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# The Working Dread? Analysing the Impact of the Hukou Reform on Firms' Monopsony Power in China

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**Abstract**

This paper uses firm-level data from the Chinese Annual Survey of Industrial Firms (CASIF) for the years 1998-2007 to analyse the impact of the household registration system (Hukou) reform in China on monopsony power of firms. I adopt a multiple-period difference-in-differences framework to exploit the non-uniform labour market reform implementation. By comparing firms in cities that adopted the reform to firms in cities that did not, I find that relaxing restrictions on geographical labour mobility decreased firms' monopsony power overall. Further heterogeneity analysis suggests that the effect can be decomposed into two offsetting forces: firms in big cities saw their monopsony power increase, while it diminished for firms in small cities. Consistent with a decrease in monopsony power, firms in reform cities spent 26% more on the worker housing fund and 7% more on unemployment insurance as a result of the Hukou reform. I find that the Hukou reform is positively related with both marginal and average products of labour.

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# 1 Introduction

The Chinese labour market is regulated by a rigid household registration system, officially termed Hukou. Access to formal jobs, education, healthcare, and the housing market is conditional on holding a local hukou status[2]. This makes migration to urban centres costly for agricultural hukou holders. As modelled in (Ngai et al., 2019), discrimination in the provision of social transfers creates a disincentive to migration and results in a surplus of rural labour. These institutional barriers to geographical labour mobility contribute to rural-urban wage gaps and inequality in access to basic social safety nets. The ratio of urban-rural per capita disposable income in China reached 2.5 in 2017 (Jain-Chandra et al., 2018). A significant rural-urban divide also exists in the levels of human development. In 2015, only 11.3% of adult workers aged 25-64 in rural areas held a high school degree, compared to 44.1% in urban areas (Li et al., 2017).

Low mobility of workers and lack of adequate social protection create a perfect setting for monopsony power to emerge. Institutional barriers to access to the job market and social transfers in urban areas can cause the labour supply curve to be inelastic, allowing firms to capture some of workers' surplus by setting wages below the marginal revenue product of labour. The vulnerability of non-urban hukou holders to exploitation by employers can also manifest itself through lack of firm-sponsored employee benefits such as training, unemployment insurance, and other social benefits.

In the light of growing rural-urban inequality, the government launched the reform of the Hukou system in 2001, allowing for easier transfers of the hukou status. This paper provides the first empirical analysis on the impact of the Hukou reform on the monopsony power of firms. I use firm-level micro data from the Chinese Annual Survey of Industrial Firms (CASIF) for the years 1998-2007 and exploit the quasi-experimental nature of the 2001 reform. The non-uniform reform implementation allows me to use a multiple period diff-in-diff framework and compare treatment cities that adopted the reform to control cities that did not. I follow (Ackerberg et al., 2015) to estimate the production function and construct Pigou's E, a commonly used method to measure monopsony power. I find that increased labour market flexibility led to a reduction in monopsony power of Chinese firms.

I further investigate heterogeneity effects and find that firms in larger cities that are

[2]The hukou status is determined across two dimensions: sector of the economy (agricultural vs. non-agricultural) and location (local vs. non-local).

attractive destinations for migrant workers see an increase in monopsony power, while it decreases for firms in small cities. Consistent with theoretical models of worker training and firm-provided benefits (Acemoglu and Pischke, 1998), the Hukou reform leads to an increase in spending on the worker's housing fund and unemployment insurance relative to control. Finally, I analyse whether the Hukou reform, by redressing labour misallocation, improves productivity of labour. I find positive effects on both the average product of labour and marginal product of labour at firm level.

This paper contributes to the existing literature in two main ways. First, most studies on the Hukou system tend to be either qualitative (Chen and Fan, 2016; Chan and Buckingham, 2008), or use household-level data to determine the impact of the hukou system on the wage structure (Dreger and Zhang, 2017), employment adjustment (Meng et al., 2010), and migration (Imbert et al., 2018). Firm-level studies are much scarcer. Most recent contributions include (Wang et al., 2021), who looks at firm-level employment adjustment following the Hukou reform. This paper builds on existing research on firm-side responses to the Hukou system.

Second, while previous studies have found the existence of monopsonistic market structures in China (Brooks et al., 2019), there have been no attempts to link the Hukou system to monopsony power among Chinese firms, including potential heterogeneity effects. Monopsony is closely related to resource misallocation and labour market frictions. Previous research has established a TFP loss of 30-50% in China relative to undistorted input markets (Hsieh and Klenow, 2009) and pointed to the coexistence of rural surplus labour and urban worker shortages as a sign of misallocation (Chan, 2010). Yet little is known about the impact of increased worker mobility via hukou reforms on firm-level productivity. I make a contribution by establishing a positive relationship between the Hukou reform and MPL and APL.

## 2 Literature Review

A growing number of studies has emphasised the emergence of monopsony power in China. (Brooks et al., 2019) find that monopsony lowers the labour share of income by 10 percentage points in China. Since the labour share of income has declined by over 12 percentage points in the period 1995-2007 in China (Bai and Qian, 2010), monopsonistic practices are increasingly important for understanding the welfare of workers. Traditionally, the literature on monopsony has emphasised lack of competition among firms, information frictions, spatial and

monetary costs of search, and signalling issues in the presence of heterogeneity (Muehlemann et al., 2013). This paper makes a contribution by highlighting how government restrictions on workers' mobility through the Hukou system can generate monopsony power.

The emergence of monopsony power is closely related to the presence of market failures. Since markets in developing countries tend to be less competitive (Sokolova and Sorensen, 2018), a number of studies has focused on firm-level analysis in the presence of market frictions, including capital constraints (de Mel et al., 2008; Banerjee and Duflo, 2014), underdevelopment of insurance markets (Field et al., 2013) and heterogeneity in entrepreneurial ability (Banerjee et al., 2019; McKenzie, 2017). I contribute to the literature on firm-level behaviour in the presence of labour market frictions by focusing on a unique institutional constraint to labour mobility through the Hukou system.

Removal of labour market frictions can enhance economy-wide productivity by changing the resource allocation across space and sectors. In China, the movement of labour from low-productivity agriculture to the higher-productivity urban sector underpinned its rapid economic growth (Meng, 2012). Consistent with this, (Zhu, 2012) finds that most of China's growth post 1978 be attributed to TFP gains from sectoral shifts. Yet the degree of misallocation in the Chinese labour market remains high, as evidenced by the coexistence of migrant labour shortages and rural labour surpluses (Chan, 2010). (Hsieh and Klenow, 2009) find that TFP would increase by 30-50% in China if input markets were undistorted. A crucial source of misallocation is the institutional rigidity of the Hukou system, which prevents the reallocation of labour across space. This paper contributes to the literature on misallocation in China by linking the easing of the Hukou system to firm-level productivity growth.

The Hukou system plays a central part in explaining labour market frictions in China. Its institutional design limits access to jobs, education, healthcare, and housing in cities for rural hukou holders, contributing to growing wage inequality as well as disparities in job permanence and formality between rural and urban hukou holders. (Meng et al., 2010) finds that rural-urban migrants were hit hardest in terms of employment after the economic downturn in China in 2008. Beyond formal restrictions on social transfers, agricultural hukou holders are subject to discrimination and social stigmatisation. (Meng and Zhang, 2001) analyse the earning differentials of migrants and urban residents in Shanghai and find that a large portion of the earnings gap is due to within-occupation factors that are unexplained and likely relate to discrimination. Similarly, (Afridi et al., 2012) find that when the hukou status is made salient and public, students with a rural hukou underperform by 10% on cognitive

tasks relative to when their social identity is held private.

