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A Research on Factors Influencing Labor Cost of Construction Projects based on VAR Model

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Abstract
The construction industry is a labor intense industry in China. In recent years, wages for Chinese workers, especially technical workers, rise a lot which causes the rapidly increase of labor cost in a construction project. Chinese construction enterprises and the industry are heavily influenced and suffering a hard time. In order to find influencing factors of rising labor cost on construction projects, the paper specifies a VAR model based on quarterly data from 2008 to 2013 and uses a Vector autoregression (VAR) model to analyze impacts of correlative factors on average daily wages of construction workers. The conclusion shows that development of the building industry and improving of overall wage level of the society have strong effects on the increase of labor wages. Meanwhile large demand of workers also has vital impact. Therefore influence of CPI is weak. However, there is not a significant relation between labor productivity and labor wages. In other words, the rising of wages are not a representation of efficiency and technology improvements and high cost doesn't bring high productivity for the enterprises. The result tells that current rising labor cost is a cause of industry development and promotion of migrant workers' awareness of rights. Chinese construction companies should take effective measures to deal with the situation and improve the efficiency of the industry.

Keywords
Labour Cost; Construction Project; Impact Factors; VAR model

1. Introduction

China is rich labor resources and cost of labor force is low comparing to developed contries. As a typical labor-intense industry, Chinese construction industry benefit a lot. Chinese construction companies have comparative advantage in international constrution market. However, recent statistics shows that labor cost in China is rising quickly. From about 2004, labor shortage first appears in the manifacturing industry, manufacturing regions like the Pearl River Delta has labor shortage for about 2 million. Shortage of labor causes the rise in labor cost. Recent years, building industry come across the same problem. Labor wage in province of high output in the constrution industry like Shandong and Jiangsu increase rapidlly. In 2010, average wage of construction workers is about 5 thousand yuan, 5 times of that in 2000.

Increase of labor cost is the inevitable result of development of economics(HUANG Ya-ling, 2007) Due to theoredical reasons in Labor Economics like marginal cost, consumption demand and wage level of the whole society, low cost labor force can not be long-term advantage during Industrialization in China.

When comparing with labor cost in developed contries, average wage per hour is above 20 dollars in US, about 5 dollars in Mexico, however about 2 dollars in China. Excessive disparity in labor cost will vanish gradually during process of economical development.

Another important factor influencing wage levels is labor productivity. In the past 30 years, other countries such as Germany, Australia, USA, Japan, and Indonesia, labor cost prices while labor productivity is rising(Allmon B. E, *et al*. 2000). Improved mechanization and technology, the price of labor force have been better utilized. But labor productivity in Chinese construction industry is not improving as quickly as the rise of labor cost. Building procedure is still mainly relying on human work without efficient technology. Therefore, improvement of labor productivity is also a problem to solve for Chinese building industry.

Construction companies suffers from the rise of labor cost. Companies even reduce the cost of materials to make up to labor cost. So researches have been conducted by scholars to find influencing factors about labor cost increase in construction industry. Factors mostly comes from two aspects, economic environment and human workers themselves.Economic development stimulates the consuption demands, cause product price rise and wage level of the whole socialty rises. That is the reason for rise of labor cost in all industries. Surveys which is conducted by the authors to find special reasons in the construction industry indicated that shortage of human labor can be the most important reason. Workers are not willing to work in the construction site as the working condition is not good. Meanwhile there are other more jobs that is safer and earns more. What's more, Chinese government raise advantage strategies favors rural famer workers so that they are willing to stay rather than working far away in the city. Huge gap of human resource resulted in rise of wages.

Summing up, according to reviewed studies and surveyes, several factors such as shortage of workers, economic development, rise of wage level high and so on, may cause labor cost increase in construction industry. In the following sections, authors will do empirical analysis through a VAR model. Factors will be demonstrated by proper index and quantified through data. In the end, authors will bring up with conclusion and proper suggestions for the Chinese construction companies to deal with the problem of rising labor cost.

