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COMPANION TO THE INTERREGIONAL INPUT-OUTPUT SYSTEM FOR CROATIA

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Abstract. This paper reports on the recent developments in constructing an interregional input-output matrix for Croatia (IIOM-HRV). As part of an ongoing project that aims to specify and implement an interregional CGE (ICGE) model for the country, the BMCRO model, a fully specified interregional input-output database was developed under conditions of limited information. Such a database is needed for future calibration of the ICGE model. This research venture is part of a technical cooperation initiative involving researchers from the Regional and Urban Economics Lab at the University of São Paulo (Nereus) and the Faculty of Economics, Business and Tourism, Department for Tourism and Economy at the University of Split.

1. Introduction

This note presents the main hypotheses and procedures applied to estimate the interregional input-output matrix for Croatia (IIOM-HRV). It describes the process by which the IIOM-HRV is constructed. A fully specified interregional input-output database is developed under conditions of limited information. The IIOM-HRV provides the opportunity to understand better the spatial linkage structure associated with the Croatian economy in the context of its 21 counties (NUTS3) and 65 sectors.

The dedication to advancing and applying the input-output methodology for studying the varied structural dimensions of the Croatian economy emerged during the 1970s. This evolution persisted until the early 1990s (Jurčić, 2001; Mikulić, 2018). Following Croatia's independence, the utilization of input-output analysis in empirical research was limited, primarily due to the unavailability of an input-output table for the Croatian economy. The most recent input-output table for Croatia in the 20th Century was compiled in 1987, and the subsequent update became available after a significant gap of 18 years, in 2005. In the aftermath, the empirical literature witnessed the emergence of input-output analysis applied in studies concerning the structural characteristics of the national economy, with limited research conducted at the regional level.

These studies encompass empirical research at NUTS level 3, estimating the impacts of EU funds inflow on an economy of a single Croatian county (Mrnjavac et al., 2006; Grčić

et al., 2005, 2004); along with a recent study by Mikulić et al. (2022) that investigates the regional economic impacts of Croatian tourism on NUTS 2 level. However, up to the present time, no comprehensive attempt has been undertaken to estimate IIOM-HRV at NUTS level 3, covering the country's 21 administrative regions, or counties, and 65 sectors.

In what follows, we summarize the main tasks and working hypotheses involved in the treatment of the initial database used in the construction process of the system. We make available the details of the methodological procedures adopted to generate the interregional system and the database used by other researchers and practitioners. We also present illustrative analyses using different indicators from the estimated database, revealing some of the main structural features of the economy of Croatia.

2. Interregional Input-Output Matrix for Croatia

2.1 Initial Data Treatment

The estimation of the IIOM-HRV is based on the Interregional Input-Output Adjustment System (IIOAS) method.[1] The IIOAS method is developed to estimate interregional input-output systems under conditions of limited information.[2] In the case of Croatia, we have used data from national and regional accounts provided by the Croatian Bureau of Statistics for 2018. The data consist mainly of the Supply and Use Tables (SUT) at the national level and regional data on sectoral production and employment. Figures 1 and 2 represent some of the structural characteristics of Croatian industries from the SUT for 2018. Tables A1 and A2 in the Appendix show the list of commodities and industries. Table 1 and Figure 3 show the list of regions.

[1] This approach has been applied for distinct interregional systems: interisland model for the Azores (Haddad et al., 2015), interregional models for Brazil (Haddad et al., 2017), Colombia (Haddad et al., 2018), Egypt (Haddad et al., 2016), Greece (Haddad et al., 2020), Lebanon (Haddad, 2014), Mexico (Haddad et al., 2020b), Morocco (Haddad et al., 2020c), Paraguay (Haddad et al. 2021), and Ukraine (Haddad et al., 2022).

[2] For surveys on recent approaches to non-survey estimation of inter-regional trade systems, refer to Gabela (2020) and Hewings & Oosterhaven (2021).

