Analysis of multiplier effects of ICT sectors – a Croatian case

Damira Keček[1,*], **Nikolina Žajdela Hrustek**[2] **and Vesna Dušak**[2]

[1] *University Centre Varaždin, University North*
104. brigade 1, 42 000 Varaždin, Croatia
⟨damira.kecek@unin.hr⟩

[2] *Faculty of Organization and Informatics, University of Zagreb*
Pavlinska 2, 42 000 Varaždin, Croatia
⟨{nikolina.zajdela, vesna.dusak}@foi.hr⟩

Abstract. The impact of Information and Communication Technology (ICT) on economic growth and development has nowadays proven to be significant for almost all national economies. In this paper, a quantitative analysis of the impact of ICT on Croatian economic growth is performed using the input-output (IO) method. The direct and indirect effects of ICT sectors are analysed. Subsequently, simple output multipliers and simple value added multipliers are then calculated. The results indicate that there are no significant differences between the ICT multipliers for the Croatian economy in 2010 and multipliers of other sectors. The largest values of multipliers of all ICT sectors are attributed to the one of ICT service sector. Moreover, significant changes were also not observed when comparing ICT multipliers for the Croatian economy in 2004 and 2010. In addition to Croatia, multiplier analysis of ICT sectors was conducted for the group of new and long-standing European Union member states. The conclusion is that, in new member states, the implementation and usage of ICT has a lower contribution to economic growth and development.

Key words: ICT sectors, input-output analysis, simple multipliers

Received: February 9, 2016; accepted: March 30, 2016; available online: April 04, 2016

DOI: 10.17535/crorr.2016.0009

1. Introduction

Information and Communication Technology (ICT) has become the most important driver of continued growth and development of any economy, stimulating the creation of new and more efficient models of organizational

* Corresponding author.

structures in the global economy. ICT can, among other things, play a significant role in the globalization of production, as well as in the transfer of technologies, enabling constant interaction via the Internet, mobile communications, digital television and e-commerce, regardless of geographical position or time zone.

1.1. Contribution of ICT to macroeconomic growth and development

The latest research on ICT indicates that the dynamics of ICT has indeed become a major driving force for productivity, competitiveness, collaboration, and superposition of resources at both a national and international level [33], [41]. The influence of ICT on productivity, economic growth and overall development is evident in ICT investments and its utilization, contributing to an increase in human capital, higher efficiency, rapid technological progress in the production of ICT goods and services, including faster growth and development of the productive ICT sector [1, 35, 51]. The importance of manufactured goods is decreasing in the leading industrial economies, whereas the importance of production data and information processing is rapidly increasing. Generally speaking, one can presume that, due to the transition from an industrial to an information society at a macroeconomic level, production and consumption of ICT goods and services is significantly increasing, which in turn exerts a positive influence on economic growth and development [9, 27]. This strategy was adopted by the United States of America which intends to invest 7.2 billion dollars in the expansion of ICT and the Internet, as declared in the American Recovery and Reinvestment Act of 2009. Europe has taken a similar path as reflected in the goals of its Digital Agenda, where by the year 2020, at least 50% of Europe's population will have Internet access through the implementation of specific projects.

Many studies have confirmed that ICT can also be classified as a general purpose technology, because ICT is a generic technology that leads to the expansion of all productive economic and social systems [2]. The main importance of a *general purpose technology* is that it leads to fundamental changes in production processes, as well as fast expansion, technological dynamics and innovative complementarity, meaning that productivity in various sectors increases specifically due to the constant progress of ICT technology. The advancement of general purpose technologies reflects directly on the entire economy in terms of increased productivity [19]. Accordingly, ICT is classified as a *general purpose technology*, given that today, computers and the associated peripheral equipment are used in all economic and social sectors [5]. The contribution of ICT as a general purpose technology has been supported by Jalava and Pohjola [24] whose study shows that the contribution of ICT sector to Finland's GDP between 1990 and 2004 was three times greater than the contribution of electricity from 1920 to 1938.

Apparently, ICT has an even greater impact on the economy, as it supports numerous service sectors. This is particularly evident at the present time, when new forms of services are gaining importance, such as e-banking, e-commerce, e-learning, e-health, and others services [15, 45]. Since the mid-1990s, a majority of researchers have identified a positive correlation between ICT investment and economic performance at aggregation levels, e.g. companies, industries, and countries [38, 39, 52, 4, 25, 28]. In the last decade, ICT investment has contributed 0.2 – 0.6 percent to annual GDP growth in Organisation for Economic Cooperation and Development (OECD) countries [37]. Moreover, studies at a macro-level conducted by van Ark and other researchers clearly demonstrate the existence of an increasing productivity gap between Europe and the USA, caused by a less effective and widespread adoption of ICT by European companies [47, 11, 12, 48, 49, 50, 17, 46, 20, 21, 22].

