SHORT-RUN LABUOR DEMAND BEHAVIOURS IN CONSTRUCTION

Paul H K Ho

Division of Building Science and Technology, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong SAR, PR China

ABSTRACT

Contractors usually hire workers to work on a specific construction project and when the project is completed, workers may be laid off. The construction industry is thus more volatile than other sectors of economy. While there are numerous researches on labour demand, there is limited previous research related to the construction labour demand. Hence, this paper aims to examine the short-run labour demand behaviours in the construction industry. Several labour demand models have been reviewed from the labour economic literature. A short-run labour demand function is derived for the construction industry. All data in this study are based on the Census and Statistics Department of the Hong Kong SAR. It is found that in the short-run, time trend and lagged employment rather than output have a significant part to play in the employment demand function. Construction firms adjust the actual level of employment towards the desired level of employment over time rather than instantaneously. Within the adjustment period, construction firms may have hesitation to hire or dismiss a large number of workers.

KEYWORDS: labour demand, production function, construction industry.

INTRODUCTION

Labour demand is defined as the amount of labour that employers seek to employ during a given time period at a particular wage rate. Uwakweh and Maloney (1991) state that most contractors hire workers to work on a specific construction project which has a finite duration. When the project is completed, the workers may be laid off. Thus, the construction industry is characterized by an area pool of labour. Contractors in need of workers hire from the area pool of labour and return workers to the pool when they are no longer needed. However, Uwakweh and Maloney's (1991) view may not fully reflect the labour demand behaviours. Except those self-employed workers, most workers are ordinarily employed by main contractors or sub-contractors or sub-sub-contractors either on a long or short term basis. No matter whether they act as main contractors, sub-contractors or sub-sub-contractors, most construction firms normally try to maintain a pool of workers as hiring or dismissal of workers are expensive. Therefore, this paper aims to derive a short-run labour demand function for analysing the employment decision of construction firms.

PREVIOURS RESEARCH ON CONSTRUCTION LABOUR DEMAND

The relevant theories relating to the short-run labour demand are well established in economics theory. Killingsworth (1970) identified three major neoclassical labour economics theories, namely the crude profit-maximising theory (Nadiri, 1968; Waud, 1968; Dhrymes, 1969), the instantaneous hours-cost-minimising theory (Brechling, 1965; Ball and St. Cyr, 1966; Brechling and O'Brian, 1967; Smyth and Ireland, 1967; Fair, 1969) and the employment-cost-minimising-over-times theory (Solow, 1968). Probably, the most seminal employment function is the one proposed by Ball and St. Cyr (1966). However, whether these theories are applicable to the construction industry are yet to be known as there is only limited previous research related to the construction labour demand.

From examining a wide set of factor price variables including material input prices, investment good prices, cost of capital, capital stock, level of capacity utilization, exchange rates and time trends through the cointegrating regression, Briscoe and Wilson (1991 and 1993) formulated the following long-run labour demand specification for the UK engineering sector:

$$E_t = a_0 + a_1(Q_t) + a_2(RW_t) + a_3(BR_t)$$

where E = level of employment, Q = construction output, RW = real wage, BR = bank rate, t = time trend, and all variables are in logarithmic values. They concluded that over the sub-period 1954-1965, output played a particularly important role in determining changes in employment; in the sub-period 1965-1976, the importance of output was considerably lower, with real wages playing a dominant role; finally, in the most recent sub-period 1976-1987, both output and real wages played important roles.

Contrary to the theoretical predictions, Ball and Wood (1995) however found that there was only a weak link between quarterly increases in total construction output and construction employment and no significant relationship between house-building and employment. They suggested that these results arose from poor quality data, especially the estimates of changes in the number of self-employed workers.

By following the vector error correction multivariate method as Briscoe and Wilson (1991 and 1993), Wong *et. al.* (2007) identified the following long-run labour demand specification for the Hong Kong construction industry:

$$E_t = a_0 + a_1(Q_t) + a_2(RW_t) + a_3(MP_t) + a_4(BR_t) + a_5(LP_t)$$

where at time t: E = manpower demand, Q = construction output, RW = real wage, MP = material price, BR = interest rate, and LP = labour productivity. They revealed that the construction output and labour productivity had a strong influence on the construction manpower demand in the long term.

