0.078
Dep. var	SOE employment		Non-SOE employment	
Hukou reform	−0.028*** (0.010)	−0.024** (0.009)	0.025*** (0.009)	0.021** (0.010)
Observations	429,303	429,303	429,303	429,303
R-squared	0.200	0.202	0.109	0.110
Dep. var	Secondary sector		Tertiary sector	
Hukou reform	−0.024** (0.011)	−0.026*** (0.008)	0.021** (0.010)	0.022** (0.009)
Observations	429,303	429,303	429,303	429,303
R-squared	0.082	0.085	0.143	0.144
Dep. var	Competitive service sector		Non-competitive service sector	
Hukou reform	0.009 (0.006)	0.004 (0.005)	0.012 (0.008)	0.018** (0.007)
Observations	429,303	429,303	429,303	429,303
R-squared	0.045	0.046	0.152	0.153
No. of cities	77	77	77	77

This table reports the DiD estimation results based on the full sample, and all the constants are not reported. All specifications control for city and year fixed effects, and controls include both individual-level and household-level characteristics such as age, gender, years of education, household size, log housing area per capita, house property dummies, and mean years of education per household. We control for city-level initial conditions, including log local GDP per capita, the share of non-agricultural population, the share of second-industrial employment, log local fiscal expenditure per capita, and log local average wage, interacted with year dummies; SOE reform intensity interacted with year dummies. SOE reform intensity is represented by the city-level difference in the share of SOE employees between 1997 and 2001. We also control for province trends in the even columns. Robust standard errors are clustered at the city level in all specifications. *$p<0.1$; **$p<0.05$; ***$p<0.01$

relative to the mean, respectively). In addition, the result for different categories of industries shows that urban natives were less likely to be employed in the secondary sector but more likely to be employed in the tertiary sector. We further divide the tertiary sector into two types, the living service sector (i.e., competitive service sector) and the social management service sector (i.e., non-competitive service sector). The result shows that urban natives more engaged in non-competitive service sectors by 1.8 percentage points, equivalent to 6% relative to the mean. This is probably because urban natives have more local advantages in terms of dialect, cultural customs, and human resources than migrants. By contrast, migrants can only be employed in competitive service jobs. These results suggest that there would be employment shifts after the *hukou* reform. These findings are comparable to some relevant reallocation effects in the local labor market (Boustan et al. 2010; Dix-Carneiro 2014; Costa et al. 2016; Dix-Carneiro and Kovak 2019; Abramitzky et al. 2023) and are also mostly similar to Jin (2022), who found that the average employment in the non-state sector increased by 5.1% 3 years after the *hukou* reform, while employment in the state sector decreased by 5.6% during the same period.

Theoretically, if the high-skilled migrants dominate among all migrants, it would be likely that the labor supply shock induced by high-skilled migrants may have an adverse impact on the high-skilled urban natives, which is called substitution effects. To test the substitution effects, we further explore which group (defined by educational attainment) has experienced the employment shift effect.

Table 5 reports the composition effects of the *hukou* reform on employment by different educational attainment. The result in Table 5 shows that the employment shift mainly occurred among urban natives with a senior high school education and above, which further confirms that the *hukou* reform was likely to attract more high-skilled migrants into the local labor market, creating a certain substitution effect for the urban natives with college education and above, and for the urban natives with senior high school education. Specifically, high-skilled natives were more likely to be displaced from the formal sectors, SOEs, and secondary sectors to the informal sectors, non-SOEs, and tertiary sectors, respectively. The increase of tertiary sector employment is mainly driven by the non-competitive service sectors. It is not surprising that the urban natives with senior high school education are also affected by high-skilled migrants. Because in early 2000s in China, the urban natives with senior high school education would probably also work in decent, well-paid jobs, which are also the target jobs for the high-skilled migrants.

5.3 Effects on income

Next, we estimate the impact of the *hukou* reform on the income of urban natives. Table 6 reports the estimated effects. Panel A shows that the *hukou* reform generally reduced the total personal income, the earnings for employed and self-employed, and the earnings for employed urban natives. Meanwhile, the *hukou* reform increased the earnings of the self-employed, although it is almost not statistically significant. Similarly, Panel B shows that the *hukou* reform decreased disposable income per capita and disposable income per laborer and increased net business income per capita, but neither is statistically significant. All these results show that, on average, the *hukou* reform had no significant impact on the income of urban natives. This evidence corresponds exactly to the results in Table 3.

Table 7 reports the estimated effects of the *hukou* reform on the income of urban natives with different skills. Panel A shows that the *hukou* reform had no significant impact on the total personal income and earnings for employed and self-employed urban natives. However, the earnings for employed in the group of urban natives with senior high school education declined significantly by 12.3%, and the earnings for self-employed increased significantly by 6.2%. Households are classified as high-educated when the education level of the household head exceeds 12 years. Panel B shows that the coefficients of disposable income per capita and disposable income per laborer of the high-educated households are relatively smaller than low-educated households, and the net business income per laborer in the high-educated households increased more than the low-educated households. This also provides suggestive evidence that high-educated households make labor adjustment such as switching to informal sector to offset the negative shocks brought by the *hukou* reform.

Table 5 The composition effects of *hukou* reform on employment by educational attainment

	(1)	(2)	(3)	(4)
Dep. var	Formal employment	Informal employment	SOE employment	Non-SOE employment
Junior and below	−0.007 (0.012)	0.009 (0.010)	−0.014 (0.010)	0.016 (0.012)
Observations	149,878	149,878	149,878	149,878
Senior high school	−0.033*** (0.011)	0.028*** (0.007)	−0.033*** (0.010)	0.028*** (0.010)
Observations	162,770	162,770	162,770	162,770
College and above	−0.020** (0.010)	0.020*** (0.006)	−0.022* (0.011)	0.021** (0.009)
Observations	116,655	116,655	116,655	116,655
Dep. var	Secondary sector	Tertiary sector	Competitive service sector	Non-competitive service sector
Junior and below	−0.006 (0.011)	0.009 (0.013)	−0.005 (0.009)	0.014* (0.007)
Observations	149,878	149,878	149,878	149,878
Senior high school	−0.035*** (0.009)	0.028*** (0.010)	0.010 (0.007)	0.019** (0.008)
Observations	162,770	162,770	162,770	162,770
College and above	−0.032*** (0.011)	0.030** (0.012)	0.009 (0.007)	0.021* (0.012)
Observations	116,655	116,655	116,655	116,655
No. of cities	77	77	77	77

