THE CREATION OF THE ESTIMATION OF THE RATIO OF INTERNAL AND EXTERNAL RESOURCES IN THE MANAGEMENT OF EXTENSIVE AND INTENSIVE FIRM DEVELOPMENT

Assoc. Prof. Anatolyi Shikhalev, Assoc. Prof. Irina Akhmetova

Assist. Lecturer Dmitry Vorontsov

Kazan (Volga region) Federal University, **Russian Federation**

ABSTRACT

In the article is carried out the general analysis of JSC "Nizhnekamskneftekhim" profit sources and losses which are separated by the internal and external factors. For the periods of 2005 - 2012 and 2005 - 2011 are constructed the models of extensive and intensive growth for the purpose of the accounting of their shares in production management on the near-term outlook.

Keywords: labor productivity, production functions, multiple regression, multiplicative Kobb-Douglas function, extensive / intensive growth, short-term planning.

INTRODUCTION

One of the main objectives of social and economic development of the Republic of Tatarstan for 2011 - 2015 is increase of competitiveness of the region. The main emphasis in its decision is placed on achievement of high standards of level and dynamics of labour productivity in sectors of petrochemistry and mechanical engineering**.**

Higher potential for these indicators achievement is available in a petrochemical complex of the region where the leader is "Nizhnekamskneftekhim" the largest producer and exporter of petrochemical production in Russia [4, 5, 6]. Its growth could be explained on the one hand with increase in the world market of the prices of petrochemical production. The last 5 years the prices of natural raw materials grew already by 72% (the price of one pound of natural rubber of the Smoked Sheet brand at the Singapore commodity exchange since last November grew by 20% to 1,81 US dollars) [7]. On the other hand, that fact that the period with 2010 - 2012гг. it is noted by a considerable advancing of average annual growth rates of revenue concerning rates of increase in product cost allows to state positive tendencies in the course of production efficiency increase.

It is known that the firms achieving high financial results at the expense of successfully developed environment in the market in the conditions of lack of possibility of continuous productivity increasing have no prospects of a sustainable development. It is expedient to spread out financial result of JSC "Nizhnekamskneftekhim" ("NKNKH") to two components one of which depends on internal organizational and technological conditions which as a whole can be reduced to productivity indicators whereas another (external conditions) is urged to characterize specific market conditions.

Production capabilities of JSC "Nizhnekamskneftekhim" as well as any other enterprise in a bigger or smaller measure is defined by a ratio of internal and external resources. It

is necessary first of all to carry to the internal resources any connected with the number of workers and their labour productivity, external - with the market conditions which finally are reflected in the sales results. For the estimation of a ratio of such internal and external factors we will reduce some indicators of the chosen firm to the separate table (tab. 1).

Table 1. Dynamics of indicators of labor productivity, number of workers and production sales revenue of JSC "Nizhnekamskneftekhim" [5]

Indicators	years							
	2005	2006	2007	2008	2009	2010	2011	2012
Revenue (mln.of roubles)	47982	53889	65183	77868	62989	96516	126021	130500
Net profit (mln.of roubles)	925	2779	3321	1115	-648	8885	16776	15277
Number of workers,thousands	15,027	17,173	18,668*	18,375	17,636	17,620	17,765	18,274
Work productivity mln.of roubles	3.193	3.138	3.202	4.247	3.571	5.477	7.093	7.141

Note: 1) the sign "*" designated the indicators received with the extrapolation with the using of a random walk method [6].

From tab. 1 follows that the crisis phenomena were reflected in the general dynamics not very considerably, except for, perhaps, arrived in which considerable decrease is observed following the results of the 2009th year. Whereas for the further analysis it will be expedient to consider mutual dynamics for conditional internal factors – number working both labour productivity on the one hand and the external indicator characterizing result of direct action of external factors, including market factors (revenue) – with another.

