

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

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Abstract

This paper analyses the impact of the household registration system (Hukou) reform in China on firms' behaviour. We develop an equilibrium search model that features labour market characteristics commonly found in developing countries such as (i) monopsonistic competition among firms, (ii) heterogeneity of firm productivity, and (iii) disadvantaged group of workers. Using historical hukou reform in China during 1998-2007, this paper empirically confirms the predictions of the equilibrium search model. A hukou reform (i) induces an increase in wage payment for rural hukou owners, (ii) reduces economic rent for monopsonistic firms, (iii) forces least productive firms to leave the market, thereby increasing average labour productivity, and (iv) increases employment for remaining firms.

1 Introduction

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 residing in the same city, contributing to growing wage inequality and disparities in job permanence between rural and urban hukou holders. Anecdotal evidences document the prevalent worker exploitation experienced by the rural hukou workers. Lack of access to social safety nets, which are tied to the Hukou status, diminishes rural hukou holders' ability to protect themselves against employers. Institutional barriers to access to the job market and social transfers in urban areas makes it difficult for workers without an urban hukou to switch employers. This lack of mobility of migrant workers particularly makes rural hukou owners vulnerable, allowing employers to capture some of workers' surplus by underpayment. To address the growing inequality between rural and urban hukou holders and create more mobility in the labour market, several provincial government launched the reform of the Hukou system in 2001, allowing for easier transfers of the hukou status.

Though much has been written about how the interaction of various social policies and the hukou status of employees influences labour market outcomes, research on the effect of hukou reform has only recently begun (Wang et al., 2021). — until now, the existing literature on Hukou has made little attempt to demonstrate the firm's responses comprehensively. We use the historical event of China's hukou reform between 2000 and 2008 to conduct a theoretical and empirical analysis of the reform's effect on firm behaviour. Our study is the first to conduct a comprehensive evaluation of the influence of hukou reform on firm behaviour utilizing firm-level microdata from the Chinese Annual Survey of Industrial Firms (CASIF) for the years 2000–2008 and microdata from the Chinese Household Income Project (CHIP) for the years 1999, 2002, 2007, and 2008. We examine the impact of hukou reform on enterprises' wage setting, employee recruitment, division of rent, market exit, and aggregate and marginal labour productivity respectively.

Studying the effect of hukou reform on the overall market is vital in that, in developing countries like China, there are a variety of systematic mechanisms in place to discriminate against specific groups of workers. Discrimination can stem from a variety of factors, including ethnicity, gender, and religion, among others. The effects of repairing a systemic discrimination against a certain class of workers on firm behaviour has been extensively examined in the gender literature. Compare to these studies on gender, investigating Chinese Hukou reform has advantages in that (i) it does not require consideration of additional cultural effects associated with gender norms and (ii) it is implemented across cities and historical periods, strengthening identification.

To begin our investigation, we detail and explain the features of Chinese firms and workers. We estimate the production function and build various measures of monopsony power, including Pigou's E and markdowns, as described in Akerberg et al. (2015) and Brooks et al. (2021). Our examination of Chinese firm-level data reveals robust evidence of monopsony behaviour and significant heterogeneity in firm-level productivities. Household-level data reveals a disparity in education and compensation across Hukou status: on average, urban hukou owners have a higher level of education and remuneration. While our data cannot conclusively demonstrate systemic wage discrimination based on workers' hukou status, they do demonstrate the existence of a systematic disadvantage associated with rural hukou ownership.

These are labour market features that most emerging economies commonly share. For example, Brooks et al. (2021) uncover robust evidence of firms' monopsony power in India, and it is now widely accepted in the literature that certain castes and females face systematic disadvantage in the country. This compels us to construct a theoretical framework that unifies various labour market characteristics. We extend Burdett-Mortensen(1998)'s model by introducing heterogeneity in firm productivity and a fragmented labour market based on hukou status. Our proposed model provides plausible mechanism such that hukou

reform (i) reduces economic rent for monopsonistic firms, (ii) forces least productive firms to leave the market, thereby increasing average labour productivity, (iii) increases average wage for rural hukou owners, and (iv) increases employment for remaining firms.

In the third step of analysis, we perform a regression analysis to test the validity of the proposed model. Due to the fact that the reform was not implemented uniformly, we can utilise a multiple period diff-in-diff framework to compare treated cities that implemented the reform to controlled cities that did not. Our regression results largely support our provided hypotheses. We observe a drop in economic rent for employers as assessed by various indexes, an increase in wage payment to rural hukou owners, an increase in average and marginal labour productivity, and the exit of the least productive enterprises as a result of hukou reform.

To summarize, our analysis suggests that the hukou reform empowered existing rural hukou owners and forced out least productive firms who were able to operate by exploiting workers. The relocation of workers into better performing firms increased average and marginal productivity of workers. Given that these findings are obtained in the face of increased in-migration to hukou-reformed cities, which should increase employers' bargaining power, our findings strongly suggest that Hukou reform mitigated monopsony power by increasing the labour supply elasticity of existing rural migrants.

Our paper makes a number of contributions to related literatures. First, our study builds on a broad body of literature demonstrating the effect of labour market friction on firms' monopsony power in the labour market. Theoretical work on this subject has focused on search friction as a fundamental component of firms' monopsony behaviour Burdett and Mortensen (1998). For example, Manning (2003); Cahuc et al. (2006); Manning and Petrongolo (2017) all demonstrate the importance of job mobility in determining enterprises' market power over wage setting. This core intuition on labor market friction guided the focus of empirical studies. Among other important studies, Abramitzky and Braggion (2006);

Naidu et al. (2017) examine the impact of restricted labour market contracts on migratory workers. Naidu and Yuchtman (2013) evaluate the effect on migrant and domestic workers of restrictive labour market contracts. Kim and Samaniego (2021) study the effect of minimum wage on firms' monopsony behavior in the context of the frictional labour market in Indonesia.

Our work is closely related to this literature in that China's Hukou reform can be regarded as a reduction in search friction for a specific group of people Ngai et al. (2019). As a recent study by Brooks et al. (2021) demonstrate the existence of monopsony power in China and points to limited geographical labour mobility with Hukou system as a possible explanation for inelastic labour supply, empirical evaluation of the Hukou reform is necessary. We contribute to the literature by analysing the impact of the Hukou reform on firm monopsony power and productivity gains.

Second, our work adds to the literature that studies the relationship between market friction and firm productivity. The emergence of monopsony power is closely related to market friction. Due to the fact that markets in developing countries are prone to various market frictions 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). Our paper investigates firms' 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.

Third, our study contributes to the literature that specifically examines the Hukou system in China. The Hukou system has been playing 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. Due to its discriminatory nature, the impact of the Hukou system has been studied broadly from a workers' perspective, either using household-level data or qualitative approaches. For example, Meng (2012) finds that rural-urban migrants were hit hardest in terms of employment after the economic downturn in China in 2008. 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.

An increasing number of works examine the effect of the Hukou system on market structure, including employment distribution, geographical inequality, and company productivity. For example, Whalley and Zhang (2007) create models of interregional labour mobility and examine the effect of the Hukou system on regional income differences. To demonstrate the effect of the Hukou system on employment allocations between urban and rural areas, Ngai et al. (2019) develop a two-sector industrialization model with imperfect labour market

mobility. As for the empirical investigation, recent work by Wang et al. (2021) use firm-level micro data to find that the hukou reform led to higher firm-level employment adjustment. However, until now, we do not have an empirical study that investigate the effect of Hukou reform on firms' monopsony power and productivity. We fill this research gap by providing rigorous empirical evaluation of changes of Hukou policy.

The remainder of the chapter is organized as follows. Section 2 reviews the China's Hukou and its reform procedure. Section 3 is devoted to introduce the data and highlights important labour market features. In section 4, we construct an equilibrium search model that contains features documented in section 3. Section 5 are devoted to test propositions from section 4. Section 6 is devoted to robustness check, and section 7 contains overall discussion. Section 8 concludes.

