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Does government investment push up manufacturing labor costs? Evidence from China

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China's labor costs have risen rapidly compared with other emerging market countries in recent years. Government investment is an essential factor pushing labor costs, a unique and exciting phenomenon in China. This paper explains why labor costs in China's industrial manufacturing industry have rapidly increased from the local government investment perspective. First, the government's preference for investment in infrastructure construction creates labor demand and drives up labor costs. Second, the improvement of infrastructure lowers the transaction costs of the enterprise sector, thus expanding the scale of production and triggering a rise in labor costs. The empirical results show that for every 1% increase in government investment, the unit labor cost increases by 0.0013 units, and the nominal labor cost increases by 1.443 units. A series of robustness tests support the results. China should rationally control the scale of government investment so that labor costs are in a moderate growth range and then promote the sustainable development of enterprises.

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Introduction

For decades, China's economy has generally followed the path of high input, high consumption, low added value, and low efficiency. To achieve rapid industrialization, a policy of low wages and low benefits has been implemented for a long time, and a high investment rate has been ensured by artificially suppressing labor compensation and population consumption, and then obtained the original capital accumulation to maintain sustained economic growth. In 2002, China's manufacturing unit labor costs were only 25%-40% of the unit labor costs of the United States, significantly lower than in the European Union, Japan, Mexico, and South Korea (Ceglowski and Golub 2010). Due to relatively low labor costs, China's manufacturing industry has a competitive advantage on the international stage (Banister 2006). However, studies in recent years have shown that China's competitiveness in terms of labor costs appears to be waning (Albaladejo 2004; Shenyong and Zhouzhou 2007). From 2000 to 2012, the hourly labor cost of China's manufacturing industry increased fivefold, with an average annual growth rate of 16.5%, and during the same period, the average annual growth rate of hourly labor costs in the United States, Japan, and Germany was 3.1%, 2.9%, and 5.1%, respectively, and the average annual growth rates of Brazil, Mexico, and the Philippines were 8.2%, 2.5%, and 6.4%, respectively. Compared with emerging countries such as India, Mexico, Brazil, and Russia, China's absolute labor cost advantage is shrinking. Compared with Southeast Asian countries, China 's manufacturing labor cost is also higher than Indonesia and Thailand.

Labor costs are an essential factor affecting the industrial shift in industrial manufacturing, especially labor-intensive manufacturing industries. For firms, rising labor costs lead to a loss of competitiveness for labor-intensive production processes in an advanced economy (Meyer 1995; Bong Joon Yonn 1998;). Several studies have explored the factors influencing the rise in labor costs from different perspectives. For example, Lehmann et al. (2013) studied the impact of payroll tax rates, i.e., social security contributions in France, on labor income (or labor costs paid by employers for this purpose) using tax rate reforms in France. They found that lower tax rates reduce labor costs and increase labor supply. A similar literature has subsequently examined the impact of social security contributions on labor costs (Alvaredo et al. 2017; Adam et al. 2019; Holzner et al. 2022). In response to the fact that labor costs in China's manufacturing sector have been rising in recent years, some studies have argued that minimum wage regulations that guarantee workers' rights have instead increased unemployment and labor costs (Fan et al. 2013; Gallagher et al. 2013; Yang 2023). In addition, urbanization in China affects labor costs by increasing the cost of living, promoting economic growth, and improving population quality (Chen et al. 2014). It has also been suggested in the literature that demographic changes due to population aging drive labor costs up (Zhang and Han 2013).

We focus on the Chinese labor cost because this issue is somewhat unique in China, when compared to other countries. For a developing country like China, which relies on local government-led infrastructure investment and construction, government investment can largely influence the labor supply market, including labor cost issues. The Chinese government is involved in the distribution of the "cake" and the production of the "cake." Local governments in China are deep players in economic development and tend to promote stable economic growth through massive infrastructure and industrial investments in times of economic downturn. A typical fact is that in 2008, the Chinese government implemented a CNY4 trillion investment program nationwide to mitigate the consequences of the global financial crisis, which also created labor demand and influenced labor mobility between industries. In addition, the Chinese government's investment brought about infrastructure improvements, which reduced the transaction costs of the corporate sector and thus expanded the scale of production, which in turn caused changes in labor costs. As China is currently one of the largest economies and exporters in the world and is known as a major producer, studying the labor cost issue in China can provide a good perspective for the development of manufacturing industries. We explore the causes of rising labor costs from the perspective of government investment, which is of practical significance. We consider both the response of unit labor cost, which includes labor productivity, and nominal labor cost, measured by labor compensation of employed persons, to government investment, and find that for every 1% increase in government investment, unit labor cost rises by 0.0013 units and nominal labor cost rises by 12.82%.

We research the labor cost issue from the perspective of government investment, extending the research perspective of previous literature. Previous literature has focused on the influences of labor costs only on macro factors such as economic development, demographics, and the impact of social insurance rates on firms 'hiring costs. This paper highlights the importance of government investment, and by filling this gap, this paper contributes to a deeper understanding of how government economic behavior influences labor costs by promoting or crowding out social investment. The research and insights in this paper have made valuable contributions to the field of labor market, and the research using China as a sample can also provide lessons for developing countries.

The rest of the article is structured as follows: Section 2 is a literature review. Section 3 outlines some basic characteristics of labor costs in China and explains the mechanism of government investment in labor costs in this paper. Section 4 is the empirical analysis section of the article, where we describe the empirical strategy, data, and empirical results, and finally, Section 5 is the conclusion.

Literature review

We have compiled two categories of literature relevant to our issue. One is on the economic and social effects of changes in labor costs, for example, labor costs affect the export effect of firms, and the other is on the exploration of the factors influencing labor costs.

Economic and social effects of changes in labor cost. Decramer et al. (2016) use firm-level data from Belgium to study how unit labor costs affect export performance. Their results show that higher unit labor costs reduce the probability of starting to export for non-exporters and increase the probability of exporters stopping. Such results validate the research of Altomonte et al. (2013) on how labor costs affect the export performance problem. Malgouyres and Mayer (2018) studied the effects of a 2013 French implemented tax credit policy (CICE) aimed at improving competitiveness and employment and found that a 10% increase in unit labor costs was associated with about 2% reduction in exports. Doulos et al. (2020) compare the difference in export growth between Greece and Portugal, two small open economies, from the perspective of unit labor costs, and they argue that austerity policies succeeded in reducing unit labor costs, contributing to the sustained growth of exports.