Due to its discriminatory nature, the impact of the household registration system on employment outcomes of migrants has been studied broadly from a workers' perspective, either using household-level data or qualitative approaches. Much less is known about how the Hukou system affects firm behaviour and market structure. Recent studies include (Brooks et al., 2019), who find the existence of monopsony power in China and point to low geographical labour mobility as a potential reason for inelastic supply of labour, but do not empirically test for the link between the two. This paper is most similar to (Wang et al., 2021), who uses firm-level micro data to find that the hukou reform led to higher firm-level employment adjustment following trade liberalisation. I contribute to the firm-level literature on Hukou by analysing the impact of the Hukou reform on firm monopsony power, investment in human capital, and productivity gains.

## 3 The Hukou Reform

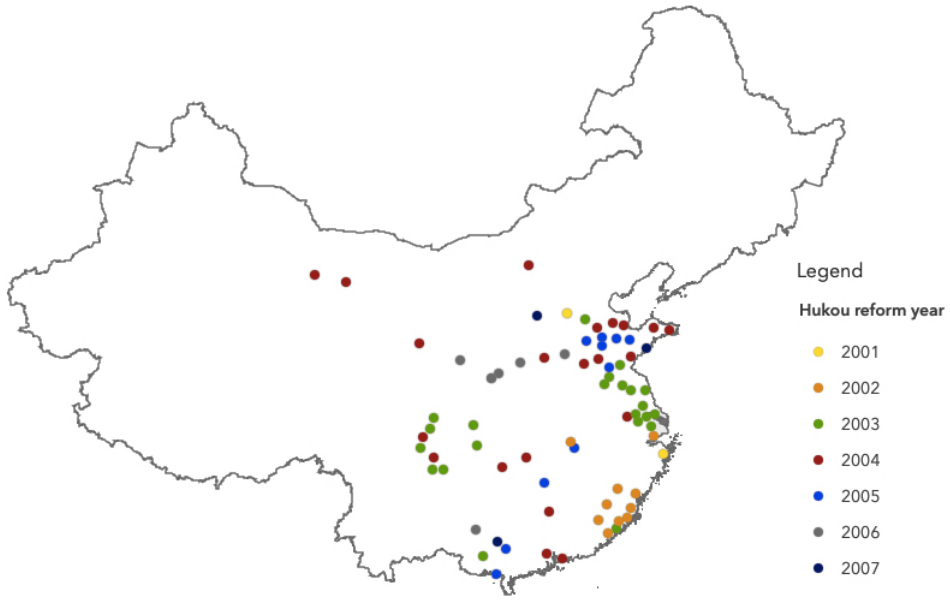
The Chinese labour market has traditionally been very rigid due to the institution of the household registration system, officially termed Hukou. Its original function was to control migration, allocate state resources such as food rations, and exercise political coercion under the Maoist government. A person's hukou is determined based on their parent's birthplace and can be divided alongside two dimensions: location (local vs. non-local) and sector of the economy (rural vs. urban). During the period of the planned economy (1949-1978), an individual could only work and live in the location of their hukou. Those wishing to move to a city had to apply for a hukou transfer (nonzhuangfei). In reality, applications were rarely approved, and the state placed strict quotas on the number of hukou transfers (Young, 2013).

Following the launching of economic reforms under Deng Xiaoping, the institution of the Hukou began to see its first changes in the early 1990s. Rapid growth in agricultural productivity due to the reform of the land ownership structure reduced the labour requirement in production (Zhu, 2012). Rural surplus labour that was freed up then moved into rapidly growing urban industries, initiating a period of rapid structural transformation. The acceleration of migration flows was accompanied by a partial relaxation of the Hukou requirements at the city level, including increasing the quota for transfers, strengthening the governance of temporary residence permits, and schools accepting rural students without a fee. Despite the partial easing of the Hukou system, most social transfers and administrative

activities continue to be determined on the basis of a person's hukou, including medical insurance, school enrolment, land ownership, housing, and access to a formal labour market (Li et al., 2017).

The focus of this paper is the largest reform of the Hukou system. Its initial version, the 1997 "Blueprint for Experiment in Small City and Town Huji Management Reform" announced by the State Council allowed for hukou transfers among rural residents but was restricted to smaller cities as an experiment. Upon successful implementation, the new round of the reform was launched in 2001. A number of cities chose to abolish the distinction between rural and urban hukou and allowed for easier changes to the hukou status. The non-uniform reform implementation among different prefectures allows me to exploit the multiple period diff-in-diff framework to capture the impact of hukou system relaxation. I follow (Wang et al., 2021) and identify 74 cities that implemented the reform before 2007. Figure 1 shows the location of those cities, together with the year of reform implementation. In the analysis, I exclude those cities that implemented the reform after 2005 to allow at least 2 years for the policy to take effect. I consider all cities that implemented the reform between 2001-2005 as treatment and all those that did not as control.

Figure 1: Cities that Implemented the Hukou Reform




*Notes: This map shows the location of cities that implemented the Hukou reform between 2001-2007 together with the reform year. For later analysis, I exclude those cities that implemented the reform after 2005 to allow at least 2 years for the policy to take effect.*

Theoretically, the main channel through which the reform could influence firms' monopsony power is increased rural-urban migration that makes the labour supply curve more elastic. The abolition of the distinction between rural and urban hukous in reform cities allows easier access to the formal labour market and social transfers in cities, which can be expected to encourage migration and speed up the process of urbanisation. Table 1 shows the change in the share of urban population in total population [3] for reform and non-reform cities in 2000 (pre-reform) and 2005 (post-reform). Reform locations experience a faster pace of urbanisation, suggesting a higher rate of migration flows into urban centres.

Table 1: Change in the Share of Urban Population in Total Population

| | 2000 Mean | 2005 Mean | Change |
|---|---|---|---|
| Non-reform cities | 0.37 | 0.44 | +0.07 |
| Reform cities | 0.29 | 0.46 | +0.17 |

*Notes: This table reports mean values of the share of urban population in total population for non-reform and reform cities for the years 2000 (pre-reform) and 2005 (post-reform). All city-level statistics are taken from the China Data Institute.*

This increased labour mobility is likely to make the labour supply curve more sensitive to changes in the wage rate. As it becomes easier for workers to relocate and change employers, monopsony power should decrease overall. However, the location of firms is likely to be crucial in determining their bargaining power in the labour market. In particular, the direction of integral migration in China has historically been towards large urban centres due to higher consumption possibilities and access to urban amenities (Xing and Zhang, 2017). This might mean that employers large cities that are attractive destinations for migrants find it easier to exert monopsonistic behaviour after restrictions on labour mobility are relaxed via the Hukou reform while small cities that would see an increased outflow of migrants might find it harder to retain workers.

# 4 Data and Methodology

## 4.1 Data

The main data source for this paper is the Chinese Annual Survey of Industrial Firms (CASIF) collected by the National Bureau of Statistics of China for the period 1998-2007. It covers all state-owned enterprises and non-state-owned enterprises with annual sales over 5 million

[3] In China, prefectures are divided into an urban and rural part.

