Croatian Operational Research Review
CRORR **13**(2022), 161-172

Economic contribution and integration of Croatian ICT sectors

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Abstract. Despite the numerous benefits of information and communications technology (ICT) in promoting economic growth and sustainable development, its impacts are insufficiently researched. In particular, there have been few attempts to quantity the contribution of ICT sectors to national economies or the level of integration between ICT sectors. In this paper, an alternative model of sector extraction is developed to quantify the importance of ICT sectors in open and closed input–output systems. The proposed model calculates the contribution of ICT sectors to the national gross value added and employment, as well as the cross-sectoral and intra-sectoral deliveries between ICT sectors. The model is applied to study the Croatian ICT sectors in the years 2010 and 2020. The results indicate that the ICT manufacturing industries lag behind ICT service industries in Croatia. The level of integration differs between individual ICT sectors.

Keywords: contribution, ICT sectors, input–output model, integration measure

Received: October 10, 2022; accepted: November 21, 2022; available online: December 22, 2022

DOI: 10.17535/crorr.2022.0012

1. Introduction

Information and communications technology (ICT) plays a crucial role in economic, social and personal progress in developing countries [23]. The continuous improvement of ICT changes the ways in which knowledge is created and transmitted, and affects how economies develop. ICT enables the transfer of knowledge from developed to developing countries, influencing economic growth and development [32]. From the national and international economic perspective, ICT plays a significant role in innovation, competitiveness and productivity [3, 4, 28]. The ICT industry has an impact on other economic sectors through technology diffusion and information transformation [22]. For the assessment of the effects of ICT on other economic sectors, given the availability of data, the choice of methodology is extremely important [2, 7].

Input–output (IO) analysis is a methodological approach that enables researchers to quantify the direct, indirect and induced effects of a particular sector as well as the interdependence between economic sectors. There is a lack of research that analyzes and quantifies the economic contribution and integration of ICT sectors based on IO tables. Some of the most relevant and recent studies that highlight the importance of ICT sectors to national economies, and which provide the theoretical and practical basis for this study, are presented in this section.

To examine the impact and competitive advantage of the ICT industry in China, the IO model was applied in [22]. The ICT industry was found to have a somewhat greater industrial influence and competitive advantage than the non-ICT industries, and it was concluded that

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investment in the ICT industry offers opportunities to secure benefits to China's overall national economy [22]. In South Korea, a higher degree of heterogeneity was found in the ICT manufacturing industry than in the ICT services industry, implying that ICT manufacturing is broadly used as an input to other industries. Effects of ICT manufacturing decreased in the analyzed period, although the sensitivity effects of the ICT industry increased [12]. In [5], it was found that the ICT sector has a strong effect on Italian economic growth, based on estimates of the output multipliers. In [29], the ICT sector's structural effects in the Greek economy were quantified. The authors' findings indicated significant effects of the Greek ICT sector on GDP and employment, driven mainly by the ICT services component.

In addition to research where the effects of ICT industries have been assessed for a single country, some authors have analyzed and compared effects of ICT sectors across several economies. A comparative analysis of backward and forward effects of the ICT manufacturing and ICT service sectors in South Korea and India, based on the IO methodology, was performed in [21]. The authors concluded that South Korea has a competitive advantage in ICT manufacturing sectors, while the catch-up effect is more pronounced in the ICT manufacturing sector in India. Comparative analysis of spillover effects of ICT and machinery equipment industry, based on the World IO Tables, was performed in [27]. Strong forward linkages were observed for the ICT industries in all analyzed countries, revealing the high impact of ICT innovations on the supply side to stimulate the growth of other industries.

In [19], World IO Tables were applied to analyze the production inducement effects of the ICT services, ICT manufacturing, chemical and medical industries in South Korea and the Netherlands. Higher backward linkages were detected for the ICT manufacturing and chemical industries in South Korea. On the other hand, higher forward linkages were found for the ICT manufacturing, ICT service and medical industries in the Netherlands. Based on the World IO tables, in [24], effects of the ICT sector were analyzed for 40 national economies. The highest contributions of ICT to the total economic output were found in Belgium and France, and the lowest in Indonesia and Bulgaria. Estimates of the backward and forward linkages imply that the ICT sector plays a significant role in highly developed economies. A comparative multipliers analysis of ICT sectors for old and new EU members was performed in [13]. The authors found that the ICT sector had a greater impact on economic growth and development in old EU member states.