The results of table 2 testify to obvious interrelation of all processes presented here – labour productivity, number working (internal factors) and the revenues, representing total influence of external factors. However despite as a whole external similar tendencies also exist the distinctions. Though on continuation of the period of 2008 - 2012 are observed the quite synchronous tendencies of all three indicators. However dynamics of all three indicators is in special interest on a period of 2011 - 2012: at insignificant increase of number of workers and revenues lack of growth of labour productivity is observed practically. Therefore, since 2011 the development of the firm happens not mostly due to production efficiency increase (intensive growth) like first of all due to growth of its scales (extensive growth). In this regard time interval from 2009 to 2012 in particular for revenue and labour productivity represents a branch of a known S-shaped logistic curve with the saturation when growth of resources slightly affects release of finished goods.

Considering that the firms with rather high labour productivity level (an internal resource) have the better ability to resist to market elements (external circumstances) than less productive enterprises it's possible to propose that their dependence on the market can be regulated in a certain degree only from the expense of internal resources.

Then we could assume that generally the firm having even average productivity (instead of bigger than others) is in bigger dependence from the market.

For the checking of this hypothesis it is possible to use the possibilities of production functions and if after the comparing of two models it appears that the share of labor-saving (intensive) growth during 2005 - 2011 will be significantly higher than during 2005 - 2012 our hypothesis will be convincingly verified.

Production functions creation. As the basic data for use of analytical opportunities of the production functions are used results of activity of chosen firm from 2005 to 2012 given in tab. 2 which contains the same indicators of tab.1 with the new missing line "Fixed assets" as an indicator of production function K.

Table 2. The chosen activity indicators of JSC “Nizhnekamskneftekhim”

Indicators	years							
	2005	2006	2007	2008	2009	2010	2011	2012
Revenue (mln.of roubles)	47982	53889	65183	77868	62989	96516	126021	130500
Fixed assets, bln.roubles	16,626*	19,928	23,230	26,532*	28,715*	32,056	34,734	42,843
Number of workers,thousands	15,027	17,173	18,668*	18,375	17,636	17,620	17,765	18,274

Note: 1) data on "fixed assets" are obtained from a source [8]; 2) the sign "*" designated the indicators received with the extrapolation with the using of a random walk method. Here modelled production function expresses the dependence of the production results from the resource expenses where are considered as a resource the saved-up work in the form of business assets (the capital K) and work (number of workers of L), and as result – part of volume of let-out production – revenue X.

Then the result of functioning of the chosen firm at macrolevel could be presented as the model in the form of the production function (PF):

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

Production functions (1) generally is nonlinear that will better be coordinated with object of research from the positions of the system analysis. In this case JSC “Nizhnekamskneftekhim” is possible to consider as a certain indivisible cell. Then PF of a general view (1) could be considered as a neoclassical if it is smooth and meets the following conditions [7]: 1) in the absence of one of resources (K or L) production is impossible; 2) with the growth of resources output grows; 3) with the increase in resources the growth rate of release is slowed down; 4) in the case of unlimited increase in one of resources release grow unlimited. Then multiplicative PF can be set by the general expression:

$$X = A \cdot K\alpha 1 \cdot L\alpha 2, \quad (2)$$

where A – coefficient of neutral technical progress; α1 and α2 – elasticity coefficients on funds and on work.

As the multiplicative PF of a look (2) is determined by the temporary number of releases and expenses of resources (see tab. 3) for it it’s possible to use the device of the

multiple regression based on the least squares method [9]. It is easy to find that expression (2) in logarithms on any basis is linear:

$$\ln X = \ln A + \alpha 1 \ln K + \alpha 2 \ln L. \quad (3)$$

As a result when using initial information of tab. 2 in all time span (2005 - 2012) we receive the model of linear multiple regression which is linear to unknown A, α1 and α2 as a regression coefficients which could be found with the standard computer programs. As a result of using (hereinafter) the author's software package the following results are received: α1 = 1,1837: α2 = - 0,4290: ln A = 1,6709. Therefore, as a result of exp (A) potentiation = exp (1,6709) = 5,3172.