RMB (around 700 thousand USD). It is the most comprehensive firm-level micro dataset for the industrial sector in China as it accounts for around 95% of Chinese industrial output and 98% of industrial exports. All firms are required to report detailed information about their balance sheet, including assets, liabilities, factors of production, costs, and revenues. An important feature of the dataset for my purposes is that it includes information about firms' investment and compensation of workers. I constrain my sample to 30 two-digit industry codes in the manufacturing sector to focus on the most labour-intensive segments of the Chinese economy.

The challenges of working with firm-level NBS data are well known from (Brandt et al., 2012). In particular, reporting bias and political interference create the potential for measurement error. I follow the standard procedure in literature to clean the data. I drop all firms that report 1) liquid assets greater than total assets, 2) total fixed assets greater than total assets, 3) net value of fixed assets (total original value of fixed asset less accumulated depreciation) greater than total assets, 4) less than 8 employees, 5) wage data is missing, negative, or null. For later analysis, I exclude firms in cities that implemented the reform after 2005 to allow at least two years for the policy to take effect. Additionally, I leave only the firms that have at least two observations on both sides of the reform year.

A potential threat to a clear identification strategy is the violation of the Stable Unit Treatment Value Assumption (SUTVA), where one unit's receipt of treatment affects the outcomes of other units. This could happen in the presence of spill over effects from reform to non-reform cities. For example, firms originally based in non-reform locations could move to big and highly urbanised cities in order to take advantage of a larger pool of labourers in neighbouring cities that adopted the reform. To avoid this complication, I drop all firms that have changed their location. A full breakdown of the number of observations by year is shown in Table 2 below.

Table 2: Number of observations in Treatment and Control Cities

| Year | Full sample | Reform | Non-reform |
|---|---|---|---|
| 1998 | 42,762 | 1,769 | 40,993 |
| 1999 | 52,527 | 2,607 | 49,920 |
| 2000 | 49,786 | 5,210 | 44,576 |
| 2001 | 61,519 | 10,121 | 51,398 |
| 2002 | 66,969 | 12,088 | 54,881 |
| 2003 | 71,678 | 12,962 | 58,716 |
| 2004 | 100,475 | 12,235 | 88,240 |
| 2005 | 110,552 | 11,368 | 99,184 |
| 2006 | 123,958 | 9,946 | 114,012 |
| 2007 | 114433 | 8,907 | 105,526 |
| Total | 794,659 | 87,213 | 707,446 |

*Notes: This table reports the number of observations in reform and non-reform cities for each sample year 1998-2007. I consider cities that implemented the reform as the Treatment group and cities that did not as the Control group.*

### 4.2 Measure of Monopsony Power

The key idea behind monopsony power can best be explained by assuming homogenous workers and asking what will happen when an employer cuts the wage by 1%. In a perfectly competitive and frictionless labour market, all workers would leave and work for a competing firm instead. Within a monopsony setting, the employer might find it harder to recruit and retain workers but does not immediately lose all of its workforce, since the labour supply curve is not infinitely elastic (Manning, 2021). In other words, when workers' wages are reduced, it is difficult for them to find work with another employer, and thus they remain in their current position. We can look at the concept of monopsony power with a viewpoint of gap between marginal product of labour and wage. In a perfectly competitive market employers are expected to hire workers until everyone is paid their marginal revenue product. Any gap between the marginal revenue product and wage would be indicative of distortions in the market structure. I follow (Kim, 2021) and use Pigou's E, a commonly applied measure of monopsony power, to quantify the gap between labour productivity and wage normalised by wage.

$$Pigou's\ E = \frac{R'(L) - W(L)}{W(L)}$$

Where W(L) is the inverse supply curve, R(L) is the firm's revenue function and R'(L) is the marginal product of labour. Pigou's E should equal to zero in a perfectly competitive setting. A positive value of the Pigou's E can be interpreted as the presence of

a monopsonistic market structure where the labour is supplied inelastically due to labour market frictions.

In CASIF, firms only report their total expenditure on wages, without information on wage for individual workers, hence I use the average wage as a proxy for individual wages. The marginal product of labour can be estimated from a production function. Since all values of inputs into production reported in the dataset are booked value and do not account for inflation, I use price deflators for investment, intermediate goods, output, and wages and follow the perpetual inventory method (Berlemann and Wesselhöft, 2014) to transform them into real values. For details on the construction of real capital stocks, see Part 1 in the Appendix. I follow the (Ackerberg et al., 2015) extension of (Levinsohn and Petrin, 2003) and use a semi-parametric method to estimate the production function, treating intermediate inputs as a proxy for unobserved productivity shocks. For details, see Part 2 in the Appendix. From the production function, I estimate Pigou's E by two-digit industry level.

### 4.3 Descriptive Analysis

This section outlines the main firm and city characteristics over the sample period. Table 3 presents summary statistics of main variables in the dataset. All values are shown in local currency. Output is equal to total sales deflated by the nation-wide factory price index. Intermediate inputs are calculated by deflating total expenditure on intermediate inputs using a nation-wide deflator for intermediate goods. Labour stock is equivalent to the number of workers. An average firm has around 189 employees, with the number varying from a minimum of 11 to a maximum of 1,920 employees. Capital stocks reflect the value of real investment in fixed assets net of depreciation [4]. There is a wide range of real wages offered by firms, as shown by the large difference between minimum and maximum values, suggesting possible heterogenous effects with regards to the wage-setting ability of firms. The mean firm is operating in the industry for 9 and a half years, with the largest value in the dataset equal to 49.

[4]For details on the construction of capital stocks, see Part 1 in the Appendix.

Table 3: Descriptive Statistics

| | Mean | SD | Min | Max | N |
|---|---|---|---|---|---|
| Output | 34,454 | 57,881 | 353.54 | 317,881 | 794,659 |
| Labour | 188.92 | 286.52 | 11.00 | 1,920.00 | 794,659 |
| Intermediate Inputs | 24,467 | 41,107 | 233.10 | 225,581 | 794,659 |
| Capital | 10,309 | 18,410 | 168.54 | 86,122 | 697,519 |
| Real wage* | 11.87 | 9.74 | 0.82 | 63.65 | 794,659 |
| Log of total sales | 9.68 | 1.37 | 4.81 | 13.31 | 794,659 |
| Age of the firm | 9.29 | 10.57 | 0.00 | 49.00 | 794,370 |
| Log of per capita city GDP | 9.84 | 0.78 | 8.10 | 11.18 | 692,533 |
| Total population (10000 persons) | 589.80 | 332.62 | 14.19 | 1,378.86 | 756,312 |
| Non-agricultural population (10000 persons) | 280.43 | 297.02 | 12.04 | 1,196.94 | 756,312 |
| Share of non-agricultural population | 0.42 | 0.22 | 0.07 | 1.00 | 756,312 |
| Agriculture share of GDP | 0.12 | 0.10 | 0.00 | 0.41 | 755,708 |
| Industry share of GDP | 0.48 | 0.09 | 0.23 | 0.67 | 755,708 |
| Services share of GDP | 0.40 | 0.10 | 0.22 | 0.74 | 755,708 |
| Industry-level Theil index of dispersion of MPL** | 0.46 | 0.11 | 0.17 | 0.77 | 794,659 |
| City-level Theil index of dispersion of MPL | 0.55 | 0.15 | 0.35 | 0.96 | 794,659 |