Some articles studied how the change in the price of labor affects the direction of technological change. Cui and Lu (2018) have argued that rising labor costs can induce (stimulate) innovation in emerging market firms. Compared with capital

intensive enterprises, the RD expenditures of labor intensive enterprises affected by rising cost of labor is more remarkable, and there are significant differences (Natarelli and Basu 2022). While emerging economies face the challenge of rising labor costs, they also provide opportunities to promote environmental governance and green development, and labor costs will have the strongest positive impact on technological innovation in a moderately concentrated market environment Jianqiang Li et al. (2020) had examine the inducement effect of labor cost on corporate innovation in emerging markets. They adopted a difference-in-differences approach, and found the inducement effect of labor cost is more pronounced for Chinese non-state-owned enterprises, firms without political connections, and firms with low labor productivity. The results support the induced innovation hypothesis in that increases in labor cost will induce invention and technology adoption.

Chih-Hai Yang (2023) examined how labor cost shocks affect firms' R&D activities, and found that after labor contract law increased labor costs, large and medium-sized firms were more active in R&D activities, while small firms suffered from labor cost shocks and reduced R&D. In addition to this, higher labor costs are linked to a loss of competitiveness. A study assessing the ability of the Romanian economy to cope with competitive pressures in a single European market found that exceeding compensation per employee (including the employer's social contribution) leads to an increase in unit labor costs and ultimately to a loss of competitiveness (Ghizdeanu et al. 2007). Huang et al. (2021) use a panel of Chinese county-level cities investigate the effects of labor costs and environmental regulations on the structure of manufacturing using a panel of Chinese county-level cities and find that the rapid increase in labor costs in Chinese urban industrial manufacturing is detrimental to employment growth and competitiveness and that the "innovation compensation" effect of environmental regulations is not sufficient to compensate for the "compliance cost" effect. The "innovation compensation" effect of environmental regulations is insufficient to compensate for the "compliance cost" effect.

Factors influencing labor costs. From the labor supply perspective, the factors that determine the wage are, first, the production cost of labor, which includes the cost of living and training and education costs, and second, the leisure effect of labor (relative effect). Modern human capital investment theory, on the other hand, suggests that through human capital investment, employees' knowledge and skills can be improved and therefore their expectations of future earnings will increase, while employers usually believe that employees who invest more in education have higher productivity and therefore employers are willing to pay higher wages to those with higher educational backgrounds (Thurow 1974). The cost of labor in an industry is determined by the relative price of its factors, which varies inextricably with the stage of economic development. In the early industrialization of an economy, capital is relatively scarce and thus relatively more expensive. As the level of economic development continues to increase, the scarcity of capital is alleviated, thus making labor relatively more expensive daily.

Some empirical evidence gives explanations for the changes in labor costs. A study shows moderate positive impact of immigration fitting demand mostly in agriculture, construction and household services. They analyse an impact of immigration on the domestic labor market in Poland and find immigrations can push up the labor cost (Duszczyk et al. 2013). Using the non-linear cost of immigration and labor costs, the effect of immigration on labor costs is investigated, and within the threshold level, an increase in immigration reduces labor costs (Zvaigzne et al. 2015). Orrenius et al. (2020) maintained the same view of labor cost, and he points out the slow labor force growth is a key underlying the U.S. GDP growth is anticipated to remain sluggish. They agree the large role for immigrant workers can help mitigate other symptoms of the economy's long-run malaise.

Another empirical study investigated that the increase in VAT and employer social security contributions contributed to lower real labor costs in 23 EU member states from 2001-2018 (Holzner et al. 2022). Another literature that examines the impact of bills on labor costs is the duo of Heckman and Page (2022), who study three different labor market regulations and find that labor contracts that provide for social security and other benefit programs raise the cost of employment for firms. In addition to social security-related regulations, the minimum wage system has been identified in much of the literature as an important factor affecting labor costs. Harasztosi and Lindner (2016) analyzes the effects of a large (~60%) and persistent increase in the minimum wage instituted in Hungary in 2001. Their estimates imply that the higher minimum wage had a small negative effect on employment, and so the primary effect was pushing up wages.

Some studies have explained for the rise in labor costs in China regarding demographics and labor supply or labor participation rates (Zhang and Han 2013). China's aging population in recent years has also largely affected labor supply, and thus labor costs.

The existing literature on labor costs makes a valuable contribution in several ways. These studies cover the socio-economic effects of labor as a factor of production, highlighting the role of labor costs in shaping the overall economic performance of countries and regions. Another type of literature focuses on various factors that affect changes in labor costs, such as labor regulations or minimum wage systems in different countries, the impact of immigration on local labor markets, and population aging. These studies provide a nuanced understanding of the determinants that drive up labor costs. However, there are still some research gaps in the existing literature. There is no literature trying to understand the labor cost problem from the economic behavior of the government, especially for a country like China where the government is deeply involved in social production and life, to what extent the government can influence market supply and demand factors. Influencing labor costs is an area worth studying, although many factors have been revealed to be key to influencing labor costs or labor markets, for example, government macro-control, economic globalization, and currency exchange rate are all considered important factors contributing to the rising labor costs in China (Banister, et al., 2006). By exploring the relationship between government investment and labor cost in China, this paper elucidates the mechanism of infrastructure construction and enterprise R&D innovation. This paper highlights the importance of government investment, and by filling this gap, this paper contributes to a deeper understanding of how government economic behavior influences labor costs by promoting or crowding out social investment. The research and insights in this paper have made valuable contributions to the field of labor market, and the research using China as a sample can also provide lessons for developing countries. We try to provide a good perspective and a sustainable impetus for the Chinese government to promote the market-oriented development of industries to facilitate China's transformation from a "manufacturing power" to a "manufacturing power".

