INPUT MANAGEMENT IN CRISIS: TOTAL FACTOR PRODUCTIVITY OF ICT SECTOR IN CROATIA

UPRAVLJANJE RESURSIMA U KRIZI: UKUPNA PROIZVODNOST ČINITELJA ICT SEKTORA U HRVATSKOJ

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Abstract: *This paper analyzes neoclassical production function and tries to find alternative sources of growth in the time of costly and even more scarce inputs. On the example of Croatian economy, it is shown that information and communications sector in Croatia is 24.5 times more productive than Croatian economy on average. Hence a special care is advised for further development of this sector which appears to be extremely effective in transformation of inputs into output.*

Key words: *Croatia, ICT sector, Total factor productivity, input management, crisis, labour, capital, human capital*

Sažetak: *U ovom se radu analizom neoklasične proizvodne funkcije nastoji naći alternativne izvore rasta u vrijeme skupih i još oskudnijih činitelja proizvodnje. On the example of Croatian economy, it is shown that information and communications sector in Croatia is 24.5 times more productive than Croatian economy on average. Hence a special care is advised for further development of this sector which appears to be extremely effective in transformation of inputs into output.*

Ključne riječi: *Hrvatska, ICT sektor, ukupna proizvodnost činitelja, upravljanje činiteljima, kriza, rad, kapital, ljudski kapital*

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1. Introduction

The current crisis that hit almost the entire world emphasized the scarcity of inputs. According to the neoclassical theory, main factors of production are capital, labour and human capital. The currently costly capital, unfavourable demographical structure of entire Europe and lacking educational funds pose the great obstacle in raising current levels of production, thus encumbering the economic recovery, especially in the countries which struggle with the a trade deficit.

Since the inputs are either too expensive or too scarce, the solution should be found in the non-input factor, total factor productivity, or overall productivity factor. It contains all the other factors that are not included in the basic production function, suck as institutional environment [5]. Institutional environment is affected by the corruption perception, effectiveness of the judicial system, educational policy, property and civil rights protection, overall security, transparency of the public purchases, red tape and a stage of the development of democratic institutions. Subsequently, business climate is affected by the institutional environment; hence institutional quality directly affects total factor productivity.

Production can be observed aggregately, as well as decomposed on sectors. However, aggregate approach is less effective since each sector suffers from different concerns. That is why an analytic approach is used in this paper.

An interesting sector to observe is information and communications technologies sector which becomes increasingly significant for Croatia in the past decade. The main hypothesis is that Croatian information and communications technologies sector is more productive in transformation of inputs into output. In other words, it is assumed that the total factor productivity of information and communications technologies sector is higher in the information and communications technologies sector than in the rest of the economy. Therefore, instead of buying additional expensive inputs, it would be much more effective to redirect inputs from less effective to more effective sectors like information and communications technologies sector.

2. Information and communications technologies sector in Croatia

According to data from the agency for research and analysis IDC Adriatics from Zagreb, the Croatian information and communications technologies market amounted to HRK6.63 billion in 2008. The size of the information and communications technologies sector as well as the speed at which it is developing was the main reason for choosing this sector for further investigation.

There have been numerous studies in the past few decades on the use of information and communications technologies and changes in the vision, strategies, business models, organizational designs and inter-organizational relations of private and public sector organizations, supported by robust theoretical conceptualization and intensive and extensive empirical evidence and in many aspects of organizations continuity from the past needs to be maintained. “Information and communications technologies Revolution” provides us with increasingly more powerful, versatile,

affordable and convenient tools in the forms of technologies, infrastructure and services [11].

Passerini and Wu define that information and communications technologies are the key driver for supporting a sustainable economic development at the global, regional and local levels. They terminate that collaboration among various types of communities, facilitated by information and communications technologies, can lead to increased social and economic development opportunities [12]. Irvine and Anderson utilize information and communications technologies effectiveness. They find out that 84 per cent of the businesses use information and communications technologies effectively, mainly to provide information and improve service quality. They found that some firms had adopted very successful methods of using the internet for sales and marketing but they ignored supply functions. Surprisingly, information and communications technologies were seen as a way of enhancing personal service and it was seen to promote quality of service [13].