Briscoe and Wilson's (1991 and 1993) and Wong *et. al.*'s (2007) specifications provide some good references for the employment demand in the long-run. However, this paper aims to investigate the short-run employment decision. It is therefore necessary to consider the fundamental theory related to the short-run labour demand.

PROPOSED SHORT-RUN EMPLOYMENT MODEL

The production function is a technical relationship by which inputs (such as land, labour, capital and firm) are efficiently transformed into physical outputs (e.g. schools, offices, etc.). For the sake of simplicity, economists often assume that given the current state of technology (B), the firm's production function consists of two major inputs in the production process: the number of worker-hour (Eh) and amount of capital (K). A widely used representation of this function is the Cobb-Douglas production function:

$$Q_t = B_t(Eh)_t^{\alpha} K_t^{\beta} \tag{1}$$

where Q = output, E = number of men employed, h = number of hours per employed man, K = capital stock, B = shift parameter indicating the state of technology, α and β = output-elasticity of inputs, and t = time period. The parameters α and β essentially determine the short-term or cyclical behaviour of productivity, while the shift parameter B essentially determines the long-term productivity trend.

A profit-maximizing firm will adjust its use of labour and capital to achieve the lowest production cost. However, every firm needs time to adjust its factor inputs. In the short-run, capital is a fixed factor of production, whereas labour is the only variable input. Ball and St. Cyr (1966) postulated the following short-run production function for a firm:

$$Q_t = B_t (Eh)_t^{\alpha} \tag{2}$$

Due to the absence of suitable data, technology progress is approximated by an exponential time trend:

$$B_t = Ae^{pt} \tag{3}$$

Substituting equation (3) into (2), the production function can be re-arranged as:

$$Q_t = Ae^{pt} (Eh)_t^{\alpha} \tag{4}$$

The total cost function of a firm is as follows:

$$C_t = W_h (Eh)_t + F_t \tag{5}$$

where C_t = total cost, W_h = effective wage per man hour, and F_t = the fixed cost. The effective wage per man hour is not a parameter but a variable, which depends on the number of hours actually worked. There may be a substantial difference distinction between nominal and productive hours worked by a worker, and so between the wage per nominal man hour and the wage per productive man hour (i.e. the effective wage per man hour). This relation depends on the particular payment scheme in operation. Ball and St. Cyr (1966) postulated a quadratic relationship as an approximation between the average wage rate and man hours worked per worker.

$$W_h = a - bh + ch^2 \tag{6}$$

Substituting equation (6) into (5), the cost function becomes:

$$C_t = aE_t h_t - bE_t h_t^2 + cE_t h^3 + F_t \tag{7}$$

From equation (4), the effective wage per man hour can be obtained:

$$h_t = \frac{Q_t^{1/\alpha}}{A^{1/\alpha} e^{pt/\alpha} E_t} \tag{8}$$

Substituting equation (8) into (7), the cost function can be written as:

$$C_t = a\left(\frac{Q_t^{1/\alpha}}{A^{1/\alpha} e^{pt/\alpha}}\right) - \frac{b}{E_t}\left(\frac{Q_t^{1/\alpha}}{A^{1/\alpha} e^{pt/\alpha}}\right)^2 + \frac{c}{E_t^2}\left(\frac{Q_t^{1/\alpha}}{A^{1/\alpha} e^{pt/\alpha}}\right)^3 + F \tag{9}$$

By adopting a cost minimizing goal, the optimal level of employment can be derived by partially differentiating C_t with respect to E_t (i.e. equation (9)), setting the result equal to zero and then solving the equation:

$$\frac{dC_t}{dE_t} = \frac{b}{E_t^2}\left(\frac{Q_t^{1/\alpha}}{A^{1/\alpha} e^{pt/\alpha}}\right)^2 - \frac{2c}{E_t^3}\left(\frac{Q_t^{1/\alpha}}{A^{1/\alpha} e^{pt/\alpha}}\right)^3 = 0 \tag{10}$$