Background and theoretical mechanisms

Characteristics of China's labor cost. China is rich in labor resources, and relatively low labor cost was a distinctive feature of China's labor market. With economic and social transformation,

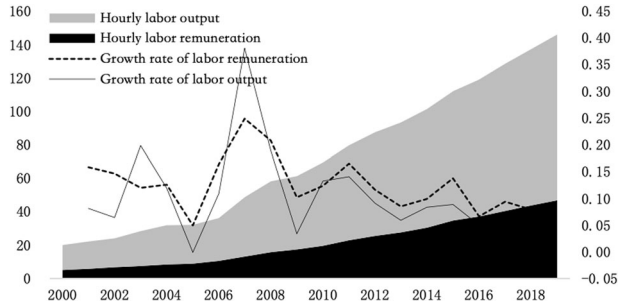

Fig. 1 Hourly labor compensation and labor output comparison (2000–2018).

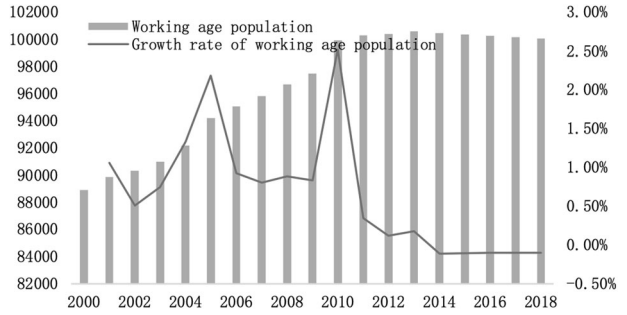

Fig. 2 Number and growth rate of working age population (2000–2018).

a change in labor cost is an inevitable phenomenon and has attracted attention and debate. Herein, we generalize the labor cost characteristics of China's manufacturing industry.

The concept of labor cost in China is like international practice and includes employee wages, social insurance premiums, corporate welfare. However, the main component of labor costs in China is labor compensation, which (employee wages and social insurance paid by employers) accounts for about 80% of labor costs according to the national sample survey on labor costs. We calculated the hourly labor compensation, hourly labor output, and the growth rate of both in China from 2000 to 2018 based on data from the China Statistical Yearbook (Fig. 1). Between 2000 and 2009, there was a slightly widening trend between the growth of hourly labor output and the growth of hourly labor compensation in manufacturing. Since 2009, the growth rate of hourly labor compensation has been above the growth rate of hourly labor output, which means that the low-cost advantage of labor in China's manufacturing industry has been gradually lost in recent years.

At the same time, China's working-age population growth rate is declining annually. The working-age population calculated at the end of 2000 was 889 million, and at the end of 2018, it was 998 million with a growth rate of only 0.65%, and the population growth rate has remained negative since 2014 (Fig. 2). The decline in the working-age population is reflected in the economy because of rising labor costs in China and, subsequently, the withdrawal of labor-intensive industries from China to more cost-advantaged locations such as Southeast Asia or Africa.

In addition, China's labor costs and economic development have maintained similar trends. On the one hand, the rapid development of the economy has pushed up the cost of living, such as increases in the cost of education and medical care, leading to an increase in the level of wages as a monetary expression of the value of labor. On the other hand, the growing demand for labor is also the fundamental guarantee of economic development. Figure 3 shows the growth rates of GDP per capita and manufacturing wages per capita between 2000 and 2018. The

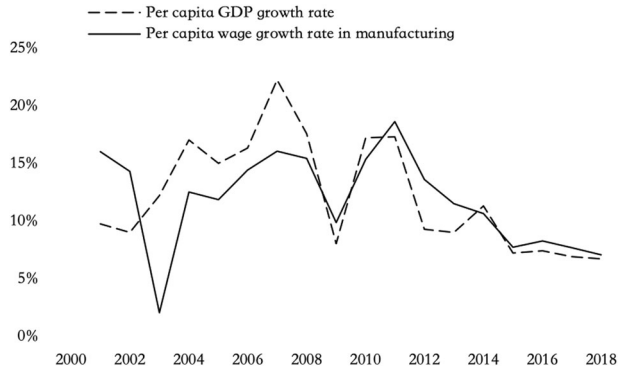

Fig. 3 Per capita GDP and per capita wage growth in manufacturing (2000–2018).

results show that the rise in labor costs in manufacturing is an inevitable trend accompanied by economic growth. However, China's economic growth is largely driven by government investment, so it is necessary to explore the relationship between government investment and labor costs.

Mechanisms of government investment affecting labor costs. We summarize three mechanisms by which government investment affects labor costs. First, government investment has promoted the formation of many infrastructures' construction, creating labor demand, the change in supply relations has promoted the rise in labor costs in manufacturing. The second is that a large amount of government investment has intervened in market economic activities, which has a crowding out effect on the private sector, and finally, the infrastructure construction caused by government investment has promoted the rise in labor costs, forcing enterprises to carry out technological research and development innovation, and forming a mutual relationship with labor costs.

Government investment and infrastructure development. Numerous studies have explained China's continuous rise in labor costs in recent years. However, no research has yet focused on the phenomenon of the inflection point in the growth rate of manufacturing wages per capita in 2010. In the context of China's economic development context, the government plays a vital role. In China's fiscal decentralization and political tournament system, driving local economic growth with infrastructure investment has become a standard macro-control tool for local governments (Zhang et al. 2007; Zhou 2007; Chen and Chen 2014).

According to China's government fixed asset investment data, in 2000, it was CNY 1650.4 billion; in 2010, it was CNY 8331.65 billion, an increase of 4.22 times, with an average annual growth rate of about 17.57%. After 2011, the growth rate gradually slowed down to CNY 129,038 billion in 2016, with an average annual growth rate of about 7.56%. In the research literature on government investment, most scholars have focused on explaining the motivations behind local governments' rush to invest, such as the promotion competition theory that identifies government investment as the easiest way to promote economic growth for local officials and the fiscal incentive theory that outlines that local governments are eager to invest in search of more financial sources since the tax-sharing reform (Qian and Roaland 1998), and the rent-seeking theory that emphasizes that government officials are eager to invest and are motivated by rent-seeking incentives (Morduch et al. 2000; Wilson 2005). The economic effects of government investment are also explored in

the literature, and large-scale infrastructure investment and investment incentive schemes have indeed promoted rapid economic growth. Government infrastructure investment enables businesses to share in the financial externalities, labor pools, and infrastructure network effects that agglomeration brings. Government-led investment places tremendous demand on primary labor, and surplus labor supply is relatively limited without structural unemployment. Massive government-led investment causes labor costs to grow faster than the rate of economic development. One possible negative outcome is that many manufacturing companies cannot afford the sharp rise in labor costs and must exit the market. In addition, the allocation of resources by government investment and the crowding-out effect on the real economy will inhibit private investment, hurting aggregate output growth.