**Real wage is nominal wage in local currency deflated by the province-specific CPI index.*

*** $Theil_{it} = \frac{1}{n_{it}} \sum_{f=1}^{n_{it}} \frac{MPL_{fit}}{MPL_{it}^{-}} log(\frac{MPL_{fit}}{MPL_{it}^{-}})$ for firm $f$, industry $i$, and year $t$.*

At the city level, the average size in terms of population is around 5.9 million inhabitants. This is in line with the rapid urbanisation rates experienced by China during the sample period. The largest city in the sample has over 13.8 million residents while the smallest has only 141,000 residents. Prefectures[5] in China are divided into an urban and rural part. The mean share of the non-agricultural population in a city is 42%. The maximum value for this variable is 100%, which can be interpreted as a fully urbanised prefecture. In terms of sectoral decomposition of output, on average industry accounts for 48% of GDP, with 12% coming from agriculture and 40% from services. This supports the notion that a mean sample city has already began the process of industrialisation. The Theil Index captures the dispersion of marginal products of labour at the level of industries and cities. In perfectly competitive markets, this value should be equal to 0 as marginal products are equalised through the free movement of labour. A mean value of 0.46 for the industry-level Theil index and 0.55 at city level indicates a level of distortion in the spatial allocation of resources, supporting the notion of rigid labour markets and a monopsonistic market structure.

Table 4 shows mean outcome variables for the whole sample period 1998-2007. A large and positive value for mean Pigou's E is indicative of the presence of a large gap between the marginal revenue product of labour and wage normalised by wage, confirming

[5]I use the terms prefecture and city interchangeably to denote the second-level administrative division in China.

the presence of monopsony power among Chinese firms. There is significant variability in firms' annual expenditure on the housing fund and unemployment insurance. Importantly, some firms report no investment in either, which is consistent with monopsonistic behaviour. The average and marginal products of labour show wide dispersion between the minimum and maximum value.

Table 4: Mean Outcomes

| | Mean | SD | Min | Max | N |
|---|---|---|---|---|---|
| Pigou's E | 14.39 | 21.78 | -0.05 | 112.36 | 794,659 |
| Housing Fund | 7.84 | 36.23 | 0 | 222 | 794,659 |
| Unemployment Insurance | 41.97 | 147.43 | 0 | 860 | 794,659 |
| APL | 259.20 | 299.41 | 9.66 | 1490.99 | 794,659 |
| MPL | 147.51 | 199.82 | 4.79 | 1026.82 | 794,659 |

*Notes: This table shows summary statistics for the main outcome variables. Pigou's E is constructed according to section 4.2, housing fund and unemployment insurance relate to the amount of expenditure on these worker benefits by employers. Average product of labour is calculated as* $APL = \frac{Y}{L}$. *Marginal product of labour (MPL) is derived from the production function. For details on the production function estimation, see Part 2 in the Appendix.*

### 4.4 Methodology

The main specification looks at the relationship between the easing of labour market restrictions through the Hukou reform and monopsony power of firms. In an ideal setting, I would want to compare how monopsony power of a firm in a reform location changed relative to if the same firm had been located in a non-reform city. However, the counterfactual is unobservable. I adopt a multiple period difference-in-differences approach that exploits non-uniform reform implementation to compare changes in monopsony power of firms in cities that adopted the reform before 2005 to firms in cities that did not. The main specification is shown below:

$$y = \beta_0 + \beta_1 hukou_{ct} + X_{ict}\gamma + Z_{ct}\delta + city \times year + \theta_i + \theta_t + \epsilon_{ict} \quad (1)$$

Where the subscript $i$ denotes the firm, $c$ is the city, and $t$ the year. $y$ relates to the outcome variables of interest, including Pigou's E, firms' expenditure on worker unemployment insurance, housing fund, MPL, and APL. Hukou is a dummy variable indicating whether the reform was active in city $c$ at time $t$.

A clear identification strategy depends crucially on the assumption of unconfoundedness, which states that treatment status needs to be independent of potential outcomes

(Angrist and Pischke, 2008). Since this assumption is unlikely to hold unconditionally due to heterogeneity in firms' characteristics, I adopt additional controls. In particular, I use firm-level fixed effects $\theta_i$ to account for any time-invariant firm characteristics that could affect monopsony power. Since I removed any firms that changed location from the sample, the firm-level fixed effects also control for any time-invariant city characteristics. However, one could still worry about the presence of determinants that vary over time. I include the age of the firm to control for potential effects of industry experience. Similarly, I add the log of total sales to capture market share.

The biggest threat to causal identification arises from potential non-random reform implementation. It is difficult to imagine a world where policy decisions are made at random. To mitigate potential concerns about self-selection of cities into the reform, I follow (Wang et al., 2021) and include city-level controls $Z_{ct}$: log of per capita GDP and share of non-agricultural population. Additionally, I include a year dummy $\theta_t$ to capture time-specific shocks to all firms. Finally, I control for the regional trend in monopsony power by interacting city dummies with years.

Serial correlation in the error term can cause traditional diff-in-diff standard errors to underestimate the standard deviation of estimated treatment effects and lead to the overestimation of the t-statistics (Bertrand et al., 2004). In the case of the hukou reform, assignment to treatment is done at the city level, which may cause standard errors of firms in the same administrative unit to be correlated. Another concern relates to potential correlations between firms in the same industry. To account for these threats to causal inference, I cluster standard errors at the city-industry level.

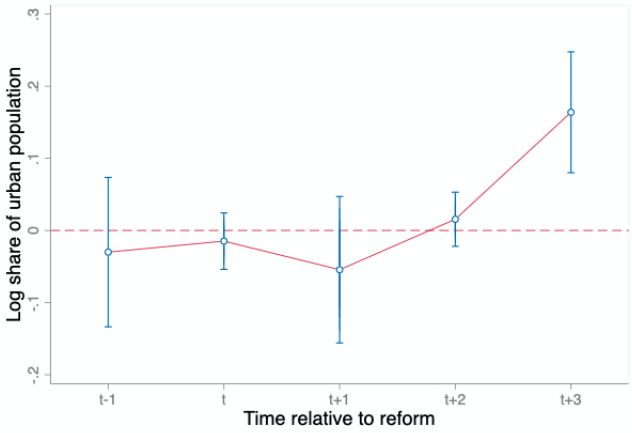
# 5 Results

## 5.1 Urban Population

The key channel through which the reform is likely to affect monopsony power is by relaxing the restrictions on labour mobility and attracting migrants to urban centres. By looking at the change in the share of urban population within prefectures, I am able to analyse the extent of the expansion of urban centres, which is indicative of the inflow of migrant workers. To investigate whether the Hukou reform attracted more migrants into cities, I plot the coefficients from a regression of the log of the share of urban population on a set of pre-reform and post-reform dummies and the actual reform year dummy, including firm fixed effects, year fixed effects, and

controls for regional trends in Figure 2 below. A visual inspection shows that in periods prior to the reform the trend is around zero and it picks up from $t+2$. This is consistent with the notion that there are likely to be lagged effects of about two years before the policy takes effect.