Previous estimates of the importance of Croatian ICT sectors focused mostly on applying the classic IO approach of multiplier calculation. In [13], output and value-added multipliers for the Croatian ICT sector were calculated for 2004 and 2010. For the year 2004, the highest type I output and type I value-added multipliers were found for the radio, television and communication equipment and apparatus sector. For the year 2010, the highest type I output and type I value-added multipliers were found for the publishing services sector. In [17], the type I and type II output, gross value added (GVA) and employment multipliers of Croatian ICT sectors for the year 2010 and 2015 were estimated. In 2015, lower type I and type II output and GVA multipliers were observed for all Croatian ICT sectors, except telecommunications services. Publishing services recorded growth in employment multipliers of both types.

Direct, indirect and induced effects for the period 2010–2015 for the Croatian ICT sector were estimated using the hypothetical extraction method [16]. The share of the direct, indirect and induced effects of the ICT sector in terms of output, GVA and employment in the total Croatian economy in 2015 amounted to 7.37%, 7.74% and 5.58%, respectively. Based on the alternative model for sector extraction, in [15], the contribution of Croatian ICT sectors and a measure of their relative integration for the year 2010 were calculated. The results indicated lower contribution values for the ICT manufacturing industry than the ICT services industry. It was also found that computer programming and consulting and telecommunications were the most closely integrated ICT sectors.

The goal of this paper is to assess the spillover effects of the Croatian ICT sectors within the national production system and identify trends in the period 2010–2020. This study fills this gap in the literature by conducting research on the GVA and employment contribution of ICT sectors and cross-sectoral and intra-sectoral interactions among ICT sectors.

The remainder of this paper is organized as follows: Section 2 describes the data sources used in this research, Section 3 describes the methodology, Section 4 presents the empirical results, and in Section 5, final remarks and recommendations for further research are presented.

2. Data sources

The main data source used to calculate the contribution of ICT sectors was the Eurostat database. IO tables were downloaded from [8]. The Eurostat national accounts aggregates by industry [9] provided GVA data, while data on the number of employees were taken from the Eurostat national accounts employment data by industry [10]. According to the definitions of ICT economic activities in the International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 4 [30], the following IO sectors include ICT activities: C26-computer, electronic and optical products, G46-wholesale trade services, except motor vehicles and motorcycles, J58-publishing services, J61-telecommunications services, J62_J63-computer programming, consultancy and related services; information services and S95-repair services of computers and personal and household goods. Sector codes C26, J61 and J62_J63 are relatively homogeneous, while sector codes G46, J58 and S95 produce goods and services that are not exclusively related to ICT activities. By integrating data from IO tables and Eurostat structural business statistics, heterogeneous sectors were disaggregated and the following sectors specific to ICT activities were obtained: G46_ICT-wholesale trade specific to ICT activities, J58_ICT-publishing activities specific to ICT activities and S95_ICT-computer repair. Procedures of data preparation and harmonization for ICT sectors can be found in [18].

3. Research methodology

The contribution of a specific sector of interest to the total economy is usually quantified using a mixed IO model and the hypothetical extraction method [6, 25, 26]. In this paper, an alternative approach is used to calculate the contributions of ICT sectors and measure the technological integration between them [14]. The traditional type I and type II multiplier approach is designed to measure total economic activity induced by a given value of final demand. The Leontief inverse matrix multiplied by a vector of final demand yields the gross output from each sector i that must be produced in a national economy to satisfy a given amount of final demand. If instead of final demand, the initial output produced by a sector of interest is applied to calculate total requirements, it results in an overestimate of the sector's contribution [11, 26]. The model of sector extraction proposed in this paper is focused on the elimination of the double-counting effects related to the existence of cross-sectoral and intra-sectoral deliveries. The determination of these interactions is based on solving a system of linear equations where the number of equations is equal to the number of observed sectors of interest.