This table reports the DiD estimation results based on the sub-samples by educational attainment, and all the constants are not reported. All specifications control for city and year fixed effects and province trends, and controls include both individual-level and household-level characteristics such as age, gender, years of education, household size, log housing area per capita, house property dummies, and mean years of education per household. We control for city-level initial conditions, including log local GDP per capita, the share of non-agricultural population, the share of second-industrial employment, log local fiscal expenditure per capita, and log local average wage, interacted with year dummies; SOE reform intensity interacted with year dummies. SOE reform intensity is represented by the city-level difference in the share of SOE employees between 1997 and 2001. Robust standard errors are clustered at the city level in all specifications. *$p<0.1$; **$p<0.05$; ***$p<0.01$

Table 6 The effects of *hukou* reform on income

	(1)	(2)	(3)	(4)
Panel A: Individual-level				
Dep. var	ln (total income)		ln (earnings for employed and self-employed)	
Hukou reform	−0.027 (0.046)	−0.033 (0.037)	−0.068 (0.066)	−0.087 (0.057)
Observations	429,303	429,303	429,303	429,303
R-squared	0.160	0.161	0.256	0.257
Dep. var	ln (earnings for employed)		ln (earnings for self-employed)	
Hukou reform	−0.103 (0.072)	−0.111* (0.063)	0.031 (0.024)	0.028 (0.024)
Observations	429,303	429,303	429,303	429,303
R-squared	0.236	0.237	0.049	0.050
Panel B: Household-level				
Dep. var	ln (disposable income per capita)		ln (disposable income per laborer)	
Hukou reform	−0.008 (0.017)	−0.012 (0.016)	−0.009 (0.016)	−0.013 (0.015)
Observations	196,870	196,870	196,870	196,870
R-squared	0.691	0.693	0.640	0.642
Dep. var	ln (earnings for employed per laborer)		ln (net business income per laborer)	
Hukou reform	−0.032 (0.066)	−0.042 (0.061)	0.054 (0.036)	0.054 (0.035)
Observations	196,870	196,870	196,870	196,870
R-squared	0.113	0.114	0.068	0.068
No. of cities	77	77	77	77

This table reports the DiD estimation results based on the full sample, and all the constants are not reported. All specifications control for city and year fixed effects, and controls include both individual-level and household-level characteristics such as age, gender, years of education, household size, log housing area per capita, house property dummies, and mean years of education per household. We control for city-level initial conditions, including log local GDP per capita, the share of non-agricultural population, the share of second-industrial employment, log local fiscal expenditure per capita, and log local average wage, interacted with year dummies; SOE reform intensity interacted with year dummies. SOE reform intensity is represented by the city-level difference in the share of SOE employees between 1997 and 2001. We also control for province trends in the even columns. Robust standard errors are clustered at the city level in all specifications. *$p<0.1$; **$p<0.05$; ***$p<0.01$

Table 7 The effects of *hukou* reform on income by educational attainment

	(1)	(2)	(3)	(4)	(5)
	Panel A: Individual-level			Panel B: Household-level	
Sample	Junior and below	Senior high school	College and above	High-edu	Low-edu
Dep. var	ln (total income)			ln (disposable income per capita)	
Hukou reform	−0.046 (0.067)	−0.003 (0.037)	−0.020 (0.036)	−0.008 (0.016)	−0.030 (0.019)
Observations	149,878	162,770	116,655	135,112	61,758
R-squared	0.131	0.123	0.123	0.698	0.677
Dep. var	ln (earnings for employed and self-employed)			ln (disposable income per laborer)	
Hukou reform	−0.056 (0.083)	−0.078 (0.068)	−0.064 (0.058)	−0.008 (0.016)	−0.033* (0.019)
Observations	149,878	162,770	116,655	135,112	61,758
R-squared	0.283	0.126	0.112	0.646	0.640
Dep. var	ln (earnings for employed)			ln (earnings for employed per laborer)	
Hukou reform	−0.071 (0.092)	−0.123* (0.072)	−0.073 (0.065)	−0.035 (0.065)	−0.066 (0.083)
Observations	149,878	162,770	116,655	135,112	61,758
R-squared	0.225	0.103	0.090	0.102	0.122
Dep. var	ln (earnings for self-employed)			ln (net business income per laborer)	
Hukou reform	−0.002 (0.045)	0.062** (0.028)	0.022 (0.024)	0.062* (0.032)	0.039 (0.072)
Observations	149,878	162,770	116,655	135,112	61,758
R-squared	0.075	0.042	0.020	0.052	0.103
No. of cities	77	77	77	77	77

This table reports the DiD estimation results based on the sub-samples by educational attainment, and all the constants are not reported. All specifications control for city and year fixed effects and province trends, and controls include both individual-level and household-level characteristics such as age, gender, years of education, household size, log housing area per capita, house property dummies, and mean years of education per household. We control for city-level initial conditions, including log local GDP per capita, the share of non-agricultural population, the share of second-industrial employment, log local fiscal expenditure per capita, and log local average wage, interacted with year dummies; SOE reform intensity interacted with year dummies. SOE reform intensity is represented by the city-level difference in the share of SOE employees between 1997 and 2001. "High-edu" indicates that the head of household has 12 or more years of education, and "Low-edu" indicates that the head of household has less than 12 years of education. Robust standard errors are clustered at the city level in all specifications. *$p<0.1$; **$p<0.05$; ***$p<0.01$

5.4 Heterogeneity analysis

Based on the empirical analysis presented, we find that the *hukou* reform had no significant impact on the employment and income of urban natives on average, but the reform did lead to a significant employment shift effect. More importantly, our estimates show that this employment shift occurred mainly in the high-skilled and medium-skilled groups. In addition, many studies have found that the impact of exogenous shocks on the local labor market may vary significantly across gender and age groups (Dai et al. 2021). Therefore, we then perform subsample regressions by gender and age. Table 8 shows a significant employment shift effect for both genders. Specifically, both women and men were more likely to be employed in the informal sector. Regarding the shifts in the secondary and tertiary sectors, however, the tertiary sector employment for women significantly increased by 2.6 percentage points, while men were more likely to shift to the tertiary sector, with an insignificant increase of 1.7 percentage points. This finding indicates that women may have a greater likelihood of being employed in the tertiary service sector than men. To