1.2. IO analysis for determining the contribution of ICT to macroeconomic growth and development

Numerous studies noted in the previous sections clearly show that the expansion of ICT and the Internet contributes to positive results, both on a micro and macro level. This section provides an overview of relevant research related to the use of IO analysis in order to determine whether and to what extent intensive investment and use of ICT can generate desired results for national economies that have recognized the role of ICT in growth and development. Using a hypothetical extraction method in the IO framework based on the aggregated six-sector IO table in 2001 in which ICT is a main sector, Bazzazan [3] provides an analysis of the economic importance of ICT in Iran at the national level. The results of analysis show that, in terms of demand, the ICT sector is ranked fourth from among six sectors and accounts for 8.6 percent of total output, whereas in terms of supply, it is also ranked fourth with 9.5 percent of total output. Similar positive results for the impact of expansion and use of ICT on economic growth is also shown in the analysis conducted for the economy of Italy by Di Carlo and Santarelli [14]. Their aim was to evaluate of the impact of ICT investments on the Italian national economy by analysing production and demand multipliers which were calculated using IO matrices released by ISTAT for the years 1995, 2000, 2005. The results have shown that ICT has a greater multiplicative effect on the productive system than the non-ICT sectors and, thus, is a key sector for economic growth.

An attempt to analyse the impact of ICT at a global world level was done by Mattioli and Lamonica [31]. In their research, the authors used the World Input Output Table for the period 1995–2009, which measured the interaction of the ICT sector with other productive sectors for 27 European countries and 13 other major countries classified as the highest industrialized countries in the world. Rasmussen forward and backward linkage indices were used for data analysis. The study confirmed that the ICT sector has a multiplier effect on other sectors, leading to the conclusion, as with numerous other previous studies, that the ICT sector plays a significant role in the economic systems of the highly developed countries.

On the other hand, some research results, especially for developed countries, do not show positive but instead negative or stagnant results from the expansion of ICT based on development indicators.

A study conducted by Rohman and Bohlin [43] and based on a sectoral approach using the IO methodology investigates the contribution of ICT sectors in driving economic performance in European economies. The authors used a decomposition analysis confirming that some countries (e.g. Germany and Spain) experienced a decline in the output growth of their ICT sectors in the period 2000–2005 when compared to the period 1995–2000. The study also notes that, at a country level, in time ICT sectors lost the advantage of export and impact of technological change, and that the impact of technological change is reduced due to lack of integration among ICT and other sectors in terms of manufacturing. On the other hand, the same analysis has shown that the technological change effect in France remains stable. Decomposition analysis conducted by Rohman [44] shows similar results for 10 European economies. Data analysis provided the same results as did previous studies, indicating that the multiplier effect of ICT sectors on the rest of the economy decreased during the period 2000–2005, when compared to 1995–2000, and finally, a decline in the output of ICT sectors was linked to the loss of export advantages and technical change gains in the said sectors. Much research on European economies on the regional level has also shown a low contribution to economic growth and development by ICT sectors.

Furthermore, decomposition analysis using IO tables performed by Zuhdi et al. [54], for Indonesia in the period 1990–2005 and Japan for the period 1995–2005, whose purpose it was to analyze the role of ICT sectors in contributing to structural changes in the national economies has indicated that ICT sectors played an important role in changing Japan's economy, but did not have a significant influence on structural changes in the economy of Indonesia. In later research, Zuhdi [55] endeavoured to obtain another perspective on the role of the ICT sector in Indonesia's national economy by applying IO analysis for the period 1990-2005. Here, Zuhdi used the simple output multipliers method to achieve his purpose. Similar results also appear in this study. The same author analyzes in [56] the impacts of final demand changes on total output of Indonesian ICT sectors applying demand-pull IO quantity model. “Whole sector change” and “pure change” conditions are considered in this study. The results of calculation show that, in both conditions, the biggest positive impact on the total output of the sectors is attributed to a change in household consumption, while the change of import has a negative impact. One of the recommendations of this study is the drafting of import restriction policies for ICT products.

A similar study of Japan’s economy was also conducted by Zuhdi and Prasetyo [57] using the IO table for 2005. The purpose of the study was to analyse total output trends of the Japanese ICT sector as influenced by final demand changes. The study also employs IO analysis to the interdependence of industries in an economy. The results show that the Japanese ICT sector exhibits a similar pattern. The authors of the study suggest the following: (1) export activity from the ICT sector should be enhanced, (2) import activity of ICT products should be restricted, and (3) more ICT domestic market should be captured.

An interesting study was conducted by Irawan [23] from the perspective of developed and developing countries. The author performed comparative analysis based on the IO Table for 2005 from four ASEAN Member States – i.e. Indonesia, Singapore, Malaysia and Thailand. The conclusion drawn from the analysis results shows that the size and structure of ICT sector is important in national economies, that ICT sectors have a positive impact on growth and development and finally, that countries which are more developed benefit much more from ICT than countries which are less developed.