The label for a given ICT sector was assigned based on the row and column number of that sector in the IO table. For the six ICT sectors of interest, the following labels were used: label 17 for sector code C26, 29 for G46_ICT, 38 for J58_ICT, 41 for J61, 42 for J62_J63 and 64 for S95_ICT.

The main equations describing the model of ICT sector extraction, and used to calculate their contribution in terms of output, GVA and employment, are given below. The model is presented for open and closed IO systems and, in addition to contribution, it provides measures of the mutual interdependence among ICT sectors and the rest of the economy. A more detailed description of the model of ICT sector extraction in the IO system is given in [14].

The contribution of each ICT sector to the total economy in the open IO system in terms of output is

$$T_j^{\mathrm{O}} = (X_j - x_j) \cdot \sum_{i=1}^{67} \alpha_{ij},\ j = 17, 29, 38, 41, 42, 64, \tag{1}$$

where X_j ($j = 17, 29, 38, 41, 42, 64$) represents the output of each ICT sector exogenously given. The values α_{ij} ($i, j = 17, 29, 38, 41, 42, 64$) are elements of the Leontief inverse matrix $L = (I - A)^{-1} = [\alpha_{ij}]$ ($i, j = 17, 29, 38, 41, 42, 64$) and represent the total direct and indirect output of sector i per unit of final demand in sector j. The elements

$$X_i = \sum_{j \in \{17,29,38,41,42,64\}} \hat{\alpha}_{ij} d_j,\ i = 17, 29, 38, 41, 42, 64 \tag{2}$$

are solutions of the system of six linear equations

$$\sum_{j \in \{17,29,38,41,42,64\}} \alpha_{ij} x_j = d_j,\ i = 17, 29, 38, 41, 42, 64, \tag{3}$$

where the coefficients α_{ij} of the system, for $i, j = 17, 29, 38, 41, 42, 64$, are values of the total deliveries of each ICT sector per unit of production. The free terms of system, denoted by d_i ($i = 17, 29, 38, 41, 42, 64$) are known double-counting values and unknowns, while x_i ($i = 17, 29, 38, 41, 42, 64$) are the initial cross-sectoral deliveries.

Since the contribution of a sector of interest, in the open IO system, is equal to the sum of direct and indirect effects, the indirect effects of each ICT sector can be calculated according to the formula

$$N_j^{\mathrm{O}} = T_j^{\mathrm{O}} - X_j = (X_j - x_j) \cdot (X_j - x_j)\alpha_{ij} - X_j,\ j = 17, 29, 38, 41, 42, 64. \tag{4}$$

The cross-sectoral and intra-sectoral deliveries among ICT sectors in the open IO system are

$$(X_j - x_j)\alpha_{ij} \text{ if } i \neq j,\ i, j = 17, 29, 38, 41, 42, 64 \tag{5}$$

or

$$(X_i - x_i)(\alpha_{ii} - 1) \text{ if } i = j,\ i = 17, 29, 38, 41, 42, 64. \tag{6}$$

By dividing deliveries of the jth ICT sector, $j = 17, 29, 38, 41, 42, 64$, by the total indirect effects of the jth ICT sector, the relative integration measure of the jth ICT sector with other ICT sectors can be obtained according to

$$\rho_{lj} = \frac{(X_j - x_j)\alpha_{lj}}{(X_j - x_j)(\sum_{i=1}^{67} \alpha_{ij} - 1)} = \frac{\alpha_{lj}}{\sum_{i=1}^{67} \alpha_{ij} - 1},\ l \neq j \tag{7}$$

and

$$\rho_{jj} = \frac{(X_j - x_j)(\alpha_{jj} - 1)}{(X_j - x_j)(\sum_{i=1}^{67} \alpha_{ij} - 1)} = \frac{\alpha_{jj} - 1}{\sum_{i=1}^{67} \alpha_{ij} - 1},\ l = j \tag{8}$$

($j, l = 17, 29, 38, 41, 42, 64$).