Information and communications technologies remain a very significant part of the European economy with an annual turnover of about €200 billion. European information and communications technologies producers represent about one-fifth of worldwide information and communications technologies production.

One of the main objectives of the EU Lisbon Strategy was to stimulate levels of information and communications technologies production and adoption across the member states [14]. In Table 1 is structure of investments in information and communications technologies in Enterprises. Most of investments in 2007 were in hardware, then in software and in telecommunication equipment, over 26%.

	2006	2007
Hardware	38,8	33,6
Telecommunication equipment	8,8	26,7
Audio and video equipment	7,9	2,2
Other information and communications technologies goods	15,7	5,8
Software, of which:	28,8	31,7
Pre-packaged software	12,2	11,5
Customized software	13,8	9,9
Own-account software	2,8	10,3
Total	100	100

Table 1. Structure of Investments in information and communications technologies in Enterprises in Croatia [1] [2]

The results from Table 1 justify the application of a high depreciation rate (25%, [9]) for information and communications technologies investments since majority of the investment in Croatian information and communications technologies sector was invested in the computer technology and software. Hence it was possible to calculate the total amount of capital having only four years of investment (2003-2007), since with 25% depreciation rate capital becomes depreciated in four years.

3. Basics of growth accounting

The level of output is the most important indicator of any economy, especially in times of crises, which has been experienced by almost every world economy by this date. Therefore each economy has to recognize its growth opportunities. The analysis of growth of an economy is called growth accounting.

Foundations of growth accounting lie in a definition of a production function for the observed economy. Through the definition of the production function one can find effects of changes in the exogenous variables analytically. In order to fit reality in the best possible way, assumptions have to be as much realistic as possible and the fitted function's properties have to comply with these assumptions.

The most common form of a production function is the Cobb-Douglas production function. The following form was introduced by Kose, Prasad, and Terrones [7]:

$$Y = AK^{\alpha}(HL)^{1-\alpha} \tag{1}$$

where (Y), (A), (K), (H) and (L) denote output, total factor productivity, capital, human capital and labour respectively.

Similarly, Gylfason [4] assumes the production function:

$$Y = BK^{\alpha}L^{1-\alpha} \tag{1a}$$

and substitutes B with the following expression:

$$B = Ae^{(1-\alpha)qt} \tag{2}$$

where (q) is labour productivity growth, (t) is time and (A) is the initial state of technology. The following expression is obtained:

$$Y = AK^{\alpha}(e^{qt}L)^{1-\alpha} \tag{3}$$

By dividing (1) with (3), the following relation is obtained:

$$H = e^{qt} \tag{4}$$

which introduces dynamics in the model, as well as the exponential trend of human capital.

In either way, a country can increase its total output by affecting one or more variables. Capital (K), the amount of physical capital, is scarce in times of financial crisis by which the world is shaken at this moment. Hence it is more likely that it is going to decrease than to increase. As a result of its scarcity, the price of capital increases. Therefore a capital induced growth would be too costly in times of depression.

Labour force (L) is also hardly changeable. Since it is derived from a population and depends on the procreative abilities of a nation, it can be affected only if there is significant unemployment. Although there is significant unemployment rate in Croatia, the unemployed are hardly employable because of the inability to comply with the labour demand. This paper will not go into analysis of labour market since the effects of changes on this market could be expected in the long run only, while in the short run L is almost constant.

Human capital (H) shows the intellectual potential of the labour force. Economists determine human capital as a stock of competences, knowledge and personality attributes, which could be gained through education and experience, embodied in the ability to perform labor so as to produce economic value [15]. According to the

definition of OECD, human capital would unite knowledge, qualifications, competence and individual characteristics which individuals gather and use in their lifetime to produce products, services and ideas in market and non-market conditions. In other words, it enriches the labour and that is why its power is equal to the one of labour, (1-α). Human capital is more easily influenced than any other type of input, but still, it takes several years, a consistent educational policy and huge assets to improve its level. Sometimes (H) and (L) are observed jointly as LH.

Finally, (A) is total factor productivity or the initial state of technology if $H = e^{qt}$. It shows the effectiveness of transformation of inputs into aggregate output. Having introduced all the inputs, further analysis will try to decompose different ways of increasing the level of total production. Let the starting level of production be Y_1 and the destination value Y_2. For the simplicity and the illustrative purposes, let Y_2 be twice as big as Y_1 (Figure 1).