Since the global financial crisis in 2008, governments of various countries have introduced government investment plans to curb economic recession. China's government has been quick to launch a series of bailout plans. In addition to the CNY 4 trillion-investment plan, it has also implemented ten major industry revitalization plans to promote industrial restructuring and independent innovation capabilities. In related studies, mainstream research focuses on whether there is a clear correlation between government investment and economic growth. From a macro perspective, government investment is an endogenous economic growth variable. From the micro perspective, it is a question worth exploring how government investment has influenced the economic market, including labor cost, through different micro institutional arrangements.

The crowding-out effect of government investment on the private sector. Traditionally, crowding out effect is often defined as the process by which a government pursues expansionary (active) fiscal policy by borrowing from corporations or the residential sector and commercial banks, leading to higher actual interest rates and competitive demand for borrowed funds, leading to reduced spending and investment in other sectors.

In the context of China, the corporate sector still needs to adopt a market-based operating mechanism fully and is insensitive to changes in interest rates. As a result, there is little competition between government and private sector investments for borrowed funds. Although the general generation mechanism of the crowding out effect has yet to be evident in China, considering the limited supply of resources and relatively inefficient government investment (Naughton 2017). In the current market, the economic system is not yet fully developed, and government investment may also have other types of crowding out effects. The government prefers to invest in infrastructure construction for political and institutional reasons. In the short term, the supply of resources in the economy and society is limited, and an increase in government investment will cause an increase in the demand for related factors of production such as human capital and raw materials. For example, constructing of a large amount of infrastructure requires a large amount of labor. With a constant supply of labor, government investment in infrastructure and other construction increases the demand for labor, which triggers an increase in the cost price of labor as a factor of production. The flow of much labor has a crowding-out effect on private sector investment and a typical market price transmission mechanism of price increases due to demand growth. On the other hand, when many economic resources are invested in infrastructure construction, the limitation on social resources leads to an increase in interest rates and a corresponding decrease in corporate R&D investment, which is the R&D crowding-out effect brought about by the government investment. In addition, there is a spatial spillover effect of government sector investment in infrastructure, especially in the transportation industry, which can significantly reduce the production costs of manufacturers in some regions (Zhang and Song 2013). Falling transaction costs and enhanced capital mobility in the corporate sector induce the corporate sector to expand production to some extent, again promoting higher labor costs with a constant supply size.

Local government infrastructure investment and enterprise innovation. Higher real wages promote enterprise innovation and industrial structure upgrading, and in the long-term equilibrium, and firms expand the frontiers of production possibilities (Hicks 1932). Expansion requires an increase in basic elements, which raises the labor cost factor. The theory of endogenous growth suggests that an increase in the capital stock per unit of effective labor leads to a decline in the cost of capital, stimulating research and development in the industry and promoting innovation and technological progress (Romer 1987). Government investment has led to an increase in the capital stock of infrastructure, which increases the return on capital for the innovation of corporate sector by expanding the size of the product market, thereby incentivizing companies to innovate.

The innovation of enterprises is closely related to the supply and demand situation of the labor market. Wages shape the production costs of enterprises. As labor costs rise, China's labor-intensive enterprises' market and international competitiveness will decline. In contrast, existing enterprises introduce advanced technologies, improve their ability to innovate, and enter the stage of "creative destruction". Government investment has accelerated industrialization, fostered enterprise innovation, expanded production, triggered demand for factors of production, and thus pushed up labor costs.

Estimation model and data

Empirical model. To estimate the effect of government investment on labor costs, we set up a panel regression model. Using panel data regression analysis can solve some missing variables, and panel data can provide more information about individual dynamic behavior (including time dimension and cross-section dimension). In the regression analysis, we use the fixed effect regression model to estimate the marginal effect of government investment on labor cost by controlling the interference of other factors. The relevant variables were controlled in the model.

$$LC_{it} = \alpha + \beta lnGI_{it} + \gamma X_{it} + \mu_k + \delta_t + \varepsilon_{it} \quad (1)$$

In Eq. (1), the subscript i denotes the region i, the subscript t denotes the time variable year. LC_{it} represents the unit labor cost, $lnGI_{it}$ is the core explanatory variable, for government investment at the provincial level. X_{it} is a set of control variables at the regional level, including the level of economic development of the region, the degree of industrialization, the number of employed people, etc. μ_k is a regional characteristic that do not change over time. δ_t is the year fixed effect, which controls macroeconomic shocks that do not change with regions and enterprises.

Variable settings. The explanatory LC_{it}(Labor cost) variable is the manufacturing labor cost of region i in the year t. We use unit labor cost for our study here and supplement it by using the average labor compensation of manufacturing workers on the job as the nominal labor cost. According to the basic formula, unit labor cost (ULC) = hourly labor compensation / hourly labor output. The hourly labor compensation is first calculated by dividing the annual average compensation by the annual working hours to obtain the hourly labor compensation. The reason why

the hourly data is needed to be calculated from the annual data is that the statistical yearbook does not provide hourly data. The data of annual average compensation is also not available directly from the database or statistical website and needs to be calculated. According to a study, the average wage of all manufacturing workers (including rural and township enterprises, etc.) is about 0.981 times that of urban areas (Wang et al. 2011), so this factor needs to be multiplied, and then a factor of 1.27 is multiplied on top of this as the approximate average annual compensation of all manufacturing workers (Lett and Banister 2009), the factor of 1.27 indicates the inclusion of costs other than wages, such as social security contributions. The annual working time is calculated based on 49 weeks (excluding legal holiday time), and 49 weeks is multiplied by the average weekly working time of employed persons to obtain the annual working time. Along the same lines, the hourly labor output is the annual value added of the manufacturing industry divided by the annual working hours of all employed persons in the manufacturing industry.