The contribution of each ICT sector to the total economic output in the closed IO system is

$$T_j^{\mathrm{C}} = (X_j - \bar{x}_j) \cdot \sum_{i=1}^{67} \bar{\alpha}_{ij},\ j = 17, 29, 38, 41, 42, 64, \tag{9}$$

where X_j ($j = 17, 29, 38, 41, 42, 64$) represents the output of each ICT sector exogenously given and $\bar{\alpha}_{ij}$ ($i, j = 17, 29, 38, 41, 42, 64$) are elements of the matrix $\bar{L}_{11}$. Elements $\bar{\alpha}_{ij}$ show direct, indirect and induced effects on the increase in production of sector i as a result of the unit growth of final demand by sector j. More details can be found in [1, 26]. Elements

$$\bar{x}_i = \sum_{j\in\{17,29,38,41,42,64\}} \tilde{\alpha}_{ij}\bar{d}_j,\ i = 17, 29, 38, 41, 42, 64 \tag{10}$$

are solutions of the system of six linear equations

$$\sum_{j\in\{17,29,38,41,42,64\}} \bar{\alpha}_{ij}x_j = \bar{d}_i,\ i = 17, 29, 38, 41, 42, 64, \tag{11}$$

where the coefficients of the system, $\bar{\alpha}_{ij}$ $(i, j = 17, 29, 38, 41, 42, 64)$ are values of the total deliveries of each ICT sector per unit of production in the closed IO system, $\bar{d}_i$ $(i = 17, 29, 38, 41, 42, 64)$ are known double-counting values, free terms of the system and unknowns and $\bar{x}_i$ $(i = 17, 29, 38, 41, 42, 64)$ are initial cross-sectoral deliveries in the closed IO system.

Since the contribution of a specific sector to the total economy in the closed IO system is equal to the sum of direct, indirect and induced effects, the induced effects of each ICT sector can be calculated using

$$\begin{aligned} I_j^{\mathrm{C}} &= T_j^{\mathrm{C}} - N_j^{\mathrm{O}} - X_j \\ &= (X_j - \bar{x}_j)\cdot\sum_{i=1}^{67}\bar{\alpha}_{ij} - ((X_j - x_j)\cdot\sum_{i=1}^{67}\alpha_{ij} - X_j) - X_j \\ &= (X_j - \bar{x}_j)\cdot\sum_{i=1}^{67}\bar{\alpha}_{ij} - (X_j - x_j)\cdot\sum_{i=1}^{67}\alpha_{ij},\ j = 17, 29, 38, 41, 42, 64. \end{aligned} \tag{12}$$

Contributions to the total national GVA in the open and closed IO system are calculated using the equations presented below. Based on (1), the contribution of each ICT sector to the total GVA in the open IO system can be obtained by

$$T(v)_j^{\mathrm{O}} = (X_j - x_j)\cdot\sum_{i=1}^{67}\alpha_{ij}\cdot v_i,\ j = 17, 29, 38, 41, 42, 64, \tag{13}$$

Where the value-added coefficients $v_i = \dfrac{V_i}{X_i}, i = 1, \ldots, 67$ represent the share of GVA of sector i in the output of sector i. Then the indirect effects of each ICT sector in terms of GVA in the open IO system are

$$N(v)_j^{\mathrm{O}} = T(v)_j^{\mathrm{O}} - V_j,\ j = 17, 29, 38, 41, 42, 64. \tag{14}$$

The contribution of each ICT sector to the total economy in terms of GVA in the closed IO system is

$$T(v)_j^{\mathrm{C}} = (X_j - \bar{x}_j)\cdot\sum_{i=1}^{67}\bar{\alpha}_{ij}\cdot v_i,\ j = 17, 29, 38, 41, 42, 64. \tag{15}$$

The induced effects of each specific ICT sector in terms of GVA can be calculated according to

$$I(v)_j^{\mathrm{C}} = T(v)_j^{\mathrm{C}} - N(v)_j^{\mathrm{O}} - V_j,\ j = 17, 29, 38, 41, 42, 64. \tag{16}$$

The equations used to quantify the contribution of ICT sectors to employment in the national economy, in both the open and closed IO systems, are the same as the equations for GVA, if v_i is replaced by e_i, where the employment coefficients $e_i = \dfrac{E_i}{X_i}, i = 1, \ldots, 67$ represent the share of the number of employees of sector i in the output of sector i.