Figure 2: The Hukou Reform and Share of Urban Population




*Notes: This figure plots coefficients on year dummies from a regression of the log of urban share on pre-reform and post-reform year dummies, including firm fixed effects, year fixed effects, and regional trend:*
$logurbanshare = \sum_{s=1} \beta_s D_{c,t+s} + \beta_0 D_{ct} + \sum_{n=1} \beta_n D_{c,t-n} + \theta_i + \theta_t + city \times year + \epsilon_{ict}$

To confirm whether the reform was effective at easing restrictions on the movement of labour and attracting workers to urban centres, I run a multiple period diff-in-diff with the log share of urban population as the dependant variable. The results are presented in Table 5 below. Both specifications include year fixed effects, firm fixed effects, and city-level controls: log of GDP per capita, share of employment in industry. Column (1) shows a model without the regional trend. In column (2), I add a control for regional trends. Standard errors are clustered at the city level. In both cases, the coefficient on hukou is positive and statistically significant, indicating an increase of around 13.5-14.5% in the share of urban population in treatment cities relative to control. This confirms that the policy was successful in reforming the institutional rigidity of the hukou system and allowed for higher worker mobility.

Table 5: The Hukou Reform and the Share of Urban Population

| | (1) lognonagr | (2) lognonagr |
|---|---|---|
| hukou | 0.146*** | 0.136* |
| | (3.73) | (2.26) |
| logGDPpercapita | -0.178** | -0.191*** |
| | (-3.29) | (-3.76) |
| indshare | -0.0504 | -0.0893 |
| | (-0.93) | (-1.39) |
| Firm FE | Yes | Yes |
| Year FE | Yes | Yes |
| Regional trends | No | Yes |
| $N$ | 680988 | 680988 |
| $R^2$ | 0.966 | 0.973 |

*Notes: This table reports results from a multiple-period diff-in-diff estimation with log of non-agricultural population as the dependant variable. Each specification includes firm fixed effects, year fixed effects, and city controls (log of per capita GDP and the share of employment in industry). Results are reported for models with and without the regional trend. Standard errors clustered at the city level in all specifications. t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

## 5.2 Monopsony Power

### 5.2.1 Pigou's E

In order to investigate the impact of the Hukou reform on firms' monopsony power, I run a multiple period diff-in-diff with Pigou's E as the dependent variable. First, I take a model with just firm-level fixed effects, year fixed effects and firm-level controls, including log of sales and firm age. The results are reported in column (1) of Table 6. In specification (2), I add log of per capita GDP and share of non-agricultural population as city-level controls. Finally, in column (3) I add an interaction term between city dummies and years as a control for regional trends. In all cases, the coefficient on *hukou* is negative and statistically significant, suggesting that monopsony power decreased overall as a result of the easing of labour market frictions.

Interestingly, the coefficients on log of sales are large, positive, and statistically significant in all specifications. This is consistent with the notion that firms with a larger market share are able to exert monopsony power over labour. Given the growing urbanisation rate seen in Section 5.1., there are likely to be important heterogeneous effects on monopsony power between large urban centres and smaller towns. The aggregate negative impact of the Hukou reform on Pigou's E may obscure the differences based on city size. Larger and more economically developed cities are more attractive locations to workers, raising the expectation that firms in those locations are able to exert more bargaining power in the labour market

than small cities that see an outflow of workers. I investigate this point further by conducting a heterogeneity analysis.

Table 6: Impact of the Hukou Reform on the Monopsony Power of Firms

| | (1) | (2) | (3) |
|---|---|---|---|
| | pigouE | pigouE | pigouE |
| hukou | -0.808** | -0.738** | -0.547* |
| | (-3.23) | (-2.86) | (-2.41) |
| logsales | 6.945*** | 7.104*** | 7.049*** |
| | (51.20) | (46.48) | (46.77) |
| Firm FE | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes |
| City controls | No | Yes | Yes |
| Regional trends | No | No | Yes |
| $N$ | 794370 | 692356 | 680777 |
| $R^2$ | 0.124 | 0.127 | 0.815 |

*Notes: This table reports results from a multiple-period diff-in-diff estimation with Pigou's E as the dependant variable. All specifications include firm fixed effects, year fixed effects, and firm-level controls (log of total sales and age of the firm). Model (2) also includes city-level controls (log of per capita GDP and share of non-agricultural population). Model (3) additionally controls for regional trends. Standard errors clustered at the city-industry level in all specifications. t statistics in parentheses.* * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

### 5.3 Heterogeneity Analysis

Increased labour mobility via the Hukou reform leads to a reduction in monopsony power at the country level. However, this aggregation is likely to obscure the heterogeneous effects that could vary with city size. In particular, large cities offer more attractive job opportunities and easier access to amenities that can be expected to "pull" migrant workers from rural areas and smaller cities. If that is the case, we should see monopsony power of firms in large cities that are a desirable destination to migrants increase and monoposony power of firms in small cities that see out-migration decrease. I investigate potential heterogeneity in outcomes by running the multiple period diff-in-diff for firms located in cities above the 75th percentile of the total city population distribution and those below the 25th percentile.

The results are reported in Table 7 below. First, I use a model with just firm-level fixed effects, year fixed effects, firm-level controls and city-level controls, corresponding to columns (1) and (3) for large and small cities, respectively. I then add a control for regional trends in columns (2) and (4). For large cities, there is a positive and statistically significant effect of the Hukou reform on monopsony power for model (1). This is consistent with the

idea that firms can exert more bargaining power over workers in locations that seem desirable and have a net inflow of migrants. Once the regional trend is added, the coefficient remains positive, but turns insignificant. I cannot exclude that previous trends in monopsony power of firms in large cities are important determinants of subsequent changes in their monopsony power.

Table 7: The Hukou Reform and Monopsony Power: Heterogeneity by City Size

| | Large Cities | | Small Cities | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | pigouE | pigouE | pigouE | pigouE |
| hukou | 1.107* | 0.223 | -1.051* | -1.145* |
| | (2.15) | (0.48) | (-2.22) | (-1.97) |
| logsales | 6.012*** | 5.917*** | 7.170*** | 7.154*** |
| | (17.97) | (18.52) | (28.51) | (28.95) |
| Firm FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| City controls | Yes | Yes | Yes | Yes |
| Regional trends | No | Yes | No | Yes |
| $N$ | 185644 | 182939 | 164035 | 157576 |
| $R^2$ | 0.110 | 0.812 | 0.132 | 0.833 |

*Notes: This table reports results from a multiple-period diff-in-diff estimation by city size with Pigou's E as the dependant variable. Large cities are defined as being above the 75th percentile of total city population distribution and small cities as those below the 25th percentile. Each specification includes firm fixed effects, year fixed effects, firm-level controls (log of total sales and age of the firm), and city controls (log of per capita GDP and the share of non-agricultural population). Results are reported for models with and without the regional trend. Standard errors clustered at the city-industry level in all specifications. t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

Firms in smallest cities see a decrease in their monopsony power, with the coefficient on Pigou's E significant at the 5% level for both model (3) and (4). This result confirms the presence of heterogeneity in the change in monopsony power of firms following a labour market reform. Intuitively, employers located in larger cities would find it easier to set wages below the marginal product of labour and still retain a portion of their workers given that urbanised locations are attractive to migrants. On the other hand, if a firm in a smaller city sets its wage below the marginal product of labour, workers can more easily leave and seek employment in growing urban centres due to a relaxation of the hukou requirements.