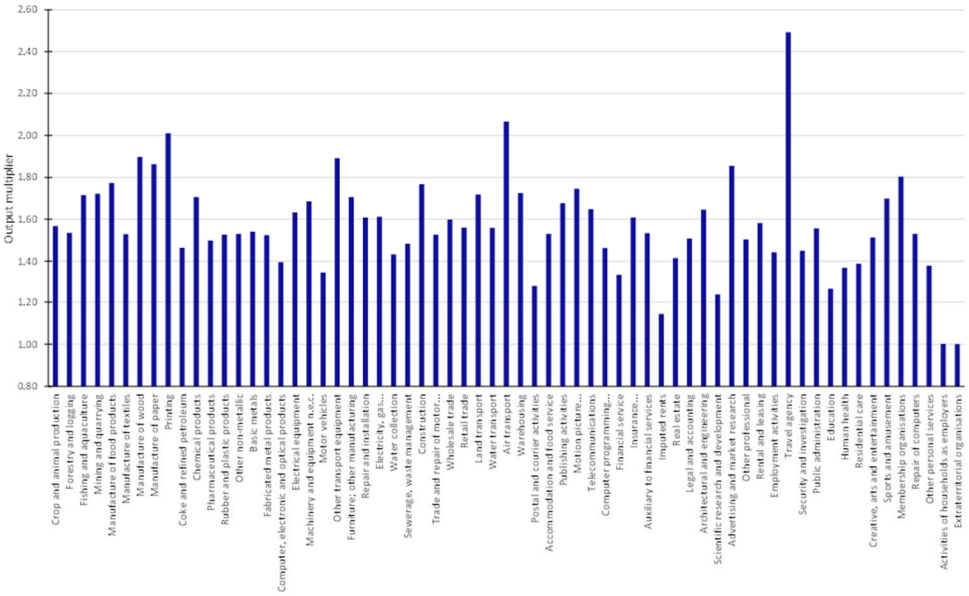
Step 1. The first step in data treatment was to build the national input-output matrix for Croatia from the SUT available at the Croatian Bureau of Statistics.

Step 2. The next step was to disaggregate the national data into the 21 regions of Croatia (NUTS Level 3).[3] The details of such a procedure are described in Sections 2.2 and 2.3.

We use shares from specific variables to estimate the regional value for investment, household consumption, government consumption, non-profit institutions serving households (NPIH) demand, and foreign exports. For each component, the variables used to calculate the shares are presented in Table 2.

Table 3 presents the regional shares for each final demand component. A general result is the spatial concentration of aggregate demand influenced by the distribution of economic activity and population across the regions. Economic activity is concentrated in the City of Zagreb.