GI_{it} (Government investment) is the core explanatory variable. Academics generally define the scope of government investment as the investment in fixed assets formed by government monetary funds invested in a field of fixed assets, mainly in infrastructure, including economic infrastructure and social infrastructure. In a broad sense, many scholars extend government investment to the entire fiscal expenditure, i.e., the sum of all government expenditure, while other literature takes the state budget funds as the proxy variable of government investment. We focus on whether investment in government-led industries affects labor costs, and therefore we measure government investment by investment in fixed assets in the state-owned economy. Moreover, we used the logarithm of the government investment variable in the empirical analysis.

We also controlled for the following variables: (1) the economic development level variable, which was represented here by one-period lagged GDP per capita in order to avoid a two-way causality between economic growth and labor costs; (2) the industrialization degree variable; represented by the ratio of value added in the secondary industry to GDP; (3) labor availability degree variable, represented by the ratio of working age 15–64 population as a proportion of the total population; (4) the employed population variable, expressed as the number of employed persons in the secondary industry at the end of the year; and (5) other variables, including regional fixed effects (eastern, central, western, and northeastern) and time fixed effects (expressed as year dummy variables, reflecting the cyclical effects of economic development and macro policies).

Data source and description. The data used for the empirical study in this paper are mainly from the China Statistical Yearbook from 2000 to 2018, as well as the statistical yearbooks of provinces and municipalities, which include a sample of 31 provinces, autonomous regions, and municipalities directly under the central government for 19 years. Table 1 lists the variables used in the empirical analysis and their calculation methods, and the descriptive statistics are presented below. The data used in the empirical study in this paper were mainly from the China Statistical Yearbook from 2000 to 2016 and the statistical yearbooks of provinces and municipalities, which included a sample of 31 provinces, autonomous regions, and municipalities directly under the central government for 16 years. Among the main variables used were regional gross domestic product (GDP), value added of secondary industry, year-end unit employees, urban unit manufacturing labor wages, year-end employment in manufacturing, fixed asset investment in the state-owned economy, number of the working-age population aged 15–64, year-end urban population, year-end employment in secondary industry, and dummy variables for whether it belonged to central China or whether it belonged to western China. The following panel regression model was constructed.

Empirical results

Basic regression results. Table 2 reports estimates based on the econometric model (1). The explanatory variable is the unit labor cost of manufacturing, and we examine the impact of government investment on unit labor cost. We add control variables such as GDP per capita and its square term, degree of industrialization, and number of manufacturing employment in the regression, while also controlling for regional and year fixed effects. Column 4 in Table 2 is the final regression result. Estimates show that for every 1 percent increase in government investment, unit labor costs increase by 0.013 units. Coefficients for other control variables show that economic development also contributes to the rise in unit labor costs, while the coefficient for industrialization levels is negative, which means that the higher the level of industrialization, the faster the growth rate of labor productivity in enterprises. This is faster than the growth rate of labor remuneration, and to a certain extent, it reduces the labor cost of enterprises. In addition, the coefficient of employment in the secondary industry is also significantly positive. In contrast, the coefficient of the proportion of the working-age population is obviously negative, indicating that many employed people are more conducive to the scale effect brought about by the concentration of the employed population by enterprises. The difference between our results and other literature is that the marginal effect of government investment is examined, which is not the conclusion of the relevant literature. We also looked at other macroeconomic factors, such as GDP, industrialization, and working-age population.

We focus on the impact of government investment on unit labor costs. But there is also literature that considers the wage level of the labor force. As an important part of the labor costs of China's enterprises, we further consider whether government investment has affected the wage level of the labor force (nominal labor cost). Using labor wage level as the explanatory variable, the core explanatory variable and the control variable unchanged, Table 3 reports the regression results of the fixed effect panel. The results show that government investment also increases the wage level of the labor force, and for every unit of government investment, the wage of the labor force increases by 1.443 units. We replaced the variable government investment by using the logarithm of the government investment variable. The regression results are shown in Table 4. The size and direction of the influence of other control variables remained largely unchanged.

Robustness tests. The reasons for the increase in unit labor cost and nominal labor cost are explained above from the perspective of government investment. To avoid the bias of the regression results due to the improper selection of indicators "budgeted funds for fixed asset investment" was used as a proxy variable for government investment instead of "fixed asset investment in the state-owned economy," and the time and region fixed effects were controlled. The regressions in models (1) and (2) used unit labor cost as the explanatory variable, and models (3) and (4) used nominal labor cost as the explanatory variable. The regressions in Table 6 show that the results of the empirical analysis were more robust. Government investment positively raises unit labor costs and nominal labor costs in manufacturing.

The economic development level of China's 31 provincial-level regions varies greatly, and we divide them into eastern, central, and western regions according to geography, and return by dividing regions into samples. Using unit labor cost as the explanatory variable, we still controlled for the relevant control variables and the fixed effects of regional years, and the results are

Table 1 Descriptive statistics.

Variable	Mean	Variance	Minimum	Maximum
Compensation per capita in the manufacturing industry	35189.72	21045.21	7917.14	113410.4
Manufacturing output per capita	95296.27	62918.03	13937.15	388484
State-owned capital investment in fixed assets	1953.716	1662.61	62.99	9119.13
Investment in fixed assets within the state budget	383.07	429.90	11.91	2553.29
Industrial value added	5202.40	6068.87	10.17	34372.46
GDP per capita	27113.64	21435.05	2759	107960
GDP	12090.47	13332.33	117.8	79512.05
Industrialization level	0.3893	0.0987	0.07	0.5649
Number of people employed in secondary industry	648.08	607.13	7.35	2563.5
Percentage of working-age people	0.7316	0.0394	0.5905	0.8429

Table 2 Impact of government investment on unit labor cost.

