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Dynamic Demand Function for the Iranian Agricultural Labour

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Abstract: Agriculture is an important economy sectors in Iran which influenced by factors of production such as labour, land and capital. The agricultural labour is affected by supply and demand for labour. However this sector is basseted with the labour surplus situation as indicated by the high labour/land ratio. The objective of this study is to examine a dynamic model of labour demand with consideration of Disequilibrium Costs (DC) and Adjustment Costs (AC) based on partial adjustment method. The dynamic demand function for the agricultural labour was estimated from 1966/67 to 2000/01. The impacts of the agricultural production, agricultural wage rate, agricultural capital price and 8 years war effect on the agricultural labour were generally analyzed. The overall results suggested that employer in the agricultural sector did not adjust the optimal level to the actual level of employment, because of high AC with respect to DC. The speed of adjustment ($1/\lambda$=22 years) was too slow, relation between capital and labour was substitution in the production process and war had negative effect on the agricultural labour demand. Hence policy makers can reduce the price of capital (offer low interest rate in the agricultural sector) to substitute capital instead of labour in the production process and reduce AC in order to diminish gap between optimal and actual employment.

Key words: Dynamic Labour Demand · Agricultural Labour · Adjustment Cost · Disequilibrium Cost · Adjustment Coefficient

INTRODUCTION

After the Islamic Revolution, Iran experienced one of the highest rates in the population growth in the world (about 3.9% annual average growth), particularly during the 1976-1986 period. Such a rapid population growth means that many of those born at that time will shortly seek employment. Hence, the country will have to contend with the rapidly growing supply of potential workers and with a mix up of insufficient labour demand, which has caused a huge problem, particularly in the agricultural sector. Although the total employment rose from 8.8 million in 1976 to 16.4 million in 2001, indicating the 86.6% increase during the 1976-2001 period; the agricultural, industrial, construction and service sectors also rose by 23.0, 86.9, 39.0 and 183%, respectively [1].

According to the latest agricultural census, 75% of the 4.4 million rural families eke out a living directly on agricultural activities. Of the 3.4 million people who work in the agricultural sector which constitute about 23% of the country's workforce, around 2.9 million or 86.3% live in the rural areas and the remaining in the urban districts. Men constitute about 91.2% of the agricultural workforce and the remaining 8.8% are women [2].

Although the agricultural sector was facing labour surplus problem (extra manpower), its productivity growth rate was 2.4% annually during 1989/90-2004/05, as compared to 1.86% for the whole economic sectors [3]. Hence, with the elimination of the excess labour problem in the agricultural sector (reduce 'labour/land' ratio) and a further mechanization of the farms, the productivity rate would grow higher. One of the main questions is "why the agricultural sector could not be able to get rid of labour surplus problem". For answering to this question the characteristic of labour demand needs to consider more in the Iranian agricultural sector. Therefore, the objective of this study is to analyze the effective factors on labour demand and recommend the optimal polices.

Generally, the different methods suggested for extracting demand for labour are such as the followings [4-5]:

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- Profit maximization approach
- Cost minimization approach
- Labour market inequality approach
- Inter-periodic demand for labour
- Dynamic demand for labour

Choosing the appropriate demand paradigm should be based on theoretical characteristic. A number of approaches are static, while others are dynamic. Perfect competition or imperfect competition market requires different methodologies for extracting demand for labour. Therefore, some literature reviews for the labour demand are briefly given in this section.

Benjamin [6] investigated the demand for the agricultural labour in Indonesia by using 4117 household sample size. He used wage, price of pesticide, area under of cultivation, type of soil, climate and dimension of household, education and age in the estimation. An empirical model was developed to test the proposition that household labour demand (farm employment) was independent of the family composition. Benjamin could not reject the null hypothesis that farm labour allocation decisions were independent of household structure. Hence, the results were robust to different specifications of the labour demand function.

Al-Jalaly [7] in his study, "Agricultural sector employment and need for off-farm employment in Pakistan", found that the employment could not increase over time in the agricultural sector. Hence, the government should increase employment in other sectors to solve unemployment crisis

Sheikh and Iqbal [8] estimated a short-term demand for labour in the Pakistani manufacturing industries (1969-1987). In their estimation, they used different variables such as, employment lag, production, cost, time trend and employment. Based on their findings, a rapid increase in the cost of employment had caused obstacle for the employment in the industries in Pakistan. They stated that the one of the main problems in the process of development in Pakistan was the high growth rate of its population and consequently supply of labour.

Macdonald and Murphy [9] examined the behaviour of employment in manufacturing in UK, using a quarterly data over the period of 1964 to 1986. They exercised a model under an imperfect competition, including production and the effect of relative price, employment, real wage, relative cost of raw materials, relative cost of energy and capital. They found that a long-run relationship did exist between the employment and other input.