The study of relevant literature shows that IO methodology was used in Croatian economy in analyzing the impact of forestry and wood industry to the economic growth, as well as on the problems of the impact of export in food industry and textile industry. The 2004 IO table for Croatia was used as reference data in all of these reviews. Lovrinčević and Mikulić in [29] quantified the importance of the Croatian forestry and wood industry using IO analysis. The obtained data indicated that the multiplier effects of the forestry and wood industry were significant. The calculated multipliers indicated high values, especially the output multiplier in section 20 – Wood products, which was also the highest multiplier among all other industries. The IO model in [8] was the main method for obtaining new findings about the state and position of exports from the Croatian food industry and its effects on the national economy. Type I multipliers and type II multipliers of gross output, value added and employment were calculated. Multiplier values indicate the strategic importance of the food sector for the national economy. The results also showed that food industry exports had the highest multiplicative effect on agricultural production and trade. In the paper [7], authors Buturac et al. measured the overall importance of textile industry for the Croatian economy in terms of gross output, value added and employment by applying IO analysis. The obtained output and value added multipliers for the textile industry were low, while the change in final demand had the strongest direct effect on employment. Relatively low multipliers of the Croatian economy reflect that this economy is service-based, and that the international competitive position of its manufacturing industry has decreased.

Led by the same aim, the authors of this article will analyse the impact a growing ICT sectors using the IO table for the Croatian economy for the years 2004 and 2010, and will compare IO multipliers between the new and long-standing European Union (EU) member states. The reason behind this is that no similar studies have used the IO methodology to investigate impact of ICT sectors on national economic growth and development. The following chapters explain the methodology and present the respective research results, conclusions and recommendations.

1.3. Definition and classification of the ICT sectors

Many definitions and classifications of the ICT sectors were encountered when reviewing relevant literature. The main data sources for analyzing the impact of ICT on growth and development of the national economy were symmetric IO tables for 2004 and 2010 from the Croatian Bureau of Statistics and Eurostat [10, 16]. Importantly, the symmetric IO tables for the year 2004 and 2010 were not designed using the same methodology and classification. Symmetric IO tables for the year 2010 were prepared according to the 2007 National Classification of Activities, that correspond in content and structure to the Statistical Classification of Economic Activities in the European Community, NACE Rev. 2. This classification differs in structure from the 2002 National Classification of Activities, which is used to prepare symmetric IO tables for 2004. The 2002 National Classification of Activities corresponds in content and structure to NACE Rev. 1.1.

The definition used in this paper to identify ICT economic activities is [13]: "The production (goods and services) of a candidate industry must primarily be intended to fulfil or enable the function of information processing and communication by electronic means, including transmission and display". This definition of ICT provides a statistical basis for measuring economic activity generated by the production of ICT goods and services and is comparable internationally. There are three main groups of ICT activities: manufacturing industry, ICT trade industry and ICT services industry. Those groups include the following productive sectors according to the 2007 National Classification of Activities in the symmetric IO table for 2010: CPA_C26 - Computer, electronic and optical products; CPA_G46 - Wholesale trade services, except for motor vehicles and motorcycles; CPA_J58 - Publishing services; CPA_J61 - Telecommunications services; CPA_J62_J63 - Computer programming, consultancy and related services, information services; CPA_S95 - Repair services of computers and personal and household goods.

According to the OECD definition [36]: “ICT products must primarily be intended to fulfil or enable the function of information processing and communication by electronic means, including transmission and display. Content corresponds to an organized message intended for human beings published in mass communication media and related media activities. The value of such a product to the consumer does not lie in its tangible qualities but in its information, educational, cultural or entertainment content.” An ICT sectors consists of two large groups: ICT products plus content and media products. Based on this definition, ICT sectors have been detected in the symmetric IO table for the year 2004 and according to [30] those sectors that correspond to the above mentioned manufacturing, trade and services ICT sectors have been identified.

Thus, sector CPA_C26 - Computer, electronic and optical products corresponds to sectors 30 - Office machinery and computers and 32 - Radio, television and communication equipment and apparatus, sector CPA_G46 - Wholesale trade services, except of motor vehicles and motorcycles corresponds to sector 51 - Wholesale trade and commission trade services, except for motor vehicles and motorcycles, sector CPA_J61 - Telecommunications services corresponds to sector 64 - Post and telecommunication services, while sectors CPA_J58 - Publishing services, CPA_J62_J63 - Computer programming, consultancy and related services, information services and CPA_S95 - Repair services of computers and personal and household goods correspond to sector 72 - Computer and related services.

2. Research methodology

Input-output analysis is considered a practical method for quantitative macroeconomic analysis. Its importance has been recognized in various aspects of planning the economic development, and in investigating complex quantitative effects of certain economic policy measures and emergency interventions in the economic development of the country [42, 53, 34]. The statistical basis of IO analysis are IO tables. In the IO table, the production system of an economy is broken down into a number of productive sectors, indicating how outputs from each sector of the economy are used as inputs by other sectors.

The basic equation in the IO model shows the impact of cross-sector flows on the total production of each sector in the IO table [34]. For sector i, the equation expressing this dependence is given as follows:

$$X_i = \sum_j X_{ij} + Y_i \tag{1}$$

where X_i is total output of sector i, X_{ij} the amount of a product from sector i used as an intermediate input in production by sector j, and Y_i is the final demand of sector i, where $i,j = 1,\dots,n$. In defining the technical coefficient $a_{ij} = \frac{X_{ij}}{X_j}$ as a ratio of a product from sector i that is required by sector j in order to produce one unit of its product, the system of equations (1) for the entire economy in matrix form can be rewritten as:

$$X = AX + Y \tag{2}$$

$$\text{where } X = \begin{bmatrix} X_1 \\ \vdots \\ X_n \end{bmatrix},\ A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} \text{ and } Y = \begin{bmatrix} Y_1 \\ \vdots \\ Y_n \end{bmatrix}.$$

Matrix A is called the technology matrix. A solution to the system (2), where I is an n-by-n identity matrix is:

$$X = (I - A)^{-1} Y \tag{3}$$

The information about conditions for the matrix $I - A$ and the matrix X is given in more detailed in [40]. The Leontief Inverse matrix $(I - A)^{-1}$, also known as a multiplier matrix, measures how the total output is changed as a result of the change in final demand. Elements α_{ij} of the multiplier matrix $(I - A)^{-1}$ represent the output of sector i directly and indirectly required per unit of final demand from sector j.