Variables	(1)	(2)	(3)	(4)
Government investment	0.007*** (2.13)	0.019*** (4.89)	0.015*** (4.80)	0.013*** (5.37)
GDP	0.398* (1.85)	0.077*** (7.64)	0.082*** (8.06)	0.143*** (8.98)
GDP2	−0.021* (−1.92)	−0.004*** (−3.07)	−0.003*** (−3.50)	−0.007*** (−3.87)
Indus		−0.699*** (3.10)	−0.821*** (3.02)	−0.732*** (3.32)
Employment			0.113*** (9.48)	0.238* (−1.81)
Share				−0.219*** (4.28)
Regional fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Observations	527	527	527	527
R2	0.313	0.328	0.405	0.622

***, and * represent significance at 1%, and 10% significance levels.

Table 3 Regression of government investment on nominal labor costs.

Variables	(1)	(2)	(3)	(4)
Government investment	1.443*** (0.27)	1.17*** (0.28)	1.299** (0.28)	1.49*** (0.28)
GDP	0.912*** (0.028)	0.918*** (0.027)	0.93*** (0.027)	0.92*** (0.029)
GDP2	−0.27* (−0.02)	−0.27*** (−0.07)	-0.28** (−0.050)	−0.30*** (−0.06)
Indus		−0.22** (0.135)	−0.21*** (0.012)	−0.22*** (0.012)
Employment			−3.46** (1.89)	−5.29* (1.94)
Share				0.94 (0.622)
Regional fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Observations	527	527	527	527
R2	0.43	0.48	0.52	0.71

***, **, and * represent significance at 1%, 5%, and 10% significance levels.

Table 4 Replace variables.

Variables	(1) FE	(2) FGLS	(3) FE	(4) FGLS
Government investment	0.067*** (4.87)	0.067*** (4.84)	0.203*** (18.48)	0.205*** (18.61)
GDP	0.948*** (2.58)	0.919** (2.49)	0.567** (1.93)	0.506** (1.72)
GDP^2	−0.48** (−2.58)	−0.046** (−2.48)	−0.058*** (3.90)	−0.054*** (3.67)
Indus	−2.163*** (−13.47)	−2.178*** (−13.46)	0.159*** (1.24)	0.191 (1.48)
Employment	0.029** (2.09)	0.029** (2.12)	−0.117*** (−10.57)	−0.118*** (−10.69)
Employment share	−1.235*** (−3.34)	−1.214*** (−3.27)	−1.528*** (−5.17)	−1.573*** (−5.33)
Regional fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes

***, and ** represent significance at 1%, and 5% significance levels.

Table 5 Fractional regression.

variables	Explanatory variable: Unit labor cost		
	Eastern region	Central Region	Western region
Government investment	0.065*** (0.0065)	0.015** (0.008)	0.014*** (0.005)
Control variables	Yes	Yes	Yes
Regional fixation effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Observations	187	136	204
R2	0.369	0.380	0.385

***, and **, represent significance at 1%, 5%, and 10% significance levels.

Table 6 The scale of government investment.

variables	Explanatory variable: Unit labor cost		
	25%	50%	75%
Government investment	0.064*** (0.002)	0.024** (0.01)	0.023** (0.009)
Control variables	Yes	Yes	Yes
Regional fixation effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Observations	108	136	344
R^2	0.351	0.326	0.308

***, and **, represent significance at 1%, 5%, and 10% significance levels.

presented in Table 5. The results of the regression by sample show that our regression results remain stable, with government investment significantly contributing to the growth of unit labor costs, with slightly different growth effects varying from region to region. We find that the effect of government investment on labor cost is greater in the eastern region of China with a marginal impact coefficient of 0.065, while in the central and western regions of China, this coefficient is 0.015 and 0.014, respectively. This implies that labor cost in the eastern region grows faster when stimulated by government investment.

Considering that the scale of government investment in different regions varies significantly according to the scale of government investment, we selected a sample of 25%, 50%, and 75% for regression. Consistent with the previous article, we controlled the control variables such as the level of economic development, the level of industrialization, and the employment of the labor force, as well as the regional fixed effect and the year fixed effect, and the regression results are shown in Table 6. The results show that when the scale of government investment is at different quantiles, the impact on labor costs remains unchanged and the coefficient becomes larger. On the 25% quantile, 50% quantile, and 75% quantile, the coefficients for government investment are 0.064, 0.024, and 0.023, respectively, which means that as the scale of government investment increases, the marginal effect of its rising labor costs decreases (Table 7).

Mechanism analysis. Government investment mainly pushes the cost of manufacturing unit labor through the channel of infrastructure investment.

First, the government's preference for infrastructure investment creates labor demand and drives up labor costs. Second, improvements in infrastructure have reduced transaction costs in the corporate sector, thereby expanding production and triggering rising labor costs. Therefore, we examine the effects of infrastructure investment. We returned to infrastructure investment as a dependent variable, with regression results reported in Table 6, and regression results from a regional sample.

We studied the impact of government investment on infrastructure development and considered sub-regional returns. The overall sample regression results showed that the marginal impact effect of government investment on infrastructure construction was positive, and in the sub-regional sample regression, this marginal impact effect was slightly different, with the eastern and western regions being more obvious, while the central region was not significant. For the central region, government investment is not inclined to infrastructure construction, and the rise in labor costs in the central region is affected by government investment but not through the mechanism of infrastructure construction.

We further consider that the eastern region has a developed economy and better infrastructure. In contrast, the western region has a very scarce infrastructure, and the government has invested much money in infrastructure construction, so it is also very reasonable to produce different effects. Overall, government investment in infrastructure has increased unit labor costs in China's manufacturing sector, a study or conclusion not drawn by other literature.

Conclusions

This paper examines the rising labor costs of China's manufacturing industry, and based on China's characteristics, we select the core explanatory variable of government investment to discuss the reasons for the rise in labor costs based on China's characteristics. China's government investment has mainly contributed to increased labor costs through infrastructure investment. We selected panel data from 31 provincial-level regions in China, examined the relationship between government investment and labor costs, passed the robustness test of replacing core variables and replacing samples, and explored the impact mechanism of government investment on labor costs by influencing infrastructure construction investment.

After controlling for variables such as economic development and labor supply, our results found that for every 1% increase in government investment, the unit labor cost increased by 0.0013 units, and the nominal labor cost increased by 1.443 units. The important role of government investment was also confirmed in the sample regression of the sub-regions, but the marginal impact effect of government investment in the eastern, central, and western regions was slightly different.