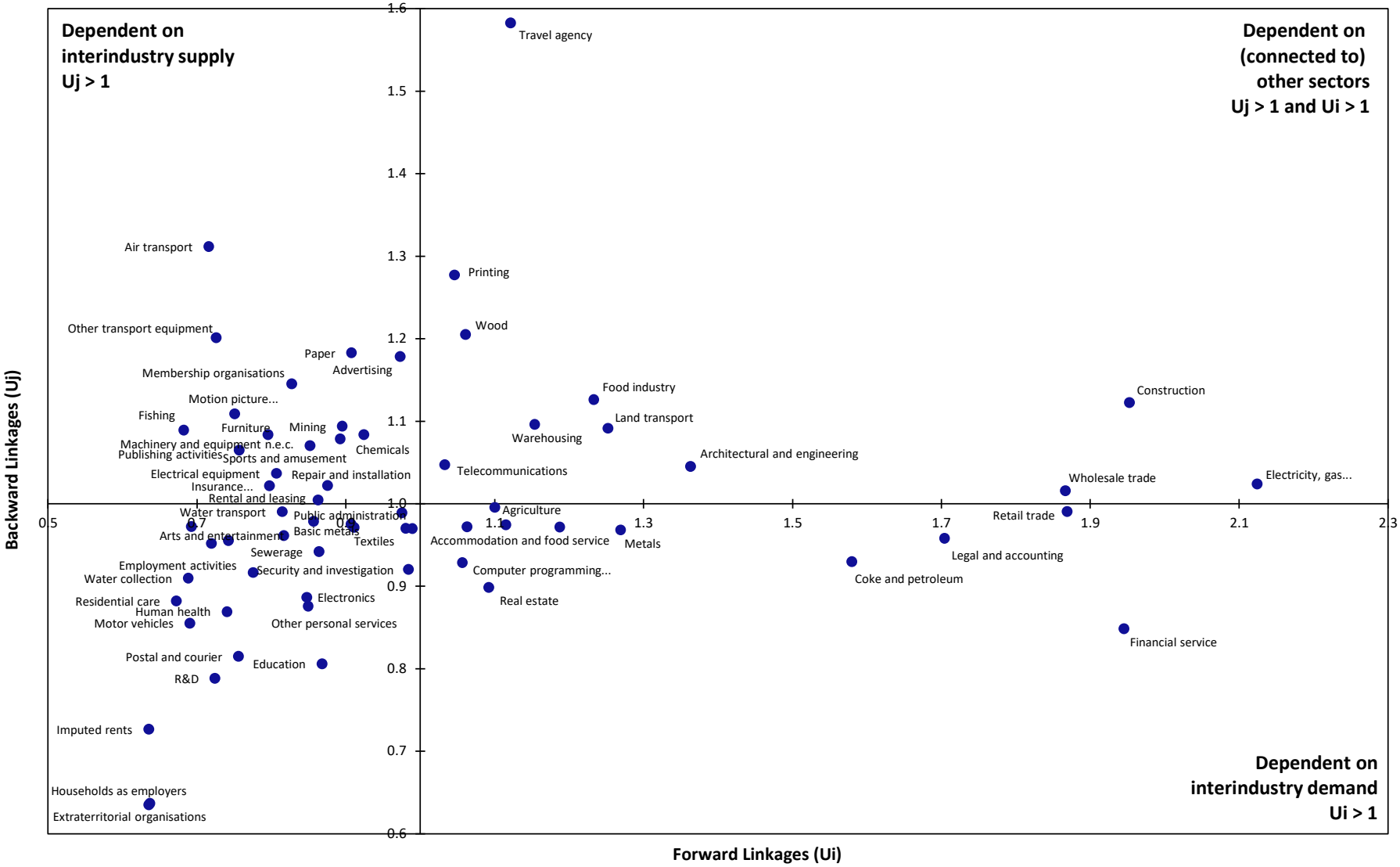
Figure 1. Output Multiplier, Croatia: 2018



Source: Croatian Bureau of Statistics. Supply and Use Tables for Croatia, 2018.

[3] NUTS corresponds to the European Union official division for regional statistics (Nomenclature of territorial units for statistics), defined at three levels depending on the number of population. Croatia has one NUTS level 1 region (Croatia), four NUTS level 2 regions (Adriatic Croatia, Panonian Croatia, Northern Croatia and City of Zagreb) and 21 NUTS level 3 regions (which correspond to administrative regions or counties).

Figure 2. Backward and Forward Linkages, Croatia: 2018



Source: Croatian Bureau of Statistics. Supply and Use Tables for Croatia, 2018.