In this paper, IO analysis is used to calculate simple multipliers. The open IO table, consisting of all production sectors of the national economy with households excluded, is used to calculate simple multipliers. In the case of the open IO table, elements of the Leontief Inverse matrix indicate the direct and indirect effects per unit of final demand. Contrary to this, inclusion of households makes the IO table closed. Households are therefore included in the calculation of Inverse Leontief matrix elements, thus indicating direct, indirect and induced effects per unit of final demand. [32, 34, 6].

The authors in [18] argue about the output multiplier and employment multiplier are derived from an open and a closed IO model. They do not recommend using the multiplier results derived from a closed IO table as they yield exaggerated estimates of the impact of program expenditures on the economy. Several simple multipliers are possible, the ones for output and value added are provided here. Simple multipliers are calculated as the ratio of the direct and indirect effect to the initial effect alone. The sum of the j-th column of the multiplier matrix indicates the output of each sector of the economy directly and indirectly as required per unit of final demand of sector j. The initial output effect on the economy is defined as the initial monetary unit's worth of sector j output needed to satisfy the additional final demand. Hence, the simple output multiplier for the sector j is defined as:

$$O_j = \sum_{i=1}^{n} \alpha_{ij}\, , j = 1, \dots, n \tag{4}$$

Simple value added multipliers express the value added of an economy directly and indirectly required per unit of final demand. For the sector j, a simple value added multiplier is computed by multiplying the j-th column of the multiplier matrix by the value added generated per unit of its output, i.e.:

$$V_j = \sum_{i=1}^{n} \alpha_{ij} \cdot \frac{v_i}{x_i}, j = 1, \dots, n \tag{5}$$

where v_i represents value added of sector i.

3. Research results

The total output of all sectors that include ICT activities at basic prices was determined to be approx. 23.1 billion kuna based on the Croatian symmetric IO table for domestic production for 2010 [10]. Total intermediate consumption of domestic products from the Croatian ICT sectors was approx. 7.6 billion kuna, while the total gross value added amount approx. 13.4 billion kuna. Of all ICT sectors, sector CPA_J61 - Telecommunications services had the largest share in the total output of all ICT sectors (around 43.1 percent), the largest intermediate consumption of domestic products (around 3.2 billion kuna) and the largest gross value added (around 6.1 billion kuna), while sector CPA_S95 - Repair services of computers and personal and household goods had the lowest share in the total output of the ICT sectors (around 4.4 percent), the lowest intermediate consumption of domestic products (around 312.3 million kuna) and the lowest gross value added (around 628.5 million kuna).

Activity sections codes	Description	Output multiplier	Value added multiplier
A	Agriculture, forestry and fishing	1.598	1.557
B+C+D+E	Mining and quarrying; Manufacturing; Electricity, gas, steam and air conditioning supply, sewerage, waste management, remediation activities	1.647	1.848
F	Construction	1.716	1.948
G+H+I	Wholesale and retail trade; repair of motor vehicles and motorcycles; Transportation and storage; Accommodation and food service activities	1.589	1.577
J	Information and communication	1.580	1.530
K	Financial and insurance activities	1.506	1.413
L	Real estate activities	1.140	1.105
M+N	Professional, scientific and technical activities; Administrative and support service activities	1.571	1.549
O+P+Q	Public administration and defence; compulsory social security; Education; Human health and social work activities	1.410	1.304
R+S+T+U	Arts, entertainment and recreation; Other service activities; Activities of households as employers; Activities of extraterritorial organisations and bodies	1.500	1.437

Table 1: *Output and value added multipliers for the Croatian economy*
Source: Author's calculations based on data from the Croatian Bureau of Statistics [10].

Table 1 shows the values of the output and value added multipliers for 2010 for various sectors of the Croatian economy according to activity sections in the 2007 National Classification of Activities. Based on multiplier values, it becomes evident that activity F - Construction had the highest contribution to the economy while activity L - Real estate activities had the lowest contribution. For the case of the ICT sectors in 2010 (Table 2), the largest output multiplier of 1.691 is attributed to sector CPA_J58 - Publishing services, meaning that a unit increase in final demand was expected to increase national output by around 1.691 units. Medium output multipliers were identified in sector CPA_C26 - Computer, electronic and optical products and in sector CPA_G46 - Wholesale trade services, except for motor vehicles and motorcycles with values of 1.581 and 1.601 respectively. The lowest output multiplier of 1.456 was in sector CPA_S95 - Repair services of computers and personal and household goods, due to the fact that ICT technology is rapidly and daily changing, and affordability of this technology is increasing. Therefore, more users decided to purchase new technology rather than repair or upgrade existing technologies.