$$E_t^* = \frac{2c}{bA^{1/\alpha}} e^{-pt/\alpha} Q_t^{1/\alpha} \tag{11}$$

E_t^* is an optimal level of employment which minimises both wage and hour costs, subject to the production function. Whenever employment is not at its optimal level, hours act as a buffer, but this has an associated cost because the average wage rate exceeds its minimum value. Thus, there is an incentive for a firm to move to the desired employment level. Brechling and O'Brien (1967) stated that the desired level of employment cannot be reached immediately, but over time, due to two main reasons. Firstly, changes in the level of employment have costs which are likely to rise with the speed of adjustment. Secondly, a firm may not be certain about future levels of E_t^* and hence, it may not adjust fully to current changes in E_t^*. Thus, a firm is expected to adjust to its desired level of employment with a lag. A convenient lag structure is the well-known stock adjustment process according to which:

$$\frac{E_t}{E_{t-1}} = \left(\frac{E_t^*}{E_{t-1}}\right)^{\lambda} \qquad 0<\lambda<1 \tag{12}$$

where λ = lag parameter. In this adjustment process, a firm is assumed to adjust a constant amount of the discrepancy between desired and actual employment in each period. When $\lambda = 0$, there is no adjustment within the period and, when $\lambda = 1$, adjustment is complete.

Combining equation (11) with (12), the level of employment can be rewritten as:

$$E_t = \left(\frac{2c}{bA^{1/\alpha}} \right)^{\lambda} e^{-pt/\alpha} Q_t^{1/\alpha} E_{t-1}^{\{1-\lambda)} \tag{13}$$

Taking logarithms on both sides of equation (13), the basic short-run employment function can be estimated by:

$$\log E_t = \lambda \log \frac{2c}{bA^{1/\alpha}} - \frac{\lambda p}{\alpha} t + \frac{\lambda}{\alpha} \log Q_t + (1-\lambda) \log E_{t-1} \tag{14}$$

$$\log E_t = a_0 - a_1 t + a_2 \log Q_t + a_3 \log E_{t-1} \tag{15}$$

where $a_0 = \lambda \log \frac{2c}{bA^{1/\alpha}}$, $a_1 = \frac{\lambda p}{\alpha}$, $a_2 = \frac{\lambda}{\alpha}$, $a_3 = (1-\lambda)$ (16)

THE DATA

For this study, the employment and output data are based on the "Quarterly Report of Employment and Vacancies at Construction Sites" and "Gross Value of Construction Works at Constant (2000) Market Prices performed by Main Contractors at Construction Sites" respectively published by the Census and Statistics Department of the HKSAR Government. While a longer period of statistical data can be available from the same source, the proposed analysis is based on the recent years between 2000 and 2007 as various coefficients in the production function may become unstable in the long-run. There are totally 32 observations which have not seasonally adjusted.

This study is only concerned with the manual workers at construction sites, excluding administrative, professional, technical and clerical employees so that the construction firms' employment decision on hiring and dismissal of workers can be examined. In order to match with the employment data, this study is only concerned with building and civil engineering works at both public and private construction sites, excluding maintenance and repair works. The output value is based on the constant market prices at the year 2000.