2 The Hukou Reform

China's household registration system, officially termed hukou, has imposed strict limits on ordinary Chinese citizens changing their permanent residence, resulting in labour market rigidity. Its primary purpose was to regulate migration, allocate state resources such as food rations, and exert efficient political control under the Maoist regime. 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 economic reforms under Deng Xiaoping, the Hukou institution underwent its initial adjustments in the early 1990s. Land reform led in a rapid growth in agricultural

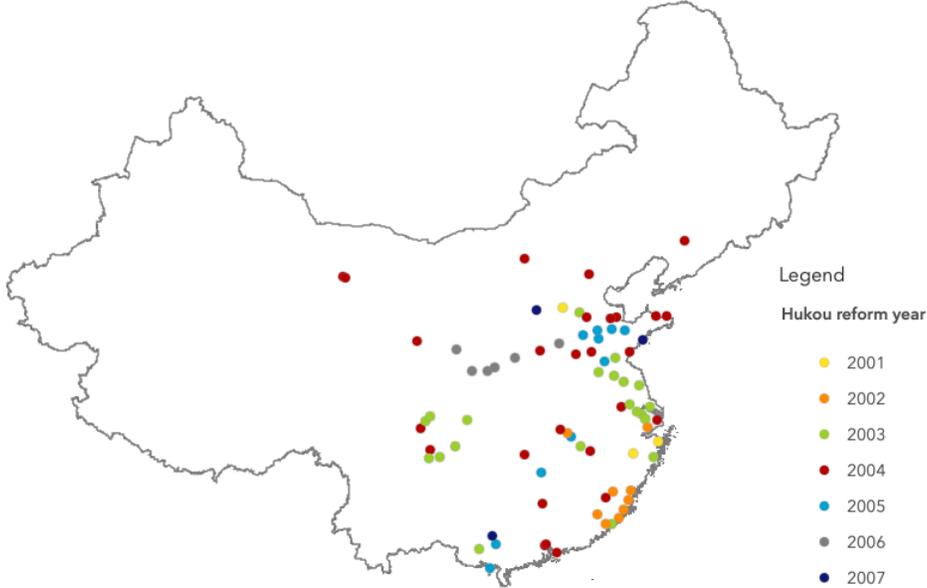
productivity, lowering the amount of labour requirement in production Zhu (2012). Surplus rural labour was then transferred to quickly rising urban industries, initiating a period of rapid structural transformation. The acceleration of migration flows was accompanied by a partial relaxation of the Hukou requirements at the city level, including an increase in the quota for transfers, strengthened 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 continued 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 discriminatory institutional background of the Hukou system particularly affects rural-urban migrants who work and reside in the city without a non-agricultural hukou status. The social segmentation in the Chinese urban labour market allows employers to exercise significant monopsony power over labour, which is especially notorious in the case of vulnerable migrant workers. Cheng et al. (2015) examine the incidence of wage arrears of rural-urban migrants in Guangdong and find that 9% of the sample has experienced delayed or withheld payments. Consistent with the wage discrimination, a number of subjective well-being indicators suggest that the hukou status affects migrants' sense of belonging in the city. Those experiencing wage arrears were 5.6% more likely to believe that life in the city would be easier with a non-agricultural hukou and 6.8% more likely to perceive that their status was lower than others in the city.

The focus of this paper is the largest reform of the Hukou system during the late 1990s and early 2000s. Its initial version, the 1997 "Blueprint for Experiment in Small City and Town Hukou 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 us to exploit the multiple period diff-in-diff framework to capture the impact of hukou system relaxation. We follow Wang et al. (2021) and Merkley (2004) and identify 80 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, we exclude those cities that implemented the reform after 2006 to allow at least two years for the policy to take effect. we 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



Theoretically, there are two offsetting channels through which the relaxation of the Hukou system could affect monopsonistic behaviour. The first one works through reducing restrictions on migration and encouraging an inflow of new workers, increasing the labour supply available to firms and putting downward pressure on wages, resulting in higher monopsony power. The second mechanism relates to workers' ability to better protect themselves against discrimination in the labour market through the expansion of social safety nets associated with

Hukou status. This should have the effect of reducing monopsony power. Since an employee can now legally reside in the city and access the formal housing market, education, and healthcare, either because it is easier to switch an agricultural hukou to a non-agricultural one or because the distinction is abolished overall, workers are more responsive to monopsonistic wage-setting, increasing the elasticity of labour supply.

Table 1: Change in the Share of Non-agricultural Hukou Holders in Total Population

	2000 Mean	2005 Mean	Change
Non-reform cities	0.34	0.37	+0.03
Reform cities	0.42	0.53	+0.11

Data source: China Data Institute

The second channel of increased worker protection depends crucially on the effectiveness of the reform in allowing migrants to obtain an urban hukou that guarantees access to social transfers. Table 1 above shows the change in the mean share of non-agricultural hukou holders in total population before the reform in 2000 and after the reform in 2005. Reform cities experience a larger increase in the share of urban hukou holders relative to non-reform cities, suggesting that the reform was successful at removing institutional barriers to hukou transfers, and thus increased labor supply elasticity of rural-migrants. The net effect of the reform on monopsony power will therefore depend on the relative magnitude of the in-migration effect, and labour supply elasticity effect. Historically, internal migration in China has been in the direction of large urban centres due to higher consumption possibilities and access to urban amenities Xing and Zhang (2017). This suggests potential heterogeneity effects depending on the size of already residing migrant population in the city and the inflow of new workers.

3 Data and Descriptive Analysis

3.1 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 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.

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. We 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, we exclude firms in cities that implemented the reform after 2006 to allow at least two years for the policy to take effect.

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, we 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	122,413	28,884	93,529
1999	142,790	34,856	107,934
2000	137,007	40,738	96,269
2001	153,284	54,356	98,928
2002	164,350	66,352	97,998
2003	177,356	80,551	96,805
2004	238,649	125,170	113,479
2005	256,047	132,870	123,177
2006	282,363	146,135	136,228
2007	260,309	135,329	124,980
Total	1,934,568	845,241	1,089,327

The second dataset comes from the Chinese Household Income Project (CHIP) available from the China Institute for Income Distribution. This household-level cross-sectional survey was carried out in collaboration with the National Bureau of Statistics (NBS) and covers main information on income and expenditure, as well as sociodemographic characteristics. The key advantage of this study for our purposes is that it discloses information on hukou status, allowing us to conduct a more nuanced analysis of worker characteristics. We make use of five waves of data collection: 1999, 2002, 2007, 2008, and 2013. For regression analysis, we exclude 2013 to keep the sample period consistent with the years for which CASIF data and information on hukou-reformed cities are available.

The dataset is divided into three categories based on household type: Rural, Urban and Migrant (Rural-to-Urban). For 1999, only the urban survey is available. For later years, we merge across all three categories to obtain the full dataset. In terms of geographical coverage, the full dataset we constructed extends to 31 provinces and 232 cities, making it a nationally representative sample. Each household and individual is georeferenced, allowing us to identify workers in reform and non-reform cities to complement firm-level results.

3.2 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. We follow Kim and Samaniego (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 we 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, we use price deflators for investment, intermediate goods, output, and wages to convert nominal values into real values. We follow the perpetual inventory method for the construction of real capital stock Berlemann and Wesselhöft (2014). For details on the construction of real capital stocks, see Part 1 in the Appendix. We follow the Akerberg 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, we estimate Pigou's E by two-digit industry level.

To establish robustness, we use an alternative measure of monopsony power that has been used in literature. This measure is based on the concept of "markup" and "markdown". Brooks et al. (2021) argue that the traditional method of estimating monopsony in the labour input as the ratio of the value of marginal product of labour to the wage (which they define as the labour "markup") is problematic because the index can be influenced by firms' monopolistic behaviour in the output market. That is, even wage-taking firms' monopolistic behavior in the product market can cause the wage to diverge from the value of the worker's marginal product. This point is relevant for Pigou's E, as the measure attributes the difference between marginal revenue and wage entirely to the degree of distortion in the labour market. To address the potentially confounding effect of firms' markup in the output market on the measure of monopsony, we employ the technique described in Brooks et al. (2021), which calculates the ratio of markups measured using different inputs.

$$\mu_{ni}^m = \frac{\theta_{ni}^m}{\alpha_{it}^m}$$

where θ_{ni}^m is the output elasticity of input m for firm n in industry i . The denominator is the share of expenditure on input in the firm's total revenues α_{it}^m . If there is no monopsonistic behaviour in the market for material inputs, then the markup μ_{ni}^m solely captures firms'

monopolistic behaviour in the output market.

Compared to the markup for material inputs, the labour markup ($\mu_{ni}^L = \frac{\theta_{ni}^L}{\alpha_{it}^L}$) contains market distortion due to both the output market distortion and the labour market distortion. Brooks et al. (2021) take the material markup as a benchmark case of no monopsony power, and calculate markdowns by taking the ratio of labour markups to material markups.

$$\frac{\mu_{ni}^L}{\mu_{ni}^M} = \frac{\frac{\theta_{ni}^M}{\alpha_{it}^M}}{\frac{\theta_{ni}^L}{\alpha_{it}^L}}$$

As can be seen from the equation, the absence of monopsony power in the labour market would imply a markup ratio of 1. Markdowns, i.e. the wedge between labour and material markups therefore capture the presence of monopsony in the labour market. That is, the additional proportional deviation between marginal product and wage indicates the labour markdown.