4. Research results

This section presents the results of the analysis of ICT sectors' contributions to the Croatian economy in 2010 and 2020. Estimates based on the formulas described in the previous section are presented in terms of GVA and employment. In addition, the results provide a measure of relative integration of ICT sectors.

	Direct effects	Indirect effect	Induced effects	Contribution
C26	760	273	502	1 535
G46_ICT	662	374	467	1 502
J58_ICT	74	59	76	210
J61	6 085	862	1 513	8 460
J62_J63	5 160	1 533	2 409	9 102
S95_ICT	302	96	233	630
Aggregated ICT sector	13 043	3 196	5 200	21 440

Table 1: *Contribution of ICT sectors to GVA in 2010, in million HRK. Source: authors' calculation.*

	Direct effects	Indirect effect	Induced effects	Contribution
C26	594	247	358	1 200
G46_ICT	899	410	487	1 796
J58_ICT	116	53	64	233
J61	5 726	1 820	1 610	9 156
J62_J63	8 270	1 960	37 476	13 976
S95_ICT	916	272	420	1 608
Aggregated ICT sector	16 521	4 762	6 685	27 968

Table 2: *Contribution of ICT sectors to GVA in 2020, in million HRK. Source: authors' calculation.*

From the results presented in Tables 1, 2, 3 and 4, it can be seen that in 2020, the aggregated ICT sector, which includes all ICT producers, generated almost 28 billion HRK of GVA (8.8% of the total Croatian GVA) and induced 115 800 jobs (6.9% of total employment). Sector J62_J63 (computer programming and related services) recorded the highest contribution to the Croatian economy and its importance in the last decade has increased in terms of both GVA and employment. In the Croatian economy, the second-most important ICT sector is telecommunication (sector code J61).

	Direct effects	Indirect effect	Induced effects	Contribution
C26	2 579	1 810	3 004	7 393
G46_ICT	2 455	2 237	2 799	7 491
J58_ICT	608	322	453	1 382
J61	9 050	6 015	9 736	24 801
J62_J63	16 946	6 674	14 482	38 102
S95_ICT	2 035	555	1 377	3 967
Aggregated ICT sector	33 672	17 613	31 852	83 137

Table 3: *Contribution of ICT sectors to employment in 2010, in number of jobs. Source: authors' calculation.*

	Direct effects	Indirect effect	Induced effects	Contribution
C26	2 202	1 071	2 463	5 736
G46_ICT	4 723	2 026	2 265	9 013
J58_ICT	1 474	627	816	2 916
J61	19 036	8 478	15 120	42 634
J62_J63	25 755	9 471	12 260	47 487
S95_ICT	5 170	1 448	1 391	8 009
Aggregated ICT sector	58 359	23 120	34 315	115 795

Table 4: *Contribution of ICT sectors to employment in 2020, in number of jobs. Source: authors' calculation.*

The two most important ICT sectors in 2020 induced more than 23 billion HRK of GVA and over 90 thousand jobs. Between them, computer programming and telecommunications accounted for 83% of the total GVA and 78% of the jobs induced by ICT. Among other ICT sectors, the lowest contribution in Croatia was estimated for sector J58_ICT. It can be seen that the contribution of the ICT manufacturing industry (sector code C26) was far behind that of ICT services. The importance of ICT manufacturing in the Croatian economy showed a decreasing trend in terms of both GVA and employment, being approximately 20% lower in 2020 than 2010, indicating that the domestic ICT manufacturing producers are insufficiently competitive. On the other hand, the contribution of ICT trade (sector code G46_ICT) increased by approximately the same percentage, pointing to a growing share of imported computers and other ICT equipment distributed by domestic traders. The relatively low level and declining trend of contribution, shown by all observed indicators, indicates that the Croatian ICT manufacturing sector lags behind the ICT service sector.