Ncube and Heshmati [10] in their paper developed a flexible adjustment model of employment with application to the Zimbabwe's manufacturing industries. They presented a dynamic adjustment model of employment with the adjustment process which was both industry and time-specific. The model was applied to a panel of ten Zimbabwean manufacturing industries observed over the period from 1970 to 1993. The long-run elasticity values showed that employment was more responsive to wages, followed by the capital stock and least by output. The relationship between the capital and labour was complement and the speed of adjustment was relatively slow.

Some researchers used labour demand for other industry such as banking. For instance, Heshmati [11] estimated the labour demand and efficiency in the Swedish banking Battese *et al.* [12] also examined the efficiency of the labour use in the banking industry in Swedish using a stochastic Frontier approach.

Haouas *et al.* [13] estimated the demand for labour in the manufacturing sector in Tunisia, using a flexible adjustment model. They investigated the process of adjustment in employment. A dynamic model was applied to a panel of six Tunisian manufacturing industries observed over the period of 1971-96. The employment demand was modelled as a function of wages, value-added and capital stock. The empirical results showed that in the long-run, the employment demand responds greatest to the value-added, followed by the capital stock changes and the least by wages. The speed of adjustment in employment and the degree of labour-use efficiency showed large variations among the sectors and over time.

Amini [14] developed a labour demand model for 14 sectors of Iran. He used a dynamic model which was consistent with the imperfect competition situation in Iran. He found that the production, price of labour and capital had a larger effect on the labour demand. The price of labour had negative effect on the employment, whereas the relationship between labour and capital in three sectors were substitution and in eight sectors complement. Reducing the price of labour was more effective on the employment in all sectors.

MATERIALS AND METHODS

A dynamic demand model is used to estimate the demand for the agricultural labour since it is consistent with imperfect condition market of Iran. The dynamic demand model specifies that the actual employment has

a gap from the optimal employment in the economy. Hence, the dynamic demand model can be established as follows:

$$LnN_t^* = Lnf(X_t) + U_t \quad (1)$$

Where; N_t^* is the optimal level of employment (planned employment), X_t is a vector of the independent variables and U_t is a residual term. Where N^* is not observable and measurable, every variable in the process of econometric estimation should be numerical. Nerlove's (1958) process is used to convert the variables based on the partial adjustment [15]. Two forms of cost have been obtained based on partial adjustment; first, DC and second, AC. The DC is the cost of the distance between the optimal employment and the actual employment and AC is the cost of firing or hiring workers to achieve the optimal employment. For example, if the cost of DC is more than AC, the firm decides to hire new workers or fire old workers to reduce its labour cost (reduce the gap) and consequently reach to the optimal level of employment. According to this role, all firms want to minimize the employment cost based on these AC and DC. The employment cost for one period can be defined as follows:

$$TC = c_1(LnN_t^* - LnN_t)^2 + c_2(LnN_t - LnN_{t-1})^2 \quad (2)$$

Where; $DC = f(LnN_t^* - LnN_t)$, $AC = g(LnN_t - LnN_{t-1})$

The Equation (2) is considered as a quadratic form because of the better model specification. Minimizing Equation (2) with respect to the level of employment and rearranging it, Equation (3) has been obtained as follows:

$$LnN_t - LnN_{t-1} = \lambda(LnN_t^* - LnN_{t-1}) \quad (3)$$

$$\text{Where...}\lambda = \frac{c_1}{c_1 - c_2}$$

Where; λ shows the adjustment coefficient, $1/\lambda$ shows the speed of adjustment between the actual and optimal level of employment. Therefore, the speed of the worker adjustment is equal to $1/\lambda$. This fraction states the number of years it takes time the gap between the optimal and actual employment is reduced to zero.

From Equation (3), the optimal level of employment (N_t^*) can be calculated based on the measurable variables and after that substitute it into Equation (1). Then, Equation (4) is resulted as follows:

$$LnN_t = (1-\lambda)LnN_{t-1} + \lambda Lnf(X_t) + U_t \quad (4)$$

Consequently, the λ can be estimated econometrically. To determine the vector X, the total cost is minimized, assuming that the capital and labour are the two main inputs, such as:

$$\text{Total Cost} = C(r,w,y) \quad (5)$$

Where; r is the price of capital, w is the wage rate and y is the total output, Equation (5) is homogenous of degree one. Using Shephards Lema and derive it with respect to labour, a derived demand for the labour can be obtained. Therefore, Equation (6) called "demand for labour", is depended on the production level and price of other inputs [16].

$$L^d = \frac{\partial C(r,w,y)}{\partial w} = L^d(r,w,y) \quad (6)$$

The vector X includes the production and price of inputs. Substituting Equation (6) to (4) produces Equation (7). Equation (7) is a dynamic labour demand and it can be estimated by the econometric methods.

$$LnN_t = a_0 + a_1 ln(N_{t-1}) + a_2 Ln(y_t) + a_3 Ln(w_t) + a_4 Ln(r_t) \quad (7)$$

Where; α_0 is equal to intercept, $1-\alpha_1$ is the adjustment coefficient (λ), α_2 is the employment production elasticity, α_3 is the wage elasticity and α_4 is the cross-price elasticity. It is expected that the estimated parameter would place in these ranges $0<\alpha_1<1$, $\alpha_2>0$ and $\alpha 3<0$.