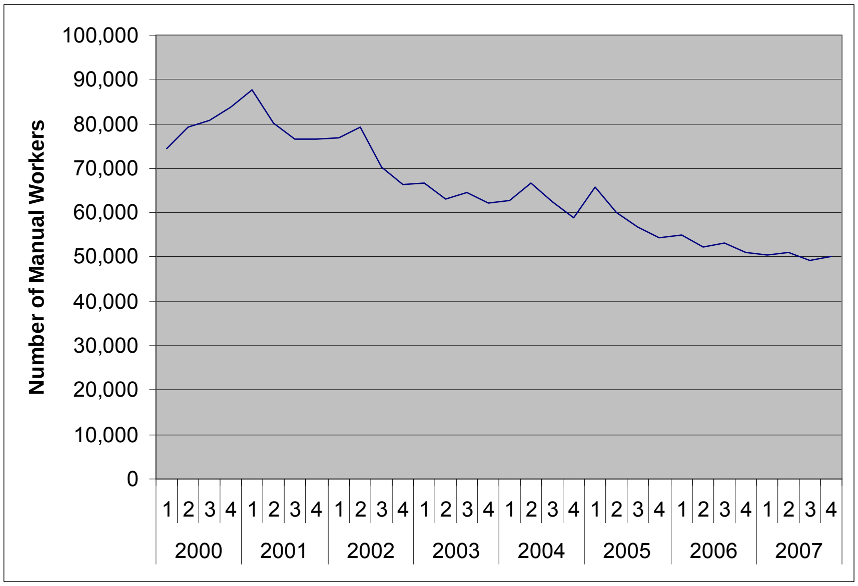

Figure 1: Number of Manual Workers at Construction Sites

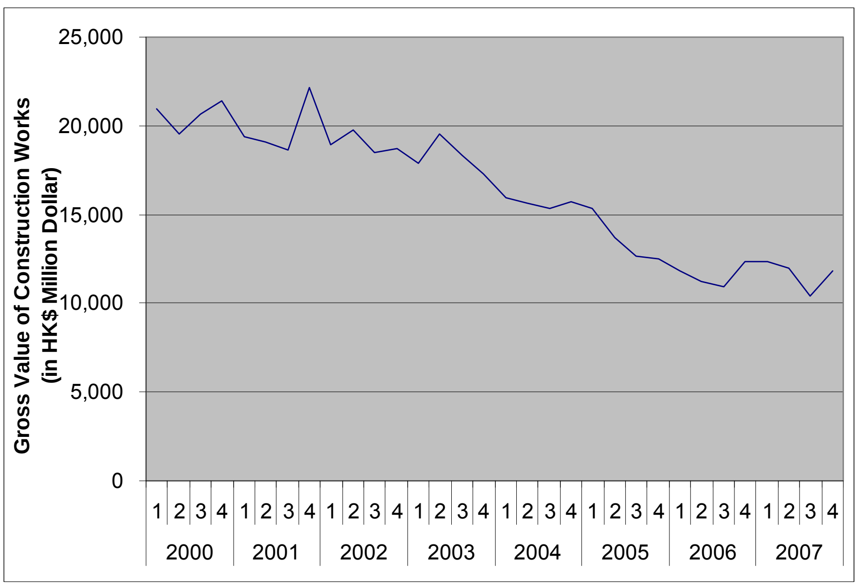

Figure 2: Gross Value of Construction Works performed by Main Contractors

Figures 1 and 2 show the number of manual workers at construction sites and gross value of construction works performed by main contractors respectively. As indicated from these figures, both the construction employment and output curves are in a downward trend, while there are also mismatches in some time periods between these two curves.

FINDINGS AND DISCUSSIONS

With the $\log E_t$ as the dependent variable and t, $\log Q_t$ and $\log E_{(t-1)}$ as independent variables, regression analysis is used to estimate the various coefficients in the basic model.

Table 1: Descriptive Statistics

	Mean	Std. Deviation	N
$LogE_t$	4.80837222	.075807001	32
t	16.50	9.381	32
$LogQ_t$	10.200364094	.1002057467	32
$LogE_{(t-1)}$	4.813760188	.0739504677	32

Table 2: Correlations

		$LogE_t$	t	$LogQ_t$	$LogE_{(t-1)}$
Pearson Correlation	$LogE_t$	1.000	-.959	.916	.957
	t	-.959	1.000	-.942	-.946
	$LogQ_t$	.916	-.942	1.000	.902
	$LogE_{(t-1)}$	.957	-.946	.902	1.000

Table 1 shows the basic descriptive statistics for each of the variables, and Table 2 shows the correlation coefficients for the variables.

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
	R Square Change	F Change	df1	df2	Sig. F Change	R Square Change	F Change	df1	df2	Sig. F Change
1	.972(a)	.944	.939	.0187965	.944	158.741	3	28	.000	
2	.972(b)	.944	.940	.0185469	.000	.235	1	28	.632	2.075

a. Predictors: Constant, $LogE_{(t-1)}$, $LogQ_t$, t b. Predictors: Constant, $LogE_{(t-1)}$, t

By using backward variable elimination method which evaluates all of the variables in the model and then removes the one with the smallest change in R^2, the SPSS software generates two models as shown in Table 3. Model 1 includes all of the independent variables of $LogE_{(t-1)}$, $LogQ_t$ and t with significantly high R^2 value of 0.944. Model 2 includes only two independent variables of $LogE_{(t-1)}$ and t with the same R^2 value of 0.944 as the model 1, but the adjusted R^2 in the model 2 is (0.940-0.939) 0.001 higher than the model 1. However, the independent variable $LogQ_t$ is removed in the model 2.