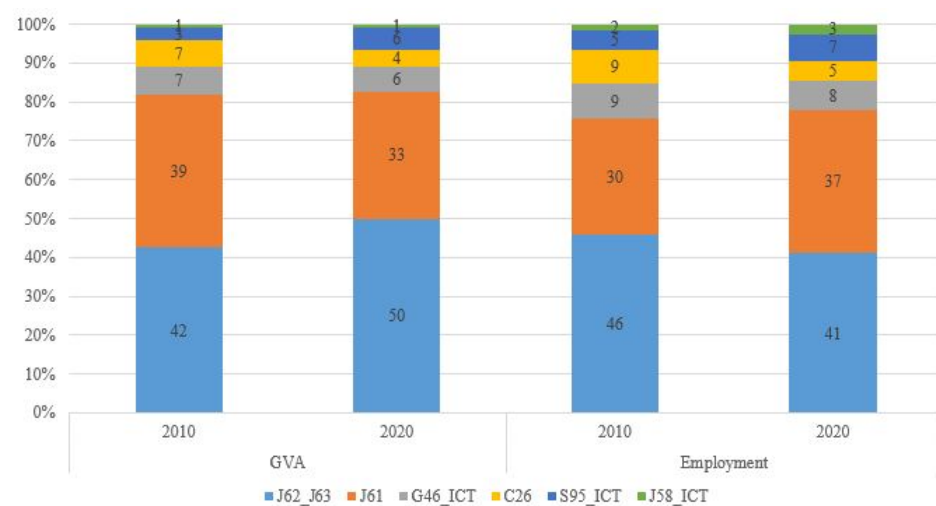

Figure 1: *Share of GVA and employment of specific ICT sectors in the GVA and employment of the aggregated ICT sector (%).*

Source: authors' calculation.

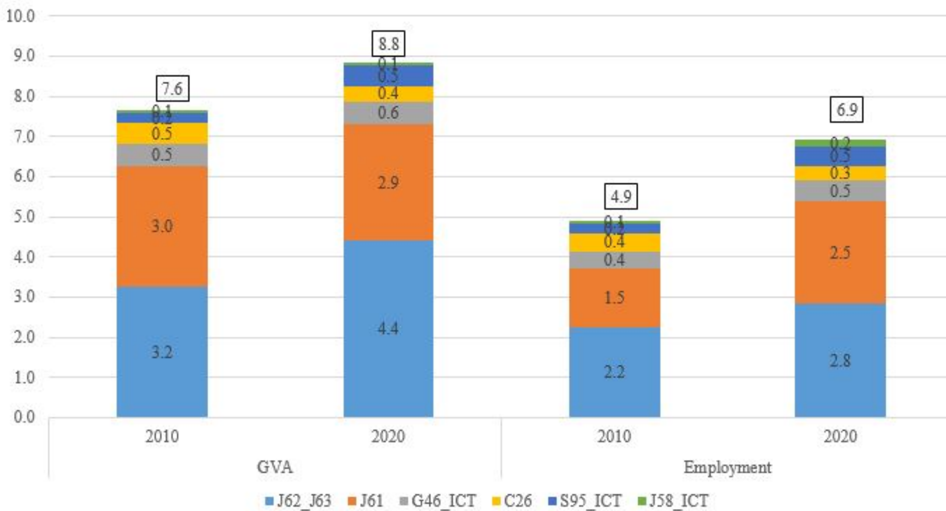

Figure 2: *Share of GVA and employment of specific ICT sectors in the GVA and employment of the Croatian economy (%).*

Source: authors' calculation.

Figure 1 shows the share of GVA and employment of specific ICT sectors in the GVA and employment of the aggregated ICT sector for the years 2010 and 2020. Of all analyzed Croatian ICT service sectors, the computer programming and related services sector recorded the highest share. Among ICT services, the contribution of publishing services to GVA and employment was marginal. Compared to Croatian ICT services activities, a relatively small share in terms of GVA and employment was found for the Croatian ICT manufacturing sector, corresponding to sector code C26.

The importance of ICT sectors to the Croatian economy can be better understood if their contributions are expressed in relative terms. Figure 2 shows the shares contributed by the aggregated ICT sector and its components to the total Croatian GVA and employment. In the observed period, extraction of domestic ICT companies from the total Croatian economy would result in a decrease of total Croatian GVA of 7.6% in 2010 and 8.8% in 2020. If there were no domestic ICT producers, Croatian employment would decrease by 4.9% in 2010 and 6.9% in 2020. In addition to the total effects, Figure 2 presents the structure of effects distributed to individual sectors. It can be seen that the computer programming and related services sector contributed the most to the Croatian economy (4.4% in 2020), followed by telecommunications services (2.9% in 2020). While computer programming significantly increased its share in the 2010–2020 period, it appears that the telecommunication industry had reached its peak by 2010.