Table 1. Gross Value Added: Croatia, 2018

#	NUTS 2	NUTS Level 2	NUTS 3	Županije	Counties	Gross Value Added ('000 kuna)	Gross Value Added (%)
R01	HR02	Pannonian Croatia	HR021	Bjelovarsko-bilogorska	Bjelovar-Bilogora	6,966,926	1.8%
R02	HR02	Pannonian Croatia	HR022	Virovitičko-podravska	Virovitica-Podravina	4,038,572	1.0%
R03	HR02	Pannonian Croatia	HR023	Požeško-slavonska	Požega-Slavonia	3,757,659	1.0%
R04	HR02	Pannonian Croatia	HR024	Brodsko-posavska	Slavonski Brod-Posavina	7,651,408	2.0%
R05	HR02	Pannonian Croatia	HR025	Osječko-baranjska	Osijek-Baranja	19,366,366	5.0%
R06	HR02	Pannonian Croatia	HR026	Vukovarsko-srijemska	Vukovar-Sirmium	8,814,445	2.3%
R07	HR02	Pannonian Croatia	HR027	Karlovačka	Karlovac	7,789,171	2.0%
R08	HR02	Pannonian Croatia	HR028	Sisačko-moslavačka	Sisak-Moslavina	9,856,908	2.6%
R09	HR03	Adriatic Croatia	HR031	Primorsko-goranska	Primorje-Gorski Kotar	32,153,787	8.3%
R10	HR03	Adriatic Croatia	HR032	Ličko-senjska	Lika-Senj	3,284,266	0.9%
R11	HR03	Adriatic Croatia	HR033	Zadarska	Zadar	13,532,983	3.5%
R12	HR03	Adriatic Croatia	HR034	Šibensko-kninska	Šibenik-Knin	7,731,117	2.0%
R13	HR03	Adriatic Croatia	HR035	Splitsko-dalmatinska	Split-Dalmatia	32,213,453	8.4%
R14	HR03	Adriatic Croatia	HR036	Istarska	Istria	23,808,036	6.2%
R15	HR03	Adriatic Croatia	HR037	Dubrovačko-neretvanska	Dubrovnik-Neretva	11,948,012	3.1%
R16	HR05	City of Zagreb	HR050	Grad Zagreb	City of Zagreb	132,092,013	34.3%
R17	HR06	Northern Croatia	HR061	Međimurska	Međimurje	8,598,892	2.2%
R18	HR06	Northern Croatia	HR062	Varaždinska	Varaždin	14,042,268	3.6%
R19	HR06	Northern Croatia	HR063	Koprivničko-križevačka	Koprivnica-Križevci	7,372,448	1.9%
R20	HR06	Northern Croatia	HR064	Krapinsko-zagorska	Krapina-Zagorje	7,689,219	2.0%
R21	HR06	Northern Croatia	HR065	Zagrebačka	Zagreb	22,668,623	5.9%
				Republika Hrvatska	**Republic of Croatia**	**385,376,571**	**100.0%**

Source: Interregional Input-Output System for Croatia, 2018.

