

APPLICATIONS OF PRODUCTION FUNCTION IN AGRICULTURE

Maria Parlińska

Department of Agricultural Economics and IER
Warsaw University of Life Sciences – SGGW
e-mail: maria_parlinska@sggw.pl

Galsan Dareev

Buryat State Agricultural Academy
e-mail: gdar@mail.ru

Abstract: The article describes some possibilities of using the production function for the theoretical analysis of agricultural economics. It's proposed a some approaches to the analysis of Agricultural economy in the Poland as national economy part and Agricultural economy in the Republic of Buryatia¹ as regional economy part. The mathematic models are made for both cases, the results is obtained, which show the production functions efficiency for macroeconomic analysis.

Key words: Production function, Agricultural economy, analyze, forecast

INTRODUCTION

The production function shows the dependence between the production result and the volume of resource use. Production function is a function that specifies the output of a firm, an industry, or an entire economy for all combinations of inputs. Almost of all macroeconomic theories, like macroeconomic theory, real business cycle theory, neoclassical growth theory presupposes production function. In this sense, production function is one of the key concepts of neoclassical macroeconomic theories. It is also important to know that there is a subversive criticism on the very concept of production function.

¹ The Republic of Buryatia is a region of the Russian Federation.

THEORETICAL BACKGROUND

The subject of study on production function is found interesting because of following reasons:

1. Production functions seem to be a group functions widely used to analyze economic processes since being highly efficient they are not difficult to study, and they require estimated capacities. Unfortunately, today production functions are no longer used to analyze the Agricultural economy in Russia and Poland due to a range of circumstances.
2. Students being specialized in economics study production functions as the theoretical discipline as well as applied science. Study on production functions is carried out within a single discipline since it is not special one.
3. Production functions are widely spread in the World where our colleagues are actively using them. But we need to come to an agreement about calculation methods and their application.

Thus, there is a precedent to apply production functions in practical analysis of economy development in the region. At the same time there are some factors restricting their use. We have mentioned them before.

To have a good understanding of the essence of production functions we should study some theory first, and then pass on to some practical decisions.

As economic process production functions seem to demonstrate dependence of production capacity on tangible resources. As a factor of production of macro level we focus on capital (usually fixed assets) K and labour L , as for the outcome it can be distinguished as follows.

- Gross product (GP) – X .
- Gross domestic product (GDP) – Y ;
- National revenue (NR) – N .

In this case we shall focus on gross output in economy – X .

Production assets are introduced in the form of basic and floating, production and non-production. The choice of this or that factor K should be defined by the purpose of study.

IMPLEMENTATION OF PRODUCTION FUNCTION IN AGRICULTURE – CASE STUDY

The results of agricultural economy development analysis of the Poland and the Republic of Buryatia are presented in this article. The model in the form of nonlinear production function is substituting the Agricultural economy.

$$X = F(K, L) \quad (1)$$

It means that production output is a function resulted from costs of resources including production assets and labour. The most widely spread are multiplied forms of production functions.

$$X = AK^{\alpha_1}L^{\alpha_2}, \quad \alpha_1 > 0, \alpha_2 > 0, \quad (2)$$

where A is total factor productivity (a ratio of neutral technical progress that is distinguished as dimension ratio).

α_1, α_2 are the output elasticities of capital and labour. These values are constants determined by available technology.

The Cobb-Douglas function can be found as particular case of this function.

$$X = AK^{\alpha}L^{1-\alpha}, \quad \alpha_1 = \alpha, \alpha_2 = 1 - \alpha \quad (3)$$

Two types of functions have being distinguished:

1. Constant Elasticity of substitution (CES).

In this case resource elasticity of substitution doesn't depend on neither K nor L , that is why it is constant.

$$X = A[(1-a)K^{-b} + aL^{-b}]^{-\frac{c}{b}} \quad (4)$$

2. Variable Elasticity of substitution (VES).

$$X = Ae^{\alpha} \cdot K^{\alpha} \cdot L^{\beta} \cdot \exp\left[c\left(\frac{K}{L}\right)\right] \quad (5)$$

Let's focus on the production function once again. There is following information for making analytical calculations:

Table 1. – Gross output, capital (fixed assets) and labour (number of agricultural employers) in Poland.

Years	Gross output (X), mln. PLN	Capital - Fixed assets (K), mln. PLN	Labour (L), thousands
2000	55985,4	106831,4	4304,6
2001 ²	55845,7	108655,5	3232,9
2002	55706,0	110479,5	2161,1
2003	56263,6	110707,5	2138,3
2004	69747,7	110935,4	2139,5
2005	63337,2	112375,7	2134,1
2006	65083,4	114669,3	2140,6
2007	81509,2	117377,2	2138,2
2008	83126,5	119921,4	2128,3
2009	79706,6	122570,0	2124,9

Source: Statistical Yearbook of Agriculture, Warsaw, 2002 -2010, own

² 2001 data are estimated.

Table 2. – Gross output, capital (fixed assets) and labor (number of agricultural employers) in Republic of Buryatia .