The advantage of using markdowns over Pigou's E is that they can isolate monopsony power in the input market by properly normalising the estimates by monopolistic distortion. The disadvantage of the markdown measure is that it is based on the assumption that the market for material inputs does not exhibit monopsony power. As much of the material market suffers from firms' monopsonistic behaviour, the markdown measure becomes imprecise. We employ both monopsony measures in the estimation to ensure that results are robust across different indexes. We follow Brooks et al. (2021) in estimating markups and markdowns using two methods (ACF and CRS). See Part 3 in the Appendix.

3.3 Descriptive Analysis

This section outlines the main firm, city, and household characteristics over the sample period. Table 3 presents summary statistics of main variables in the CASIF 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 249 employees, with the number varying from a minimum of 12 to a maximum of 2,820 employees. Capital stocks reflect the value of real accumulated investment in fixed assets net of depreciation ¹. 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 average firm has been in business for approximately 11 years, with the highest value in the dataset equal to 52.

Table 3: CASIF Descriptive Statistics

	Mean	SD	Min	Max	N
Capital	16,576.51	32,377.23	226.52	154,700.64	1,907,525
Output	46,552.10	84,556.20	606.56	467,956.00	1,934,568
Labour	248.51	414.51	12.00	2,820.00	1,934,568
Intermediate Inputs	32,686.12	59,227.03	386.81	327,120.00	1,934,568
Real wage*	12.42	10.12	0.97	65.79	1,934,568
Log of total sales	9.90	1.38	5.52	13.74	1,934,568
Age of the firm	10.84	11.63	0.00	52.00	1,933,925
Log of per capita city GDP	9.90	0.90	5.54	12.66	1,846,374
Total population (10000 persons)	580.53	308.52	13.89	1,378.86	1,846,374
Non-agricultural population (10000 persons)	262.76	259.69	11.57	1,196.94	1,846,374
Share of non-agricultural population	0.42	0.22	0.07	1.00	1,846,374
Agriculture share of GDP	0.11	0.09	0.00	0.38	1,844,730
Industry share of GDP	0.50	0.09	0.25	0.67	1,844,730
Service share of GDP	0.39	0.09	0.23	0.72	1,844,730
Industry-level Theil index of dispersion of MPL**	0.45	0.10	0.27	0.80	1,934,580
City-level Theil index of dispersion of MPL	0.47	0.11	0.30	0.82	1,934,568

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

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

At the city level, the average population is around 5.8 million inhabitants. This is in line with the rapid urbanisation rates experienced by China during the sample period.

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

The largest city in the sample has a population of over 13.8 million, while the smallest has a population of only 139,000. The average share of the non-agricultural population² in a city is 42%, highlighting the barriers to hukou transfers. The maximum value for this variable is 100%, which corresponds to a prefecture where the whole population holds urban hukous. In terms of sectoral decomposition of output, on average industry accounts for 50% of GDP, with 11% coming from agriculture and 39% from services. This supports the notion that a typical sample city has already begun the industrialisation process. 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 0.45 for the industry-level Theil index and 0.47 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 the presence of monopsony power among Chinese firms. Log of labour compensation includes total payable wages and expenditure on workers' benefits³. The average and marginal products of labour show wide dispersion of labor productivity across firms.

Table 4: Main outcomes

	Mean	SD	Min	Max	N
Pigou's E	11.48	14.77	0.05	74.36	1,899,013
APL	265.67	315.73	12.35	1,582.84	1,934,568
MPL	128.45	155.13	5.53	779.23	1,934,568
Log of labour compensation	7.16	1.29	2.46	12.18	1,934,568
Markup (ACF)	3.05	452.56	0.00	398,832	1,900,337
Markup (CRS)	1.14	4.47	0.00	4,385.27	1,900,337
Markdown (ACF)	1.02	2.05	0.00	419.66	1,900,337
Markdown (CRS)	1.02	1.80	0.03	280.00	1,900,337

²The division into agricultural and non-agricultural population is based on hukou status rather than de facto occupation.

³Workers' benefits include employee education expenses, unemployment insurance, R&D expenses, pension and medical insurance, labour insurance, and expenditure on the housing fund.

Out of the two alternative measures of markups, ACF yields a larger mean value of 3.05. This method also has the largest standard deviation. CRS estimate is slightly smaller at 1.14. These figures are roughly in line with Brooks et al. (2019) estimates of markups for China using CASIF. The consistent mean value of 1.02 for both measures of markdowns reflects the normalisation of the output elasticity of labour when taking the ratio of labour markups to markups for intermediate inputs, as described in Part 3 of the Appendix.

Table 5 shows descriptive statistics for main variables in the CHIP data. Most observations (56%) come from the Rural Survey, followed by Urban (37%). Migrants are the least represented group with around 6% of observations drawn from this survey. Most individuals (62%) hold a Rural hukou status. Note that the percentage of rural hukou holders is higher than the percentage of rural households, indicating that some individuals are living in urban areas but still hold a rural hukou, which is consistent with the rigidity of the institutional background of the hukou system. The average annual salary for the sample is 5534.70 yuan. The average individual in the dataset is 37 years old. The sample is well balanced on gender, with 51% male respondents and 49% female respondents.

In terms of education and employment characteristics, almost half of the sample has completed Middle school. Notably, only 9.6% of the sample has gone to college or above, while 5.12% is illiterate or never schooled. This might be related to the higher proportion of rural respondents in the data. The most frequently reported economic sector of employment is manufacturing, with 22% of the individuals belonging to that category. This is in line with China's rapid industrialisation, in particular in the labour-intensive manufacturing sector. The sector employing the second largest proportion of people is Construction and the third Transport and Communication. The average education levels and prevalence of relatively low-skill industries create an appropriate sample for analysis of workers that might be especially vulnerable to exploitation by employers.

Table 5: CHIP Descriptive Statistics

	Freq.	Percent	Cum.
Household Type			
Rural	138,239	56.90	56.90
Urban	88,645	36.48	93.38
Migrant	16,084	6.62	100.00
Hukou			
Rural	145,098	62.13	62.13
Urban	81,815	35.03	97.17
Resident Hukou	6,342	2.72	99.88
Others (foreign nationality etc)	270	0.12	100.00
Annual salary (M)	5534.70		
Annual salary (SD)	9494.76		
Age (M)	37.03		
Age (SD)	44.35		
Sex			
Male	119,733	51.06	51.06
Female	114,749	48.94	100.00
Educational level			
Illiterate or never schooled	9,497	5.12	5.12
Literacy classes	317	0.17	5.29
1-3 years of elementary school	13,391	7.21	12.50
4 or more years of elementary school	39,684	21.38	33.88
Middle school	91,718	49.41	83.29
Professional or technical school	13,205	7.11	90.40
College or above	17,813	9.60	100.00
Economic sector			
Mining and geological survey	3,576	3.58	3.58
Industry	6,007	6.01	9.58
Construction	11,008	11.01	20.59
Transport, comm, posts, telecom	6,650	6.65	27.24
Commerce and trade	3,750	3.75	30.98
Restaurants and catering	3,783	3.78	34.77
Materials supply, marketing, warehouse	660	0.66	35.43
Real estate	1,087	1.09	36.51
Public utilities	3,374	3.37	39.89
Personal service or consulting service	335	0.33	40.22
Public health, sports, social welfare	5,346	5.34	45.57
Education, culture, arts, broadcast	3,916	3.92	49.48
Scientific and technical service	4,616	4.62	54.10
Finance, insurance	2,810	2.81	56.91
Party, government, or social organisation	3,954	3.95	60.86
Other	2,906	2.91	63.76
Don't know	114	0.11	63.88
Manufacturing	22,048	22.04	85.92
Wholesale, retail and food services	9,918	9.92	95.84
Leasing and Business Services	1,789	1.79	97.63
Services to Households and Other Services	2,196	2.20	99.82
International Organizations	40	0.04	99.86
Security activities	12	0.01	99.87
Law	82	0.08	100.00
<i>N</i>	243,371		

Since rural hukou holders cannot access the labour market for urban hukou holders, individuals holding a rural hukou status will have a lower reservation wage than urban hukou holders with similar abilities. Table 6 below shows the average annual salary by

hukou status⁴ from five waves of CHIP data: 1999, 2002, 2007, 2008, and 2013. A quick inspection of the descriptive statistics shows that urban hukou holders have a mean annual salary of 6,881.2 yuan, which is higher than the average of 4,870.1 yuan for rural hukou holders.

Table 6: Average salary by hukou status

	Mean	SD	Min	Max	N
Rural Hukou	4,870.13	8,634.53	0.00	40,167.85	144,991
Urban Hukou	6,881.26	10,583.33	0.00	40,167.85	81,791
Total	5595.47	9433.70	0.00	40167.85	226,782

Notes: The questionnaire for CHIP surveys varies significantly year-to-year as well as across household types (Rural, Urban, Migrant). For 1999 and 2002 we use "Total annual income from the work unit" together with any work benefits to determine annual salary. For 2007 and 2008, we use "What is your average monthly income from your current job" to obtain annual values for salary. For 2013 we use "Total income from this job". All values are in local currency. We deflate the reported salary by the province-specific CPI index from the China Statistical Yearbooks to obtain real values.