We also focus on other explanations for rising labor costs in China in the literature. For example, scholars focus on the phenomenon of "land finance" in China, which refers to the fact that some local governments in China rely on revenues from the sale of land use rights to sustain local For example, some scholars have focused on the phenomenon of "land finance" in China, which refers to the fact that some local governments in China rely on revenues from land use rights to maintain local fiscal expenditures or to meet fiscal needs. Li et al. (2020) suggests that when local governments have limited land supply and raise land prices, they raise housing prices and thus force workers to raise their wage expectations in response to rising housing costs and that large increases in local government revenues and expenditures also affect economic growth and labor productivity in the region, thereby improving or raising labor factor compensation. This literature and our study examine rising labor costs from the government's perspective, and there is also a correlation between "land finance" and government investment. One of the sources of funds for local government investment in China is "land finance" revenue. In

Table 7 Effects of infrastructure investment (Explanatory variable: Infrastructure investment).

	Population sample	Eastern region	Central Region	Western region
Government investment	1.314** (0.614)	2.772*** (0.163)	0.447 (0.981)	2.144*** (0.089)
Control variables	Yes	Yes	Yes	Yes
Regional fixation effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Observations	527	187	136	204
R^2	0.695	0.645	0.463	0.488

***, and **, represent significance at 1%, 5%, and 10% significance levels.

recent years, local governments in China have used a large amount of government debt funds to invest in infrastructure construction and "land finance." The difference is that we study the effect of infrastructure construction on labor costs directly from the perspective of local government investment, and the destination of the "land finance" revenue is also mainly invested in infrastructure projects. Based on the history of Chinese government investment, this paper explains that labor costs in China's manufacturing sector showed a significant upward trend after 2009 because of the "infrastructure craze" that started in different parts of China in 2008.

The issue of labor cost is a topic that has been discussed for a long time, especially in the context of the current lack of global economic development momentum and the aging of the population. It is necessary to explore the sustainable development of labor costs. For China, government investment reflects the guide role of the Chinese government in the market economy. However, it will inevitably produce some negative macroeconomic and social effects. First, the primary source of funds for local government investment is the income from land concessions and bond issuance. If the invested infrastructure projects do not have good profitability, it is an enormous financial burden for local governments. Moreover, some major infrastructure projects have greater capital needs, and relying solely on government investment in construction may be counterproductive. Government-led public investment can have a "crowding-out effect" on private investment, as traditional economic theory suggests that public investment is less efficient than private investment.

The main conclusion of this paper is that, after controlling for economic development and other related factors, government investment pushes labor costs up too fast, which is detrimental to the current development of China's manufacturing industry, making it easy for companies to lose competitive costs and bringing about imbalances in industrial development. From the perspective of the Chinese government, the government should consider how to fully mobilize the allocation of market resources and how to lead private capital into the construction of major infrastructure projects instead of relying on the government's own financial investment. Of course, the rising labor cost is already a global problem, and no country can solve the problem by simply suppressing the rising labor cost.

As a developing country with an ageing society, China's government investment should focus on rural construction and guarantee investment in rural infrastructure firstly. Despite the contribution of past government investment in accelerating urbanization, China's current urban-rural disparities are still evident, with a shortage of rural infrastructure. Under China's current development concept of promoting common prosperity through rural revitalization, government investment should be combined with rural construction and rural governance to improve the infrastructure in rural areas in terms of transportation, water conservancy and electricity, and to upgrade the living and production conditions of rural residents. It should stop investing in urban infrastructure, squeezing out social capital investment and artificially creating demand thereby accelerating rising labor costs. And secondly, Government investment can provide financial support and guarantee for the construction of rural revitalization projects, can create more employment opportunities, attract urban talents to rural entrepreneurship, solve the problem of rural population loss and employment, promote the balance of labor supply and demand, so that labor costs grow within an appropriate range. Last but not least, Government investment should clarify its investment scope, in China's market economy conditions, the government needs to invest in basic projects and public welfare projects on the one hand, and on the other hand, it should invest in important industries, such as high-tech industries, which can promote the innovation and research and development of enterprises, reduce the cost of labor, and also promote the optimization and upgrading of industrial structure. In addition, for many general competition projects in the market competition, the government investment should be completely withdrawn, and the enterprise investment should be responsible for it.

Future research can further focus on the labor productivity issue in China, especially in conjunction with some government actions (e.g., government debt raising, government investment, etc.). For example, whether government debt or government-led investment in infrastructure construction promotes firm innovation and affects labor productivity. Exploring how the government's macro policies have influenced the micro behaviors of firms and how they have affected industrial development and market structure is a direction worthy of continued research (Zvaigzne et al. 2014).

Data availability

Data to support the findings of this study are available on the website of the National Bureau of Statistics of China and in the China Labor Statistics Yearbook (2000–2019), as well as statistical annual reports at the provincial level. The data on labor costs came from the authors' secondary calculations However, the availability of this data is limited, and it is used with permission from current research. The other data we used in this study was publicly available.

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References

Adam S, Phillips D, Roantree B (2019) 35 years of reforms: a panel analysis of the incidence of, and. employee and employer responses to, social security contributions in the UK. J Public Econ 171:29–50

Albaladejo LM (2004) China's competitive performance: a threat to East Asian manufactured exports? World Develop 32(9):1441–1466. https://doi.org/10.1016/j.worlddev.2004.03.006

Altomonte C, di Mauro F, Osbat C (2013) 'Going beyond labor costs: how and why structural and micro-based factors can help explaining export performance?', ECB Compnet Policy Brief 01/2013