Table 4: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.059	1.203		1.712	.098	-.405	4.523
	t	-.004	.001	-.455	-2.552	.016	-.007	-.001
	$LogQ_t$	.049	.101	.065	.485	.632	-.158	.256
	$LogE_{(t-1)}$	.480	.142	.468	3.385	.002	.190	.771
2	(Constant)	2.534	.688		3.684	.001	1.127	3.941
	t	-.004	.001	-.510	-3.754	.001	-.006	-.002
	$LogE_{(t-1)}$	.487	.139	.475	3.492	.002	.202	.772

Based on the Table 4, the derived short-run employment models for the construction industry are as follows:

Model 1 $\log E_t = 2.059 + 0.004t + 0.049 \log Q_t + 0.480 \log E_{t-1}$

Model 2 $\log E_t = 2.534 + 0.004t + 0.487 \log E_{t-1}$

As models 1 and 2 have the same high R^2, one may argue that statistically both models can explain the same proportion (94.4%) of variability in the dependent variable $LogE_t$. However, the observed significance level for $LogQ_t$ in the model 1 is significantly different from zero (0.632). Hence, one cannot reject the null hypothesis that there is no relationship between the dependent variable, $LogE_t$ and the independent variable, $LogQ_t$. Thus, statistically, model 2 is more preferable, while model 1 is more consistent with the equation (15). Based on the model 2, there is a strong statistically relationship between employment and time trend and lagged employment; however, there can be no statistical relationship between employment and output.

The $LogE_{(t-1)}$ variable is used to adjust the actual employment to the desired employment. Based on the coefficient a_3 = 0.487 and $a_3 = (1 - \lambda)$, the quarterly adjustment coefficient (λ) is equal to 0.513. This indicates that 51.3% of any difference between the logarithms of desired and actual employment is made up during a quarter. Thus, the average adjustment period will take approximately two quarters on the condition that there will be no further fluctuation in output. Obviously, some construction firms may take a longer or shorter period, depending on their committed workload.

The time trend variable is used to take into account the technological progress which is expected to vary smoothly over time. Since the coefficient a_2 is 0 and $a_2 = \lambda/\alpha$, α is equal to zero. As $a_1 = \lambda\rho/\alpha$ and $\alpha = 0$, ρ is also equal to zero. This indicates that the rate of technological progress in construction over the period of 2000–2007 was extremely slowly, if not zero. This was probably due to the recession of the construction industry in Hong Kong during this period (see Figure 1) when most construction firms were not willing to invest in advanced plant and equipment in their production process.

The conventional economic theory states that there should be a close relationship between the level of employment and output in the long-run. As noted above, the $LogQ_t$ variable is insignificant or removed based on the models 1 and 2 respectively. The finding does not support the proposition that a construction firm will increase (or decrease) its desired level of employment in anticipation of higher (or lower) levels of construction output. Although this finding contradicts to the conventional economic theory, it is consistent with the Ball and Wood's (1995) study that there was only a weak link between quarterly increases in total construction output and construction employment.

In order to further examine the relationship between employment and output, a simple regression analysis is carried using $\log E_t$ and $\log Q_t$ as the dependent and independent variables respectively. The results are encouraging in which R^2 is very high (0.839) and the observed significant levels from ANOVA and t statistics are both less than 0.0005. The resulting model is as follows:

$$\log E_t = -2.260 + 0.693 \log Q_t$$

the above finding indicates that there is a strong relationship between employment and output at least in the long-run. This is consistent with the Cobb-Douglas production function.