Discrimination on the basis of the hukou status is not confined to the dual nature of the labour market. Significant disparities also exist in access to education, indirectly feeding into subsequent labour market outcomes for rural hukou holders. Table 7 shows the average educational level by hukou status, where 1 is the lowest category, and 9 the highest. There is a strong correlation between urban hukou status and educational outcomes, suggesting that there could be indirect channels through which the institutional background of the hukou system disadvantages rural hukou holders in the labour market. Taken together, these statistics suggest that rural hukou holders face barriers in access to education and earn less relative to urban hukou holders.

Table 7: Average educational level by hukou status

	Mean	SD	Min	Max	N
Rural Hukou	5.38	1.56	1.00	9.00	103,790
Urban Hukou	6.38	1.71	1.00	9.00	75,388
Total	5.80	1.70	1.00	9.00	179,178

Notes: The educational categories are defined as follows: 1 "Illiterate or never schooled" 3 "Literacy classes" 4 "1-3 years of elementary school" 5 "4 or more years of elementary school" 6 "Middle school" 8 "Professional or technical school" 9 "College"

⁴We exclude individuals with a foreign nationality that do not have a domestic hukou status. We also exclude the "Resident Hukou" category that appears in the 2013 wave of the survey and does not distinguish between rural and urban status.

or above"

Based on the descriptive statistics, (i) urban hukou holders have a higher educational level relative to rural hukou holders, (ii) urban hukou holders have a higher mean annual salary relative to rural hukou holders, (iii) there is a gap between MPL and W , which indicates the presence of firms' monopsonistic behaviour. These are the characteristics that are commonly found in segmented labour markets where workers face discrimination along one of its segments. This motivates us to construct a model that features the structural discrimination based on workers' reservation wage.

4 Equilibrium Model

The descriptive statistics in the previous section portrays the essential features of the labor market in China. We now develop a stationary equilibrium model that incorporates the key features of the labor market we showed in the previous section. To reflect the monopsonistic behaviour of the companies, our model modifies Burdett and Mortensen (1998) with heterogeneous firm productivity. The Burdett-Mortensen model gives a theoretical foundation for a monopsonistic conduct of enterprises. Finally, we follow Kim and Samaniego (2021); Engbom and Moser (2018), by establishing a segmented labour market so that workers with the specific Hukou are bound to locate jobs inside their labour market.

4.1 Workers

The problem for workers is a straightforward adaptation of Burdett and Mortensen (1998). We assume that workers joining the labor market are composed of (i) wage-earners and (ii) self-employed.

Labor markets are segmented according to employees' Hukou status, with enterprises treating each labour market separately. As such, workers with urban hukou holder cannot join the labour market for rural hukou holders and vice versa. For each labour market segment,

search is a random process. Workers maximize their lifetime income discounted at a rate ρ , and receive job offers according to a Poisson process with arrival rate λ_h^i where $i = s, w$ (self-employed, wage-earner), and $h = U, R$ (Urban Hukou, Rural Hukou). For instance, λ_U^s denote the job arrival rate for the self-employed worker with urban hukou, and λ_R^w is the job arrival rate for wage-earner with rural hukou. Firms strategically post wage offer ω in each labor market U and R with consideration of worker's wage, ω , other firms' wage posting, and self-employed workers' benefit, b_h . We define the distribution of the firm's expected wage payment as $F_h(\omega)$.⁵

Wage-paying jobs will be terminated exogenously with δ_h ratio, or endogenously by laborers moving ahead to the better paying formal sector jobs. Let S_h be the value function of an h -hukou agent if s/he works as self-employed, and $W_h(\omega)$ be the value function of h -hukou agent whose expected wage is ω . Then the following Bellman equations can be formulated.

$$(1) \quad \rho S_h = b_h + \lambda_h^s \int_{R_h}^{\bar{\omega}_h} \max\{W_h(x) - S_h, 0\} dF_h(x)$$

$$(2) \quad \rho W_h(\omega) = \omega + \lambda_h^w \int_{\omega}^{\bar{\omega}_h} (W_h(x) - W_h(\omega)) dF_h(x) + \delta_h [S_h - W_h(\omega)]$$

where $\bar{\omega}_h$ denote highest wage payment and R_h reservation wage for h hukou workers respectively. From these equations the reservation wage can be derived as follows:

$$(3) \quad R_h = b_h + (\lambda_h^s - \lambda_h^w) \int_{R_h}^{\bar{\omega}_h} \frac{1 - F_h(x)}{\rho + \delta_h + \lambda_h^e (1 - F_h(x))} dx$$

We assume job arrival rate for urban hukou holders is higher than that of rural hukou owners ($\lambda_U^i > \lambda_R^i, i = s, w$). Considering that urban hukou owners are residents in the city, it is plausible to assume that they have a better local network. Similarly, we assume that self-employed people with urban hukou have a higher utility than self-employed workers with rural hukou ($b_U > b_R$). To simplify our argument, we assume $\lambda_h^s = \lambda_h^e = \lambda_h$, and then reservation wage of a worker with outside offer x becomes $R_h = b_h$, and we assume urban hukou holders have higher reservation wage than rural hukou holders. Given that urban hukou holders benefit from a social safety net and are in a relatively advantageous position

⁵The wage package can differ in different dimensions for wage-earning workers. For example, it is often the case that formal sector workers receive benefits such as insurance subsidies. We address this difference in benefits by defining wage as the entire monetary compensation for the worker. The wage is after tax (if it is levied) but before social security deduction. Social security is considered part of their compensation as it entitles them to a pension and health benefits.

to find alternative jobs with a local network, our hypothesis is credible.

Now, we define the steady-state measure of the self-employed and the labor supply. Let I_h denote the steady-state number of h hukou workers in the self-employed. In the steady-state, the flow of workers to wage-paying job, $\lambda_h^e[1 - F_h(R_h)]I_h$, equals the flow from wage-paying job to self-employment, $\delta_h(m_h(q_h) - I_h)$, where q_h is the benefit provided to h hukou owner. And therefore,

$$(4) \quad I_h = \frac{\delta_h m_h(q_h)}{\delta_h + \lambda_h^e(1 - F_h(R_h))}$$

Let the steady-state number of workers employed with a wage no greater than ω be given by $G_h(\omega)(m_h(q_h) - I_h)$, where I_h is the total self-employed workers, and $G_h(\omega)$ is the wage distribution of wage-earning workers. At the steady-state, the flow of workers leaving employers offering a wage no greater than ω equals the flow of workers returning to such employers,

$$(5) \quad (\delta_h + \lambda_h^w(1 - F_h(\omega))G_h(\omega)(m_h - I_h) = \lambda_h^e(F_h(\omega) - F_h(R_h))I_h$$

where $F_h(\omega) - F_h(R_h)$ represents the share of workers whose reservation wage is R_h who will accept an offer less than or equal to ω , and I_h measure of self-employed. From (4) and (5), we can derive the unique steady-state distribution of wages earned by employed workers.

$$G_h(\omega) = \frac{F_h(\omega)}{1 + \kappa_h^w(1 - F_h(\omega))}$$

where $\kappa_h^w \equiv \frac{\lambda_h^w}{\delta_h}$. The steady-state number of workers earning a wage in the interval $[\omega - \epsilon, \omega]$ is represented by $dG_h(\omega)(m_h - I_h)$, while $dF_h(\omega)$ is the measure of firms offering an expected wage payment, ω , in the same interval. Following the Burdett and Mortensen (1998), the measure of workers per firm offering a wage, ω , at the steady state can be expressed as

$$(6) \quad n_h(\omega|F_h) = \frac{(m_h - I_h)dG_h(\omega)}{dF_h(\omega)} = \frac{k_h m_h}{(1 + k_h(1 - F_h(\omega)))^2}$$

4.2 Firms

There is a continuum of heterogeneous firms whose idiosyncratic productivity, p , is drawn from the distribution Γ . Let $H (= R, U)$ be the set of labor markets where firms operate. Firms employ from rural and urban hukou-owner labour marketplaces respectively, using different wage posting strategies that take into account workers' reservation wages and wage posting by other firms. Firms commit to paying a wage ω for the remainder of the match. They operate a linear production technology combining n_h workers from each labor market h to produce flow output. Then the total production is

$$y(p, n_R, n_U) = p \sum_{h=R,U} z_h n_h$$

where z_h represent ability of workers with h hukou.