The two sectors: CPA_J61 - Telecommunications services, CPA_J62_J63 - Computer programming, consultancy and related services, and information services, including the previously mentioned sector CPA_S95 - Repair services of computers and personal and household goods, belong to ICT services industries. These had relatively low output multipliers with values below 1.5. A similar conclusion relating to the above mentioned sectors can also be drawn for value added multiplier.

Year 2004		Year 2010	
Sector code	Value added multiplier	Sector code	Value added multiplier
30	1.682	CPA_C26	1.631
32	1.875		
51	1.651	CPA_G46	1.600
64	1.489	CPA_J61	1.404
72	1.426	CPA_J58	1.835
		CPA_J62_J63	1.407
		CPA_S95	1.418

Table 2: *Output multipliers for ICT sectors for 2004 and 2010*

Source: Author's calculations based on data from the Croatian Bureau of Statistics [10].

Year 2004		Year 2010	
Sector code	Output multiplier	Sector code	Output multiplier
30	1.694	CPA_C26	1.581
32	1.798		
51	1.676	CPA_G46	1.601
64	1.536	CPA_J61	1.484
72	1.479	CPA_J58	1.691
		CPA_J62_J63	1.475
		CPA_S95	1.456

Table 3: *Value added multipliers for ICT sectors*

Source: Author's calculations based on data from the Croatian Bureau of Statistics [10].

When comparing the output multiplier and value added multiplier values in the Croatian ICT sectors for 2004 and 2010, it is observed that the values in 2010 decreased, but not significantly (see Table 2 and Table 3).

Similarly, based on calculations of total sectoral multipliers using symmetric IO tables for 2004 and 2010 for all sectors of the Croatian economy, the authors in [26] conclude that significant changes in cross-sectoral relations during these two periods did not occur and that the overall sectoral multiplier decreased in the most comparable activities.

Subsequently, a discussion on output and value added multipliers for new and long-standing EU member states is carried out (Table 4, Appendix 1 and Table 5, Appendix 2). By comparing the minimum and maximum values of the output and value added multipliers for almost all ICT sectors, a gap between the minimum and maximum values of new and long-standing EU member states was observed, indicating that the long-standing EU member states utilized ICT more efficiently for economic growth and development .

In fact, for sector CPA_C26 - Computer, electronic and optical products, which is covered by manufacturing, output multipliers were the lowest and highest among new EU member states, with 1.131 for Hungary and 1.595 for Slovenia, respectively. The lowest and highest output multiplier values for the same sector among long-standing EU member states were 1.524 for Belgium and 1.849 for France, respectively. In the ICT trade sector denoted by CPA_G46 - Wholesale trade services, except for motor vehicles and motorcycles, the difference in the maximum (0.011) and minimum (0.028) output multiplier values for new and long-standing EU member states is almost negligible. Among ICT service sectors, differences were found to exist between sectors CPA_J58 - Publishing services and CPA_J61 - Telecommunications services and sectors CPA_J62_J63 - Computer programming, consultancy and related services, information services and CPA_S95 - Repair services of computers and personal and household goods. New EU member states had lower minimum and maximum multiplier values for sectors CPA_J58 - Publishing services and CPA_J61 - Telecommunications services than long-standing members. On the other hand, sectors CPA_J62_J63 - Computer programming, consultancy and related services, information services and CPA_S95 - Repair services of computers and personal and household goods had lower minimum multiplier values in new EU member states, but greater maximum multiplier values in long-standing EU member states. Differences for the minimum and maximum values of the value added multiplier in the above analyzed sectors when comparing new and long-standing EU member states do exist, but they are not significant.

4. Conclusion

Rapid technological progress in the production of ICT goods and services, and faster growth and development of the ICT productive sector, has a significant impact on the productivity and efficiency of all the other sectors of national economies, as well as on the growth and overall development of social and economic systems as a whole. This research analyses the impact of ICT on Croatia's economic growth using the IO method to calculate simple output and value added multipliers. A comparative analysis of multipliers based on accessible symmetric IO tables was performed for ICT production, service and trade sectors of the Croatian economy. The analysis results indicate that the differences in multiplier values in the mentioned sector for the period in question were not significant. The values of the output multiplier for ICT sectors ranged from 1.479 to 1.798 in 2004 and from 1.456 to 1.691 for 2010, while the values of the value added multiplier ranged from 1.426 to 1.875 in 2004 and from 1.407 to 1.835 for 2010. This leads to conclusion that the contribution of ICT to growth and development of the Croatian economy decreased during those years.