Table 8 The composition effects of *hukou* reform on employment by gender

	(1)	(2)	(3)	(4)
Sample	Male	Female	Male	Female
Dep. var	Formal employment		Informal employment	
Hukou reform	−0.027*** (0.009)	−0.015 (0.011)	0.019*** (0.007)	0.018** (0.008)
Observations	206,776	222,527	206,776	222,527
R-squared	0.149	0.304	0.102	0.066
Male vs. female	*p*-value = 0.133		*p*-value = 0.831	
Dep. var	SOE employment		Non-SOE employment	
Hukou reform	−0.029*** (0.010)	−0.019* (0.010)	0.021** (0.010)	0.021** (0.010)
Observations	206,776	222,527	206,776	222,527
R-squared	0.142	0.230	0.129	0.107
Male vs. female	*p*-value = 0.154		*p*-value = 0.926	
Dep. var	Secondary sector		Tertiary sector	
Hukou reform	−0.026*** (0.010)	−0.024*** (0.008)	0.017 (0.011)	0.026*** (0.008)
Observations	206,776	222,527	206,776	222,527
R-squared	0.061	0.091	0.105	0.189
Male vs. female	*p*-value = 0.782		*p*-value = 0.249	
No. of cities	77	77	77	77

This table reports the DiD estimation results based on the sub-samples, and all the constants are not reported. All specifications control for city and year fixed effects and province trends, and controls include both individual-level and household-level characteristics such as age, gender, years of education, household size, log housing area per capita, house property dummies, and mean years of education per household. We control for city-level initial conditions, including log local GDP per capita, the share of non-agricultural population, the share of second-industrial employment, log local fiscal expenditure per capita, and log local average wage, interacted with year dummies; SOE reform intensity interacted with year dummies. SOE reform intensity is represented by the city-level difference in the share of SOE employees between 1997 and 2001. Robust standard errors are clustered at the city level in all specifications. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

further explore possible gender differences, we perform the seemingly unrelated test and report the *p*-values for regression coefficients. The *p*-values of the seemingly unrelated test show that there are no differences in the employment shift between males and females. This evidence echoes the previous findings in Table A6, i.e., the inflows of high-skilled migrants for both genders may pose similar effects on the corresponding groups of urban natives.

Then, we examine the impact of the *hukou* reform across age groups. Following Dai et al. (2021), we divide three age groups (20–29, 30–49, 50 +) for the estimation. Table 9 reports the gender and age differences in the employment shift effects. For both men and women, the employment shift effects occurred mainly in the 30–50 age group, probably because this age group characterized by a prosperous labor force prior to retirement is more likely to be affected by the inflows of younger educated migrants (see Table A5). In addition, young and middle-aged male workers (20–29) were more likely to move from the formal sector to the informal sector to be employed. Compared to women, it is possible that men in this group have more needs and opportunities to be employed. Therefore, they are more likely to have flexible employment choices and transit across different jobs when faced with an external labor supply shock. Moreover, there are some intriguing patterns for the older cohorts. For instance, male middle-aged and older workers (50 +) were less likely to be employed in the secondary sector (e.g., a decline of 1.5 percentage points at the significance of 15%, *p*-value = 0.140). This could be because a large number of young high-skilled migrant workers (see Table A5) have created a certain substitution effect on them, forcing them out of the secondary sector. Meanwhile, women aged 50 and above were more likely to re-enter the tertiary sector to seek job opportunities with an increase of 1.3 percentage points (*p*-value = 0.100), since the impact of high-skilled migrants has prompted the transformation of the local industrial structure, thereby stimulating the labor demand for considerable service sector jobs. As a consequence, it provides women with many competent jobs and informal employment opportunities, especially when men in households face negative employment shocks or shifts, motivating women to actively re-enter the labor market (Dai et al. 2021).

To further explore the gender-specific effects of the *hukou* reform, we examine its impact on the personal income of both men and women. The result is reported in Table 10, showing that the *hukou* reform has resulted in an average decrease of 5.6% in men's total personal income, along with declines of 12.9% and 14.2% in earnings for employed and self-employed and earnings for employed, respectively. However, the earnings for self-employed of men remain unchanged. By contrast, women impacted by the *hukou* reform did not experience significant changes in these incomes. However, there was a noteworthy increase of 4.7% in earnings for the self-employed of women. These results suggest that men may have a greater chance to transition from non-private employment to private employment rather than choosing self-employment. This employment shift has resulted in a decline in the average income for men. On the contrary, the employment shift of women did not have a significant negative impact on their income but increased their earnings for self-employed, suggesting that women were more likely to shift and re-enter the tertiary service sector, especially in the self-employed business.

Table 9 The composition effects of *hukou* reform on employment by gender and age

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	20–29		30–49		50 +	
	Male	Female	Male	Female	Male	Female
Dep. var	Formal employment					
Hukou reform	−0.033* (0.018)	−0.009 (0.019)	−0.037*** (0.009)	−0.027** (0.013)	−0.002 (0.010)	0.005 (0.009)
Observations	25,832	27,922	110,583	121,688	69,409	71,942
Dep. var	Informal employment					
Hukou reform	0.026* (0.015)	0.013 (0.013)	0.031*** (0.008)	0.030** (0.012)	0.001 (0.007)	0.006 (0.007)
Observations	25,832	27,922	110,583	121,688	69,409	71,942
Dep. var	SOE employment					
Hukou reform	−0.014 (0.016)	0.002 (0.017)	−0.045*** (0.012)	−0.039*** (0.013)	−0.004 (0.011)	0.005 (0.008)
Observations	25,832	27,922	110,583	121,688	69,409	71,942
Dep. var	Non-SOE employment					
Hukou reform	0.007 (0.019)	0.001 (0.014)	0.039*** (0.013)	0.042*** (0.016)	0.003 (0.010)	0.006 (0.008)
Observations	25,832	27,922	110,583	121,688	69,409	71,942
Dep. var	Secondary sector					
Hukou reform	−0.009 (0.016)	−0.002 (0.013)	−0.033*** (0.011)	−0.042*** (0.010)	−0.015 (0.010)	−0.002 (0.005)
Observations	25,832	27,922	110,583	121,688	69,409	71,942
Dep. var	Tertiary sector					
Hukou reform	0.002 (0.020)	0.006 (0.018)	0.026** (0.012)	0.044*** (0.011)	0.015 (0.011)	0.013 (0.008)
Observations	25,832	27,922	110,583	121,688	69,409	71,942
No. of cities	77	77	77	77	77	77

