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Is There A Compensation?
The Causal Effect of Housing Prices on Wages in Manufacturing Industry

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1 Introduction

Housing means a lot to people from a place to live to an asset to invest, and people directly react to housing prices. People are located in places with affordable living costs based on their wages. It tells the law of one wage that city has higher prices for goods and services providing a given level of utility, workers will require higher wages to work here (Winters, 2009; Partridge et al., 2010). And high wages could be seen as compensation for high costs of living, limited amenities. Therefore, I want to find out are there actually exists the compensating effect that high housing prices could lift wages.

I start my analysis in the manufacturing sector, which contains a large proportion of migrant workers or low-skilled workers, who usually live in informal housing to avoid high housing costs (Niu et al., 2021). After an empirical study using the instrument variable of land supply constraints (Saiz, 2010; Liang et al., 2016), I found the effect in this industry is nearly zero. I also separately run the regression for two industries, the common one and the high-tech one. The results are still insignificant, yet with a more positive value for the high-tech industry. The results show that the worker type influences the effect. My research enriches the literature of wage compensation for high housing prices at a more granular level and in the context of China. For further analysis, there is a need to expand the current manufacturing industry to all industries, especially for service industry.

2 Literature Review

Housing is a priority for Chinese young men to get married. There is a famous ancient saying that "*with a house, there is a home*". And the proportion of owning a house in Chinese people is a lot larger than in other countries. And therefore, housing prices mean a lot to citizens. Waxman et al., 2020 found that Chinese people even sacrifice their consumption to buy a home, which is a lot different from the US. And informal housing highly reduced the urbanization costs for low-skilled workers by helping accommodate huge migrant inflows, where housing prices constitute a large proportion of living costs in cities.

Regional wage gap studies are prevalent among studies. It starts from the homogenous

worker assumption and proposes the law of one wage that if a city has higher prices for goods and services providing a given level of utility, workers will require higher wages to work here (Winters, 2009; Partridge et al., 2010). Existing studies referred to wages as compensation for long commutes, health risks and costs of living (Mayock, 2016; Zax, 1991; Viscusi and Moore, 1987; Moretti, 2013). The existing research mostly concentrated on developed countries. Liang et al., 2016 implemented the instrument variable approach and found the increase in housing prices could lift the average wages. But the specification is a bit raw for each city's average wages including different sectors of industries.

Therefore, I start from the manufacturing sector, trying to find whether the compensation for high housing prices exists in the context of China. The wage data is from the *database of China's industrial enterprises* and measured by employee compensation wage payable divided by the number of employees. Due to the reverse causality issue from the high wages' attraction to labor, which could increase the housing demand and then housing prices, I use the same instrument as Liang et al., 2016, the land supply constraint measured by the lag term of log construction land area.

Lots of research found land constraints play an important role in housing prices, which shows that cities with limited land supply generally have high housing prices (Glaeser et al., 2005; Saiz, 2010; Quigley and Raphael, 2005; Saks, 2008). For the implementation of the instrument variable, Saiz, 2010 proposed that land constraints play an important role in land supply, thus often being used as instrument variables. The constraints could be physical construction land area or geographical terrain. They think the former instrument tends to be endogenous due to man-made decisions. However, in the Chinese context, the central government has limited the land supply quota of Eastern regions and stipulated to protection of rural land since 2003 (Liang et al., 2016). Therefore, the physical land constraints here are more exogenous since the local government couldn't easily adjust its land supply.

3 Data

3.1 Data Information

3.1.1 Main Variables of Interest

The housing prices data is from CEIC database. It is city-year level, covering 284 cities and ranging from 2011 to 2013. I take the logarithm to normalize its distribution.