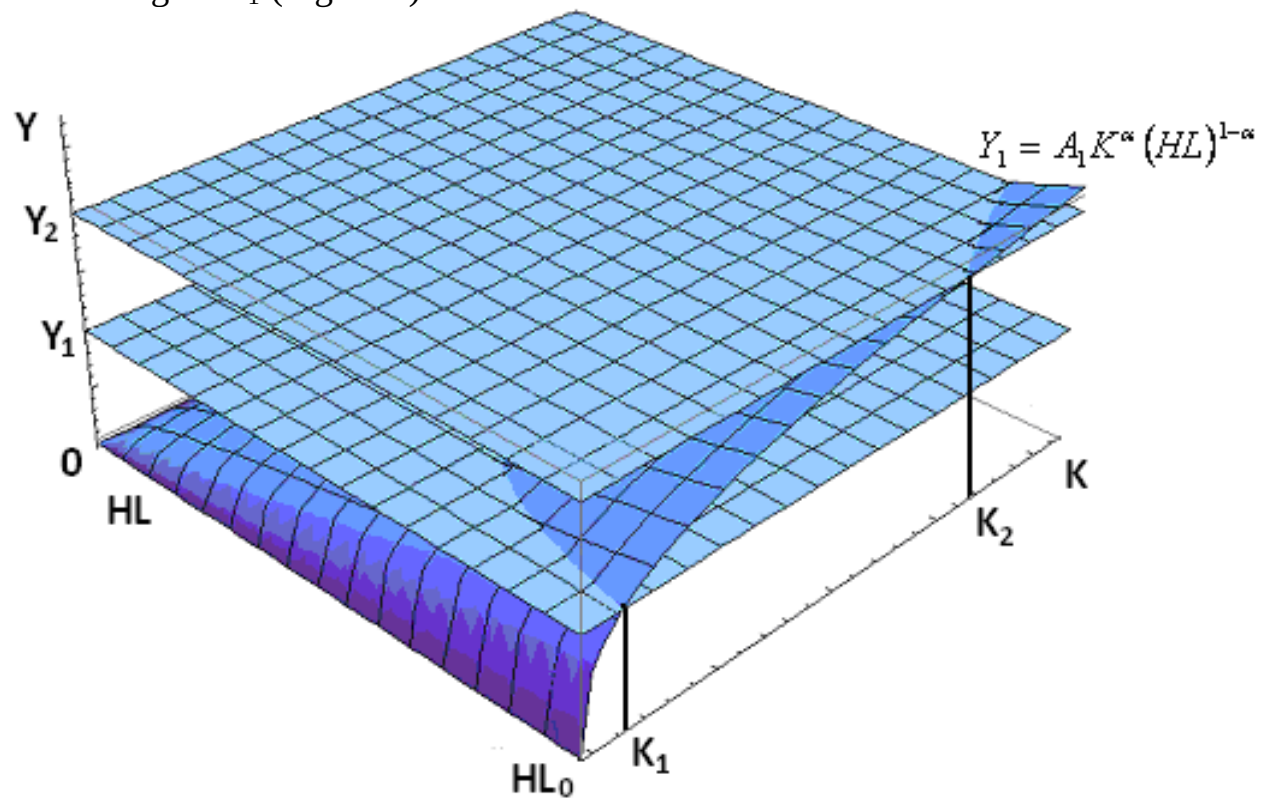

Figure 1. Production function with two layers.

One can easily see from the Figure 1 that, assuming constant level of labour in the short run, higher level of capital would be required (K should increase from K_1 to K_2) in order to attain higher production. Since it is mentioned that during current crisis capital is too expensive, an alternative ways of obtaining higher levels of output should be found.

As human capital is also taken as constant, the only factor left to be affected is the total factor productivity (A). Increasing it twice, the higher level of output can be attained without any change in the amounts of capital and labour (Figure 2).