Then PF in a multiplicative look from 2005 to 2012 with the taking into account expression (3) will look like:

$$X = 5{,}3172 \cdot K1{,}1837 \cdot L- 0{,}4290. \quad (4)$$

The calculated values of coefficients of multiple regression as a whole meet qualifying standards by the Fischer and Student's (t-test) criterias. The reliability of the received equation (4) according to Fischer is 97,2%; the importance of coefficients of regression of this equation on Student's is 99,6% and 30,2%. It is clear that the importance of the last is significantly less than necessary 90%. However considering the fact that the coefficient of determination of R^2 = 0,89 (means that independent variables of the model cover 89% of all relationships cause and effect) characterizes quite sufficient completeness of coverage of operating exogenous factors of K and L on a resultant (endogenous) indicator X. Also the rather low level of a logarithm of an error of the approximation of 1,62% (then an absolute value of an error of approximation = exp (1,67) = 5,07% ≈ 5% - see the tab. 3) the received model (4) could be used for the further calculations taking in mind that Durbin-Watson's criterion characterizing the existence or lack of significant autocorrelated rest is 2,24 which is differs from value 2 when it is considered that in model (4) the autocorrelated remains are principally absent [10].

For the purpose of more serious evidence about the degree of a solvency of the received model (4) we will illustrate absolute and relative errors of initial approximation of a look (3) in the form of the list of the author's computer program, presented in tab. 3.

Table 3. Table of deviations of linear function a look (3)

Number in data file /years	Data		Deviations	
	raw	calculated	absolute	relative, %
1/2005	3,8710	3,8359	0,0348	0,9005
2/2006	3,9870	3,9940	- 0,0071	- 0,1787
3/2007	4,1170	4,1388	0,0383	0,9183
4/2008	4,3550	4,3029	0,0520	1,1953
5/2009	4,1430	4,4141	- 0,2712	- 0,5462
6/2010	4,5700	4,5668	0,0029	0,0636
7/2011	4,7880	4,6363	0,1513	3,1613
8/2012	4,8710	4,8725	- 0,0012	- 0,0247
Logarithm of the summary approximation error				1,6230%

So with the a concrete view of PF look like (4) it is possible to receive a better understanding about its properties as the difficult by its nature reflection of the existing at the time of modelling social -economic phenomena and processes.

Maintenance analysis of the of received PF of a look (4) for 2005 - 2012. Throughout the work with the received PF model for the estimation of growth factors of the chosen firm the quoted and adapted technique [7] recommends to distinguish the extensive factors of growth (from the f increase in expenses of resources which means the increase in production scales) and intensive factors (due to increase of efficiency resources using). Thus production efficiency is estimated as the relation of the reached results to the expenses. For this purpose at first it is necessary to determine by basic data the degree of frequency rate of distinctions of the variables X, K and L accepted to modelling as the relation of their sizes for 2012 to their initial values in 2005. As a result we will receive: 1) the revenue increased in the chosen firm in X * = (X2012/X2005) = (42,843 billion roubles / 16,626 billion roubles) = 2,5769 times; 2) the fixed business assets increased in K * = (K2012/K2005) = (130,500 billion roubles / 47,982 billion roubles) = 2,7198 times; 3) number of the workers occupied in production process in L * = (L2012/L2005) = (18,274 thousand people / 15,027 thousand people) = 1,2161 times.

For the further analysis it is necessary to give the economic interpretation of the regression parameters A, α1, α2 the equations in an additive and multiplicative form (3) and (4) respectively. Parameter A is interpreted as the parameter of neutral technical progress: at fixed α1 and α2 output (here – its parts in the form of revenue) in a point (K, L) it is more than more is A. Here α1 acts as elasticity of release on fixed assets and α2 as the elasticity of release on work. So according to a type of PF (4) the increase in fixed assets at 1% the revenue will increase by 1,1477% ≈ 1,15% whereas with the increase taken in production for 1% the revenue will decrease on 0,4290% ≈ 0,43%. It is quite obvious that in a case α1>α2 we have labor-saving (intensive) growth whereas in the return case an extensive growth takes place.

Discussing the nature of growth rates it is necessary to estimate for our case the justice of performance of a ratio (α1 + α2>1) the performance of which testifies that a resultant indicator "the revenue X" grows quicker than the regressors in average (factors of K and L operating in model); here the received model is usual for the growing economics. However as a result of modelling of a type of PF (3) or (4) coefficients of regression have values: α1 = 1,1837; α2 = - 0,4290. Then expression α1 + α2 = 1,1837 – 0,4290 = 0,7547 that is much less than 1 which means that is the sum of two coefficients of regression of PF of a look (4) isn't usual for the growing economy.