The wage data is from the *database of China's industrial enterprises*, whose statistical scope is large and medium-sized manufacturing enterprises with sales of more than 20 million yuan in the Chinese mainland. From 2011, the database has provided the total number of workers and total wage payable data, therefore I think it could be a measure of average wages. But the sample is only manufacturing firms. The explicit expression of the wage measurement is in Eq 1.

$$Average\ Wage = \frac{Employee\ Compensation\ Payable}{Number\ of\ Employees} \tag{1}$$

Detailedly, the wage data is in firm-year-level, covering 339701 firms, 284 cities and ranging from 2011 to 2013. Considering the existence of some zombie corporations just for the transfer of money and firms with extreme average wages, I replaced the values smaller than 1% and larger than 97%, getting a more normalized distribution.

For the latter heterogeneity tests, I specified two industries based on the industry type code. The manufacturing industries can be categorized into 3 types. The first type mainly relies on local resources like mining. The second type contains more common manufacturing work like food processing, textiles, furniture manufacturing, etc. I refer to the second type as the common manufacturing industry. The third type of manufacturing industry is the high-tech industry, including handicrafts, communication equipment, computers, other electronic equipment, etc. Since the first industry has a strong regional preference, I only concluded the second and third types of industry, referring to common manufacturing industry and high-tech manufacturing industry.

3.1.2 City Features

Firstly, I add the nighttime light as a proxy for local economic development. The data is from *Defense Meteorological Satellite Program* and measured by the average of log values. Next, I add the number of colleges in each city because human capital is highly correlated with both wages and housing prices. Cities with more educated people are more attractive to other educated people. A higher education level somehow indicates higher value-added jobs, thus obtaining higher wages. Also, the attraction of migration increases local housing demand, thus lifting the housing prices. In all, it could be a potential omitted variable. At last, I add the industry structure since different industry sectors obviously offer inherently different wages. I measure it by dividing the total value-added of the third industry by the second industry.

3.1.3 Company Controls

The database of China's industrial enterprises contains a rich range of industrial statistical indicators including major technical and economic indicators such as industrial added value, gross industrial output value, and industrial sales output value, as well as main financial cost indicators, employees, and total wages. To control for the idiosyncratic observable characteristics of firms, I choose 6 variables, total assets, total debts, operating income, operating costs, operating revenue as well as number of total workers. All six variables were transformed using logarithmic scaling to reduce the effect of outliers and achieve a more normalized distribution.

3.1.4 Land Area Constraints

Referring to Liang et al., 2016, I here implement the instrument variables for housing prices using the physical land supply side constraints. The source is from CEIC database. The measurement is the lag of the log land supply each year. The log term interprets the variable as growth. I also use the lag term to better ensure the variable's exogenity.

3.2 Summary Satistics

The summary statistics are shown in Tabel 1.

Table 1: Summary Statistics

Variable	N	Mean	SD	Min	Max	Label
lnhp	842496	10.25	1.180	5.130	12.77	log housing prices
lnwage	844934	2.870	0.980	0.480	5.210	log average wages
City Features						
nlc	835582	4.270	5.160	0.0100	22.61	nighttime light
college	834344	15.08	19.83	1	91	# of college
indstr	844934	0.850	0.430	0.110	4.030	industry structure
Company Controls						
TotalAsset	844825	10.79	1.390	0	20.67	total assets
TotalDebt	840456	9.820	1.780	0	19.96	total debts
ComIncome	844870	11.49	1.130	3	20.06	operating income
ComCost	844830	11.32	1.140	0	19.83	operating cost
ComRev	746927	8.300	1.870	0	18.35	operating reveune
TotalWorkers	844934	5.440	0.910	0	12.32	# of total workers
Instrument Variable						
ll1	837421	4.950	0.910	0	7.280	lag of log land area
Heterogenity Analysis						
indtype	721025	2.160	0.470	1	3	firm's industry type

4 Empirical Approach

4.1 Baseline Regression

Firstly, I tried the OLS regression. The regression equation is shown in Eq 2.

$$lnw_{ict} = \beta_0 + \beta_1 lnhp_{ct} + \gamma \mathbb{X}_c + \upsilon \Gamma_i + \omega_i + \delta_t + \epsilon_{ict} \tag{2}$$

The lnw_{ict} indicates the log average wage of the company i, city c, year t. ln_hp_{it} is the log of housing prices. $\mathbb{X}_c$ is the city features, including the nighttime light, number of colleges and industry structure. Γ_i is the company controls, containing the total assets, total debts,

operating income, operating costs, operating revenue as well as number of total workers. I also add the city fixed effect ω_i and year fixed effect δ_t to control idiosyncratic unobservable differences for each city and common shocks each year. The results are shown in Table 2.