In addition to quantifying the contribution of the ICT sector as a whole and its various components, the methodology applied in this paper provides an interesting insight into the mutual interdependence of ICT sectors. Using the alternative model of ICT sector extraction, the intensity of integration between ICT sectors was estimated. By analyzing the interactions among ICT sectors in the open IO system, it is apparent that the relative integration measure differs for ICT sectors (see Figure 3). It can be seen that computer programming is not only the most important sector according to the contribution to total economic activity, but producers in this sector are also strongly integrated with other ICT companies. Most of the indirect effects of the computer programming and related services sector are linked to the telecommunications services sector and on itself. This points to a high level of cooperation between Croatian companies which are engaged in production of software and other programming services.

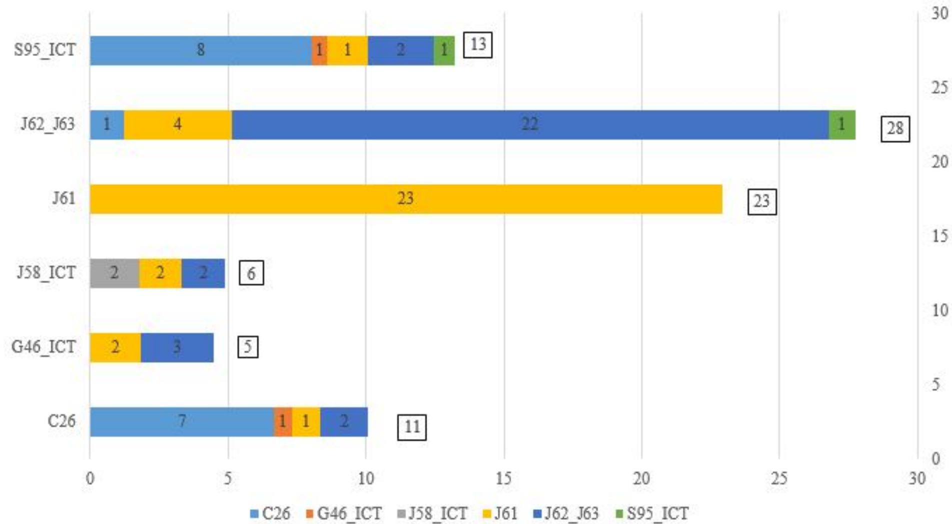

Figure 3: *Relative integration measure of ICT sectors in the open IO system for 2020 (%). Source: authors' calculation.*

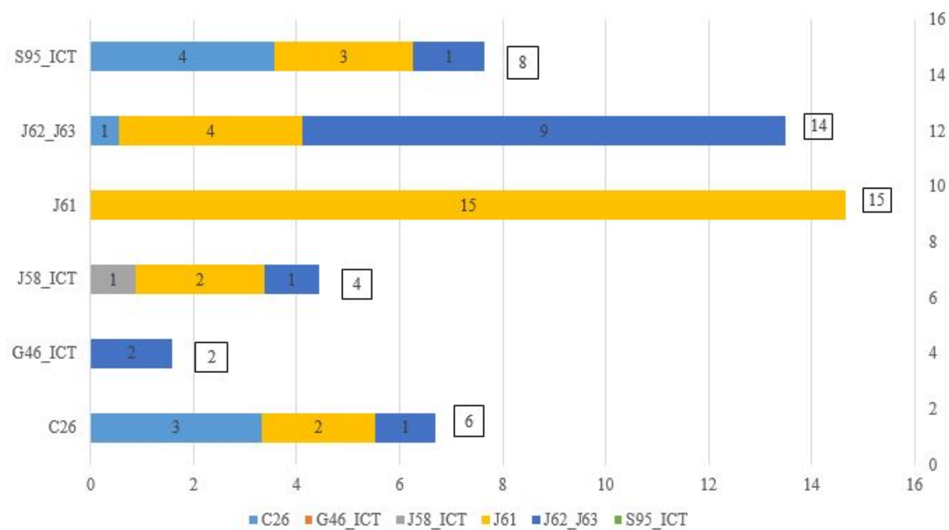

Figure 4: *Relative integration measure of ICT sectors in the closed IO system for 2020 (%). Source: authors' calculation.*