This table reports the DiD estimation results based on the sub-samples, and all the constants are not reported. All specifications control for city and year fixed effects and province trends, and controls include both individual-level and household-level characteristics such as age, gender, years of education, household size, log housing area per capita, house property dummies, and mean years of education per household. We control for city-level initial conditions, including log local GDP per capita, the share of non-agricultural population, the share of second-industrial employment, log local fiscal expenditure per capita, and log local average wage, interacted with year dummies; SOE reform intensity interacted with year dummies. SOE reform intensity is represented by the city-level difference in the share of SOE employees between 1997 and 2001. Robust standard errors are clustered at the city level in all specifications. *$p<0.1$; **$p<0.05$; ***$p<0.01$

Table 10 The effects of *hukou* reform on income by gender

	(1)	(2)	(3)	(4)
Sample	Male	Female	Male	Female
Dep. var	ln (total income)		ln (earnings for employed and self-employed)	
Hukou reform	−0.056* (0.032)	−0.006 (0.049)	−0.129** (0.054)	−0.033 (0.071)
Observations	206,776	222,527	206,776	222,527
R-squared	0.145	0.161	0.134	0.303
Male vs. female	*p*-value = 0.195		*p*-value = 0.062	
Dep. var	ln (earnings for employed)		ln (earnings for self-employed)	
Hukou reform	−0.142** (0.065)	−0.070 (0.074)	0.009 (0.032)	0.047* (0.028)
Observations	206,776	222,527	206,776	222,527
R-squared	0.125	0.294	0.060	0.041
Male vs. female	*p*-value = 0.223		*p*-value = 0.271	
No. of cities	77	77	77	77

This table reports the DiD estimation results based on the sub-samples, and all the constants are not reported. All specifications control for city and year fixed effects and province trends, and controls include both individual-level and household-level characteristics such as age, gender, years of education, household size, log housing area per capita, house property dummies, and mean years of education per household. We control for city-level initial conditions, including log local GDP per capita, the share of non-agricultural population, the share of second-industrial employment, log local fiscal expenditure per capita, and log local average wage, interacted with year dummies; SOE reform intensity interacted with year dummies. SOE reform intensity is represented by the city-level difference in the share of SOE employees between 1997 and 2001. Robust standard errors are clustered at the city level in all specifications. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

6 Robustness

6.1 Parallel trend assumption

A key identification assumption in the difference-in-differences (DiD) framework is the parallel trend assumption. The validity of our identification strategy rests on the parallel trend assumption that, in the absence of the *hukou* reform, employment and income changes of urban natives would follow similar trends between reform and non-reform cities.

Goodman-Bacon (2021) and de Chaisemartin and D'Haultfœuille (2020) point out that the staggered DiD estimator is a weighted estimate of all possible multiple 2×2 estimators, where the possible "negative weight" problem is likely to make the classical DiD estimator no longer consistent. In order to observe whether the "negative weight" problem exists and how serious it is in the context of this study, we first decompose the DiD estimator before conducting the common trend test.[30] Figure A1 in Online Appendix A shows that "Timing groups" are almost all distributed on the left side of "Weight = 0.05," while the "Never-treated vs. Timing" groups are mostly distributed on the right side of the abscissa, suggesting that the "negative weight" problem caused by "Timing groups" may not be very serious. However, to check for the robustness and credibility of the results, we continue to address the potential issues of heterogeneous treatment effects using other new DiD estimators.

In order to strengthen the validity of our identification, based on the discussions on potential problems of staggered DiD estimators, we follow Callaway and Sant'Anna (2021), de Chaisemartin and D'Haultfoeuille (2020, 2022), and Liu et al. (2022) to address such concerns (i.e., heterogeneous treatment effect issues and unobservable time-varying confounding factors).[31]

Figure 2 plots the estimates and their 95% confidence intervals using the method developed by Callaway and Sant'Anna (2021). We find that the estimates for all employment types have a relatively stable trend before the policy but have changed significantly after the reform. For example, the probability of being employed in SOEs and the secondary sector decreases significantly after the policy, while the likelihood of working in non-SOEs and the tertiary sector (especially in non-competitive service sector) increases significantly. Moreover, the dynamic effects persist for about 4–5 periods after the *hukou* reform, although some periods are not statistically significant. Therefore, there exist no pre-existing differences in trends, so the baseline results are valid.

6.2 Potential confounding factors

During the sample period, if only the impact of the *hukou* reform exists and the endogenous problems are well solved, then we can obtain the causal effects of the

[30] Figure A1 in Online Appendix A reports the decomposition results of Goodman-Bacon.

[31] We report parallel trend plots using the estimation methods of de Chaisemartin and D'Haultfoeuille (2020, 2022) and Liu et al. (2022) in Figures A2-A4 in Online Appendix A.

hukou reform on the employment and income of urban natives. However, in addition to the impact of the *hukou* reform, many other possible confounding policies occurred during our sample periods, such as SOE reform, trade liberalization reform (WTO), minimum wage policy, and higher education expansion policy. One study has found that SOE reform has an impact on firms' employment adjustment (Wang et al. 2021). In addition, trade liberalization reform and minimum wage policy also affect the labor supply behavior of individuals (Dai et al. 2021). Therefore, in this section, we re-estimate the model in the baseline specification after considering these confounding factors.

SOE reform First, we exclude the impact of SOE reform. In the setting of the benchmark model, we have controlled for the impact of SOE reform by including the interaction between SOE reform intensity and year dummies. The SOE reform intensity is represented by the change in SOE employment share in urban areas between the start (1997) and the end (2001) of SOE reform. However, this may suffer from endogeneity issues, as our outcome variables (i.e., all types of employment) are likely to be correlated with the change in SOE employment in the same UHS data. To alleviate this concern, we follow Dai et al. (2021) and Wang et al. (2021) and use the Chinese Industrial Enterprise Database (1997–2009) to calculate the employment share of SOEs at the prefecture level. We incorporate it as a control variable into the benchmark regression equations.[32]

WTO entry Second, we consider the impact of trade liberalization. A number of studies have found that the trade liberalization reform following China's accession to the WTO in 2001 had a significant impact on firms' employment adjustment, household labor supply response, and institutional policy reform (Wang et al. 2021; Dai et al. 2021; Tian 2022). For example, Wang et al. (2021) found that the *hukou* reform had a greater impact on firms' employment adjustment in areas with larger tariff reductions than in non-reform areas. Dai et al. (2021) found that regions with greater tariff reductions experienced relatively larger wage declines, and households responded to this trade shock in various ways, such as more women re-engagement with family members in the labor market, more young adults co-residing with parents, and lower household savings. Furthermore, Tian (2022) showed that regions with higher levels of trade liberalization adopted more pro-migrant policies. Therefore, we control for the WTO entry factor by adding both export and import tariffs at the city-year level. To further alleviate potential endogeneity problems, we lag these tariffs by one period.[33]

[32] However, we may still not completely exclude possible impact of SOE reform. To argue that the impact of SOE reform does not affect our conclusions, we re-run the regression without SOE reform intensity controls. We find that the coefficients are not significantly different from the results in Table 4. This result suggests that SOE reform does not significantly contaminate our estimator.