When the relationship between the capital and labour in the production process is substitution or complement, the relevant estimated parameter will therefore be negative or positive ($\alpha 4<0$ and $\alpha_4>0$). When the price of capital is increased, two effects will occur, the substitution and output effects. With the increase in the capital price, a relative price of labour decrease after that demand for labour is increased. In this case, labour substitute for capital in the process of production. This is called the substitution effect. Whereas, when the price of capital increases, the total cost of production increases. Then, the results decline in demand for all the inputs. This is called output effect [17]. If the output effect is greater than the substitution effect, the relationships between the labour and capital are complement and vice versa.

All data in the current research are based on the secondary data from the different sources collected. The used data were obtained from the Statistical Centre of Iran, Management and Planning Organization (Macroeconomic Office) and Central Bank of Iran databases from 1966/67 to 2000/01. The reason for using the database depends on the availability of the data sources in Iran. From these databases, we obtained the measured agricultural value added (total production) and the aggregate agricultural capital stock, both of which were converted into constant thousands Rial (1997=100) local currency. The database also provided the labour in the agricultural sector based on thousands persons.

Wage in the agricultural sector is based on the total payment of the agricultural worker in different years (1997=100) divided by the total agricultural employment. Price of the capital is calculated based on the user's cost of capital. The concept analysis of the user's cost of capital relies mainly upon the pioneered works of Jorgensen [18]. The user's cost of capital is the unit cost for the use of a capital asset for one period, i.e., the price for employing or obtaining one unit of the capital services. The user's cost of capital is also referred to as the "rental price" of the capital goods, or the "capital service price". The mathematical formulation can be expressed as follows:

$$C_t^p = (Dep_t + IN_t - CINF_t) \quad (8)$$

Where; C^p is price of one capital unit, Dep is the depreciation rate of the capital per year, IN is interest rate in the medium term where it shows a proxy of opportunity cost for capital and $CINF_t$ is the inflation rate for the capital goods. Equation (8) states that while the depreciation rate or interest rate increases, it will lead to an increase in the capital price; and while the inflation rate for the capital goods increases, it will lead to a decrease in the capital price and vice versa.

RESULTS AND DISCUSSION

The first step of the analysis of this study is to check for the stationary test for all the economic variables involved in the econometric estimations. The unit root test is vital for the co-integration and causality test [19, 20]. The stationary test, carried out to avoid any spurious regressions in the current study, examined by the use of the standard Augmented Dicky Fuller (ADF) and Philips-Perron (PP) tests [21, 22]. It is generally known that the results of these tests often depend on the number of lag included. Table 1 reported the ADF and PP unit root test results.

Therefore, the results of last columns in Table shows that all variables are integrated in the first difference or integrated of order one I(1). In other words, the results indicated that the null hypothesis of a unit root could not be rejected for all the variables in all levels. It implies that all the variables in the model are found to be I(1) non-stationary.

If a series must be differenced d times before it became stationary, then it contained d unit root test and was said to be integrated in the order d, denoted i(d). The concept of co-integration mimics the existence of the long-run equilibrium, to which an economic system

Table 1: Unit Root Test for the Dynamic Demand for Labour Variables

		Critical Value at Level				Critical Value at Level				
Variable	ADF	1%	5%	10%	PP	1%	5%	10%	Status	Integration
Ln(y)	-6.82	-3.64	-2.95	-2.61	-7.06	-3.64	-2.95	-2.61	Intercept	I(1)***
DV	-6.55	-3.58	-2.92	-2.60	-6.55	-3.58	-2.92	-2.60	Intercept	I(1)***
Ln(r)	-6.90	-3.61	-2.93	-2.60	-6.90	-3.61	-2.93	-2.60	Intercept	I(1)***
Ln(w)	-10.8	-3.64	-2.95	-2.61	-12.9	-3.64	-2.95	-2.61	Intercept	I(1)***
Ln(N(-1))	-2.25	-2.63	-1.95	-1.61	-2.21	-2.63	-1.95	-1.61	None	I(1)**

***Significant at 1% Level, ** Significant at 5% Level

None means without Intercept and Trend, Intercept means with Intercept

In Table 1, where;

y = total agricultural production (billion Rial, 1997=100),

N = agricultural labour (thousand people),

DV = dummy variable for eight years war between Iran and Iraq (1980/81 to 1987/88),

r = capital price (user cost of capital), (percent, dimensionless),

w = real worker wage (Rial, 1997=100),

The symbol "Ln" represents the natural logarithm of variables

Table 2: Results of the Estimation Dynamic Demand Function for the Agricultural Labour