Years	Gross output (\bar{X}), mln RUB	Capital - Fixed assets (\bar{K}), mln RUB	Labour (\bar{L}), thousands
2000	4481,7	3799,0	60,9
2001	5164,2	4655,0	60,3
2002	5638,1	5031,0	58,0
2003	6344,7	4715,0	71,7
2004	7471,4	7133,0	67,3
2005	8036,6	6676,0	56,2
2006	8993,5	8335,0	54,1
2007	10546,2	8103,0	54,9
2008	11745,6	8944,0	55,8
2009	12086,3	9523,0	55,9

Source: Russian Statistical Yearbook, Moscow, 2010, Regions of Russia: Social and Economic Indicators, Moscow, 2010.

Production function (3) is used for the analysis in both cases. Multiplicative production function is determined from a time series of production result and resource costs (X_t, K_t, L_t) , $t=1, \dots, T$, where T is the length of time series. It is assumed that there is T number of relationship $X_t = \delta_t A K_t^{\alpha_1} L_t^{\alpha_2}$ where δ_t is correction coefficient, which aligns the actual and estimated production results, and shows the result fluctuation under the influence of other factors. At the same time $M\delta_t = 1$. This function is linear in logarithms

$$\ln X_t = \ln A + \alpha_1 \ln K_t + \alpha_2 \ln L_t + \varepsilon \quad (6)$$

where $\varepsilon_t = \ln \delta_t$, $M\varepsilon_t = 0$. It is obtained a model of linear multiple regression.

Function parameters A , α_1 , α_2 can be determined by the method of least squares.

This model can be used to analyze and forecast the Agricultural economy in the Poland.

$$X' = 1 \cdot 10^{-13} K^{3,493} L^{0,0458} \quad (7)$$

From the analysis of coefficients α_1, α_2 in the function (7) shows that $\alpha_1 + \alpha_2 > 1$. Therefore, the function (7) be called a disproportionate and quickly growing. Coefficient $\alpha_1 = 3,493$ means that the increase in fixed assets by 1% causes an increase in gross output of agriculture in the Poland by 3,5%. And coefficient $\alpha_2 = 0,0458$ shows the number of employers increase by 1% causes the gross agricultural output growth by only 0.05%. Hence, we can conclude that Agricultural economy growth in the Poland is highly dependent on the fixed assets development and their high productivity. The coefficient of neutral technical

progress A is close to zero and significantly reduces the value of gross output in Polish agriculture.

For describing the development of the agricultural economy in the Republic of Buryatia has received the following production function:

$$X' = 4,4476 \cdot 10^{-1} K^{1,0688} L^{0,1046} \quad (8)$$

Analysis of the elasticity coefficients for the function (8) shows that $\alpha_1 + \alpha_2 > 1$, i.e. function (7) is increasing disproportionately. Increase in fixed assets by 1% causes the increase in gross output in agriculture in the Republic of Buryatia by more than 1.06%. But the increase in the number of employers per 1% increase in gross output by 0,1%.. Therefore one can say, that a qualitative indicator of capital productivity in agricultural economics is more important than labour productivity.

CONCLUSION

One can conclude that agricultural economy growth in the Poland is highly dependent on the fixed assets development and their high productivity. Production growth in the Republic of Buryatia largely depends on the value of assets growth in agriculture, rather than growth in the number of employers.

REFERENCES

- Cohen, A.J. and Harcourt, G.C. (2003) Retropectives: Whatever Happend to the Cambridge Capital Theory Controversies? /Cohen, A.J. and Harcourt, G.C. //Journal of Economic Perspectives. – №17(1). – pp.199-214.
- Дареев Г.Е. (2003) Использование производственных функций в макроанализе сельскохозяйственного производства в регионе /Г.Е. Дареев //Состояние и перспективы развития агропром. комплекса Забайкалья: Материалы ежегод. науч.-практ. конф. (4-6 февр. 2003 г.) /Бурят. гос. с.-х. акад. им. В.Р. Филиппова. – Улан-Удэ,– С.272 – 276.
- Дареев Г.Е. (2003) Производственные функции /Г.Е. Дареев //Развитие агробизнеса и сельских территорий в Байкал. регионе: Материалы междунар. семинара (9-13 сент. 2002 г.) /Бурят. гос. с.-х. акад. им. В.Р. Филиппова, Швед. ун-т с.-х. наук. и др. – Улан-Удэ, – С.96 – 101.
- Дареев Г.Е. (2006) Производственные функции в моделировании экономического роста регионального АПК /Г.Е. Дареев //Инновации молодых ученых – сел. хозяй-ву: Всерос. конф.: Сб. материалов/ МСХ РФ. – М., ФГНУ «Росинформагротех», – ч.1. – С.21-27. – Библиограф. с.27 (3 назв.)
- Колемаев В.А. (1998) Математическая экономика: Учебник для вузов. – М.: ЮНИТИ, – 240 с.
- Moroney, J. R. (1967) Cobb-Douglass production functions and returns to scale in US manufacturing industry /Moroney, J. R. //Western Economic Journal. vol 6, №1, December – pp 39-51.