Figure 3. List of Regions

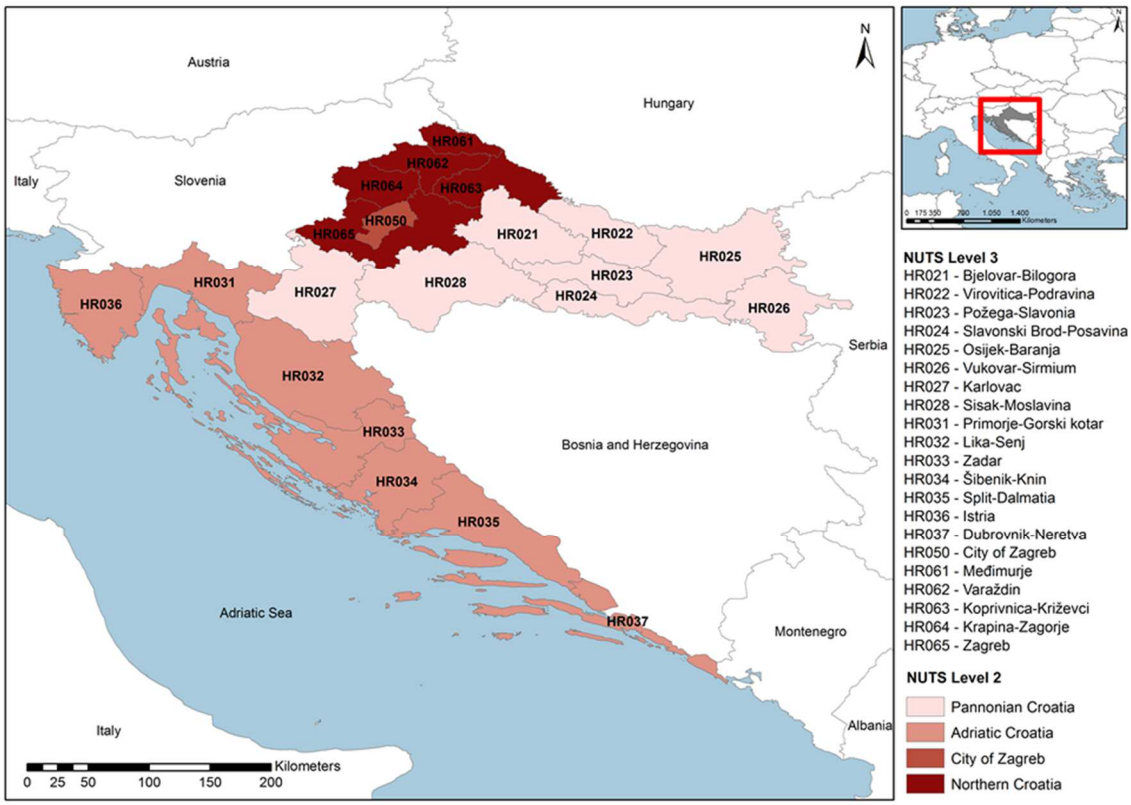


Table 2. Data Sources Used to Calculate Regional Shares of Final Demand

Description	Variables used to calculate regional shares	Source (Croatian Bureau of Statistics)
Gross fixed capital formation	Value added in construction	Gross Value Added for the Republic of Croatia by Counties, 2018
Final consumption expenditure by households	Total value added	Gross Value Added for the Republic of Croatia by Counties, 2018
Final consumption expenditure by government	Value added in public administration and defense activities	Gross Value Added for the Republic of Croatia by Counties, 2018
Non-profit organizations serving households (NPISH)	Value added in public administration and defense activities	Gross Value Added for the Republic of Croatia by Counties, 2018
Export	Regional volumes of foreign trade in goods and services	Export by Counties, 2018

Table 3. Regional Shares of Final Demand Components

REG	Counties (HR - NUTS 3)	Gross fixed capital formation	Final consumption expenditure by households	Final consumption expenditure by government	Non-profit organisations serving households (NPISH)
R01	Bjelovar-Bilogora	2.18	1.81	0.85	0.85
R02	Virovitica-Podravina	1.44	1.05	0.49	0.49
R03	Požega-Slavonia	1.27	0.98	0.28	0.28
R04	Slavonski Brod-Posavina	2.46	1.99	1.18	1.18
R05	Osijek-Baranja	4.90	5.03	4.35	4.35
R06	Vukovar-Sirmium	2.78	2.29	0.86	0.86
R07	Karlovac	2.18	2.02	0.99	0.99
R08	Sisak-Moslavina	3.21	2.56	0.91	0.91
R09	Primorje-Gorski kotar	9.94	8.34	7.68	7.68
R10	Lika-Senj	1.57	0.85	0.30	0.30
R11	Zadar	4.75	3.51	3.52	3.52
R12	Šibenik-Knin	2.58	2.01	1.54	1.54
R13	Split-Dalmatia	10.25	8.36	8.73	8.73
R14	Istria	9.96	6.18	4.22	4.22
R15	Dubrovnik-Neretva	5.45	3.10	2.75	2.75
R16	City of Zagreb	17.71	34.28	53.97	53.97
R17	Međimurje	2.10	2.23	1.16	1.16
R18	Varaždin	3.20	3.64	2.03	2.03
R19	Koprivnica-Križevci	1.58	1.91	0.91	0.91
R20	Krapina-Zagorje	2.58	2.00	0.65	0.65
R21	Zagreb	7.90	5.88	2.62	2.62
	Republic of Croatia	**100.00**	**100.00**	**100.00**	**100.00**

2.2 Estimation of the Interregional Trade Matrices

Step 3. In order to estimate the interregional system, it has been necessary to estimate the trade matrices among the 21 regions of Croatia. This procedure has been made by calculating three components: (i) the regional demand for domestic products; (ii) the regional demand for imported products; and (iii) the total supply of each region to the domestic and foreign markets by commodity.