Due to [7] the further analysis of a received PF look (4) it is expedient to carry out in the terms of Kobb-Douglas function when the special case of PF of a general view (2) is the function like

$$X = A \cdot K\alpha \cdot L\,(1 - \alpha), \qquad (5)$$

where α = α1 / (α1 + α2) = 1,1837 / (1,1837 - 0,4290) = 1,5684; then (1 – α) = (1 – 1,5684) = - 0,5684, and expression of standard multiplicative function (4) in the form of Kobb-Douglas function on the basis of expression (5) will look like:

$$X = A \cdot K\,1{,}5684 \cdot L\ - 0{,}5684. \qquad (6)$$

For the achievement of the objectives of research – the verification of a work hypothesis of dynamics (negative or positive) of the internal reserves of the firm we need to determine the private efficiencies of resources for the capital productivity (EK) and for the labour productivity (EL) by the following formulas:

EK = X* / K* = 2,5769 / 2,7198 = 0,9475;

EL = X* / L* = 2,5769 / 1,2161 = 2,1190,

where X * is the growth of the revenue (as organic part of total production) for 2005 - 2012; K * - growth of volume of business assets for the same period; L * - growth of workers number for the same period.

Further basing on the function of the type (6) the generalized indicator of efficiency E as the geometrical average (as we estimate the dynamic average) of the private indicators could be found in a look

E = EKα · EL(1 – α) = 0,94751,5684 · 2,1190 - 0,5684 = 0,9189 · 0,6526 = 0,5997 ≈ 0,60 (times).

Then the average production scale in dynamics could be determined as a geometric average, proceeding from the resources growth rate:

M = K*α · L*(1 – α) = 2,71981,5684 · 1,2161 - 0,5684 = 4,8032 · 0,8948 = 4,2979 ≈ 4,30 (times)

Thus the general growth of revenue as the organic part of the general production of JSC "Nizhnekamskneftekhim" from 2005 to 2012 by 4,30 times happened due to growth of production scales, whereas only in 0,60 times – due to the increase in production efficiency. Then the ratio of scale growth and growth of efficiency could be expressed as their relation: S = E / M = 0,60/4,30 = 0,14 (times). In other words during 2005 - 2012 in the general growth the share of efficiency in relation to a share of scale made wasn't more than 14 % (approximately the one seventh from the general growth).

To confirm or disprove our work hypothesis we will carry out the similar analysis (on the main indicators) for the control period of 2005 - 2011 – the previous period reduced for one year.

Development of the PF model during the 2005 - 2011 and its analysis. According to initial tab. 1 the following type of new PF is received:

X = 5,3283 · K1,1857 · L- 0,4319. (7)

Received PF of a look (7) could be characterized with the following statistics: reliability of the received equation according to Fischer is 90,1%; the importance on Student criteria of regression coefficients for the first and second coefficients is 97,9% and 26,3% (also low); coefficient of determination of R^2 = 0,8380; the approximation error is 1,85% in a logarithmic scale or 6,4% in interval scale; autocorrelation degree on Durbin-Watson's criterion slightly differs from two: DU = 2,018 ≈ 2,00 that means that the autocorrelated remains in the equation (7) are practically absent. As the production function of a look (4) is differs on basic data from new PF (7) for only one year so their parameters differ as a whole slightly.

We will calculate values of indicators for the Kobb-Douglas function of a look (6) for the further calculations: α = α1 / (α1 + α2) = 1,1857 / (1,1857 - 0,4319) = 1,5734; then (1 – α) = (1 – 1,5734) = - 0,5734, and expression standard multiplicative function (4) in

the form of Kobb-Douglas function for 2005 - 2011 on the basis of expression (5) unlike a look (6) for 2005 - 2012 will look like:

$$X = A \cdot K\ 1{,}5734 \cdot L - 0{,}5734. \quad (8)$$

For the further calculations within the studied period (2005 - 2011 – see tab. 2) were received the following values of the results of dynamics of studied dependent and independent parameters: X * = 2,6264 (times); K * = 2,0891 (times); L * = 1,1822 (times).