Table 2: The OLS Estimation Results

	(1)	(2)	(3)	(4)	(5)
	lnwage	lnwage	lnwage	lnwage	lnwage
lnhp	0.107***	0.113***	0.123***	0.0486*	0.0619**
	(0.0239)	(0.0240)	(0.0288)	(0.0257)	(0.0261)
nlc	0.00559	0.00635	-0.00793	-0.00406	-0.00172
	(0.00685)	(0.00695)	(0.00535)	(0.00439)	(0.00489)
college	-0.00438***	-0.00486***	0.0115	0.000323	0.00374
	(0.00159)	(0.00156)	(0.00733)	(0.00679)	(0.00654)
indstr	0.166***	0.175***	0.503***	-0.164	0.129
	(0.0492)	(0.0493)	(0.135)	(0.125)	(0.114)
_cons	-1.578***	-1.689***	0.367	2.541***	1.847***
	(0.244)	(0.246)	(0.304)	(0.295)	(0.345)
Company Controls	Yes	Yes	Yes		Yes
Year Fixed Effect		Yes		Yes	Yes
Individual Fixed Effect			Yes	Yes	Yes
N	723129	723129	652808	765305	652808
r2	0.409	0.413	0.885	0.796	0.885

Clustering city level standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The OLS results show that the increase in housing prices will lift wages. It means that companies in areas with high housing prices tend to offer higher prices as compensation to workers compared to regions with low housing prices. But it's obvious that there exists endogeneity issue. The main source of this endogeneity comes from the reverse causality, which refers to cities with higher average wages attracting more labor, thus increasing the demand for housing and pushing up housing prices.

Therefore, I implement the instrument variable approach by using the land supply constraint, measured by the lag term of log construction land area (Liang et al., 2016). Considering the validity of this instrument, land is a main input to constructing housing. Areas with limited land supply tend to have higher housing prices given the same demand, thus satisfying the first-stage correlation assumption. Secondly, the central government has limited the

land supply quota of Eastern regions and stipulated to protection of rural land since 2003. Therefore, the land supply couldn't be easily adjusted by the local government, satisfying the exogeneity restriction. Moreover, for the first stage regression, I add all the city features as controls including nighttime light, which could strengthen the exclusion restriction since people may think the increasing land supply could propel local economic development, therefore lifting the local housing prices.

The two stage regression equations are shown in Eq 3 and Eq 4.

First Stage:

$$lnhp_{ct} = \alpha_0 + \alpha_1 lag\_log\_land_{ct} + \gamma' X_c + \delta_t + \mu_{ct} \tag{3}$$

Second Stage:

$$lnw_{ict} = \beta_0 + \beta_1 lnhp_{ct} + \gamma X_c + \upsilon \Gamma_i + \omega_i + \delta_t + \epsilon_{ict} \tag{4}$$

The baseline regression results are shown in Table 3.

Table 3: The Baseline Regression Results

	(1)	(2)	(3)	(4)
	OLS, robust	OLS, cluster	IV, robust	IV, cluster
lnhp	0.0619***	0.0619**	0.210***	0.210
	(0.00409)	(0.0261)	(0.0475)	(0.478)
nlc	-0.00172***	-0.00172	-0.00296***	-0.00296
	(0.000567)	(0.00489)	(0.000822)	(0.00767)
college	0.00374***	0.00374	0.00333***	0.00333
	(0.000996)	(0.00654)	(0.00100)	(0.00714)
indstr	0.129***	0.129	0.0971***	0.0971
	(0.0177)	(0.114)	(0.0189)	(0.131)
Company Controls	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
City Fixed Effect	Yes	Yes	Yes	Yes
N	652808	652808	644367	644367
F	12065.9	2004.2	11915.3	1886.5

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

As we can see, the instrument regression's First stage F stat is far more than 10, indicating

the validity of relevance. However, when I use the cluster standard errors, the results turn out to be insignificant, while using the heteroskedasticity-robust standard errors, the results are significant. But there's a need to use the cluster standard errors. I cluster the standard errors at city level because I think companies in the same city are interacting with each other. For instance, the agglomeration phenomenon affects companies' location-choosing behavior that firms are likely to agglomerate together to enjoy some common infrastructure. Therefore, the insignificant and positive coefficient actually indicates no effect.