By using the latest data for 2010, output and value added multipliers were analysed for all sectors of Croatian economy, and a comparison to the multipliers of the ICT sectors was also performed. The results show that the average value of output multipliers, as well as that of value added multipliers for all ICT sectors is around 1.5, which is consistent for the majority of multiplier values in all other activity sections with the exception of the respective four sections. Two of those four activity sectors had the lowest multiplier values: L (Real estate activities) and O+P+Q (Public administration and defence; compulsory social security; education; human health and social work activities, while the other two sectors: F (Construction), and B+C+D+E (Mining and quarrying; manufacturing; electricity, gas, steam and air conditioning supply, sewerage, waste management, remediation activities) had the highest multiplier values. Moreover, a comparative multiplier analysis was conducted for a set of EU countries which were, for the purpose of this paper, classified into two groups: new and the long-standing EU members, in order to establish whether ICT contributes equally to growth and development in long-standing EU member states, as opposed to new member states. The obtained results indicate a divide in the multiplier values between the new and long-standing EU member states leading to the conclusion that long-standing EU member states have capitalized on the potential of ICT sector more for the purpose of growth and development, as opposed to the new member states that subsequently joined the EU.

The unavailability of data necessary for calculating the remaining multipliers associated with IO analysis (e.g. employment multiplier) is one of the main limitations of undertaking this kind of research in Croatia, as is the case in other observed European Union countries. Another limitation of this analysis is due to the lack of data and the impossibility of performing long-term continuing analysis of the impact of ICT on the growth and development of the Croatian economy. The cause may be that, since becoming independent, the Republic of Croatia has not given much importance to the creation of IO tables, as is evident by the availability of only two IO tables, those for 2004 and 2010. Such information would enable recording and observing significant changes. Emphasis should be placed on the fact that a direct inter-sectoral comparison based on data available in IO tables from 2004 and 2010 cannot be carried out given that the methodology for creating IO tables for the respective years has not been consistent. Guidelines for future research should move towards more detailed research on data availability in order to collect additional data for applying alternative methods related to IO tables that would then be able to measure the ICT impact on economic growth and development. For instance, literature on national economies emphasis is placed on use of the Computable General Equilibrium (CGE) and the Input-Output Economic Model which enable monitoring of policy changes and provide an explanation of medium- but also long-term trends and inter-sectoral changes in policy on development and technology.

References

[1] Azari, R. and Pick, J. B. (2005). Technology and society: Socioeconomic influences on technological sectors for United States counties. International Journal of Information Management, 25, 21–37.

[2] Basu, S. and Fernald, J. (2006). Information and communications technology as a general-purpose technology: Evidence from U.S. industry data. Federal Reserve Bank of San Francisco. Available at: http://www.frbsf.org/publications/economics/papers/2006/wp06-29k.pdf [Accessed on March 11, 2013].

[3] Bazzazan, F. (2009). The economic importance of ICT in Iran - input-output approach. Paper presented at the International Conference on Information and Financial Engineering, 17-20 April, 2009, Singapore.

[4] Bloom, N., Sadun, R. and Van Reenen, J. M. (2007). Americans Do I.T. Better: US Multinationals and the Productivity Miracle. SSRN eLibrary.

[5] Bresnahan, T. F. and Trajtenberg, M. (1995). General purpose technologies: Engines of growth. Journal of Econometrics, 65, 83–108.

[6] Burrows, L. R. and Botha, A. P. (2013). Explaining the changing input-output multipliers in South African: 1980-2010, Paper presented at the Biennial Conference of the Economic Society of South Africa, 25-27 September 2013, Bloemfontein.

[7] Buturac, G., Lovrinčević, Ž., and Mikulić, D. (2014). Hrvatska tekstilna industrija u Europskoj uniji - konkurentnost i značenje za ukupno gospodarstvo (Croatian textile industry in European Union - competitiveness and importance for economy). Tekstil, 63(3-4), 113–125.

[8] Buturac, G. and Vizek, M. (2015). Izvoz prehrambene industrije i učinci na gospodarstvo: slučaj Hrvatske (Export of Croatian food industry and effects on economy: The case of Croatia). Ekonomski pregled (Economic Review), 66(3), 203–230.

[9] Ceccobelli, M., Gitto, S., and Mancuso, P. (2012). ICT capital and labour productivity growth: A non-parametric analysis of 14 OECD countries. Telecommunications Policy, 36(4), 282–292.

[10] Croatian Bureau of Statistics. Available at: www.dzs.hr [Accessed on November 15, 2015].

[11] Daveri, F. (2002). The new economy in Europe, 1992-2001. Oxford Review of Economic Policy, 18(3), 345–362.

[12] Daveri, F. (2004). Why is there a productivity problem in europe? CEPS. Working Document No. 205, Bruxelles.

[13] Department of Economic and Social Affairs. (2008). International standard industrial classification of all economic activities. United Nations. Statistical papers, Series M No. 4/Rev.4, Revision 4, New York.

[14] Di Carlo, C. and Santarelli, E. (2010). Contribution of ICT to economic growth in Italy: Input Output analysis. Ministry of Economic Development. Department of Communications.

[15] European Commission (EC). (2006). i2010 –First Annual Report on the European Information society. Available at: http://eurlex.europa.eu/LexUriServ/site/en/com/2006/com2006_0215en01.pdf [Accessed on March 10, 2013].

[16] Eurostat. Available at: http://ec.europa.eu/eurostat/web/esa-supply-use-input-tables/data/workbooks [Accessed on November 15, 2015].

[17] Gordon, R. J. (2004). Why was Europe left at the station when America's productivity locomotive departed?. National Bureau of Economic Research. Working Paper Series No. 10661.