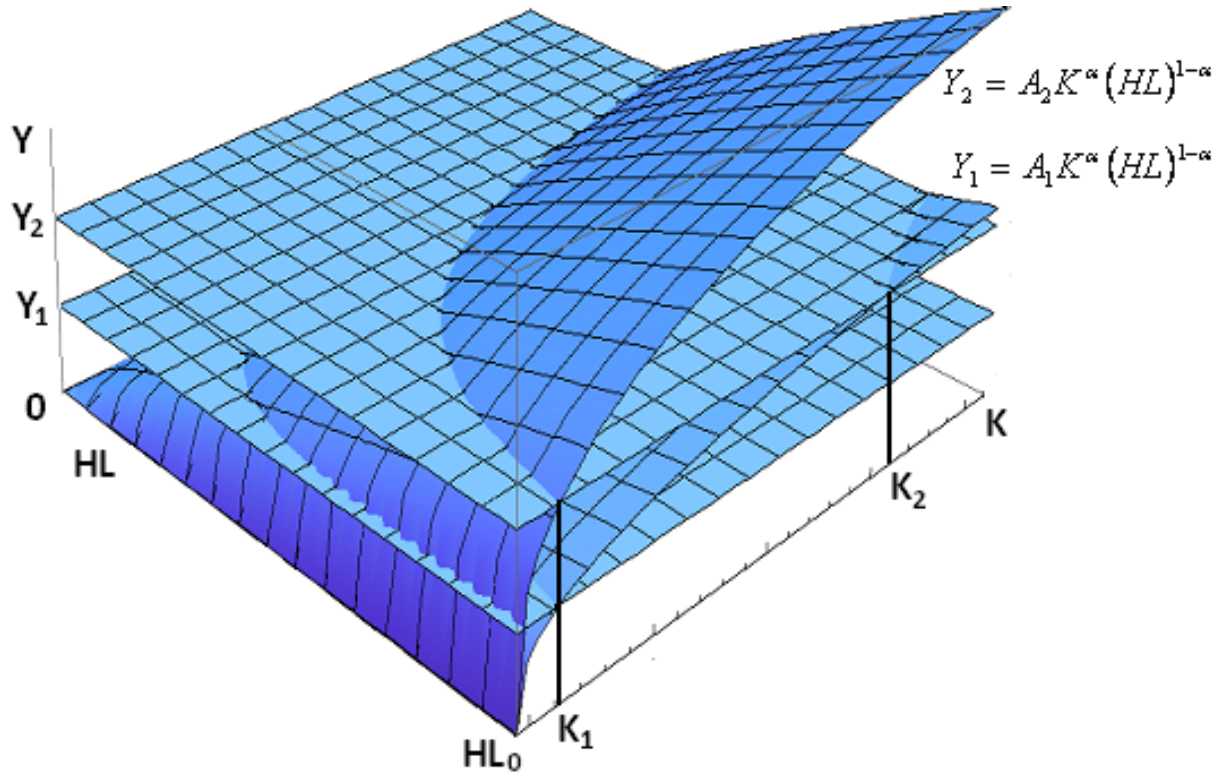

Figure 2. Two production functions with two layers.

The previous graph shows that a higher level of output Y_2 can be obtained either by increasing capital to (K_2), or by increasing total factor productivity to (A_2). Important property of total factor productivity (TFP) is that it does not express decreasing returns, unlike (L), (K) and (H). Therefore a special attention will be given to the analysis of TFP, the most productive factor of a production function.

For a production function defined in (1) both Gylfason (1999) and Kose, Prasad, Terrones (2008) assume that $\alpha = 1/3$:

$$Y = AK^{1/3}(HL)^{2/3} \qquad (5)$$

where (K) and (L) are easily obtainable, and (H) can be calculated using Mincer earnings equation [6]:

$$\ln Y = a_0 + a_1 S + a_2 t + a_3 t^2 \qquad (5)$$

where (S) is the average years of schooling, keeping the rest of notation same. Regression coefficients a_0, a_2 and a_3 have no other purpose than to extract all the non-schooling effects on incomes. However, a product a_1S represents the amount of human capital.

[7] offer a shortcut for calculation of human capital, using data from their analysis:

$$H = 0.085 \times S \times Y \qquad (6)$$

However, this analysis is more appropriate for the overall economy than for the sector analysis, which is to be done in this paper. It is hence assumed that labour and human capital are observed as a single variable (L) in order to simplify the calculation. It is the foundation for the further calculation of total factor productivity in the Croatian economy and specifically in the Croatian information and communications technologies sector. Having the simplified version of a production function, the expression for its calculation is as follows:

$$A = \frac{Y}{K^{1/3} L^{2/3}} \tag{7}$$

If the sector is observed, than all variables apply for the observed sector only.