Name	Coefficients	Estimated Parameters	T-test Statistics	Accepted at Level
Constant	α_0	0.225	0.45	--
Ln(N(-1))	α_1	0.956	14.27	1%
Ln(y)	α_2	0.0565	2.44	5%
Ln(w)	α_3	-0.0323	-1.23	--
Ln(r)	α_4	0.002	3.68	1%
DV	α_5	-0.0116	-2.55	5%
R^2				0.98
Adj-R^2				0.98
DV				1.76
F-Statistics				247.7

converges over time and residual term (U_t) can be interpreted as disequilibrium error (i.e., the distance that the system is away from the equilibrium at time, t). If the independent and dependent variables were both I(1) and $U_t \sim I(0)$, the two series would then be co-integration of order CI(1,1).

According to unit root test for the residual of dynamic demand function, it shows that it is stationary in level (I(0)). Hence, we can use the results derived from the models without any doubt on the spurious regression [19, 21-24].

The results of the estimated regression cooperate for the dynamic demand model for the agricultural labour is reported in Table 2, as follows:

where; α_1=0.956 is the employment lag coefficient, 1-α_1=0.0.044 is the deflator coefficient, α_2=0.056 the employment production elasticity, α_3=-0.032 wage elasticity, α_4=0.002 the cross price elasticity and α_5=-0.011 is the Dummy Variable (DV) for 8 years war (between Iran and Iraq). The labour demand was estimated using the Least Square method. The results show that only the wage elasticity is not significant. All coefficients have the right sign and no auto-correlation problem was detected.

Based on the theoretical expectation, the coefficients should be in the range of $0<\alpha_1<1$, $\alpha 2>0$, $\alpha 3<0$. The positive and negative sign of α_4 can present the substitution and complementation effects between the capital and labour, respectively. The α_5 shows the effect of the 8 years' war in the form of dummy variable on the labour demand expected to would be negative.

CONCLUSION

The objective of the current study is to examine a dynamic model of the agricultural labour demand with the consideration of the DC and AC based on the partial adjustment method proposed by many researchers [6, 7, 14, 15].

When the unemployment rate is less than 3%-5% the country is in the normal situation of employment in the other word whilst this amount is above 5%, the country will be in alarming situation. The unemployment rate has been in an alarming range in the urban and rural areas especially for the after Islamic Revolution period, particularly for the youth and educated people [1]. On the other hand; migration to cities because of the differences in wages, job opportunity and social motivations between the rural and urban areas, as well as the improvement in the capital intensive methods in the agricultural sector, has been an increasing phenomena. The production elasticity in the labour demand function is 0.0565 (α_2), it shows while production increases only a small increase occurs in the labour demand. Therefore the agricultural sector can not contribute in the economy for decreasing unemployment rate, while the agricultural production increases. This result is the same as Al-Jalaly [7] findings. This study showed that the employment could not increase over time in the agricultural sector. Therefore, the government should increase employment in other sectors to decline unemployment crisis.

The adjustment coefficient is equal to 0.044 (1-α_1=λ), suggesting that the speed of adjustment was too slow that was similar to Ncube and Heshmati [10]. Hence, it will take 22.7 (1/λ=22.7) years for the actual employment to adjust itself to the optimal level of employment. The wage elasticity is negative (α_3=-0.0323). The cross price elasticity (capital elasticity) is 0.002 (α_4). This elasticity indicates that the relationship between the capital and labour in the agricultural sector is substituted. The coefficient α_5 (-0.0116) means that the effect of the 8 years' war on the labour demand was negative.

While in the agriculture sector, the supply of labours is bigger than the demand for it and a high labour/ land ratio (labour surplus problem) is reported. It is caused by a high birth rate in the rural as compared to the urban areas (statistics confirm this claims, [1]). Although the rate of migration to the urban areas was quiet high, it could not accommodate the increasing population in the rural area to remove the labour surplus problem. In other words, it is not possible for the agriculture sector to completely be released from the labour surplus problem in the short-run. Sheikh and Iqbal [8] found the same result. They stated that the one of the main problems in the process of development in Pakistan was the high growth rate of its population.

The overall results suggested that the employer in the agricultural sector did not adjust the optimal level to the actual level of employment because of the high AC with respect to DC. The relationship between the two important inputs, capital and labour in the production process is substitution. This means that when the capital price is increased, the demand for labour also increases. Hence, policy makers can reduce the price of capital (by offering a low interest rate in the agricultural sector) to substitute the capital instead of the labour in production process. Polices to reduce the AC in order to diminish the gap between the optimal and actual employment are thus needed.

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