2. Empirical Analysis

In order to do the empirical analysis, the paper will establish a VAR model. The VAR is commonly used for analyzing the dynamic impact of random disturbances on the system of variables, through lagged regression analysis of each variable, forecast the relevant series and analyze dynamic effects of random disturbance to the variable system, illustrate complex phenomena in a simple way. The paper will construct a 6-variable VAR model(Ahmed M. Khalid, Masahiro Kawai, 2003)

2.1 Variables and Data Collection

Six variables should be specified to demonstrate influecing factors. National Average Daily Wage of Comprehensive Labor Cost(NADW) is an index obtained from China Engineering Cost Network. This index can indicate labor cost of construction projects. Consumer Price Index(CPI) is a variable to show the consumption level which is obtained from the National Bureau of Statistics. Since most workers of the construction industry come from rural area, the paper use Average Cash Income of Rural Family per person (ACI) to show the income level of rural people. The data of ACI also comes from National Bureau of Statistics. The variable of Demand Numbers of Workers of the Building Industry(DN) is counted by Ministry of Human Resources and Social Security of China to reflect demand of workers of the industry. And the last two variables can reflect development of building industry, Output of Building Industry(OBI)

and Labor Productibity(LP) of the industry. All the variables are quaterly data from first quarter of 2008 to first quarter of 2013.

2.2 The VAR Model

Six variables of NADW, CPI, ACI, DN, OBI and LP are endogenous variables in the system, add an constant variable "c" as a exogenous variable. The expression of the model is given by:

$Y_t = A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + c + et$

in which Y_t is a k vector of endogenous variables,c is a constant exogenous variables, A_1; ...; A_p are matrices of coefficients to be estimated, and e_t is disturbance variable that may be contemporaneously correlated with each other but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables. As variables stated above, we use natural logarithm of data to build the model, because the logarithm form is more stable and result of model will not be changed. Therefore, Y=[$\ln(NADW_t)$, $\ln(CPI_t)$, $\ln(ACI_t)$, $\ln(DN_t)$, $\ln(OBI_t)$ and $\ln(LP_t)$], each represented value at period t.

2.2.1 Lag exclusion tests /lag length criteria

It is very important to determine the lag-length before using a VAR for analysis. Usually we use Lag Length Creteria and lag exclusion tests to find the appropriate lag.which are determined based on the smallest value of Arkaike (AIC), Schwarz (SC) and Hannan-Quinn (HQ) of the VAR model**.** As shown in Table 1, FPE means final prediction error, when lag is two, AIC, SC, HQ are all minimum, so the appropriate lag is 2 in this model.

Table 1: VAR Lag Length Criteria

Lag	LR	FPE	AIC	SC	HQ
0	NA	2.03e-12	-9.897459	-9.599215	-9.846985
1	232.4413	4.31e-19	-25.47809	-23.39038	-25.12477
2	75.39714*	3.35e-22*	-34.25481*	-30.37764*	-33.59864*

* indicates lag order selected by the criterion

Conduct the lag exclusion test when lag is 2, results shown in Table 2, Joint p-value is 0.00 which indicates that at lag-length 2, all endogenuous variable is significant at 1% level.

Table 2: VAR Lag Exclusion Test

	Chi-squared test statistics	p-value
ln(ACI)	368.9830	0.0000
ln(NADW)	5.010128	0.542515
ln(CPI)	7.487247	0.278124
ln(OBI)	846.9371	0.0000
ln(DN)	16.64866	0.010665
ln(LP)	270.6975	0.0000
Joint	9147.217	0.0000

2.2.2 AR roots test

AR roots test is mainly to test the stationarity of a VAR model. As lag-length is determined, AR roots test graph at lag-length 2 is demonstrated in Figure 1. No root lies outside the unit circle, which illustrate VAR model satisfies the stability condition