As the model assumes perfect segmentation of labor markets and production technology is a linear combination of production from different labor segments, entrepreneurs can maximize their aggregate profit by maximizing profit in each labor market separately.

$$(7) \quad \pi_h(\omega) = \max_{\omega \geq R_h} \{(pz_h - \omega) n_h(\omega|F_h)\}$$

where $n_h(\omega|F_h, H_h)$ is the labor hired at wage ω , given F_h . In other words, employers decide wages in each segmented labor market to maximize (7), considering the expected wage payment distribution, $F_h(\omega)$, and the measure of workers available with expected wage ω in labor market h , $n_h(\omega|F_h, H_h)$, which is derived in equation (6).

As proved by Burdett and Mortensen (1998), under the assumption of continuous productivity distribution, there is a unique productivity that corresponds with equilibrium wage. We denote this distribution as $J_h(p)$. Following BM (1998), we can derive

$$(8) \quad \omega_h^*(p) = z_h \left[p - \int_{\frac{b_h}{z_h}}^p \left(\frac{1+k_h^e(1-J_h(p))}{1+k_h^e(1-J_z(x))} \right)^2 dx \right]$$

Note that firms who are able to hire workers and make profits $\left(p \in \left[\frac{b_h}{z_h}, \bar{p} \right] \right)$ join in the labour market. We can see equilibrium expected wage, $\omega_h^*(p)$, is determined by an effect of worker productivity, firm productivity, and wage posting strategies by other participating firms in labor market h . This equation has important implications to understand the effect of hukou reform on equilibrium wage.

4.3 Equilibrium characterization

The critical characteristics of the equilibrium wage and the employment in our model closely follows Burdett and Mortensen (1998); Engbom and Moser (2018); Kim and Samaniego (2021). We feature some of the characteristics below.

Proposition 1: Hukou reform increases wage distribution of rural hukou holders in the first stochastic dominance way. This, in turn, reduces employers' rent.

From $\omega_R^*(p) = z_R \left[p - \int_{\frac{b_h}{z_h}}^p \frac{A_R(x)}{A_R(x)} dx \right]$ where $A_R(p)$ is defined as $1 + k_R^e(1 - J_R(p))$ ($A_R(p) = 1 + k_R^e(1 - J_R(p))$), we can study the change in equilibrium wage in response with increases in the benefit of social protection (change in b_R). It is straightforward to derive $\frac{\partial \omega_R^*(p)}{\partial (\frac{b_R}{z_R})} = \frac{A_R(p)}{A_R(\frac{b_R}{z_R})} > 0$. As the lowest reservation wage in labor market h increases, we observe the equilibrium wage distribution increases for previous rural hukou holders. Note that hukou reform is no more less than increasing benefit of social protection. It is related with increasing non-employment outside option.

Proposition 2: Hukou reform increases employment of rural hukou holders by firms whose productivity is greater than $p > \frac{b'_R}{z_R}$, where b'_R is the new reservation wage, while it pushes out the least productive firms from the market whose productivity is $\frac{b_R}{z_R} < p < \frac{b'_R}{z_R}$. As these least productive firms who were able to operate by hiring rural hukou workers, average labour productivity and total factor productivity necessarily increases.

From

$$n_h(\omega|F_h) = \frac{k_h m_h}{(1 + k_h(1 - F_h(\omega)))^2}$$

We can easily verify

$$\frac{\partial n_h(\omega|F_h)}{\partial \omega} > 0$$

This proposition infers that whereas there are least productive firms leaving the market with the hukou reform, the remaining firms hire more workers. With the truncation of the least productive firms, the average firm productivity and labour productivity will necessarily increase.

Proposition 3: Rural hukou holders earn less than urban hukou holders with comparable abilities.

To show thi, let us assume that an urban hukou worker and a rural hukou worker have the same productivity ($z_U = z_R$). Then one can verify $\omega_U^*(p) > \omega_R^*(p)$.

$$\begin{aligned} & \omega_U^*(p) > \omega_R^*(p) \\ = & z_U \left[p - \int_{\frac{z_U}{z_U}}^p \frac{[1+k_U(1-J_U(p))]^2 Q_U(y)}{[1+k_U(1-J_U(y))]^2 Q_U(p)} dy \right] > z_R \left[p - \int_{\frac{z_R}{z_R}}^p \frac{[1+k_R(1-J_R(p))]^2 Q_R(y)}{[1+k_R(1-J_R(y))]^2 Q_R(p)} dy \right] \\ \iff & \int_{R_R}^p \frac{[1+k_R(1-J_R(p))]^2}{[1+k_R(1-J_R(x))]^2} dx > \int_{R_U}^p \frac{[1+k_U(1-J_U(p))]^2}{[1+k_U(1-J_U(x))]^2} dx \end{aligned}$$

As $R_U > R_R$, $J_U(p) \succeq_{FOSD} J_R(p)$ and $k_U > k_R$, LHS must be larger than RHS.

In order to test the theoretical predictions of the model, we conduct an empirical analysis using a multiple period difference-in-difference framework, drawing on both firm-level panel data from CASIF and household-level cross-sectional data from CHIP to understand the behaviour and dynamics on both the supply and demand side of the labour market. The following sections will outline the methodology and present results on firms' monopsony power, labour compensation, productivity, firm exit, and the earnings gap between rural and urban hukou holders.

5 The Consequent of the Hukou Reform

5.1 Estimation Strategy

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, we 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. Instead, we 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:

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

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, labour compensation, MPL, APL, markdowns, and markups. 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, we adopt additional controls. In particular, we use firm-level fixed effects θ_i to account for any time-invariant firm characteristics that could affect monopsony power. Since we 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. We include the age of the firm to control for potential effects of industry experience. For regressions of labour compensation, we 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, we follow Wang et al. (2021) and include city-level controls Z_{ct} : log of per capita GDP and share of non-agricultural population. Additionally, we include a year dummy θ_t to capture time-specific shocks to all firms. Finally, we 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

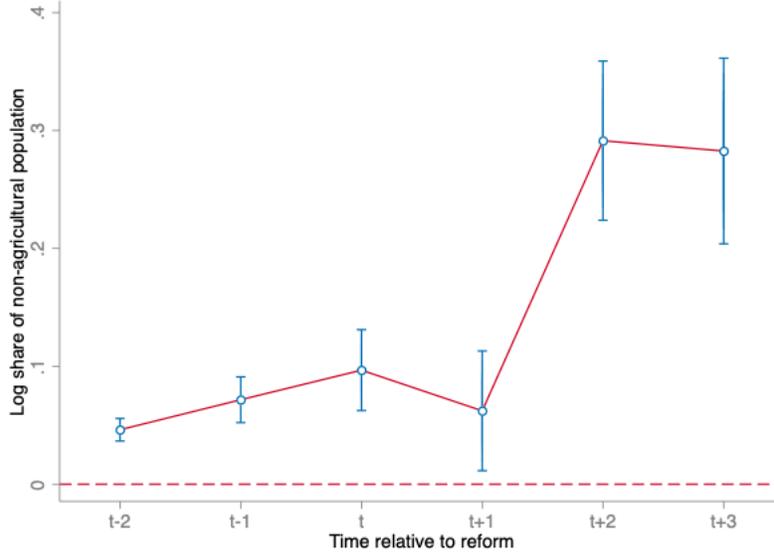
underestimate the standard deviation of estimated treatment effects and lead to the overestimation of the t-statistics Bertrand et al. (2004). In the case of the hukou reform, assignment to treatment is done at the city level, which may cause standard errors of firms in the same administrative unit to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

5.2 Results

5.2.1 Urban Population

The key channel through which the reform is likely to affect monopsony power is by relaxing restrictions on transfers of hukou status from agricultural to non-agricultural, to which most social safety nets are tied. To investigate whether the Hukou reform was successful at facilitating changes to migrants' hukou status, we plot the coefficients from a regression of the log of the share of non-agricultural hukou holders 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 at least two years before the policy takes effect.

Figure 2: The Hukou Reform and Share of Urban Population



This figure shows coefficients on year dummies from the below regression:
 $logurbanshare = \sum_{s=1} \beta_s D_{c,t+s} + \beta_0 D_{ct} + \sum_{n=1} \beta_n D_{c,t-n} + \theta_i + \theta_t + city \times year + \epsilon_{ict}$

To confirm whether the reform was effective at easing restrictions on the changes of hukou status, we run a multiple period diff-in-diff with the log share of urban population as the dependant variable. The results are presented in Table 8 below. Both specifications include year fixed effects, firm fixed effects, and city-level controls: log of GDP per capita and share of employment in industry. Column (1) shows a model without the city-specific trends. In column (2), we add a control for city-specific 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 5.9-6.6% 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 facilitated access to social transfers for migrant workers.