[33] In addition, we also construct a measure of trade policy uncertainty, which we follow Facchini et al. (2019) and measure it using the Normal Trade Relations (NTR) gap. We interact the NTR gap with year dummies and include it as a control variable in the regression. We obtain similar results, which are available upon request.

Minimum wage policy Finally, we consider the impact of minimum wage policies. The impact of minimum wage policies on labor market outcomes has been extensively discussed in existing studies (Card and Krueger 1994; Flinn 2006; Brochu and Green 2013; Dube et al. 2016; Clemens and Wither 2019; Cengiz et al. 2019; Bossler and Gerner 2020; Manning 2021; Dustmann et al. 2022). Following Dai et al. (2021), we collect and sort out the minimum wage of each city over the year from the China City Statistical Yearbooks and incorporate it into the benchmark model as a key control variable.

Tables A8 and A9 in Online Appendix A report the estimated results of the employment shift effects and skill-biased effects after controlling for three main confounding factors above. Table A8 in Online Appendix A shows that when we exclude the effect of confounding policies as much as possible, the employment shift effects are still present. Similarly, we also find a robust result in Table A9 in Online Appendix A, suggesting that the employment shift effects mainly occur in the high-skilled and medium-skilled groups. These results are in line with Tables 4 and 5.

Higher education expansion policy Recently, some studies have pointed out that higher education expansion policies may lead to an increase in the share of urban higher education population (Chen and Zhang 2016), which can lead to a rise in TFP for those industries that used more human-capital intensive technologies (Che and Zhang 2018) and a shock to the urban labor markets (Wu and Zhao 2010; Xing and Li 2011). To exclude the interference of this policy, we first follow Chen and Zhang (2016) by constructing the interaction term between the number of universities in each city in 1998 and the incremental size of national undergraduate enrollment with a four-period lag as a proxy variable for the higher education expansion policy. We further include this variable in the regression equations. As a result, we find similar results (see Table A10 and Table A11 in Online Appendix A).

6.3 Alternative measures of hukou reform

Since the key explanatory variable "whether city *c* adopted the *hukou* reform in year *t*" is a dummy variable, it cannot comprehensively reflect the real reform intensity of the *hukou* reform. Following the existing literature, this paper further uses the reform index to perform a substitution test on the key explanatory variables. Specifically, we use the following two indices: first, the *hukou* openness index of over 340 prefectures from 1997 to 2010 published by Fan (2019); second, the data of pro-migrant policy documents published by Tian (2022).[34] We calculate the pro-migrant index of various cities from 1997 to 2009, including the cumulative number of pro-migrant regulations and the cumulative score of pro-migrant regulations.[35]

[34] We do not use the threshold index for 120 cities published by Zhang et al. (2019) since their threshold index data is cross-sectional; thus, we cannot capture the changes over year, which is not suitable for our research.

[35] We report part of the *hukou*-index-related results in Table A12–Table A13 in Online Appendix A.

In addition, the *hukou* reform at that time involved two types: "entry barrier" reform and "unified *hukou*" reform. We are mainly concerned with the impact of "entry barrier" reform on labor mobility and the urban labor market. To further verify whether different types of reforms have different impacts on our estimation results, we add restrictions to the identification criteria of the *hukou* reform, i.e., only cities that have implemented both types of the *hukou* reform at the same time are identified as reform cities. On this basis, we re-estimate Eqs. (1) and (2) and obtain results that are in line with our expectations.[36]

6.4 Alternative samples

Exclude outflow effects Labor mobility tends to be two-way, with both inflows and outflows. Only those in urban areas with more net labor inflows are more likely to be affected by a significant labor supply shock. Therefore, to alleviate the confounding effect of labor outflows, we restrict the sample to several special cities. These cities include the core cities in the "Yangtze River Delta" and "Pearl River Delta" regions and all provincial capitals in the reform cities, as labor outflows in these regions are relatively small.[37] Table 11 reports the result of the employment shift effect after taking the labor outflow effects into account. The result shows that the employment shift effects still exist when we exclude the potential labor outflow effects, suggesting that our main results are robust.

Alternative unbalanced samples Since our paper uses the sample of cities with at least one observation period before and after the reform throughout the entire sample period, the balanced panel data at the prefecture-year level from 1997 to 2009 is ultimately retained. However, this may be somewhat restrictive for the sample. To exclude the potential sample-selection effect, we no longer impose this restriction. We then re-estimate the regression equations by using the unbalanced panel sample of all cities from 1997 to 2009 (see Table A14 in Online Appendix A). The results show that our findings are robust.

Consider policy lagged effects In addition, given the possible lagged effects of the *hukou* reform (Wang et al. 2021), we drop the sample of cities that adopted reforms after 2007 and re-estimate the baseline models. Finally, since the number

[36] Existing research suggests that the abolition of urban and rural *hukou* (or "unified *hukou*" reform) will only have a significant impact on residents with local *hukou*, while the impact on migrants is very limited (Song 2014). However, a recent study by Jin and Zhang (2023) used the "unified *hukou*" reform as a proxy variable of "quota reform" to study its impact on labor mobility, and found that "unified *hukou*" reform significantly promoted the inflows of rural migrant workers. To further examine the impact of "unified *hukou*" reform, we conduct tests and find no significant results. The results are available upon request.

[37] For the definitions of "Yangtze River Delta" and "Pearl River Delta," please refer to the "Regional Planning of the Yangtze River Delta Region" and "Outline of the Reform and Development Plan of the Pearl River Delta Region (2008–2020)." This paper uses 16 core cities in the Yangtze River Delta region, namely Shanghai, Nanjing, Suzhou, Wuxi, Changzhou, Zhenjiang, Yangzhou, Taizhou, Nantong, Hangzhou, Ningbo, Huzhou, Jiaxing, Shaoxing, Zhoushan, and Taizhou in Zhejiang Province, and 9 major cities in the Pearl River Delta region are Guangzhou, Shenzhen, Zhuhai, Foshan, Jiangmen, Dongguan, Zhongshan, Huizhou, and Zhaoqing.

of cities with the *hukou* reform in our paper is closer to that in Wang et al. (2021) after excluding the provincial-coded reform cities, we then re-estimate the baseline results after excluding these cities. We report the result of the average employment shift effects after dropping both "last two year" and "provincial coded" reform cities in Table A15 in Online Appendix A. Table A15 shows that our main results are still robust to the possible sample-selection problem. Another method to address this potential lagged effect issue of *hukou* reform is directly dropping the sample in the last two year (i.e., 2008 and 2009). Similarly, we find robust employment shift effects in Table A16 in Online Appendix A.