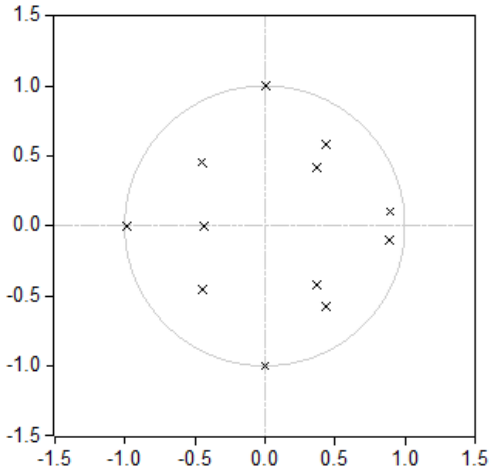

Figure 1: AR Roots Test Graph

2.2.3 Pairwise Granger causality tests

Table 3: Granger Causality Test

Null Hypothesis:	F-Statistic	Prob.	Conclusion
DN does not Granger Cause NADW	7.97006	0.0117*	Reject
NADW does not Granger Cause DN	3.79576	0.0681**	Reject
CPI does not Granger Cause NADW	4.93331	0.0402*	Reject
OBI does not Granger Cause NADW	0.06920	0.7957	Accept
LP does not Granger Cause NADW	0.41549	0.5278	Accept
ACI does not Granger Cause NADW	1.49463	0.2382	Accept
* denotes rejection of the hypothesis at the 5% level			
** denotes rejection of the hypothesis at the 10% level			

Table 2 reports the statistics for pairwise Granger causality tests. As the research aims to identify the influencing factor labor cost, the table just lists related results. At 5% level, null hypothesis is rejected, so DN and CPI may be the Granger cause of NADW. And at 10% level, hypothesis of "CPI does not Granger Cause NADW" is rejected. So at 10% level, we can tell that NADW and DN interact on each other. However, hypothesis about OBI, LP and ACI are accepted, which means these three factor are not the Granger cause of NADW.

2.3 Impulse Response Function Analysis

Through VAR model, we know that the six variables form a balanced system in a long run. However when a random disturbance is happened, variables can be influenced in short term, and the impact can be pass through the dynamic structure of the VAR model to all other endogenous variables. Impulse response function(IRF) is used to measure how the current and future value of endogenuous variables can be impacted when a standard deviation shock is added to stochastic error. Through this, we can estimate dynamic interaction between variables and their effects.

The AR roots test mentioned above shows that the VAR satisfies the stability condition. So the IRF is valid. Here presented responses of variable ln(NADW) to all six variables.