### 5.4 Investment into Human Capital

Since the net effect of these offsetting forces is a decrease in monopsony power overall, a crucial question concerns the actions that employers take to retain workers and maximise

profits in an environment where it is increasingly easier for workers to relocate to a better job opportunity. (Acemoglu and Pischke, 1998) construct a theory of training and worker benefits where an equilibrium with high training rates and low quit rates arises in an institutional setting where firms have an incentive to retain workers. Consistent with this, the Hukou reform and a general reduction in monopsony power should incentivise firms to provide fringe benefits to employees in order to retain them and to invest in employee education in order to capture productivity gains from retained employees.

To investigate this point, I first run equation (2) excluding the regional trend with the expenditure on the housing fund and unemployment insurance as dependant variables in columns (1) and (3) of Table 8. Firms in reform cities spend 7% more on unemployment insurance relative to non-reform cities. For the housing fund, the results are not significant, potentially because the model is under-identified prior to the inclusion of regional trends. I then rerun the model including regional trends in columns (2) and (4). Once city trend is controlled for, I find a 26% increase in spending on the housing fund, statistically significant at 1%, but the results for unemployment insurance turn insignificant.[6] This could reflect the large number of missing values for this variable in the data set (over one-third).

Table 8: The Hukou Reform and Investment in Human Capital

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | loghousefund | loghousefund | logunempins | logunempins |
| hukou | -0.0314 | 0.264** | 0.0781* | -0.0636 |
| | (-0.41) | (2.99) | (2.18) | (-1.76) |
| logsales | 0.202*** | 0.197*** | 0.259*** | 0.250*** |
| | (17.35) | (16.73) | (26.06) | (26.55) |
| Firm FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| City controls | Yes | Yes | Yes | Yes |
| Regional trends | No | Yes | No | Yes |
| $N$ | 60062 | 43847 | 173127 | 129901 |
| $R^2$ | 0.100 | 0.881 | 0.078 | 0.789 |

*Notes: This table reports results from a multiple-period diff-in-diff estimation with the log of expenditure on the worker housing fund and log of expenditure on unemployment insurance by the firm as dependant variables. Each specification includes firm fixed effects, year fixed effects, firm-level controls (log of total sales and age of the firm), and city controls (log of per capita GDP and the share of non-agricultural population). Results are reported for models with and without the regional trend. Standard errors clustered at the city-industry level in all specifications. t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

[6]Since the result for unemployment insurance is not robust to the inclusion of regional trends, I cannot rule out that trends in the expenditure on unemployment insurance were important for determining subsequent provision of unemployment insurance.

Given the discriminatory nature of the Hukou system, access to affordable housing remains a major challenge for rural migrants (Huang and Tao, 2015), making the provision of safety nets by employers a key policy concern. The above results show that reducing institutional barriers to spatial mobility decreases firms' monopsony power and incentivises employers to invest in their workers. Several labour economics studies have found worker benefits can lead to an increase in labour productivity. (Acemoglu and Shimer, 2000) find a positive effect of unemployment insurance on the productivity of workers in the US. In a developing country context, (Adhvaryu et al., 2018) design an RCT providing soft skills training to garment workers in India and find increased efficiency and task complexity among treated workers. In the next section, I investigate whether the Hukou reform had an impact on labour productivity.

### 5.5 Productivity Analysis

The Hukou reform can affect firms' productivity through various channels. The first one concerns the relationship between the provision of welfare and labour productivity discussed in Section 5.4. The second one deals with the allocation of resources across space and industries. As seen in (Hsieh and Klenow, 2009), failures in input markets can prevent the optimal allocation of labour. Consistent with this, allowing for easier movement of workers across space could result in productivity gains from improved resource allocation. I investigate the firm-level productivity change by running the main specification with two dependent variables: average product of labour and marginal product of labour.

Table 9: The Hukou Reform and Firm Productivity

| | (1) APL | (2) APL | (3) MPL | (4) MPL |
|---|---|---|---|---|
| hukou | 11.97** | 5.186* | 6.925* | 2.291 |
| | (2.75) | (2.09) | (2.54) | (1.50) |
| logsales | 143.4*** | 141.1*** | 82.22*** | 80.90*** |
| | (66.01) | (66.09) | (57.43) | (57.87) |
| Firm FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| City controls | Yes | Yes | Yes | Yes |
| Regional trends | No | Yes | No | Yes |
| $N$ | 692356 | 680777 | 692356 | 680777 |
| $R^2$ | 0.306 | 0.836 | 0.303 | 0.837 |

*Notes: This table reports results from a multiple-period diff-in-diff estimation with the Average Product of Labour (APL) and Marginal Product of Labour (MPL) as dependant variables. Each specification includes firm fixed effects, year fixed effects, firm-level controls (log of total sales and age of the firm), and city controls (log of per capita GDP and the share of non-agricultural population). Results are reported for models with and without the regional trend. Standard errors clustered at*

*the city-industry level in all specifications. t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

The results are presented in Table 9 above. Columns (1) and (3) report the coefficients from a regression of APL and MPL, respectively, on the hukou dummy, including firm fixed effects, year fixed effects, firm-level controls and city controls. In both cases, there is a positive and statistically significant impact of the hukou reform on firm-level productivity of labour. This provides evidence that there are productivity gains from the reallocation of labour following the easing of restrictions on rural-urban migration. The results are also consistent with Section 5.4. and indicate that higher levels of human capital may lead to increased worker productivity. Columns (2) and (4) additionally control for the regional trend. The coefficient remains positive and statistically significant for APL, although it halves in magnitude. In the case of MPL, the coefficient remains positive, but turns insignificant.