This high level of cooperation is probably linked to the high degree of specialization of providers of computer services, which requires them to delegate some services to subcontractors. The relatively high integration of the computer programming and telecommunications industries is probably a result of the application of modern technologies, which have led ICT services to become increasingly dependent on reliable, high-speed internet access. These results are in line with the findings in previous studies [15, 20, 31], according to which the development of programming, consulting, data processing and website maintenance services implies the availability of quality telecommunication services, primarily high-speed broadband internet connections.

In the future, improved telecommunication services as a result of deployment of 5G networks will probably induce an even higher degree of integration among ICT sectors. Higher relative integration of ICT sectors implies that positive effects of economic expansion of one ICT producer result in spillover of positive stimulus to other ICT companies. The telecommunications services sector is primarily interconnected with other telecommunications companies. The ICT wholesale trade and ICT publishing sectors are integrated more strongly with non-ICT activities than with other ICT sectors, as indicated by their low relative integration measures. The computer repair sector had the most intensive impact on the computer, electronic and optical products sector, while most of the indirect effects of the latter were related to intra-sectoral deliveries. Given indirect and induced effects, the relative integration measure in the closed IO system is lower than in the open IO system, because of the relatively low share of ICT products in household consumption (see Figure 4).

5. Conclusion

Analysis of the relationships between a certain sector and other productive sectors is essential in assessing the structural role of the sector within the economic system. As ICT sectors are identified as important economic growth accelerators in many economies, in this paper, the roles of the ICT sectors in the Croatian economy were analyzed. The ICT industry's inter-industrial linkage and the competitive advantage through those linkages in the Croatian national economy were also examined. A broad overview of the economic effects of ICT sectors and integration among them was provided.

The aggregated ICT sector generated 8.8% of total Croatian GVA and induced 6.9% of total Croatian employment in 2020. According to both indicators, the role of the ICT industry in the Croatian economy increased from 2010 to 2020. Economic effects in Croatia are highly concentrated in two of the most important ICT sectors: computer programming and related services and telecommunication services, which together induced 83% of total GVA and 78% of total jobs. On the other hand, publishing activities specific to ICT recorded the lowest contribution. While most ICT activities recorded relatively strong growth in the analyzed period, computer, electronic and optical products was the only ICT sector that recorded a decrease in contribution. This indicates that the Croatian ICT manufacturing sector is less competitive and lags behind the ICT service sectors.

The relative integration measure of ICT sectors indicates that producers in the computer programming, consultancy and related services sector are strongly integrated with other ICT companies, primarily with telecommunications services and other producers in the same branch. Those two sectors are mutually supportive. Due to globalization and internationalization of ICT services, computer programming and related services require a high quality of telecommunications services, especially during 2020 when the COVID-19 pandemic additionally limited human mobility and in-person contact. The ICT wholesale trade and ICT publishing sectors are poorly integrated with other ICT sectors, but are more strongly integrated with other Croatian productive sectors. The ICT repair services sector by its nature needs computer components delivered from the computer, electronic and optical products sector, while the computer production sector, except intra-sectoral deliveries of computer components, has negligible effects on other ICT sectors.

The limitations of this research are primarily related to the assumption of constant technical coefficients, which is a standard assumption in IO analysis. Technical progress over time leads to changes in production technology and potential changes in technical coefficients. Therefore, the assumption of constant technical coefficients is acceptable only in the short term and if the structure of economic sectors changes slowly over time.

The results present an analytical background which could be used in the development of strategies aimed at increasing the role of ICT sectors in future economic growth in Croatia.

Policy measures supporting ICT producers could result in significant positive multiplicative effects. The presented model of ICT sector extraction is applicable to the analysis of ICT sectors in all economies using the same classification of activities. In future work, the model could be used for comparative analysis of ICT sectors between European Union economies.

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