Keep stable natives The employment shifts exist under the important assumption that the composition of urban natives does not change significantly (i.e., the urban natives are relatively stable during the pre-reform and post-reform periods). Given the limitations of repeated cross-sectional data, we cannot observe the same individual during our sample period. And since we define the urban natives based on legal *hukou* status. Urban natives in our research also include permanent migrants. To further alleviate the concerns about the composition of urban natives and the issue of permanent migrants, we exclude the people who came to the city within 3 and 5 years, respectively, from our sample of urban natives, and then rerun the regression. We find that the results do not change significantly (see Table A17 in Online Appendix A).[38]

6.5 Permutation test

We further conduct a falsification test to validate our identification strategy. Specifically, we first construct a pseudo-policy variable by randomly selecting 46 out of 77 cities as reform cities and then randomly assigning these 46 cities to spurious reform years between 2001 and 2009. Subsequently, we re-estimate Eq. (1) and perform the exercise 500 times by replacing them with the pseudo-policy variables. Finally, we plot the simulation results (see Figure A5 in Online Appendix A). Theoretically, if the policy is exogenous, then the randomly constructed policy variable should not produce significant results. As expected, our permutation test result shows that the estimated coefficients of the pseudo-policy variables are largely centered around the value of zero, reinforcing our confidence that the *hukou* reform is relatively exogenous. This means that our main results are unlikely to be biased.

[38] One may also consider the issue of return migration. Existing studies define return migrants as those migrants who have migrated back to their hometowns from places of work or residence (e.g., Zhao 2002; Zhang et al. 2020). However, most of them can only define interprovincial return migrants by using population census data (e.g., Liang et al. 2014). We are not able to identify return migrants at the prefecture level in this study. The detailed discussion of the return migration issue requires further research, which is beyond the scope of this paper.

7 Discussion

The traditional labor supply theory holds that the increase in migrants would significantly increase the labor supply in the local labor market, which may crowd out the employment opportunities of urban natives, that is, the substitution effect. At the same time, the rapid increase of labor inflows will reduce the labor cost of enterprises in the local labor market, thereby increasing the demand for local labor and attracting more private-owned enterprises (POEs) or self-employed persons to enter the market. To test the hypothesis, we use the data from the 1995 Industrial Census, 2004 Economic Census, and China City Statistical Yearbooks to conduct a preliminary discussion. Specifically, we estimate the following econometric equations:

$$\ln poe_{ct} = \alpha_0 + \alpha_1 Hukou\_reform_c \times Post_t + \xi_c + \lambda_t + X_{ct} + v_{ct} \quad (3)$$

$$\ln poe\_emp_{ct} = \beta_0 + \sum_{j=-6, j\neq -1}^{6} \beta_j Hukou\_reform_{c,t-j} + \xi_c + \lambda_t + X_{ct} + u_{ct} \quad (4)$$

Equation (3) uses the difference-in-differences (DiD) method to estimate the causal effects of the *hukou* reform on POEs based on data from the 1995 industrial census and 2004 economic census. The dependent variable $\ln poe_{ct}$ represents the logarithm of the number of POEs or the number of employees of POEs in city c and year t. $Hukou\_reform_c$ indicates whether city c adopted the *hukou* reform from 2001 to 2004. $Post_t$ is a dummy variable that takes the value 1 if it is 2004; otherwise, it is 0. ξ_c and λ_t denote city fixed effects and year fixed effects, respectively. $\boldsymbol{X_{ct}}$ represents the interaction term between the characteristics of the city in the base period and the year dummies. v_{ct} is a random error term. Similarly, we estimate Eq. (4) using data on POEs and self-employed persons in urban units from China City Statistical Yearbooks from 1990 to 2009. The key dependent variable we care about, $\ln poe\_emp_{ct}$, represents the logarithm of the number of urban POEs or self-employed persons in city c and year t. The standard errors are clustered at the city level. u_{ct} is a random error term, and the other variables are the same as in Eq. (3).

Table 12 reports the estimation result of Eq. (3). We find that the number of POEs in urban areas with the *hukou* reform is higher than that in urban areas without such reform, especially for small POEs. The result suggests that more small-sized POEs entered the local labor market after the *hukou* reform. In addition, the *hukou* reform led to a significant increase in the number of employees in medium-sized and large POEs instead of small-sized POEs, which is likely due to the limited or less elastic labor demand for the small-sized POEs at the early stage. Furthermore, the results by educational attainment of employees suggest that the *hukou* reform mainly increased the demand for high-skilled workers, which is in line with the evidence that the *hukou* reform induced more high-skilled migrant workers to enter the local labor market.

Since the estimates above only use two-period panel data, we may not be able to perform a test of ex-ante trends. To avoid this problem, we re-estimate Eq. (4) using data from the China City Statistical Yearbooks. Figure 3 reports the staggered DiD estimation results. Figure 3 shows that before the *hukou* reform, there is no

Table 11 Robustness: exclude potential outflow effects

	(1)	(2)	(3)	(4)
Dep. var	Formal employment	Informal employment	SOE employment	Non-SOE employment
Hukou reform	−0.034*** (0.011)	0.035*** (0.008)	−0.019 (0.012)	0.020* (0.011)
Observations	271,692	271,692	271,692	271,692
R-squared	0.244	0.065	0.191	0.102
Dep. var	Secondary sector	Tertiary sector	Competitive service sector	Non-competitive service sector
Hukou reform	−0.042*** (0.008)	0.042*** (0.011)	0.017** (0.007)	0.024** (0.012)
Observations	271,692	271,692	271,692	271,692
R-squared	0.084	0.149	0.045	0.149
No. of cities	48	48	48	48

This table reports the DiD estimation results based on the selected sample, and all the constants are not reported. All specifications control for city and year fixed effects, province trends, and controls include both individual-level and household-level characteristics such as age, gender, years of education, household size, log housing area per capita, house property dummies, and mean years of education per household. We control for city-level initial conditions, including log local GDP per capita, the share of non-agricultural population, the share of second-industrial employment, log local fiscal expenditure per capita, and log local average wage interacted with year dummies; SOE reform intensity interacted with year dummies. SOE reform intensity is represented by the city-level difference in the share of SOE employees between 1997 and 2001. The number of cities declines from 77 to 48 as we only keep the reform cities which are provincial capitals and those in the "Yangtze River Delta" and "Pearl River Delta" regions. Robust standard errors are clustered at the city level in all specifications. *$p<0.1$; **$p<0.05$; ***$p<0.01$