Compared to the positive and significant OLS results, it justifies there is a positive bias in the OLS estimation. Specifically, it means that if companies in that city are offering higher wages, new immigrants will be attracted, generating more housing demand and lifting the local housing prices.

For the zero effect of housing prices on wages, it contradicts the results from Liang et al., 2016, who found the general cities' average wages will be lifted by housing prices. The reason may come from the manufacturing industry I choose. Since manufacturing firms generally have more workload-based and lower wages with a larger proportion of migrant and low-skilled workers compared to the service industry, the housing prices lifting effect is mostly sourced from the service industry, which offers more flexible, city environment-based salaries. That's because a lot of workers in the manufacturing industry are living in informal housing, which is less sensitive to local housing prices.

4.2 Heterogenity of Industry Types

Here I separately run the regression for the common manufacturing industry and high-tech manufacturing industry, whose categorization is mentioned in the data information section. The results are shown in Table 4, which is consistent with baseline regression of significant and positive OLS coefficients and insignificant instrument results.

The insignificant instrument results also justify the negative bias in OLS estimation. But for the high-tech industry, the coefficient is larger relative to the common manufacturing industry. While the high-tech industry relies more on skilled workers and tends to offer

Table 4: The Regression Results of Different Industries

	(1)	(2)	(3)	(4)	(5)	(6)
	Common Manu Industries			High-Tech Manu Industries		
	OLS, cluster	IV, robust	IV, cluster	OLS, cluster	IV, robust	IV, cluster
lnhp	0.0600**	0.170***	0.170	0.0554	0.744***	0.744
	(0.0266)	(0.0491)	(0.431)	(0.0365)	(0.200)	(1.368)
nlc	-0.00199	-0.00270***	-0.00270	-0.00659	-0.0129***	-0.0129
	(0.00510)	(0.000961)	(0.00771)	(0.00571)	(0.00224)	(0.0171)
college	0.00311	0.00273**	0.00273	0.00935	0.00496	0.00496
	(0.00706)	(0.00118)	(0.00750)	(0.00753)	(0.00313)	(0.0214)
indstr	0.134	0.102***	0.102	0.0994	-0.0562	-0.0562
	(0.117)	(0.0219)	(0.127)	(0.143)	(0.0612)	(0.391)
Company Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
City Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
N	459487	453199	453199	117685	116463	116463
F	1772.6	7525.9	1685.5	475.1	1648.7	516.1

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

different wages in different cities[1], the lifting effect is indeed larger.

5 Conclusions

After empirical analysis, I found in the manufacturing industry, higher housing prices don't mean higher wages. The potential reason is that manufacturing work is more targeted at low-skilled workers, who may live in informal houses that is less sensitive to local housing prices. Recall the finding in the research from Liang et al., 2016 that housing prices could lift the average wages, I here prove the main source is not from manufacturing industry jobs. The potential mechanism is more relevant to the service industry, which offers more flexible, city environment-based salaries to attract workers, therefore generating the compensation effect. The mechanism is shown a little by the subgroup regression of the common manufacturing industry and high-tech industry. In brief summary, the general manufacturing industry doesn't pay their workers higher wages in high housing prices cities as compensation because

[1]The different cities here refer to different costs of living, amenities and other features that are considered when high skilled workers choose jobs

their job targets are low-skilled workers, who are of large supply in most high housing prices cities and not very sensitive to housing prices. For further analysis, it's worth expanding the wage variable from only the manufacturing industry to all industries, especially the service industry to find out the true source of this lifting effect.

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