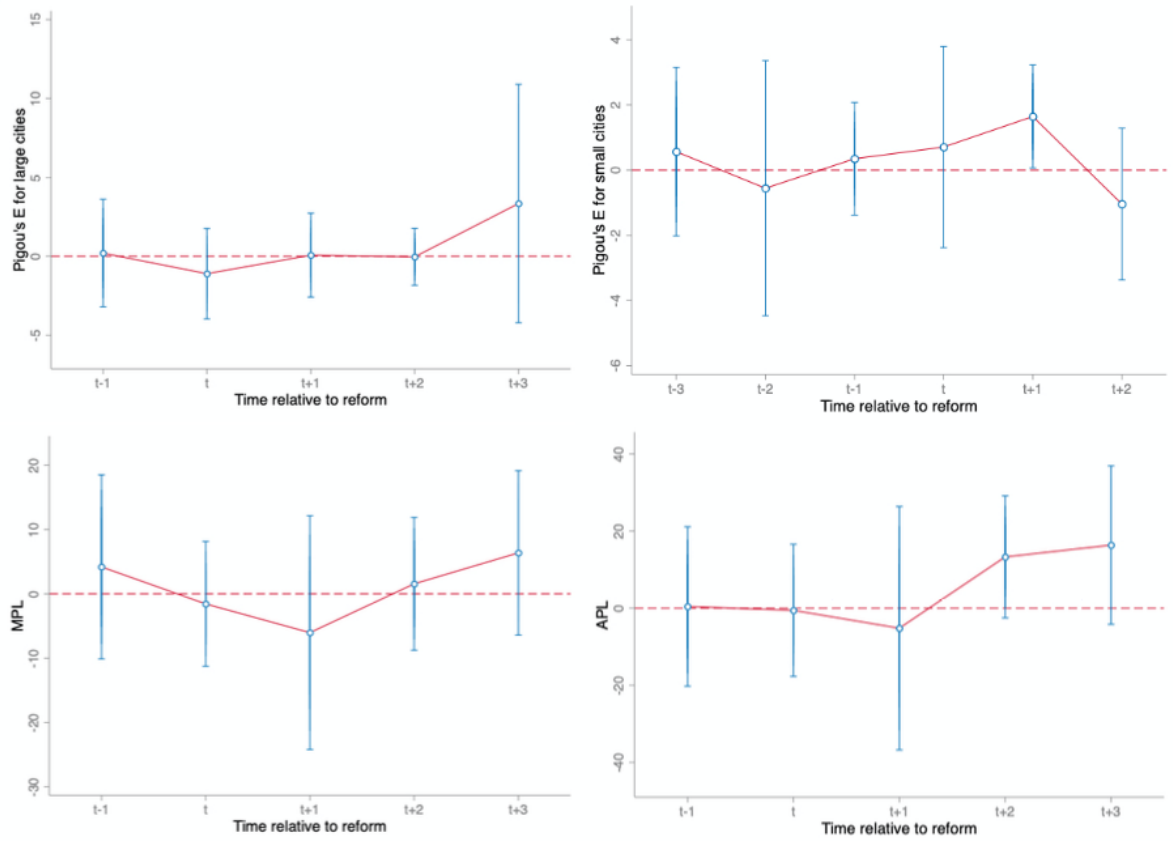
# 6 Robustness Checks

## 6.1 Pre-trend Analysis

The most important assumption in the diff-in-diff framework is parallel pre-trends. Outcome variables in treatment and control cities should be following the same trajectory prior to the reform. To verify whether the coefficients are not picking up some of the changes that were already underway prior to the policy reform, I re-run regressions for my main outcome variables $y$ and include a set of year dummies for the pre-implementation and post-implementation periods. The specification includes firm fixed effects, year fixed effects, firm-level controls, and city-level controls, as shown in equation (2) below.

$$y = \sum_{s=1} \beta_s D_{c,t+s} + \beta_0 D_{ct} + \sum_{n=1} \beta_n D_{c,t-n} + X_{ict}\gamma + Z_{ct}\delta + \theta_i + \theta_t + \epsilon_{ict} \tag{2}$$

Figure 3: Pre-trends for main outcome variables




*Notes: This figure shows coefficients from a regression of main outcome variables on a set of year reform dummies, including firm fixed effects, year fixed effects, firm controls, and city controls. Vertical bands show the 95% confidence intervals.*

Figure 3 above plots the coefficients on year dummies for four main outcomes: Pigou's E for large and small cities, MPL, and APL. In all cases, the coefficients are centred around zero prior to reform implementation in time $t$. The coefficient on Pigou's E for large cities shown in the top-left corner picks up three years after the hukou reform in time $t+3$, suggesting a lag before policy takes effect. Due to an insufficient number of observations, only the coefficient on Pigou's E for small cities in the top-right corner can be traced back to time $t-3$. The trend stays flat until $t+1$, when the coefficient becomes slightly positive before eventually turning negative in $t+2$. Trends for MPL and APL are shown in the bottom row. No effects on productivity are detected prior to the reform. After $t+1$, coefficients become statistically different from zero, indicating a positive impact on both MPL and APL. While my analysis is mostly confined to one period before the reform due to data availability, this inspection of pre-trends suggests that there was no significant divergence in the trajectory of main outcome variables in treatment cities relative to control just before the reform was implemented.

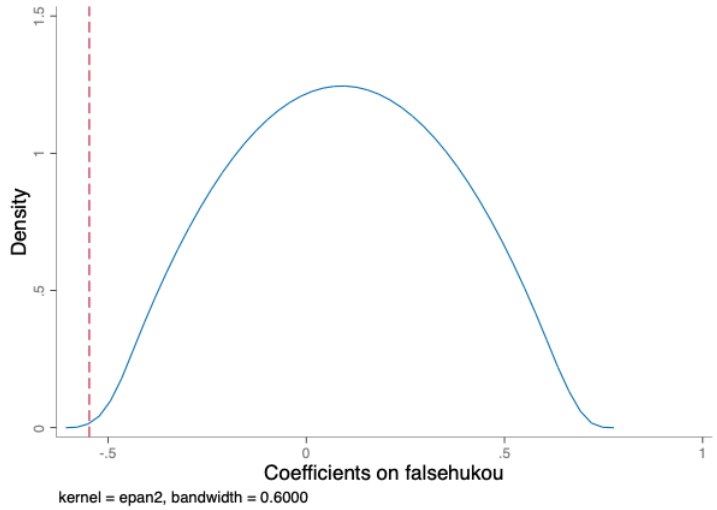
### 6.2 Falsification Test

In order to further validate my identification strategy, I conduct a falsification test. If the change in monopsony power is driven by the Hukou reform, then a false policy variable should have no effect on Pigou's E. For each reform city, I generate a random reform year between 1998 and 2007 that is different from the actual reform year. Based on the false reform year, I construct a $falsehukou$ dummy, which takes the value of 1 if reform is in place in city $c$ at time $t$. I then re-run the main specification 500 times, including firm-level fixed effects, firm-level controls, year fixed effects, city controls, and controls for regional trends. The model with a fake policy dummy is shown below:

$$Pigou's\ E = \beta_0 + \beta_1 falsehukou_{ct} + X_{ict}\gamma + Z_{ct}\delta + city \times year + \theta_i + \theta_t + \epsilon_{ict} \qquad (3)$$

I plot the distribution of coefficients on $falsehukou$ from 500 simulations of equation (3) in Figure 4 below. The distribution is centred around 0, indicating that a random reform does not influence Pigou's E. The red dashed vertical line shows the coefficient I obtained in Section 5.2 when running the same regression for the actual hukou dummy. There are no simulated coefficients to the left of the vertical reference line. This suggests my coefficient is unlikely to be biased or obtained by chance.

Figure 4: Falsification Test




*Notes:This figure plots the coefficients from 500 simulations of equation (3) containing a false hukou year dummy. The red vertical line shows the coefficient obtained in the results section 5.2 when the same model was run for the actual hukou dummy.*

# 7 Discussion

The validity of results presented in this paper depends on the strength of my identification strategy. In particular, since local government officials in cities decided whether or not to implement the reform, the assignment to treatment is non-random and can plausibly be expected to be correlated with firm and city characteristics. While the multiple period diff-in-diff framework controls for time invariant fixed effects and the inclusion of city-level and firm-level controls mitigates potential endogeneity issues from time-varying characteristics, results could still be spurious if outcomes in reform and non-reform cities are not following a parallel pre-trend. I include the city-specific trend in the main specification to control for deviations from the common trend (Angrist and Pischke, 2015).

