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The Estimation of Labor Force Demand Function Using ARDL Method (Studied in Mazandaran Province)

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ABSTRACT

The present article seeks to estimate labor force demand in Mazandaran province. To estimate the province's labor force demand during the years 1990-2009, ARDL method and error correction model were used. The results show that in the long run, capital stock and capital productivity have a positive effect on labor force demand and per capita capital has a negative effect on it. There is a significant relationship between labor force's short-term variations and its long-term balance. The restoration rate toward balance in error correction model is -0.3.

Keywords: *labor force demand, ARDL method, error correction model*

1. INTRODUCTION

The increasing growth and permanent development of economy lies in the optimum exploitation of producing resources. The human resource plays an important and vital role in this respect. Human resources play a dual role in economic planning's since on one hand it is viewed as the development factor and on the other hand is viewed as the development purpose. Human capital has achieved serious attention in development theories in recent decades and the countries' partial privileges are identified based on their human resources. The existence of unemployment crisis in Iran's economy threatens the country's long economic-social life. There is two-digit unemployment rate in Iran now as a result it would not be irrational to think that today's labor market changes will figure out future economic changes. Since the issues related to human resources are from both economic and non-economic aspects, they are of great importance in massive planning in such a way that employment has been the most important concern of the Iran's planners. In the present situation, high population with its high demands and the increasing number of youth and demands has challenged Iran's job opportunities. As a result, it will be of great importance to consider this important issue and take some compatible and structured policies to increase investment in economy. It also requires some wide-range and functional researches, so in the present article, the labor force demand in Mazandaran province has been estimated using an economic approach. This article is divided into five parts. In the following section, the theoretical framework is briefly discussed. The third section is about review of the related literature. Model estimation is provided in the fourth section. Conclusion and suggested studies are presented in section five and end with references.

2. THEORETICAL FRAMEWORK

The proposed theories in the literature of labor factor demand can be divided into two major groups: The first group is the labor stable theories which examine the position of labor factor demand from the employers at a time. In this relationship, the extracted models are examined via the maximum profit or minimizing the producer's cost function.

The second group consists of labor demand's dynamic theories which consider the labor factor demands provided by producing units during some periods of time. There is a difference between the real and desirable labor factor. This difference is because of the adjusted costs and non-equilibrium. If the firms decide to adjust their labor to achieve a desirable level of employment, they should pay the adjustment costs like the employment and labor dismissal costs. So it is possible that they accept to pay the non-equilibrium cost because of the high costs of adjustment. Hence, firms seek to minimize the total costs of adjustment and non-equilibrium. In the dynamic labor demand approach, the labor adjustment rate is presented in a desirable way which indicates the labor market's sticky. In the present study, stable theories are the main focus of this study.

2.1 Stationary Theories Of Labor Demand

a. How to maximize the producer's profit function?

A producer can usually change the cost and production level in a special unit and his final goal is achieving the maximum profit. If we assume that there is competition in the product market, the producer's total income will be obtained by multiplying the number of sold units by the price of goods which is fixed. The firm's profit is derived from the subtraction of the income from the cost.

$$\pi = p.f(L,K) - W.L - R.K - b \qquad (1)$$

In which P is the price of each product unit, W is the wage rate, R is the capital price (the rental price for each capital unit), b is the fixed cost, L and K are the labor and capital amounts respectively, and f(L,K) is the firm's production function. The labor demand and capital functions can be obtained by maximizing the profit function of the producer and providing first-order conditions and solving them for L, K based on W,P and R. As a result, the labor factor demand function can be expressed as follows:

$$L^d = L^d (W, R, P) \qquad (2)$$

Labor demand has a reverse relationship with the wage rate and a positive relationship with the product price. The relationship between the labor demand and capital price depends on the substitution or complementary relationship between the capital and labor. If the capital and labor are complementary, the labor demand will have a reverse relationship with the capital price. When the labor and capital are substitution, there will be a direct relationship between the labor demand and capital price. It is worth mentioning that the labor factor demand function based on P, R and W is homogeneous of degree zero. Using this characteristic, the labor demand function is written as follows:

$$L = L (W/P, R/P) \qquad (3)$$

In which, W/P is the real wage rate and R/P is the real price of the capital. When the capital and labor are complementary, labor demand usually has a negative relationship with the real wage. And if be substitution, the relationship between the labor demand and the real price of the capital will be positive respectively.