Let's determine the private efficiencies of resources for capital productivity (EK) and for the labor productivity (EL) by the following formulas:

$EK = X^* / K^* = 2{,}6264 / 2{,}0891 = 1{,}2572;$

$EL = X^* / L^* = 2{,}6264 / 1{,}1822 = 2{,}2216,$

Then on the basis of the expression (8) the generalized indicator of efficiency E and the average scale of production in the dynamic of M can be found in a look

$E = EK\alpha \cdot EL(1 - \alpha) = 1{,}25721{,}5734 \cdot 2{,}2216 - 0{,}5734 = 1{,}3435 \cdot 0{,}6327 = 0{,}8500 = 0{,}85$ (times),

$M = K^*\alpha \cdot L^*(1 - \alpha) = 2{,}08911{,}5734 \cdot 1{,}1822 - 0{,}5734 = 3{,}1873 \cdot 0{,}9085 = 2{,}8957 \approx 2{,}90$ (times).

The results and general conclusions. So, the analysis which has been carried out at the first stage as the substantial analysis with formation of a working hypothesis of decrease in production efficiency during 2011 - 2012 is confirmed by a modelling method with the using of the production functions constructed for the periods of 2005 - 2012 and 2005 - 2011.

The received results testify that the offered way of using the production functions as an instrument of the estimation of the ratio of extensive and intensive processes of development also can be the methodological basis for the assessment of the condition of studied internal and external production factors in dynamics with the acceptance of the appropriate management decisions directed on increase of production efficiency in the short term (short-term planning). Also the offered stage-by-stage approach in using of of production functions could be used and the monitor of researches of such class.

REFERENCES

[1] The program of social and economic development of the Republic of Tatarstan for 2011-2015// "The Republic of Tatarstan" Gazette - Vol No. 189 (27611). - No. 89-90.

[2] The program "Labour Productivity Increase at the Enterprises of Machine-building and Petrochemical Complexes of the Republic of Tatarstan for 2013-2016" //"The Republic of Tatarstan" Gazette. - Vol: No. 196 (27613) - No. 98-99.

[3] Results of development of the industry, the consumer market and foreign economic activity of the Republic of Tatarstan in 2012. Kazan: Republic of Tatarstan Ministry of Trade and Industry, 2013. – 126 p.

[4] "Nizhnekamskneftekhim" Open Joint Stock Company (JSC "NKNH"). The report for 2012 on RSB. – Nizhnekamsk: JSC "Pechatny dvor". – 104 p.

[5] “Nizhnekamskneftekhim” Open Joint Stock Company (JSC NKNH). The report for 2009 on RSB. – Nizhnekamsk: JSC “Pechatny dvor”. – 116 p.

[6] “Nizhnekamskneftekhim” Open Joint Stock Company (JSC NKNH) .The report for 2006 on RSB. – Nizhnekamsk: JSC “Pechatny dvor”. – 102 p.

[7] Association of rubber of the Singapore commodity exchange (Rubber Association of Singapore Commodity Exchange), http://www.vestifinance.ru/articles/7535

[8] Source of data on JSC for tab. 1

[9] Martyshchenko L.A., etc. Military and scientific researches and development of arms and military equipment. Part 1. M.: Ministry of Defense, Russian Federation, 1993. – 301 p.

[10] Kolemayev V.A. Mathematical economics: The textbook for higher education institutions. – M.: YuNITI-DANA, 2002. – 399 p.

[11] Data on fixed assets for 2005 - 2012 for tab. 2

[12] Sigel E. Practice business statistician. - M.: IDES "Williams", 2002. - 1056 p.

[13] Econometrics: The textbook / Under the editorship of I. I. Yeliseyeva. – M.: Finance and statistics, 2004. – 344 p.

[11] Dushenkina E.A. Economic theory. Abstract of lectures. M.: Eksmo, 2008. - 160 p.

[14] The annual report of “Nizhnekamskneftekhim” Open Joint Stock Company (JSC NKNH) for 2011. – Nizhnekamsk: JSC “Pechatny dvor”. – 116 p.