Step 4. We have assumed that regional demands for domestic and import products follow the national pattern for all users. In other words, economic agents share the same technology and preferences everywhere. However, it is essential to note that we have estimated different trade matrices for each commodity, allowing us to have different regional sourcing for intermediate inputs and final products.

Step 5. The regional demand for domestic products is calculated, for each user (intermediate consumption and domestic absorption components), using the information provided in the matrix of demand-generating coefficients (**DOMGEN**). These coefficients are defined as the ratio of each element of the national use matrix to its respective column total.

Step 6. The gross regional demand for domestic products is obtained by multiplying the demand-generating coefficients by (i) a matrix with the total sectoral output of each region in the main diagonal and zero elsewhere; (ii) the total investment demand in each region; (iii) the total household consumption in each region; (iii) the total NPIH demand in each region; and (v) the total government expenditure in each region. Information on gross value added for 11 industries (Table 4 and Figure 4) from the Croatian Bureau of Statistics provides the main data for calculating the regional shares of sectoral output. We use the number of persons in employment in legal entities (situation as on 31 March, 2018) for 65 economic activities and 21 counties from the Croatian Bureau of Statistics to complement the sectoral value added data and calculate the regional shares for 65 industries from the SUT.

Step 7. The procedure to estimate the demand for imported products is similar. Analogously, we have created a matrix of demand-generating coefficients for imported products (**IMPGEN**), defined as the ratio of each element of the national matrix of imports over the respective column sum in the use matrix.

Step 8. The next step was to estimate the domestic supply by commodity (**SUPDOM**) in each region, which has been done by taking the difference between the total output by commodity ($\mathbf{x}^r$) and the exports by commodity ($\mathbf{exp}^r$) in each region. Thus, having the domestic demand and supply by region and commodity (**DEMDOM** and **SUPDOM**), we have to ensure the equilibrium between them in aggregate terms. Thus, we have adjusted the aggregate value of (gross) total domestic demand for each commodity to have total domestic demand equivalent to total domestic supply.

Step 9. The next step has been to construct, for each commodity, matrices with regional trade shares ($\mathbf{SHIN}^i$). In other words, we have created matrices for each sector representing the regional share of the total domestic trade. Considering *s* origin and *d*

destination regions, we have estimated 65 matrices (one for each commodity) of *21* x *21* (origin x destination). These shares have been estimated using previous work by Dixon and Rimmer (2004).

Step 10. We generate matrices of size *21* x *21* (region x region) for each commodity – $\mathbf{SHIN}^{i}$, where the intra-regional trade shares are placed on the main diagonal and the interregional trade shares off-diagonal. Note that the column values add to one.

Step 11. Using the $\mathbf{SHIN}^{i}$ matrices, we have estimated initial values for the trade matrices by multiplying each $\mathbf{SHIN}^{i}$ by its respective reference value in $\mathbf{DEMDOM}$.

Step 12. After the RAS procedure, we have included in each $\mathbf{TRADE}^{i}_{s,d}$ matrix the respective row from $\mathbf{DEMIMP}$. In other words, we added the Rest of the World as one of the origins. Thus, now *s* is equal to 22 since it represents the 21 Croatian regions plus the Rest of the World (Table 5 and Tables A4-A5 in Appendix).