b. How To Minimize The Producer's Expenditure

One of the most important issues in the theoretical discussion of the firm is minimizing the total costs for a fixed level of production and the prices of inputs and output. This cost function is defined as a function of production level and prices and provides a complete description of the firm's behavior in competition situations. This cost function is the concave and homogeneous of degree 1 based on inputs' prices and has a positive relationship with the production level and inputs' prices. Demand equation system will be obtained by deriving this function based on inputs' prices according to Shephard's Lemma theorem. This system is a function of production level and inputs' prices. In fact, with using Shephard's Lemma and derivation of the producer's cost function in proportion with the inputs' prices will be obtained inputs' demand functions. To clarify the issue, we assume labor and capital as the two main factors. Assuming W, R and Y as wage rate, profit rate or the rental cost of each capital unit, and production level, the producer's cost function will be defined as follows:

$$C = C (W, R, Y) \qquad (4)$$

This cost function has a direct relationship with every independent variable and is based on the labor and a capital price is considered homogeneous of degree 1. By deriving the above cost function based on W, the labor demand function will be obtained:

$$Ld = \frac{\partial C (W,R,Y)}{\partial W} = Ld (W, R. Y) \qquad (5)$$

The labor demand function based on inputs' prices is homogeneous of degree 0. Based on this characteristic, the labor factor demand function is written as follows:

$$L^d = L^d (Y, W/R) \qquad (6)$$

As a result, the labor demand is dependent on the two factors of production level and the relative price of labor factor W/R. Labor demand has a direct relationship with production and a reverse relationship with the relative price of labor factor. If we consider production as something fixed, increasing the relative price of labor factor will decrease the labor factor demand. It means that capital will replace labor factor and the production will become a capital-intensive because the proportion of capital to labor k/l which indicates capital-intensive. On the other hand, if we consider the relative price of labor as something fixed, production increase will lead into an increase in the labor demand. In other words, considering the technique as something fixed, more production necessitates more labor factor (Amini, 2001).

3. REVIEW OF THE RELATED LITERATURE

In this section, we will pay attention to some studies carried out abroad which are related to labor demand and cooperation. Rosen & Qwandt (1977) examined the American labor market using the annual statistical data during the years 1930-1973. In this examination the following cases were estimated: Labor demand equations, the observed amount of labor as well as labor supply and the real wage adjustment. In these researches, demand equilibrium level for the labor is defined as a function of input prices' vector and production level. Macdonald and Murphy (1992) examined the

employment behavior of manufacturing industry in England using the seasonal time-series statistical data between the years 1965-1986. This period includes both Oil Shocks in the years of 1973 and 1979 which serve as an evidence for a decrease in employment even less than the employment level in 1964. In the present study, a model of labor demand under the condition of imperfect competition is used and its variables' vectors include production and the effects of relative prices. In the present study, the number of employees in England's manufacturing industries (LEMP) is a function of the production amount of the industry section (LQ), real wage index of the industry section (LW/P), the relative cost of the basic materials (LRMP), relative fuel price (LFP) and the capital stock in the industry section (RK). Based on the results obtained from this study which is a neoclassical model, there is a long-term relationship between employment and a vector of the mentioned variables because of the imperfect competition labor markets. Model of the labor market which shows that capital and production had positive influence on employment and the relative price of other basic materials, the real wage index, and the relative cost of fuel had a negative influence on employment.

In a study carried out by Sheikh, K. H. and Zafar-Igbal (1992), first the employment functions for 13 manufacturing industries were estimated for the years 1970-1987. Then the employment elasticity was calculated based on the employment cost. This elasticity provides us with some important information about what percentage of variation in the employment will happen if we have one percent variation in the employment cost. The results show that the employment elasticity for 10 industries between 13 manufacturing industries is positive and statistically significant. The maximum employment elasticity is for paper industry (1/11) and the minimum level is for special industry (0.6). The minimum employment elasticity means that labor demand happens in a situation in which Pakistan manufacturing industry uses capital-intensive technology. Other results show a negative relationship between each employee's employment cost and employment level. Brisco and Wilson (1992) have examined the condition of labor cooperation rates based on sexuality and age in England. In this study, women's labor cooperation rate model is provided in 8 age ranges. The estimations and predictions of these models are compared with each other to short and long terms. They concluded that the real wage coefficient in the middle age range models of women's labor cooperation rate is positive and significant which indicates the superiority of substation effect over the income effect. However, this variable coefficient is negative in high and low age range groups which indicate the higher strength of income effect.