Even with a strong identification strategy, the nuanced nature of the hukou reform creates potential for measurement error. I use a binary variable *hukou* to capture whether the reform was in place in city $c$ at time $t$. In reality, there is heterogeneity in the types of administrative changes that the hukou reform entails. For example, Hubei completely abolished the distinction between non-agricultural and agricultural hukous, Beijing granted the transfer of a local hukou conditional on having a fixed place of residence and a stable source of income, and Shandong abolished migration control centres as a result of the hukou reform (Merkley, 2004). Other papers have attempted to capture the extent of hukou reforms by constructing indices of hukou stringency. However, (Zi, 2018) uses a province-level index that may obscure city-level heterogeneity and (Zhang et al., 2019) adopts an index based on investment, home purchases, and employment that is still in the early stages of research, hence I adopt multiple period diff-in-diff as my main framework.

Another source of measurement error relates to lack of data on individual wages and workers in CASIF. My estimation of MPL can only reflect the average value of MPL, obscuring potential heterogeneity in education and skill levels of workers. This is a commonly encountered problem in literature using CASIF. As highlighted in section 5.4., I also find a large number of missing values for variables that reflect firm-provided benefits, including education expenses, R&D expenditure, and medical insurance. Due to data unavailability, I am not able to discuss these outcomes.

Finally, since I removed all the firms that changed location from the dataset, I am only ale to investigate the internal change within provinces and cities following the Hukou reform. My analysis is also constrained to manufacturing firms, which precludes me from

commenting on general equilibrium effects in the labour market. In particular, while I find that monopsony power decreased overall for firms in my sample, the effects on employment adjustment and wage-setting ability of employers in the service sector remains unexplored. This could be a fruitful area for future research.

# 8 Conclusion

Does the relaxation of institutional barriers to labour mobility decrease the monopsony power of firms? This paper looks at the largest reform of the traditionally rigid household registration system in China and provides evidence that removing spatial constraints on the mobility of labour and improving access to social safety nets diminishes the ability of firms to exploit workers by setting wages below the marginal revenue product of labour. Heterogeneity effects are important in this case. In particular, firms in larger cities that are likely to be attractive destinations for migrants see an increase in their bargaining power, while monopsony power of employers in smaller cities decreases when it is easier for workers to relocate to another job opportunity.

Increased worker mobility has important implications for human capital investment decisions of firms. Consistent with a decrease in monopsony power, employers have an incentive to retain workers and raise their productivity by providing on-the-job benefits. Firms in reform locations spend 26% more on the worker's housing fund and 7% more on unemployment insurance relative to employers in non-reform cities. This is consistent with rising worker productivity. Both the average and marginal products of labour are found to be increasing as a result of the Hukou reform. Finally, labour mobility matters for the spatial allocation of resources in the economy. Frictions in input markets create an important source of inefficiency. Future research could focus on linking the Hukou reform to the dispersion of marginal products of labour across firms and cities.

# Appendix

**Part 1: Construction of Capital Stocks**

**Step 1**: Generate the nominal purchase of fixed assets in the current year $V_s$ = original value of fixed assets in the current year – original value of fixed assets in the previous year.

**Step 2**: Calculate the nominal value of fixed assets $V_t$ according to the below function:

$$V_t = V_s \prod_{t=s}^{t} (1 + r_t) \tag{4}$$

Where $r_t$ is the average growth rate in the two-digit industry in time period $t$. The assumption is that the growth rate of the original value of fixed assets of an enterprise is equal to the average growth rate of the original value of fixed assets in the two-digit industry where the enterprise belongs to. This gives us the nominal investment $V_t$.

**Step 3**: Calculate net nominal investment $I_n$, where $\delta_t$ is depreciation in year $t$.

$$I_n = V_t - \delta_t. \tag{5}$$

**Step 4**: Calculate the real investment $I_t$ by deflating real investment values by a province-specific fixed asset investment index [7].

**Step 5**: Using the perpetual inventory method, construct real capital stocks:

$$K_{t+1} = (1 - \delta_k)K_t + I_t \tag{6}$$

Where $\delta_k$ is the capital depreciation.

$$\delta_k = \frac{accumulated\ depreciation/\ original\ value\ of\ fixed\ assets}{the\ sample\ year\ -\ the\ establishment\ year} \tag{7}$$

**Part 2: Production Function Estimation using ACF**

I assume a Cobb-Douglas functional form with capital $k_{it}$,labour $l_{it}$, productivity shocks observable to firms but not econometricians $w_{it}$, and shocks unobservable to econometricians and firms $\epsilon_{it}$ shown below:

$$y_{it} = \beta_k k_{it} + \beta_l l_{it} + w_{it} + \epsilon_{it} \tag{8}$$

The main econometric concern when estimating a production function is the endogeneity introduced by the correlation between inputs and $w_{it}$. In dynamic micro panel data models with large $N$, small $T$, and variables with little variation such as capital, OLS will yield an upward-biased estimate due to positive correlation between unobserved factors and the error term, while fixed effects will produce downward bias due to negative correlation in

[7] All price deflators and the two-digit industry growth rates are taken from the Chinese Statistical Yearbooks of the National Bureau of Statistics and normalized to the base year 1998.

the time-demeaned equation (Wooldridge, 2016).

To address potential endogeneity issues due to productivity shocks $w_{it}$, I adopt the (Ackerberg et al., 2015) extension of (Levinsohn and Petrin, 2003) and use a semi-parametric estimation method with intermediate inputs as a proxy for unobserved productivity. Since CASIF has a large number of values of investment that are negative or zero, using intermediate inputs that are reported more accurately as a proxy allows for a more efficient estimation. The crucial assumption underlying this approach is that the idiosynchratic shock to productivity at time $t$ is uncorrelated with the values of the state variable decided at time $t-b$ and with lagged values of the free variables (decided at time $t-\zeta$, where $0<\zeta<b$) and the state variable (Rovigatti and Mollisi, 2018).

Under the following assumptions:
i) $m_{it}=f_t(w_{it},l_{it},k_{it})$ is the proxy variable function, invertible in $w_{it}$. $m_{it}$ is monotinically increasing in $w_{it}$.
ii) $k_{it}$ is the state variable decided at $t-b$.
iii) $l_{it}$ is chosen at time $t-\zeta$, where $0<\zeta<b$.
iv) $w_{it}=E[w_{it}|w_{i,t-1}]+\xi_{it}$. The productivity shock evolves exogenously following a first-order markov process. $\xi_{it}$ is the idiosynchratic productivity shock at time $t$.
v) The intermediate input $m_{it}$ does not enter the production function to be estimated[8].

I can rewrite equation (8) with the proxy variable function inverted and plugged in.

$$y_{it}=\Phi_t(m_{it},w_{it},l_{it},k_{it})+\epsilon_{it} \tag{9}$$

Stage 1: Estimate $\Phi$ to separate out $\epsilon_{it}$.

Stage 2: Regress $w_{it}$ on $w_{i,t-1}$ non-parametrically to find the idiosyncratic productivity shock $\xi_{it}$. Using $\xi_{it}$, recover the moment conditions.

[8]Assumption v) is needed to avoid perfect collinearity among free variable coefficients in the first stage. In the LP specification, labour and intermediate inputs are allocated simultaneously at time $t$, making both $l_{it}$ and $m_{it}$ a function of the state variable and productivity. This means labour would appear both as a free variable and in the nonparametric polynomial approximation $\Phi_t$.

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