In the short-run, the level of employment will only be adjusted slowly over time (two quarters here) rather than instantaneously. In the very short-run (i.e. within the early stage of the adjustment process), the level of employment is largely fixed like other production function variables due to few reasons. Firstly, most construction firms may take up few projects at the same period of time and most projects need some time (e.g. two to three years) for completion. As the contract value (i.e. also the output) is well known in advance, this allows labour resource planning over certain period of time. Hence, they can also adjust the available float in programme in order to achieve a smooth labour resource. Indeed, it may become very expensive or even impossible to employ more than a certain maximum number of workers within a period of time. Secondly, over-time commonly happens in the construction industry and acts as a buffer to cater for certain fluctuation in labour demand. Thirdly, construction firms may be uncertain about the permanency of output demand in a longer future period. Under such circumstances, construction firms may have hesitation to hire or dismiss a large number of workers because the possibility of their early hiring or dismissal may be undesirable.

CONCLUSIONS

The derived short-run employment function that fitted to the Hong Kong construction industry produces reasonably sensible results in view of its R^2 values, significance levels and coefficient magnitudes. In the long-run, there is a strong relationship between employment and output in construction in accordance with the Cobb-Douglas production function. In the short-run, time trend and lagged employment have a significant part to play in the employment demand function. Construction firms adjust the actual level of employment towards the desired level of employment over time rather than instantaneously. Hence, in the very short-run, construction firms may have hesitation to hire or dismiss a large number of workers. This study contributes to our better understanding of the short-run labour demand behaviours in construction.

REFERENCES

Ball, J. and St Cyr, E. (1966) Short-term employment functions in British manufacturing, *Review of Economic Studies*, 33, 179-207.

Ball, M. and Wood, A. (1995) How many jobs does construction expenditure generate?, *Construction Management and Economics*, 13, 307-318.

Brechling, F.P.R. (1965) The relationship between output and employment in British manufacturing industries, *Review of Economic Studies*, 32, 187-216.

Brechling, F.P.R. and O'Brien, P. (1967) Short-term employment functions in manufacturing industries: an international comparison, *Review of Economics and Statistics*, 49, 279-287.

Brechling, F.P.R. and O'Brien, P. (1970) The specification of short-term employment models, *The Review of Economics Studies*, 37, 281-285.

Briscoe, G. and Wilson, R. (1991) Explanations of the demand for labour in the United Kingdom engineering sector, *Applied Economics*, 23, 913-926.

Briscoe, G. and Wilson, R. (1993) *Employment forecasting in the construction industry*, Avebury Publishing Co., Hants, England.

Dhrymes, P.J. (1969) A model of short-run labour adjustment, in Duesenberry, et. al. (eds.), *The Brookings Model: Some Further Results*, North-Holland Publishing Co., Amsterdam, pp. 110-150.

Killingsworth, M.R. (1970) A critical survey of neoclassical labour models, *Oxford Bulletin of Economics and Statistics*, August, 133-165.

Fair, R.C. (1969) *The short-run demand for workers and hours*, North-Holland Publishing Co., Amsterdam.

Nardiri, M.I. (1968) The effects of relative prices and capacity on the demand for labour in the US manufacturing sector, *Review of Economic Studies*, 35, 273-288.

Wong, J.M.W., Chan, A.P.C. and Chiang, Y.H. (2005) Time series forecasts of the construction labour market in Hong Kong: the Box-Jenkins approach, *Construction Management and Economics*, 23, 979-991.

Wong, J.M.W., Chan, A.P.C. and Chiang, Y.H. (2007) Forecasting construction manpower demand: a vector error correction model, *Building and Environment*, 42, 3030-3041.

Waud, R.N. (1968) Man-hour behaviour in US manufacturing: A neoclassical interpretation, *Journal of Political Economy*, 75, 407-427.

Uwakweh, B.O. and Maloney, W.F. (1991) Conceptual model for manpower planning for the construction industry in developing countries, *Construction Management and Economics*, 9, 451-465.

Smyth, D.J. and Ireland, N.J. (1967) Short-term employment functions in Australian manufacturing, *Review of Economics and Statistics*, 49, 537-544.

Solow, R.M. (1968) Short-run adjustment of employment to output, in Wolfe, J.N. (eds.), *Value, Capital and Growth*, University Press, Edinburgh, 481-484.