Baltagi & Rich (2003) have searched for technology variations and labor demand in American industries for the period of 1959-1996. The results shows that labor share in production achieved its minimum when the technology was neutral. In 1980s proficiency -based technology led into labor demand movement.

In this section, we will introduce some studies carried out inside the country about labor demand and cooperation. Although the discussion and study of human resource constitute one of the most important issues for provinces, there has been little research on the provincial level. Most of the studies were carried out descriptively and focused on clarifying the existing facts. Some of these researches are mentioned below.

In their study, Amini and faliji (1997) have examined the labor demand in Iran's mine and industry section. In the present research, the condition of the labor demand in Iran's mine and industry section was examined using the time-series method during the years 1966-1994. In this study, using producer cost function and Shephard's Lemma, the labor demand function is extracted as a function of production level, labor force and capital prices. Besides, because of the absence of the statistical data about the capital and labor prices, using of feature homogeneous of degree 0 to the labor demand function into prices, this function is defined based on the production level and labor's relative price. Finally, the capital per capita variable instead of the relative labor force price was used in estimating the equations. The labor demand function is considered as a function of production level and capital per. In some sections of the article, it is mentioned that one of the problems of the standard model is that it is designed for complete employment and does not consider the unemployed capacity of the producing units, while one of the most important problems facing Iran's economy is the existence of the unemployed capacity of capital facilities. To solve this problem, an empirical model is suggested which considers the labor demand function as a function of capital per capita, capital productivity, and capital stock. Capital productivity is considered as a substitution for measuring the potential capacity of the production. All the parameters in the confidence level of 99% are significant and their signs are in accordance with the theoretical expectation. Since the empirical model focuses on the capacity making problems, it is considered as superior to the standard model. Based on the results of the present study, labor force demand will increase by increasing the production capacity (capital stock) if the other factors remain fixed.

In this relationship, compared to the standard model, the influence of capital per capita on the labor force demand is more. Moreover, labor demand will increase by

increasing the capital productivity (along with increasing the application of the production capacity) if the other factors remain fixed.

Farjadi (1997) evaluated the labor force cooperation rate models among men and women and predicted them until the year 2004. In this study, he examines the labor force cooperation rate based on sexuality and age in Iran. In this study, men and women's cooperation rates were examined in seven and ten age groups respectively.

The results from the economic estimations show that besides the population variables, the followings have a significant influence on the labor force cooperation rate of men and women:

Economic and cultural variables like education, unemployment rate, real wage index, inflation rate, GDP per capita, employees' shares in the section of industry, services and farming, the minimum wage index, per capita social security expenditures and so on.

Albaji (2001) estimated the demand and supply functions for the labor force in Khoozestan province using cointegration method and error correction model based on sexuality and different economic sections. To estimate labor force demand, Ghanadi (2002) estimated the productivity of the labor force in the industries of Koozestan province for the period of 1971-1999.

4. RESEARCH MODELS

As it was stated in section 2, some theories are stable or dynamic. Stable situation depends on the market condition, complete or imperfect competition; there are different perspectives about labor force demand in stable and dynamic conditions. Based on the theoretical frameworks of the labor force demand and the empirical studies, the demand for the labor force can be generally defined as a function of the relative price of the labor force, value added, capital stock and capital productivity. In the present study, because of the lack of statistics about the relative price of the labor force and wage in the labor force demand function in Mazandaran province, the capital per capita was employed. In empirical models, the capital per capita is used as a fake variable of the wage like the empirical studies of Lorenzo-Alvarez and etal (2002), Scott (2003) and Davia (2005). Among different models of labor force demand, those which are supported by the theory and empirical studies are used. In the present study, besides the standard model of the labor force demand (which is a function of the province's value added and capital per capita), the empirical model (which considers the labor force demand as a function of capital per capita, capital stock and capital productivity) has been examined. In the present study, OLS, ARDL and ECM tests have been employed. The following equations tend to estimate the labor force demand.

$$LEP = a_o + a_1 LGRP + a_2 LKEP + \varepsilon$$

$$LEP = a_o + a_1 LGRPK + a_2 LCAP + a_2 LKEP + \varepsilon$$

LEP: is the algorithm of the total labor force demand (employees).

T: is the technology and technical progress (trend variable).

LGRPK: is the capital productivity.

LKEP: is the proportion of the capital to the labor force (capital per capita).