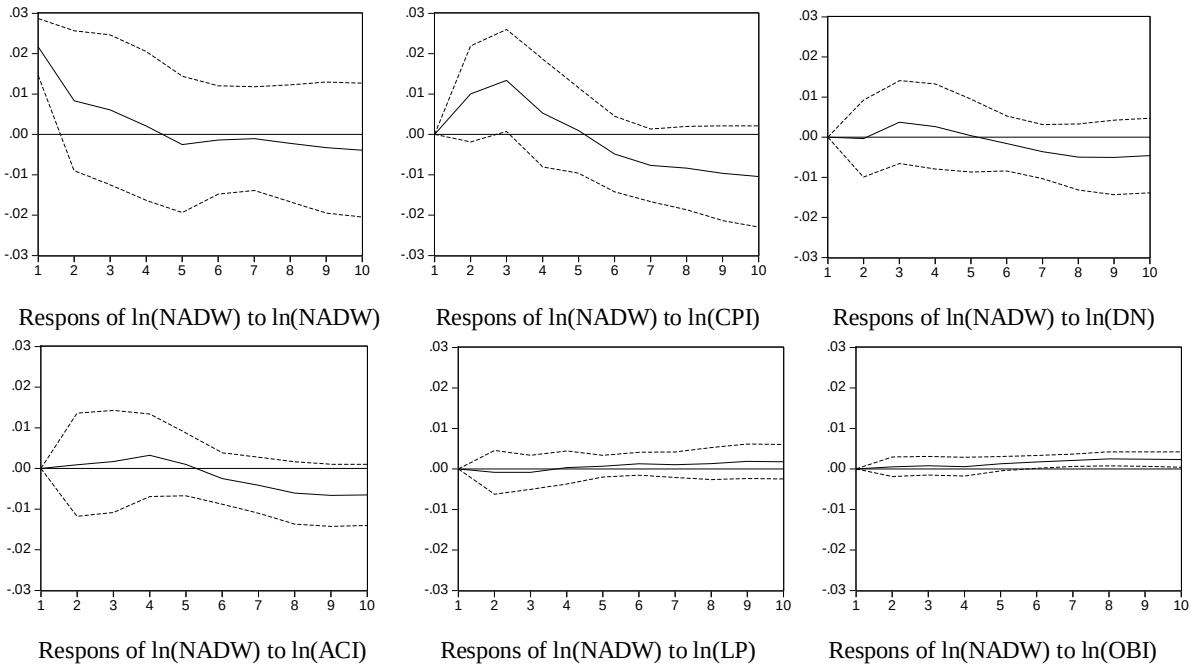

Figure 2: Response to Cholesky One S.D. Innovations

The horizontal axis represents the lag period of the impact (quarterly), the vertical axis represents the number of responses; solid line represents the impulse response function; dotted line is the confidence curve of twice response function standard errors. Zone between two dotted lines shows the possible range of responses.

Response to CPI is very significant, following is DN and ACI. Though response to LP and OBI is relatively small. NADW respond positive to the CPI shock, the value reaches the top at the 3rd quarter and then begin to decline, becomes zero and then falls negtive after the 5th quarter. Response curve to DN and ACI are similar. The respond is not very remarkable. Surprisingly the same, two also rise to top and then fall negtive after 5th quarter. Response period of NADW is relatively to other factors.

2.4 Variance Decomposition

Variance decomposition is to decompose variance of one variable in the system to each disturbance, provides relative degree of influence of each disturbance factors on variables. Likewise, the horizontal axis represents the lag period of decomposition(quarterly), the vertical axis represents the Contribution rate of variables. Six decomposition lines are demonstrated in Figure3. We can tell that the contribution rate of CPI is the most, from the 3rd quarter keeps above 45% and reach 50% at the 10th quarter. The second and third is NADW itself and DN, respectively accounting for 35% and 20%. Other factors ACI, OBI and LP constribute little.

3. Conclusion

To sum up,the paper studied dynamic influence in a 6-variable system consist of NADW, CPI, ACI, DN, OBI and LP. Surprisingly, the conclusion is basicly the same, CPI and DN have the most impact on NASW, ACI, OBI and LP account little for the change of NADW. Therefore, we can bring out that the increase of labor cost is mostly caused by rise of comsumption level and large demand of labor force. What is essential to note is that correlation between labor productivity and labor cost is not strong and positive. As the labor cost is rising quickly, productivity in our industry is not keeping up. Leading to the decline of capital value and working effeciency. As offered in the research, rising of labor cost is a trend of development of the society and industry, the companies need to find solution to increase the labor

productivity. Carrying out job training program, applying new technology, more effective human resource management. Likewise, the government should formulate preferential policy to encourage workers to work in construction industry.

Some limitations of this study are worth mentioning. Establishing and test of VAR model is still being discussed, influence of sequence of variables in impulse response function and variance decomposition is not clear. Meanwhile, other model should be build to verify the result of model in this paper and further study of detailed correlation between factors and interact influencing mechanism is needed. Different areas have different local situation, reasons may be not the same, research need to be more specific. All these help to clear exact reason for rising labor cost.

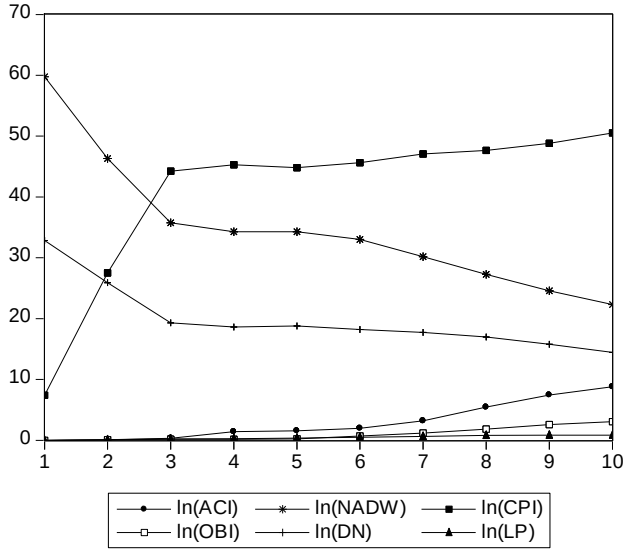

Figure 3: Variable Decomposition of ln(NADW)

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