Alvaredo F, Breda T, Roantree B, Saez E (2017) Contribution ceilings and the incidence of payroll. taxes. De Economist 165(2):129–140
Banister J (2006) Manufacturing Employment in China. Monthly Labor Review 128(11):9-27
Ceglowski J, Golub S (2010) Just how low are China's labor costs? World Econ 30(4):597–617. https://doi.org/10.1111/j.1467-9701.2007.01006.x
Chen Z, Chen S (2014) Institutional environment, local government investment impulse and local soft budget. Econ Res J 3:76–87
Cui YM, Lu CR (2018) Are China's unit labor costs still competitive? A comparison with ASEAN countries. Asian-Pacific Econ Lit 32(1):59–76
Decramer S, Fuss C, Konings J (2016) How do exporters react to changes in cost competitiveness? World Econ 39(10):1558–1583. https://doi.org/10.1111/twec.12412
Doulos D, Katsaitis O, Zombanakis G (2020) Is the emphasis on unit labor costs an effective export-promoting policy? A comparison between Greece and Portugal. Eurasian Econ Rev 10:393–410. https://doi.org/10.1007/s40822-020-00145-2
Duszczyk M, Góra, Marek, Kaczmarczyk P. Costs and benefits of labor mobility between the EU and the Eastern Partnership Countries: the case of Poland[J]. IZA Discussion Papers, 2013, 7664. https://doi.org/10.2139/ssrn.2345580
Fan C, Ying G, Jing F (2013) The effects of the labor contract law on the Chinese labor market. J Empir Legal Stud 210(3):462–483. https://doi.org/10.1111/jels.12016
Gallagher ME, Giles J, Park A, Wang M (2013) China's 2008 labor contract law: implementation and implications for China's workers. IZA Discussion Papers (2). https://doi.org/10.1177/0018726713509418
Ghizdeanu I, Tudorescu V, Voinescu R (2007) Macro-economic models used in assessing the effects. of Structural Reforms in Romania. IWE
Harasztosi P, Lindner A (2016) Who pays for the minimum wage? [J]. Conference on Wage Developments in Central and Eastern Europe
Heckman J, Pages C (2022) The employment cost of labor market regulations: lessons from Latin America and the Caribbean1[J].usa inter
Hicks JR (1932) The Theory of Wages. Am J Sociol 32(125)
Holzner M, Vizek M, Vukšić G (2022) Wage bargaining coordination, taxation and labor costs: the effects of fiscal devaluation. Comp Econ Stud 64:324–349. https://doi.org/10.1057/s41294-021-00180-1
Huang Y, Sheng L, Wang G (2021) How did rising labor costs erode China's global advantage? J Econ Behav Org 183:632–653. https://doi.org/10.1016/j.jebo.2021.01.019
Lehmann E, Marical F, Rioux L (2013) Labor income responds differently to income-tax and payroll-tax reforms. J Public Econ 99:66–84
Lett E, Banister J (2009) China's manufacturing employment and compensation costs: 2002-06. Monthly Labor Rev 132(4):30–38
Li J, Shan Y, Tian G, Hao X (2020) Labor cost, government intervention, and corporate innovation: evidence from China. J Corp Financ 64:101668. https://doi.org/10.1016/j.jcorpfin.2020.101668
Li X, Zhao X, Yang X (2020) Does land finance drive up labor costs in China? China land. Science 34(09):38–47
Malgouyres C, Mayer T (2018) Exports, and labor costs: evidence from a French policy. Rev World Econ 154:429–454. https://doi.org/10.1007/s10290-018-0320-x
Meyer K (1995) Direct foreign investment in Eastern Europe the role of labor costs. Comp Econ Stud 37:69–88
Morduch J, Sicular T (2000) Politics, growth, and inequality in rural China: does it pay to join the Party? J Public Econ 77(3):331–356. https://doi.org/10.1016/S0047-2727(99)00121-8
Naughton B (2017) The current wave of state enterprise reform in China: a preliminary appraisal. Asian Econ Policy Rev 12(2):282–298. https://doi.org/10.1111/aepr.12185
Orrenius PM, Zavodny M, Gullo S (2020) How does immigration fit into the future of the U.S. Labor Market? [J]. IZA Discussion Papers, 2020.https://doi.org/10.24149/wp2005
Qian Y, Roland G (1998) Federalism and the soft budget constraint. Social Science Electronic Publishing. Am Econ Assoc 88(5):1143–1162
Romer PM (1987) Crazy explanations for the productivity slowdown. NBER Macroecon Ann 2:208–210
Shenyong Z, Zhouzhou W (2007) The status and trends of international competitiveness of China's labor force. International Conference on Management Science & Engineering. https://doi.org/10.1109/ICMSE.2007.4422061
Thurow LC (1974) The economics of public finance. Brookings Institution
Wang Y, Li W, Li X (2011) Research on international competitiveness of Chinese manufacturing using the method of unit labor cost. Stat Res 10:60–67
Wilson S (2005) From Mao to market: rent seeking, local protectionism, and marketization in China. Perspect Politics 2(04):883–885. https://doi.org/10.2307/20066004
Yang CH (2023) Strengthening worker benefits or destroying jobs: effect of the 2008 labor contract law in China. Int Rev Law Econ 73:106–121. https://doi.org/10.1016/j.irle.2022.106121
Bong Joon Yoon (1998) The 30th anniversary special issue on economic crisis in Korea: as viewed by scholars in the U.S.: Articles; Labor Cost Increases and the Currency Crisis of Korea
Zhang G, Song R (2013) Transportation impact on manufacturing industry inputs in China. Econ Res J 7:63–75
Zhang J, Gao Y, Fu Y, Zhang H (2007) Why does China enjoy so much better physical infrastructure. Econ Res J 3(3):4–19
Zhang W, Han G (2013). How have labor market developments affected labor costs in China? Hong Kong Institute for Monetary Research
Zhou L (2007) Governing China's local officials: an analysis of promotion tournament model. Econ Res J 7(36):36–50
Zvaigzne A, Saulaja I, Zeiferte D (2014) Labor supply in the regions of Latvia. Econ Sci Rural Dev Conf Proc (36):43–50
Natarelli J, Basu A (2022) Slower immigration and rising labor costs[J]. Construction Accounting & Taxation 32(5)
Zvaigzne A et al. (2015) Management of private forests and alternatives for its improvement in latvia [J]. Econ Sci Rural Dev (39):142–152

Author contributions

YL: conceptualization, formal analysis, methodology, and writing—original draft. ZY: validation, funding acquisition, writing—review & editing. RF: validation, methodology, supervision, writing—review & editing. All authors substantially contributed to the article and approved the submitted version.

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