LGRP: is the GDP of the province.

LCAP: is the algorithm of the capital stock.

ε : is the disturbance term.

Labor force demand includes the relationship between the wage rate (the labor force price) and the amount of employment and indicates how much labor force an employer can demand (with a fixed wage rate).
The labor force demand curve shows the maximum amount of employment which an employer can demand with a special wage rate and period of time (Sobhani, 1993p. 23). Capital productivity is related to the value added that each capital unit makes in the society (Sobhani, 1372, p. 47).

Capital stock: is the value of the investments in the economy minus their amortization (Sobhani, 1993, p.57). The data used in the present study is from the period of 1990-2009 and also the present information in Mazandaran planning and management organization (which were used in provincial reports) as well as the statistical calendar of the province.

4.1 Unit Root Test

Since most of the economic variables are in stationary,

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Table 1: the values of augmented Dickey-Fuller (ADF) test.

N. lags	Prob	T statistics	Variables	
0	0.03	-3.30	Capital reserve algorithm	D(LCAP)
0	0.03	-3.28	Capital per capita algorithm	D(LKEP)
0	0.03	-3.27	Capital productivity algorithm	D(LGRPK)
0	0.004	-4.84	Province's value added algorithm	D(LGRP)
0	0.01	-2.44	Labor force demand algorithm	D(LEP)

Source: research findings

they should be tested before using any variables in the empirical demand model. To test the variables augmented Dickey-Fuller test (ADF) test is used. In the present study, the tested variables were examined based on the unit root test. The results are provided in as it is clear all the variables were in the in stationary level. The making differences of variables than all them are stationary

4.2 Estimating the models based on OLS and ARDL

OLS test for the research model: for this estimation, we use OLS. Model 1 is chosen to estimate the province's labor force demand as follows:

$$LEP = a_o + a_1 LGRP + a_2 LKEP + \varepsilon$$

Based on the results from the model estimation, the estimated coefficients are significant in the confidence level. The influences of the province's capital per capita and value added on labor force demand are positive. However, Watson Durbin- Watson Statistics is 0.94.

LEP = 12/64 + 0/05LGRP + 0/24LKEP + 0/93MA

(5.83) (2.68) (12) (526.15)

R^2=0.98

$\bar{R}^2$=0.98 HDW= 0.94

In the second model, the estimation is as follows:

$$LEP = a_o + a_1 LGRPK + a_2 LCAP + a_2 LKEP + \varepsilon$$

The result of the labor function estimation is as follows:

LEP = 14/44 - 0/39LGRPK + 1/36LCAP - 18/66LKEP

(-7.34) (45.4) (7.66) (-3.98)

R^2 =0.99

$\bar{R}^2$=0.99 HDW= 1.23

The coefficient signs are the according of economic opinions. Labor force demand has a negative relationship with the capital per capita. An increase in the capital per capita shows the capital-intensive its productions and a decrease in the labor force demand. The identification coefficient of more than 99% is a good indicator of the value and identification of variables. The capital stock coefficient in this estimation is positive meaning that an increase in the production capacity (capital stock) will lead to an increase in the labor force demand (if the other factors remain fixed). Of course, the capital stock coefficient is significant and shows the negative influence of this variable on the labor force demand. It means that an increase in the capital productivity (with an increase in employing the existing production capacity) will decrease the labor force demand if the other variables remain fixed.

4.3 Estimating the dynamic model of labor force demand function

ARDL method and Micro fit software are used to estimate the changing model of the labor force function. In dynamic relationships among the variables, it should be noted that variables appear in the model with a stop. To understand the number of desirable lag, Hannan-Quinn and Schwartz Bayesian criteria are used.

Table 2: the results of the dynamic relationship for the dependent variable of the province's labor force demand algorithm. ARDL (1,1,0,1)

Prob	coefficients	Variables	
0.00	0.99	Labor force demand algorithm	LEP
0.00	-11.53	Capital per capita algorithm	LKEP
0.00	12.15	Capital per capita algorithm with lag 1	LKEP(-1)

0.08	0.05	Capital productivity algorithm	LGRPK
0.00	0.89	Capital reserve algorithm	LCAP
0.00	-0.90	Capital reserve algorithm with lag1	LCAP(-1)
0.99		The adjusted identification coefficient	
1.68		Watson camera	
1.68			