Table 8: The Hukou Reform and Share of Urban Population

	(1)	(2)
	lognonagrshare	lognonagrshare
hukou	0.0590*	0.0658**
	(2.04)	(2.61)
logGDPpc	-0.000492	-0.0142
	(-0.02)	(-0.69)
indshare	0.0248	-0.0516*
	(0.81)	(-2.32)
Firm FE	Yes	Yes
Year FE	Yes	Yes
Regional trends	No	Yes
<i>N</i>	1546024	1546024
<i>R</i> ²	0.976	0.988

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.2.2 Monopsony Power

In order to investigate the impact of the Hukou reform on firms' monopsony power, we run a multiple period diff-in-diff with Pigou's E as the dependent variable. First, we take a model with just firm-level fixed effects, year fixed effects and firm-level controls, including firm age. The results are reported in column (1) of Table 9. In specification (2), we add log of per capita GDP and share of non-agricultural population as city-level controls. Finally, in column (3) we add a city-specific linear regional trend. 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.

Table 9: Impact of the Hukou Reform on the Monopsony Power of Firms

	(1)	(2)	(3)
	pigouE	pigouE	pigouE
hukou	-0.292*	-0.213*	-0.245*
	(-2.35)	(-1.99)	(-2.18)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
City controls	No	Yes	Yes
Regional trends	No	No	Yes
<i>N</i>	1594895	1522831	1522192
<i>R</i> ²	0.717	0.756	0.720

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

We do a regression with two measures of markdown as the dependent variable to confirm the robustness across multiple measures of monopsony.⁶ First, we use a model with

⁶Details on the different methods of markup and markdown construction can be found in Part 3 of the Appendix.

just firm fixed effects and year fixed effects, corresponding to columns (1) and (4) in Table 10 below. For both methods of markdown estimation, there is a negative and statistically significant effect on markdowns for firms located in reform cities relative to non-reform cities. For models (2) and (5), we add city-level controls. The coefficient is similar in magnitude, but becomes marginally insignificant. Finally, we add the regional trend and find a negative and statistically significant effect for both markdown measures, with coefficient similar in magnitude to the first set of results. Overall results suggest that the Hukou reform decreased the ability of firms to exert market power in the labour market and drive a wedge between wage and marginal value product of labour.

Table 10: Impact of the Hukou Reform on Markdowns

	(1)	(2)	(3)	(4)	(5)	(6)
	ACF	ACF	ACF	CRS	CRS	CRS
hukou	-0.0400** (-2.75)	-0.0256 (-1.71)	-0.0370* (-2.21)	-0.0347** (-2.90)	-0.0217 (-1.75)	-0.0311* (-2.23)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
City controls	No	Yes	Yes	No	Yes	Yes
Regional trends	No	No	Yes	No	No	Yes
N	1325317	1261178	1261178	1325317	1261178	1261178
R^2	0.647	0.645	0.647	0.627	0.626	0.627

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

While this result confirms findings from Table 9, it could be driven by a change in the ability of firms to markup their output in the output market, rather than a change in market power in the labour market.⁷ To investigate whether this is the case, we run the same regression for two measures of markups.

If the decrease in markdowns is mainly due to a rise in firms' markups in the output market, there should be a positive and statistically significant effect of the Hukou reform on firm markups. Columns (1) and (4) of Table 11 below present results from a model with just firm and year fixed effects for two alternative measures of firm markups. In the case of ACF,

⁷Recall that markdowns are constructed as a ratio of the labour markup to the markup for material inputs where no monopsony power is assumed. A decrease in markdowns could therefore be driven by an increase in the true markup Brooks et al. (2021).

the coefficient is large but statistically insignificant. For CRS, the coefficient on *hukou* is close to zeros and statistically insignificant. Columns (2) and (5) show that results for ACF and CRS remain insignificant even after city controls are added. Finally, columns (3) and (6) show that results stay insignificant after the addition of the regional trend. This provides evidence that a decrease in markdowns saw in section 5.2.3. is due to the reduced market power in the labour market rather than an increased market power in the output market.

Table 11: Impact of the Hukou Reform on Markups

	(1)	(2)	(3)	(4)	(5)	(6)
	ACF	ACF	ACF	CRS	CRS	CRS
<i>hukou</i>	-1.157 (-0.73)	-1.216 (-0.84)	2.144 (1.56)	-0.00188 (-0.48)	-0.00131 (-0.35)	-0.000756 (-0.18)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
City controls	No	Yes	Yes	No	Yes	Yes
Regional trends	No	No	Yes	No	No	Yes
<i>N</i>	1325317	1261178	1261178	1324911	1261178	1261178
<i>R</i> ²	0.426	0.426	0.427	0.472	0.469	0.472

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.2.3 Heterogeneity Analysis

While the overall effect of the Hukou reform on monopsony power is negative, this aggregate analysis obscures potential heterogeneity effects based on city size. In particular, Manning (2010) develops a theory of agglomeration based on the assumption that labour supply curve to individual firms is more elastic in larger markets due to a more competitive nature of urban markets, implying a smaller monopsony power for larger prefectures. This suggests firms in smaller and larger cities are likely to differ in their capacity to exert bargaining power over labour following the Hukou reform. We investigate this point further by conducting a heterogeneity analysis.

Increased labour mobility via the Hukou reform leads to a reduction in monopsony power at the overall country level. However, since the direction of migration in China has historically been towards large cities, the Hukou reform could have heterogeneous effects

depending on city size. In particular, since large cities are expected to have a larger number of migrants already residing there, the effect of allowing protection to workers that previously held an agricultural hukou can be expected to be more pronounced, even if higher in-migration rates relative to small cities put a downward pressure on wages. To investigate this point, we re-run the multiple period diff-in-diff for firms located in cities above the 85th percentile of the total city population distribution and those below the 15th percentile.

The results are reported in Table 12 below. First, we 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. We then add a control for regional trends in columns (2) and (4). For large cities, there is a large, negative, and statistically significant effect of the Hukou reform on monopsony power for model (1). This is consistent with the idea that greater social protection against worker exploitation which makes the labour supply more responsive to wage cuts dominates the effect of in-migration and larger labour supply. Once the regional trend is added, the coefficient remains negative, but decreases in magnitude and turns insignificant. We cannot exclude the possibility that previous trends in monopsony power of firms in large cities are important determinants of subsequent changes in their monopsony power.

Table 12: The Hukou Reform and Monopsony Power: Heterogeneity by City Size

	Large Cities		Small Cities	
	(1)	(2)	(3)	(4)
	pigouE	pigouE	pigouE	pigouE
hukou	-1.465*** (-4.26)	-0.311 (-1.00)	-0.936** (-2.96)	-1.173** (-2.96)
agew	-0.0156* (-2.02)	-0.00395 (-0.50)	-0.0150* (-1.96)	-0.0189** (-2.91)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
City controls	Yes	Yes	Yes	Yes
Regional trends	No	Yes	No	Yes
<i>N</i>	235965	235965	225347	225347
<i>R</i> ²	0.715	0.716	0.744	0.777

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Firms in smallest cities also see a decrease in their monopsony power, with the

coefficient on Pigou's E significant at the 1% level for both model (3) and (4), which shows that the result is robust to the inclusion of the regional trend. By comparing columns (2) and (4), we can deduce that in the larger city, the in-migration mechanism appears to cancel out the protection mechanism, whereas in the smaller city, the protection mechanism is stronger than the in-migration mechanism. This could be due to a smaller volume of in-migration towards smaller cities, which decreases the importance of larger supply of labour bringing down wage levels and allows the channel of increased social protection against employers to dominate. The set of results for Pigou's E suggest a negative impact of the Hukou reform on monopsony power of firms, which holds up for both largest and smallest cities. To ensure that this result is not driven by the choice of a specific measure of monopsony power, we investigate the effect on markdowns and markups.

5.2.4 Labour compensation

Since a decrease in monopsony power is confirmed using a number of alternative measures, 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, we first run a model with firm fixed effects, year fixed effects, log sales as firm-level controls and the log of labour compensation as dependant variables in column (1) of Table 13. Firms in reform cities spend 3.8% more on wages and worker benefits relative to non-reform cities. We then rerun the model including city controls in

column (2). The result remains highly statistically significant and indicates a 2.4% increase in spending on labour compensation relative to control. Column (3) shows that the result is robust to the inclusion of the regional trend and shows an effect of about a 2.6% increase in worker compensation.