[18] Grady, P. and Muller, R. A. (1988). On the use and misuse of input-output based impact analysis in evaluation. The Canadian Journal of Program Evaluation, 3(2), 49–61.

[19] Guerrieri, P. A. O. L. O. and Padoan, P. C. (2007). Modelling ICT as a general purpose technology. Evaluation. Available at: http://www.coleurope.eu/content/publications /pdf/Collegium2035.pdf [Accessed on March 10, 2013].

[20] Inklaar, R., O'Mahony, M. and Timmer, M. (2005). ICT and Europe's productivity performance: Industry-level growth account comparisions with the United States. Review of Income and Wealth. 51(4), 505–536.

[21] Inklaar, R., Timmer, M. P., and van Ark, B. (2007). Mind the gap! International comparisons of productivity in services and goods production. German Economic Review. 8(2), 281–307.

[22] Inklaar, R., Timmer, M. P., and van Ark, B. (2008). Market services productivity across Europe and the US. Economic Policy, 53, 140–194.

[23] Irawan, T. (2014). ICT and economic development: Comparing ASEAN member states. Int Econ Econ Policy, 11, 97–114.

[24] Jalava, J. and Pohjola, M. (2008). The roles of electricity and ICT in economic growth: Case Finland. Explorations in Economic History, 45(3), 270–287.

[25] Jorgenson, D. W., Ho, M. S., and Stiroh, K. J. (2008). A retrospective look at the U.S. productivity growth resurgence. Journal of Economic Perspectives, 22(1), 3–24.

[26] Keček, D., Dušak, V., and Žajdela Hrustek, N. (2015). Sinergijski učinci input-output modela i Markovljevih lanaca za međusektorsku analizu (Synergic Effects of Input-Output Model and Markov Chains for Cross-Sectoral Analysis). Privredna kretanja i ekonomska politika (Economic Trends and Economic Policy), 137(2), 37-61.

[27] Khuong, M. V. (2011). ICT as a source of economic growth in the information age: Empirical evidence from the 1996–2005 period. Telecommunications Policy, 35(4), 357–372.

[28] Kretschmer, T. (2012). Information and communication technologies and productivity growth: a survey of the literature. OECD. Digital Economy Papers No. 195, Paris.

[29] Lovrinčević, Ž. and Mikulić, D. (2014). Utjecaj šumarstva i drvne industrije na gospodarstvo Hrvatske (The impact of forestry and wood industry on Croatian economy). Šumarski list (Forestry Journal), 11-12, 551–562.
[30] Mas, M., Robledo, J. C., and Pérez, J. (2012). ICT sector definition transition from NACE Rev. 1.1 to NACE Rev. 2: A methodological note. European Commission. JRC Technical Report, Luxembourg.
[31] Mattioli, G. and Lamonica, R. (2013). The ICT role in the world economy: An input-output analysis. Journal of World Economic Research, 2(2), 20–25.
[32] McLennan, W. (2006). Information paper: Australian national accounts: Introduction to input-output multipliers, No. 5246.0, Australian Bureau of Statistics.
[33] Menou, M. J. and Taylor, R. D. (2006). A grand challenge: Measuring information societies. The Information Society an International Journal, 22(5), 261–267.
[34] Miller, R. E. and Blair, P. D. (2009). Input-Output Analysis: Foundations and Extensions. 2nd edition, New York: Cambridge University Press.
[35] Nashab, E. H. and Aghaei, M. (2009). The effect of ICT on economic growth: Further evidence. International Bulletin of Business Administration, 5, 46–56.
[36] OECD. (2009). Information economy product definitions based on the central product classification (version 2). OECD. Digital Economy Papers No. 158.
[37] OECD. (2014). Measuring the digital economy: A new perspective, OECD Publishing. Available at: http://www.keepeek.com/Digital-Asset-Management/oecd/science-and-technology/measuring-the-digital-economy_9789264221796-en#page1 [Accessed on March 15, 2015].
[38] Oliner, S. D. and Sichel, D. E. (2000). The resurgence of growth in the late 1990s: Is information technology the story?. Journal of Economic Perspectives, 14(3), 3–22.
[39] Oliner, S. D. and Sichel, D. E. (2002). Information technology and productivity: Where are we now and where are we going?. Federal Reserve Bank of Atlanta Economic Review, 3, 1–13.
[40] Peterson, B. and Olinick, M. (1982). Leontief models, Markov chains, substochastic matrices, and positive Solutions of matrix equations. Mathematical Modelling, 3, 221–239.
[41] Popova, I., Popov, O., and Dalin, R. (2005). ICT knowledge 4 ICT diffusion. Information and Communication Technologies and the Knowledge Economy, 2, 792–799.
[42] Raa, T. T. (2006). The Economics of Input-Output Analysis. Cambridge: Cambridge University Press.
[43] Rohman, I. K. and Bohlin, E. (2010). On the ICT economy in the European countries: Investigating the contribution of the ICT sectors using the input-output model. 21st European Regional ITS Conference, Copenhagen, 13-15 September, 2010.
[44] Rohman, I. K. (2013). The globalization and stagnation of the ICT sectors in European countries: An input-output analysis. Telecommunications Policy, 37, 387–399.
[45] Selwyn, N. and Facer, K. (2007). Beyond the digital divide: Rethinking digital inclusion for the 21st century. Available at: http://archive.futurelab.org.uk/

resources/documents/opening_education/Digital_Divide.pdf [Accessed on July 20, 2013].