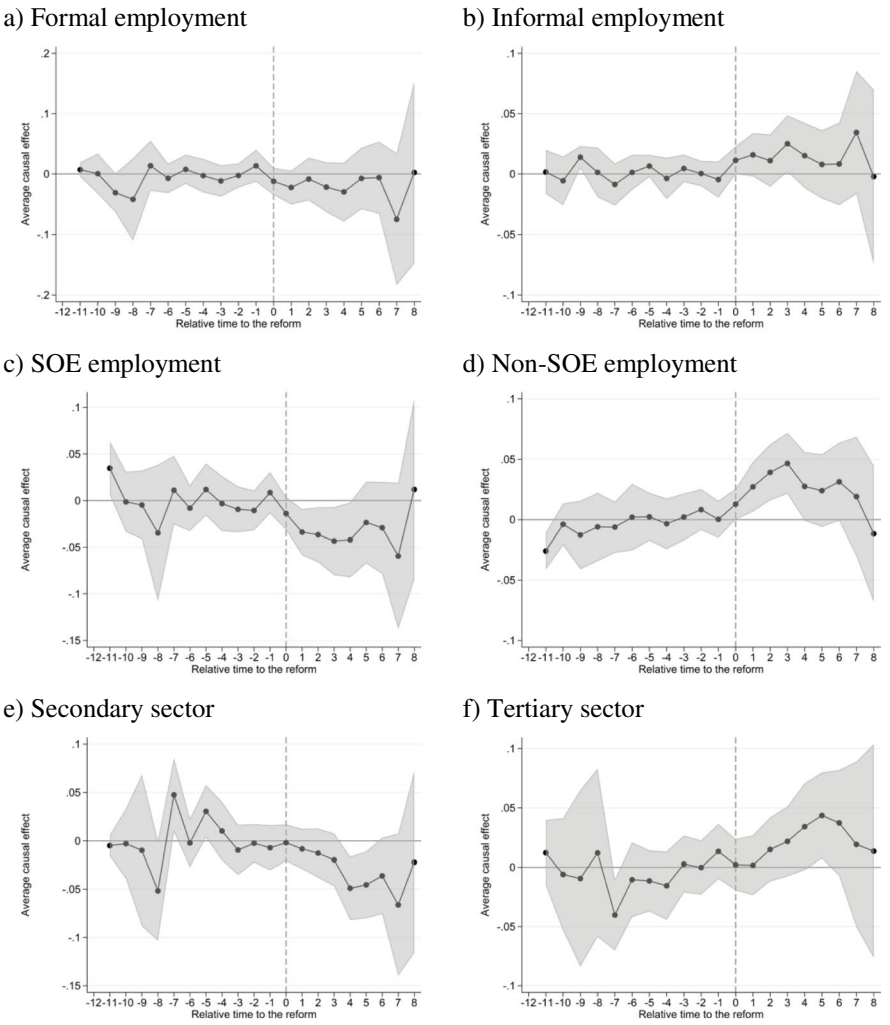

Fig. 2 Parallel trends test based on Callaway and Sant'Anna (2021). *Notes*: This figure shows the composition impact of the *hukou* reform on employment, and all these sub-figures plot the regression coefficients and 95% confidence intervals based on the following model: $Y_{ct}=\alpha_0+\sum_{j=-P}^{Q}\tau_j \cdot Hukou_{c,t-j}+\theta \boldsymbol{X_{ct}}+\lambda_c+\xi_t+\varepsilon_{ict}$, where Y_{ct} is the aggregated share of employment in each prefecture c and year t. $\boldsymbol{X_{ct}}$ includes all city-level initial conditions, such as minimum wage and trade uncertainty index, at their base-period values, since the underlying assumption by using "csdid" is that all covariates are time constant. The other variables in the model are the same as in Eq. (3). We report the doubly robust DiD estimator based on stabilized probability weighting and ordinary least squares. The vertical dashed lines indicate the timing of the *hukou* reform. Standard errors are clustered at the city level

significant difference in the number of urban self-employed individuals between reform and non-reform areas, suggesting that the parallel trend assumption holds. After the adoption of the *hukou* reform, the number of urban self-employed persons in the reform areas increased significantly.

Table 12 Discussion: the effects of *hukou* reform on entrepreneurship

	(1)	(2)	(3)	(4)
Panel A: ln (number of POEs)				
	All	Large-sized	Medium-sized	Small-sized
Hukou reform	0.463*** (0.161)	0.226* (0.123)	0.208 (0.126)	0.502*** (0.164)
R-squared	0.967	0.980	0.981	0.955
Panel B: ln (employment of POEs by size)				
	All	Large-sized	Medium-sized	Small-sized
Hukou reform	0.084 (0.340)	0.260** (0.130)	0.345** (0.145)	0.156 (0.347)
R-squared	0.909	0.993	0.984	0.839
Panel C: ln (employment of POEs by educational attainment)				
	College and above	Senior high school	Junior and below	
Hukou reform	0.354* (0.212)	0.211 (0.303)	0.166 (0.324)	
R-squared	0.962	0.920	0.919	
Panel D: ln (employment of POEs by size and educational attainment)				
	College and above	Senior high school	Junior and below	
	Large-sized			
Hukou reform	0.368*** (0.129)	0.294** (0.124)	0.214 (0.134)	
R-squared	0.987	0.991	0.992	
	Medium-sized			
Hukou reform	0.311** (0.121)	0.324** (0.137)	0.326** (0.147)	
R-squared	0.983	0.982	0.983	
	Small-sized			
Hukou reform	0.367* (0.206)	0.233 (0.310)	0.232 (0.328)	
R-squared	0.928	0.852	0.850	
No. of cities	257	257	257	257
Observations	514	514	514	514

This table reports the 2×2 DiD estimation results using the 1995 industrial census and 2004 economic census data. All specifications control for city and year fixed effects, and control for extra initial city conditions interacted with year dummies. Initial city conditions include log local GDP per capita, the share of non-agricultural population, the share of second-industrial employment, log local fiscal expenditure per capita, and log local average wage. The *hukou* reform cities include those cities that implemented the reform during 2001 and 2004 and without missing initial city conditions, and there are 76 reform cities in our DiD estimation. Robust standard errors are clustered at the city level. *$p<0.1$; **$p<0.05$; ***$p<0.01$