Table 13: Impact of the Hukou Reform on Labour Compensation

	(1)	(2)	(3)
	loglcomp	loglcomp	loglcomp
hukou	0.0381***	0.0241***	0.0256***
	(6.07)	(3.78)	(4.36)
logsales	0.386***	0.386***	0.384***
	(109.29)	(104.67)	(104.66)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
City controls	No	Yes	Yes
Regional trends	No	No	Yes
N	1351370	1285863	1285863
R^2	0.906	0.904	0.905

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Given the discriminatory nature of the Hukou system, the the impact of access to social safety nets on workers' welfare remains a critical 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) discover that unemployment insurance increases worker productivity in the United States by allowing workers to be selective and seek higher-productivity jobs, as well as by encouraging businesses to create those jobs. 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, we investigate whether the Hukou reform had an impact on labour productivity.

5.2.5 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 5.3. 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. We investigate the firm-level productivity change by running the main specification with two dependent variables: average product of labour and marginal product of labour⁸.

Table 14: The Hukou Reform and Firm Productivity

	(1)	(2)	(3)	(4)
	APL	APL	MPL	MPL
hukou	8.508*	1.830	2.319*	0.407
	(2.54)	(0.76)	(2.52)	(0.56)
agew	-0.290***	-0.0475	-0.0719***	-0.00896
	(-5.70)	(-1.01)	(-5.17)	(-0.69)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
City controls	Yes	Yes	Yes	Yes
Regional trends	No	Yes	No	Yes
<i>N</i>	1547262	1547262	1547262	1547262
<i>R</i> ²	0.766	0.770	0.779	0.782

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results are presented in Table 14 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 5.3. and indicate that extending social safety net to rural-migrant worker may lead to increased worker productivity. Columns (2) and (4) additionally control for the regional trend. In both cases, the coefficients remains positive, but decrease in magnitude and become insignificant. This could be due to pre-existing regional trends in productivity growth.

⁸The marginal product of labour is estimated using a standard method Akerberg et al. (2015)

5.2.6 Firm exit

According to Proposition 2 in the Model, the productivity gains shown in the previous section are a result of the process of firm exit by the least productive firms and an increase in employment by remaining firms. This section will empirically evaluate this prediction by comparing the productivity of exiting and remaining firms and performing the multiple period diff-in-diff for the number of exiting firms and the number of workers hired by remaining firms. Table 15 below shows descriptive statistics for the average and marginal products of labour for exiting⁹ firms and remaining firms. There are 614,940 firms that left the market during the sample period and 1,319,628 that remained. Firms that exit have noticeably smaller values of both APL and MPL, confirming the theoretical propositions of the model.

Table 15: Firm Productivity

	Mean	SD	Min	Max	N
Exiting firms					
APL	197.60	269.05	12.35	1,582.84	614,940
MPL	51.71	77.35	1.32	442.45	614,940
Remaining firms					
APL	297.39	330.52	12.35	1582.84	1,319,628
MPL	75.46	92.46	1.32	442.45	1,319,628

To verify that the Hukou reform leads to the least productive firms leaving the market, we perform a multiple period difference-in-differences estimation with the number of exiting firms by city, year, and industry as the dependant variable. Column (1) of Table 16 shows a model with year fixed effects, firm fixed effects, and firm-level controls: age of the firm and log of sales. Column (2) adds city controls: log of per capita GDP and share of non-agricultural population. In both cases, the coefficient on *hukou* is statistically significant. Once the regional trend is added in column (3), the result turns insignificant, suggesting possible pre-trends in the number of firms exiting the market. Nonetheless, the result suggests that cities implementing the Hukou reform see more firms leaving the market relative to cities that did not implement the reform.

⁹We define exiting firms as those that have disappeared from the sample. Since CASIF records only those enterprises with annual sales above 5 million RMB, a disappearance of the firm from the sample could also mean that their sales dropped below the threshold required for inclusion in the survey, which is a commonly highlighted issue in literature.

Table 16: The Hukou Reform and Firm Exit

	(1)	(2)	(3)
	nofirms	nofirms	nofirms
hukou	0.324*** (4.36)	0.211** (2.78)	0.149 (1.23)
logsales	-0.225*** (-9.79)	-0.271*** (-9.34)	-0.266*** (-8.97)
agew	-0.0202*** (-10.58)	-0.0229*** (-9.80)	-0.0263*** (-10.98)
City FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Regional trends	No	No	Yes
<i>N</i>	88429	76088	76088
<i>R</i> ²	0.258	0.260	0.269

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
All variables collapsed at the city-year-industry level.

Finally, Table 17 performs the same estimation for the log of the number of workers hired only for firms that remained in the market. The specification with firm fixed effects, year fixed effects, and firm-level controls in column (1) shows a highly significant 2.7% increase in the number of workers hired. Once the city-level controls are added in column (2) that result becomes insignificant. However, The inclusion of the regional trend in column (3) results in a significant 1% increase in employment. These results confirm that although the employment effect is modest, remaining firms absorb the additional labour force of rural hukou holders after the least productive firms leave the market.

Table 17: The Hukou Reform and Employment in Remaining Firms

	(1)	(2)	(3)
	logL	logL	logL
hukou	0.0277*** (3.59)	0.0122 (1.61)	0.0108* (2.43)
logsales	0.257*** (73.97)	0.257*** (72.18)	0.261*** (76.35)
agew	0.00472*** (25.12)	0.00471*** (24.01)	0.00390*** (21.64)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
City controls	No	Yes	Yes
Regional trends	No	No	Yes
<i>N</i>	1013943	975684	975684
<i>R</i> ²	0.916	0.916	0.919

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.2.7 Earnings gap between rural and urban hukou holders

Firm-level analysis in the previous sections confirmed the impact of the hukou reform on the monopsony power of firms, labour compensation, productivity, and firm exit dynamics. However, firm-level data can obscure heterogeneity in worker characteristics, in particular with relation to the hukou status, that is crucial for understanding the nature of labour market fragmentation. In this section, we make use of household-level data from the Chinese Income Project (CHIP) to supplement earlier results and investigate disparities in earnings among workers based on their hukou status.

We have seen that significant differences exist in terms of both salary and educational levels among rural and urban hukou holders. Next, we conceptualise the impact of the hukou reform on earning inequalities. According to Proposition 1, the hukou reform should, by allowing access to social benefits for rural hukou holders, increase their outside option and bring the equilibrium wage for rural hukou holders higher. To validate this point, we perform a multiple period diff-in-diff for the sub-sample of rural hukou holders to compare the salaries of rural hukou holders in reform cities relative to rural hukou holders in non-reform cities. Table 18 shows the results from three specifications: 1) city and year fixed effects 2) additionally including individual-level characteristics, and 3) further controlling for city-level variables (log of per capita GDP and share of non-agricultural population). In all cases, there is a positive and statistically significant coefficient on *hukou*, suggesting that salaries of rural hukou holders in reform cities increased relative to those in non-reform cities.

Table 18: The Hukou Reform and Earnings of Rural Hukou Holders

	(1)	(2)	(3)
	logsalary	logsalary	logsalary
hukou	1.592** (2.66)	1.345* (2.34)	1.481* (2.12)
age		-0.0940*** (-15.04)	-0.100*** (-15.45)
educ		0.278*** (12.87)	0.308*** (10.13)
sex		-1.759*** (-19.86)	-1.706*** (-16.49)
marriage		-0.190** (-3.25)	-0.206** (-2.76)
City FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
City-level controls	No	No	Yes
N	68239	48762	34658
R^2	0.234	0.411	0.398

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: For the analysis, we restrict the sample to four waves of CHIP data: 1999, 2002, 2007, and 2008 to match the sample period of CASIF data for which we have information on hukou-reformed cities. Standard errors are clustered at the city level.