Source: research findings

In order to determine the variables' desirable stops in the present study, Shwarts- Bazin criterion is used which leads to more economy in the desirable lag. In this study, the stop is assumed as one. The software chose the following model as the best. The summary of the results from changing model is provided in table (2). The following assumption is tested to check if the long-term relationship produced by this method is fake or not.

$$H_0 : \sum_{i=1}^{p} \Phi_i - 1 \geq 0$$

$$H_1 : \sum_{i=1}^{p} \Phi_i - 1 < 0$$

Φ_i shows the coefficient of the dependent variable with a lag in the right side of the equation. The desirable stop here is one so p=1. The null hypothesis shows the non-existence of co integration or the long-term relationship. Because the condition for the short-term changing relationship to move towards the long-term equation is that the total coefficients should be less than one. To test this, we should calculate the subtraction of one from the total coefficients with the dependent variable stop in changing model and divide it by total standard deviation of the coefficients. If the obtained absolutely value statistic is bigger than the absolutely value of critical amounts provided by Benerjee, Dolado, Master (1992), the null hypothesis will be rejected and the existence of a long-term relationship will be accepted. To test the existence of long-term relationship based on changing model, T statistics is used as follows:

$$\tau = \frac{(0.90)-1}{(0.002)} = -4.54$$

In dynamic model, the T statistics is -4.54 which is smaller than the corresponding T amount (-4.05) in Benejee, Dolado, Master table. Hence, the null hypothesis showing the non-existence of the long-term relationship is rejected. So, we can conclude that the above-mentioned short-term dynamic relationship tends to long-term adjustment. However, we cannot claim this in estimating the coefficient of the long-term model of the province's labor force function.

These coefficients show a long-term relationship between the existing variables in the model. The results determine the insignificantly of these coefficients. The above results indicate that the capital productivity elasticity in the long run is 0.05.

It means that if the capital productivity changes for one percent, the province's labor force demand will change for 0.05 in the same direction. However, this amount is not statistically significant. Moreover, an increase in the province's capital per capita will lead to a decrease in the labor force demand by 11.53 percent. Using the data of the present study, we can make the following claim about the capital reserve: the positive capital reserve coefficient (0.89), or one percent increase in the capital reserve in the long run, is the same as labor force demand.

While the coefficients are obtained in the long-term model, we will test the hypothesis about meaningfulness of coefficients using the parent test.

The significant coefficient test: the parent test is used to significantly check the coefficients. The parent statistics is defined as follows:

$$W = \phi'(\hat{\theta}_U)\{\hat{V}(\phi[\hat{\theta}_U])\}^{-1}\phi(\hat{\theta}_U)$$

In which ϕ shows the coefficients' limitation function which is $\hat{\theta}_U = 0$ (in general, θ is a vector including some limitations), $\hat{\theta}_U$ is the estimated coefficients and $\hat{V}(\phi[\hat{\theta}_U])$ is the variance $\phi(\hat{\theta}_U)$. The results of the test show that there is a relationship between the independent and dependent variables for each variable in the confidence level of 95% except the unemployment rate variable.

The long-term adjustment relationship is related to short-term labor force demand variations using the results from error correction model (ECM). The stop length in the error correction model is one.

ΔLEP = 0/86dLCP – 11/53dLKEP + 0/56dLGRPK – 0/003ECM

(20.56) (-1.17) (-20.76) (1.86)

R^2=0.98

$\bar{R}^2$=0.98 HDW=1.68

In each period (every year), 3 percent of a period's non-adjustment is adjusted in the following period's labor force demand.

5. RESULTS AND SUGGESTIONS

Based on the results from the equation estimation, the most important and influential factors on the equations' coefficients have been identified and used in the province's policies to increase its labor force demand. The result of estimating the equation shows the existence of a direct relationship between the labor force demand as the dependent variable and the province's value added. It means that an increase in the province's value added will lead to an increase in the province's labor force demand. The result of estimating the second equation shows the fact that there is a long-term relationship among the labor force demand, capital reserve and capital per capita, and capital productivity. Based on this relationship, an increase in the province's capital productivity and capital per capita has a negative relationship with labor force demand while there is significant and positive relationship between the capital amount and labor force demand in the province. It means that if the investment amount in the provincial level increases, there will be more labor force demand. The estimated error correction model (which relates the variations in the labor force demand in Mazandaran province to its long-term adjustment relationship) showed that in the case of the existence of non-balance in the system, the resulted deviation tends to the adjusted profit with a slow pace and in one period interval, so the model will reach to another adjustment.

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