8 Conclusions

Using China's Urban Household Survey (UHS) from 1997 to 2009 and *hukou* reform data, this paper examines the impact of the internal migration policy change on the migration patterns and labor market outcomes of urban natives in China. The change of internal migration policy refers to the relaxation of *hukou* entry requirements implemented by prefectural governments since 2001. The relaxation of migration restrictions is primarily targeted at high-skilled migrants, which has been understudied in previous studies. Moreover, the "entry barrier" *hukou* reform is

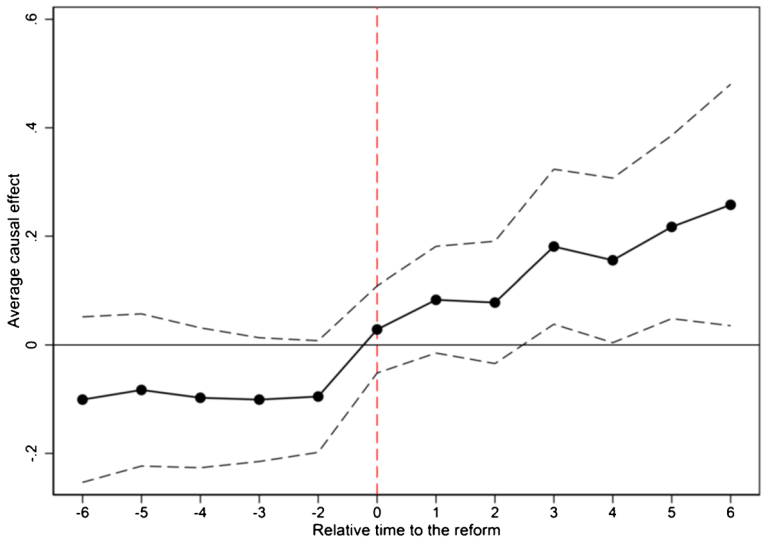

Fig. 3 Difference of entrepreneurship between reform and non-reform cities. *Notes*: Estimated coefficients (β_j) and 95% confidence interval from the staggered difference-in-differences regression: $\ln poe\_emp_{ct}=\beta_0+\sum_{j=-6,j\neq-1}^{6}\beta j \cdot Hukou\_reform_{c,t-j}+\xi_c+\lambda_t+\boldsymbol{X_{ct}}+u_{ct}$, where $\ln poe\_emp_{ct}$ is log number of employers or entrepreneurs (entrepreneurship) in urban areas in city c and year t. $Hukou\_reform_{c,t-j}$ is a dummy variable indicating the relative time when city c implemented the *hukou* reform, excluding the baseline period. λ_t indicates year fixed effects, ξ_c denotes city fixed effects. $\boldsymbol{X_{ct}}$ is a vector variable indicating a group of city-level variables interacted with year dummies. The city-level variables include log local GDP per capita, the share of non-agricultural population, the share of second-industrial employment, log local fiscal expenditure per capita, and log local average wage. u_{ct} is the error term. β_j measures the average causal effect of the *hukou* reform on entrepreneurship in urban China. The number of POE employers or entrepreneurs in urban areas and the city-level initial conditions are both taken from the China City Statistical Yearbooks

being implemented on a city-by-city basis, which allows us to use the staggered DiD method to examine the impact of the reform on both migration and labor market outcomes of urban natives.

We find that the cities with *hukou* reform was more likely to attract high-skilled migrants. Moreover, the inflow of high-skilled migrants is more pronounced in the younger cohort group (aged 20–29) and within-prefecture migration and across-prefecture migration groups. These findings provide the empirical evidence on the impact of the merit-based *hukou* entry policy targeting for the high-skilled migrants, which is also consistent with existing studies (e.g., Zhou 2021).

The large number of inflows of high-skilled migrants would induce a labor supply shock on the local urban labor market, posing a pressure on urban natives. However, we did not find a negative impact on urban natives. Instead, the result shows that, on average, the *hukou* reform had no significant impact on the employment level and income of urban natives. This finding echoes the existing literature on the modest effect of internal migration on the labor market outcomes of urban natives (e.g., Meng and Zhang 2010).

We find that the *hukou* reform caused a certain employment shift effect in the local labor market. Moreover, this employment shift effect occurred mainly among high-skilled workers and medium-skilled workers. Further heterogeneity analysis shows that the employment shift effect existed for both men and women, especially in the 30–50 age group. Combining the employment shift effect and income changes by gender, we find that men were more likely to shift to be employed in the private economic units, with their total income negatively affected, while women were more likely to shift and re-entered to work in the service sector. Notably, there was a significant increase in net business income but no significant change in other income, suggesting that women would be likely to choose to re-enter the labor market and engage more in the service jobs. This evidence aligns with the insurance role of households against the external labor market shocks (e.g., Dai et al. 2021). Further preliminary discussion shows that the *hukou* reform cities attracted more private-owned enterprises (POEs) or self-employed individuals to enter the urban labor market, which in turn stimulated the local labor demand, especially for high-skilled workers. The employment shifts and demand expansions, particularly for high-skilled workers, both help to explain the little impact of *hukou* reform on the overall employment and income of urban natives.

Our research enriches the literature on the impact of immigration on the local labor market. This paper finds the employment shift effects and skill-biased effects of *hukou* reform, providing new evidence on how internal migration affects natives. In addition, this paper provides important policy implications. The local governments throughout China are persistently rolling out measures to ease the restrictions on internal migration, with a significant focus on attracting individuals with high skills. Consequently, this paper delivers insightful perspectives on the current *hukou* policies. Moreover, the international migration policies primarily focus on attracting high-skilled talent in certain countries. Thus, this paper also offers implications for international migration policies for these countries.

Our study also has limitations. For example, one important issue is that the *hukou* reform could impact the labor mobility and composition of migrants in each city in China, creating a dynamic where a gain in migration population for one city could be a loss for others. Another one is that the *hukou* reform we examined could have a general equilibrium impact through many other channels beyond the labor markets, including housing market, firms' entry and exit, and non-tradable goods and services (An et al. 2024). We have explored the preliminary impact of this reform on firms' responses, but an in-depth and comprehensive study, often requiring structural models (e.g., Sieg et al. 2023; Tombe and Zhu 2019), is beyond the scope of this paper, and it remains an avenue for future research.

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Data availability The data we use in this paper are confidential, and we are not allowed to release the data.

Declarations

Conflict of interest The authors declare no competing interests.

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