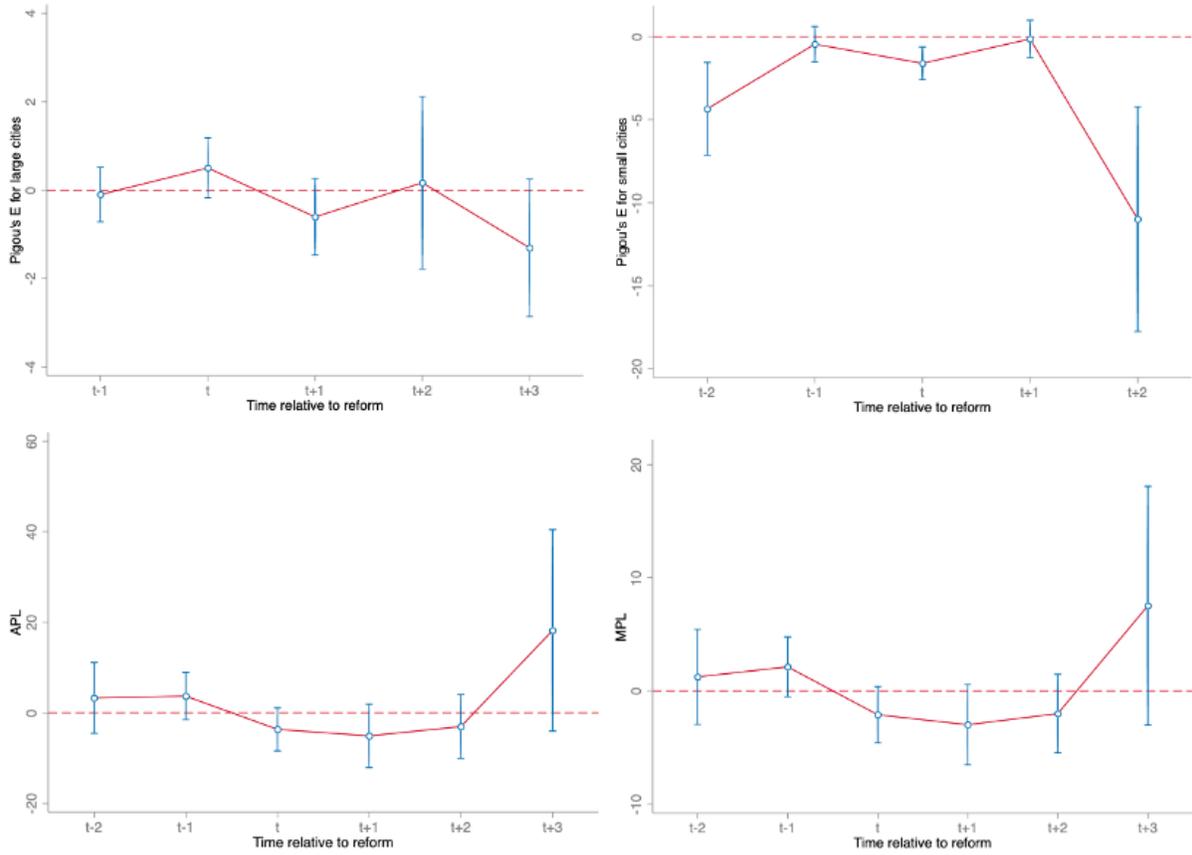
6 Robustness Checks

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, we 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.

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

Figure 3: Pre-trends for main outcome variables



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 becomes different from zero three years after the hukou reform in time $t + 3$, suggesting a lag before policy takes effect. The trend for Pigou's E in small cities also sharply drops in $t + 3$, although imprecisely estimated. Trends for MPL and APL are shown in the bottom row. No effects on productivity are detected prior to the reform. After $t + 2$, coefficients become statistically different from zero, indicating a positive impact on both MPL and APL. While my analysis is mostly confined to two periods 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.

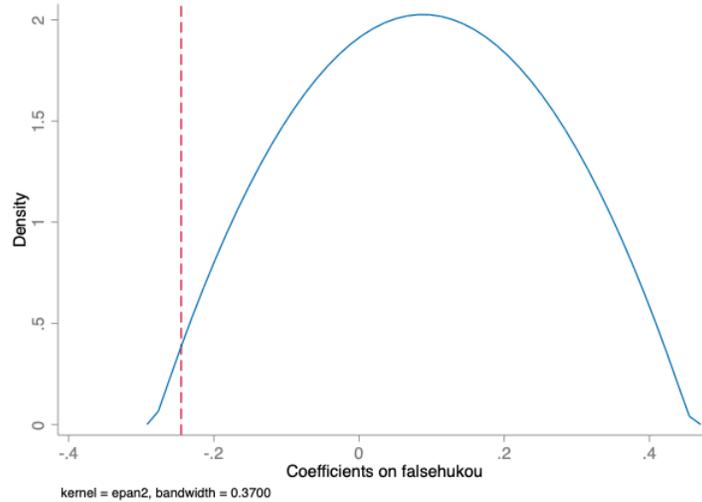
6.2 Falsification Test

In order to further validate my identification strategy, we 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, we generate a random reform year between 1998 and 2007 that is different from the actual reform year. Based on the false reform year, we construct a *falsehukou* dummy, which takes the value of 1 if reform is in place in city c at time t . We 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:

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

We 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 5.2.1 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 our coefficient is unlikely to be biased or obtained by chance.

Figure 4: Falsification Test



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 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. We 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. We 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) is only capable of establishing hukou stringency at the provincial level, obscuring city-level heterogeneity. Zhang et al. (2019) creates an index based on investment, home purchases, and employment that reflects the Hukou system’s stringency. However, this index is still in its infancy and has received little attention in the literature. As a result, we use a widely used dummy index.

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. We 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, we are not able to discuss these outcomes individually and report results for aggregate labour compensation instead.

Finally, since we removed all the firms that changed location from the sample, we are only able to investigate the internal change within provinces and cities following the Hukou reform. This could be a fruitful area for future research.

8 Conclusion

Does the relaxation of the hukou system 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. This result holds across different measures of monopsony power, such as Pigou’s E and markdowns and is valid for firms in

both the largest and smallest cities in the sample.

The Hukou reform 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 3.8% more on labour compensation (wages and benefits) relative to employers in non-reform cities. Consistent with earlier research arguing for a positive association between unemployment insurance and worker productivity, both the average and marginal products of labour are increasing as a result of the Hukou reform. Our analysis leaves unanswered critical questions about the effect of hukou reform on spatial resource allocation or labour productivity across cities. Future research could examine the relationship between the Hukou reform and the dispersion of labor’s marginal products 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:

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

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 δ_t is depreciation in year t .

$$I_n = V_t - \delta_t. \quad (5)$$

Step 4: Calculate the real investment I_t by deflating real investment values by a province-specific fixed asset investment index ¹⁰.

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

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

Where δ_k is the capital depreciation.

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

Part 2: Production Function Estimation using ACF

We assume a value-added production function with capital k_{it} , labour l_{it} , productivity shocks observable to firms but not econometricians w_{it} , and shocks unobservable to econometricians and firms ϵ_{it} shown below:

$$y_{it} = \beta_k k_{it} + \beta_l l_{it} + w_{it} + \epsilon_{it} \quad (8)$$

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

¹⁰All 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} , we adopt the Akerberg 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 idiosyncratic 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 monotonically 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. ξ_{it} is the idiosyncratic productivity shock at time t .
- v) The intermediate input m_{it} does not enter the production function to be estimated¹¹.

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

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

Stage 1: Estimate Φ to separate out ϵ_{it} .

¹¹Assumption 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 Φ_t .

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

Part 3: Estimation of Markups and Markdowns

This section summarizes Brooks et al. (2021) who introduce distinct methods for calculating markups and markdowns, each based on a different set of production function assumptions. First approach derives the input elasticity θ_{nki}^m from the Akerberg et al. (2015) estimation of the translog gross output production function in three inputs (labor, material, and capital), hence this method is referred to as ACF. Due to the advantage of a readily available coefficient on material inputs from the production function, this method has been widely used in the literature to estimate markups. However, it does not guarantee correct identification¹². Another limitation is that it assumes a constant production function across firms within the two-digit industries; productivity only differs by a factor-neutral productivity parameter.

$$\mu_{ni}^m = \frac{\frac{\partial \log(F_i)}{\partial \log(x_{mni})}}{\frac{q_{mi}x_{mi}}{p_{ni}y_{ni}}}$$

The second approach (CRS) assumes that the production function is constant returns to scale and focuses on estimating the gross profit margin rather than deriving the input elasticity. The formula shown below is sales over all input costs (materials, labour, and capital). With CRS and no input market distortion, this index should capture the markup. While the CRS production function is a strong assumption in one dimension, it is less restrictive in another: it allows for time-varying firm-specific production functions and more generic forms of technological change. While measures of total sales, payments to labour, and expenditure on materials are readily available in CASIF and capital stocks can be constructed according to the Perpetual Inventory method, cost of capital is missing from the dataset.

¹²Akerberg et al. (2015) do not suggest to follow their procedure for gross output functions that are not Leontief in material inputs.

Assuming that capital can be borrowed at the interest rate $r = 10\%$ and a depreciation rate $\delta = 5\%$, $q_K = 0.15$.

$$\mu_{nki}^m = \frac{\text{sales}}{\text{costs}} = \frac{py}{q_K x_K + q_L x_L + q_M x_M}$$

We measure markdowns by taking the ratio of labour markups to material markups derived from each of the three markup estimation methods described above. In determining the markup for labour, we assume the production function is Cobb-Douglas in inputs, implying a constant elasticity of labour θ^L . Using as a benchmark the fact that in the absence of monopsony power the markdown should be one, we calibrate the elasticity of labour so that the constant term in a regression of markdowns on firm's share of the labour market at the province level is one. Since labour payments appear both in the firm's labour market share and in the construction of markdowns, we instrument for firm's share in the labour market by firm's share in the output market to avoid spurious regressions. Finally, we winsorise all markups and markdowns at 3% to deal with potential measurement error.

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