[46] Timmer, L. P. and van Ark, B. (2005). Does information and communication technology drive EU-US productivity growth differentials?. Oxford Economic Papers, 57(4), 693–716.

[47] Van Ark, B. (2002). Measuring the new economy: An international comparative perspective. Review of Income and Wealth, 48, 1–14.

[48] Van Ark, B., Inklaar, R., and McGuckin, R.H. (2003a). The contribution of ICT-producing and ICT-using industries to productivity growth: A comparison of Canada, Europe and the United States. International Productivity Monitor, 6, 56-63.

[49] Van Ark, B., Inklaar, R., and McGuckin, R. H. (2003b). 'Changing gear': Productivity, ICT and service industries in Europe and the United States. In: F. Christensen and P. Maskell (eds), Industrial Dynamics of the New Digital Economy. Cheltenham, UK and Northampton, MA, USA: Edward Eldgar: 56–99.

[50] Van Ark, B., O'Mahony, M., and Timmer, M. P. (2008). The productivity gap between Europe and the United States: Trends and causes. Journal of Economic Perspectives, 22(1), 25–44.

[51] Van Dijk, J. A.G.M. (2005). The Deepening Divide. Inequality in the Information Society. London: CA: Sage.

[52] Wan, Z., Fang, Y., and Wade, M. (2007). A ten-year odyssey of the 'IS productivity paradox' - A citation analysis (1996-2006). Proceedings of the Americas Conference on Information Systems (AMCIS) 2007, Keystone, Colorado, USA.

[53] Wang, X. and Hofe, R. (2007). Research Methods in Urban and Regional Planning. Berlin: Springer-Verlag.

[54] Zuhdi, U., Mori, S., and Kamegai, K. (2012). Analyzing the role of ICT sector to the national economic structural changes by decomposition analysis: The case of Indonesia and Japan. Procedia - Social and Behavioral Sciences, 65, 749–754.

[55] Zuhdi, U. (2014a). Using multipliers analysis in order to get another perspective related to the role of ICT sectors in national economy of Indonesia: 1990-2005. Journal of Physics: Conference Series 495.

[56] Zuhdi, U. (2014b). The impacts of final demand changes on total output of Indonesian ICT sectors: An analysis using input-output approach. IOP Conf. Series: Materials Science and Engineering 58.

[57] Zuhdi, U. and Prasetyo, A. D. (2014). Examining the total output changes of ICT sectors of Japan: An approach of input – output. Procedia - Social and Behavioral Sciences, 109, 659–663.

APPENDICES

	Sectors codes											
	CPA_C26		CPA_G46		CPA_J58		CPA_J61		CPA_J62_J63		CPA_S95	
New member states of EU	Output multiplier	Value added multiplier	Output multiplier	Value added multiplier	Output multiplier	Value added multiplier	Output multiplier	Value added multiplier	Output multiplier	Value added multiplier	Output multiplier	Value added multiplier
Croatia	1.581	1.631	1.601	1.600	1.691	1.835	1.484	1.404	1.475	1.407	1.456	1.418
Slovenia	1.595	1.693	1.683	1.625	1.868	2.250	1.852	2.009	1.552	1.539	1.402	1.451
Czech Republic	1.328	2.824	1.862	1.831	1.897	2.085	1.618	1.563	1.808	1.793	1.782	1.815
Slovakia	1.463	2.558	1.567	1.493	1.548	1.569	1.654	1.599	1.571	1.519	1.174	1.155
Hungary	1.131	1.692	1.563	1.635	1.654	1.694	1.431	1.394	1.365	1.332	1.438	1.442

Table 4: *Output and value added multipliers for ICT sectors for new member states of EU for 2010*
Source: Author's calculations based on Croatian Bureau of Statistics [10] and Eurostat [16] data

	Sectors codes											
	CPA_C26		CPA_G46		CPA_J58		CPA_J61		CPA_J62_J63		CPA_S95	
Long-standing member states of EU	Output multiplier	Value added multiplier	Output multiplier	Value added multiplier	Output multiplier	Value added multiplier	Output multiplier	Value added multiplier	Output multiplier	Value added multiplier	Output multiplier	Value added multiplier
Germany	1.654	1.812	1.773	1.756	1.840	1.937	2.016	2.396	1.493	1.451	1.316	1.205
France	1.849	2.430	1.769	1.781	1.818	1.836	1.881	1.933	1.609	1.511	1.488	1.387
Italy	1.689	1.885	1.873	1.843	1.904	2.012	1.811	1.731	1.698	1.654	1.652	1.480
Belgium	1.524	1.714	1.592	1.546	1.799	1.815	1.685	1.667	1.782	1.814	1.699	1.707
United Kingdom	1.710	1.720	1.786	1.816	1.683	1.638	1.465	1.450	1.461	1.396	1.462	1.419

Table 5: *Output and value added multipliers for ICT sectors for long-standing member states of EU for 2010*
Source: Author's calculations based on Eurostat [16] data