4. Total factor productivity of Croatian economy and of the information and communications technologies sector

Expression (7) determines all the inputs for a total factor productivity calculation. Datasets for capital, labour and income (revenue) are obtained from the following sources: production is listed in [1] and [2]. The value of physical capital (K) in the base period 1993 is obtained from data published in [3] combined with the [1] and [2] data sets for total investments, taking into account a depreciation rate of 6% [7]. Number of workers is also taken from [1] and [2]. Look at the Table 2:

Year	Capital (HRK Bill.) δ = 6% [3]	Investments (HRK Bill.) [1], [2]	Employed [1],[2]	GDP (HRK Bill.) [1],[2]
	K	I	L	Y
1993	156,9	6,03	1.343.450	39,003
1994	209,8	12,21	1.315.750	87,441
1995	234,9	13,58	1.301.900	98,382
1996	270,5	22,90	1.301.900	107,981
1997	323,2	31,14	1.288.050	123,811
1998	386,0	33,54	1.384.841	137,604
1999	452,3	34,73	1.364.495	141,579
2000	520,2	35,33	1.340.958	152,519
2001	593,1	39,67	1.348.308	165,639
2002	678,9	48,45	1.359.015	181,231
2003	786,9	62,49	1.392.510	198,422
2004	912,7	67,02	1.409.634	214,983
2005	1047,4	71,72	1.420.574	231,294
2006	1199,4	84,58	1.467.876	250,531
2007	1373, 7	94,76	1.516.909	275,013

Table 2. Labour, Investments, Capital and GDP in Croatia from 1993–2007 ([1],[2],[3])

The previous table gives all the data needed for calculation of total factor productivity for Croatian economy. For the information and communications technologies sector analysis, inputs are as follows: (K_I) is the sum of all the current and up to 3 year old investments with the depreciation rate δ_I = 25% [9], (L_I) is taken from the Croatian Chamber of Economy Information Technology and Statistics Centre, as well as the

revenues of the sector (Y_I). Capital of information and communications technologies sector in Croatia is given with the Table 3.

	Investments in information and communications technologies sector [10]	Years ago	Depreciation factor [9]	Non-depreciated capital
	HRK Mill.	t	1-δt	
2004	161.36	3	0.25	40.34
2005	180.20	2	0.50	90.10
2006	209.38	1	0.75	157.03
2007	182.70	0	1.00	182.70
Capital of information and communications technologies sector in 2007:				470.17

Table 3. Capital of information and communications technologies sector in Croatia in 2007

Having all these data, a final table, Table 4 is obtained:

Croatia, 2007	Physical capital (HRK Bill.)	Employed	Production (HRK Bill.)	Total factor productivity
	K	L	Y	A
Entire Economy	1,373.66	1,516,909	275.01	0.0019
ICT Sector only	0.47	29,095	33.77	0.0459

Table 4. Total factor productivity for Croatia and information and communications technologies sector only in 2007

The results show the huge difference between the overall productivity of an information and communications technologies sector as compared to the Croatian economy as a whole, showing that information and communications technologies sector is 24.5 times more effective in transformation of inputs. In other words, the same amount of labour and capital yields 24.5 times greater earnings in the Croatian information and communications technologies sector than in the Croatian economy on average.

5. Conclusion

The current crises forces the economic policy makers to find means to increase production and return their economies to the path of economic growth, unlike the decline that occurred during past two years. However, this task will be especially demanding when it is known that capital is scarce and expensive, while population in Europe has more a tendency to decline than to increase. At the same time, the increase in the human capital levels requires time and currently lacking assets. Since

all the inputs are hardly changeable, there is only one factor which could be affected: total factor productivity (TFP), which shows the effectiveness of input transformation into output. An information and communications technologies sector is taken as an example since it develops rapidly in the last decade. It is shown that total factor productivity in the information and communications technologies sector is 24.5 times greater than total factor productivity in the Croatian economy as a whole. It suggests that the policy makers should invest bigger efforts in improving institutional quality, as well as to redirect the inputs from the less effective sectors to the more productive sector such as information and communications technologies sector.

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