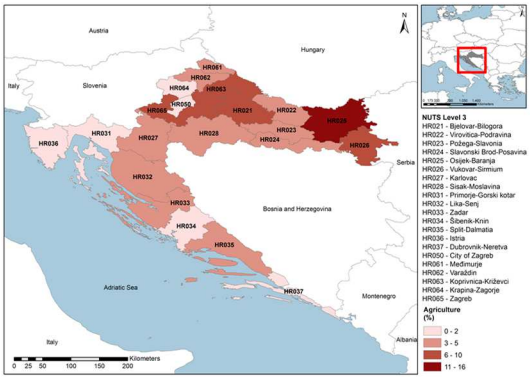
Table 4. Regional Shares of Sectoral Output (in %)

REG	Counties (HR - NUTS 3)	A Agricul-ture	B-E Mining	C Manufac-turing	F Construc-tion	G-I Trade	J Information	K Financial activities	L Real estate activities	M_N Professional activities	O-Q Public adminis-tration	R-U Other service activities	Gross value added
R01	Bjelovar-Bilogora	10.25	1.17	2.13	2.18	0.82	0.50	1.75	2.00	0.85	2.10	1.01	1.81
R02	Virovitica-Podravina	3.84	1.14	1.24	1.44	0.64	0.21	0.59	1.31	0.49	1.33	0.76	1.05
R03	Požega-Slavonia	2.98	1.26	1.06	1.27	0.65	0.46	0.36	1.38	0.28	1.38	0.58	0.98
R04	Slavonski Brod-Posavina	5.25	1.76	2.96	2.46	1.11	0.81	0.80	2.78	1.18	2.47	1.22	1.99
R05	Osijek-Baranja	15.58	5.66	5.47	4.90	3.01	3.39	2.47	5.37	4.35	6.68	5.10	5.03
R06	Vukovar-Sirmium	8.44	3.73	1.79	2.78	1.51	0.74	0.73	3.12	0.86	3.44	1.72	2.29
R07	Karlovac	2.73	1.99	3.54	2.18	1.38	0.69	1.06	2.13	0.99	2.71	1.42	2.02
R08	Sisak-Moslavina	5.47	3.16	4.28	3.21	1.59	0.51	0.98	3.00	0.91	3.31	1.83	2.56
R09	Primorje-Gorski kotar	2.30	6.43	12.49	9.94	9.03	3.75	4.31	10.46	7.68	6.79	8.21	8.34
R10	Lika-Senj	2.94	1.39	0.25	1.57	0.75	0.20	0.27	1.52	0.30	1.09	0.59	0.85
R11	Zadar	5.30	3.70	1.50	4.75	3.58	0.77	2.63	6.51	3.52	3.77	4.10	3.51
R12	Šibenik-Knin	0.84	2.51	1.28	2.58	2.14	0.57	1.03	3.74	1.54	2.17	3.33	2.01
R13	Split-Dalmatia	3.22	7.62	3.89	10.25	9.88	5.15	6.78	12.04	8.73	9.55	11.91	8.36
R14	Istria	2.11	8.47	5.13	9.96	9.36	4.29	3.14	6.62	4.22	4.19	5.03	6.18
R15	Dubrovnik-Neretva	1.64	2.70	0.30	5.45	5.65	1.03	1.60	3.55	2.75	2.76	3.08	3.10
R16	City of Zagreb	2.15	30.33	21.12	17.71	35.32	72.03	64.65	19.91	53.97	32.60	41.16	34.28
R17	Međimurje	4.76	2.26	5.73	2.10	1.19	0.70	1.06	2.14	1.16	1.68	1.06	2.23
R18	Varaždin	3.29	3.72	8.93	3.20	2.33	1.79	2.38	2.77	2.03	3.41	2.53	3.64
R19	Koprivnica-Križevci	7.68	1.81	3.27	1.58	1.24	0.27	1.33	1.82	0.91	1.87	1.36	1.91
R20	Krapina-Zagorje	1.75	2.27	4.77	2.58	1.26	0.37	0.76	1.95	0.65	2.18	0.88	2.00
R21	Zagreb	7.50	6.92	8.87	7.90	7.57	1.77	1.31	5.87	2.62	4.50	3.11	5.88
	Republic of Croatia	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

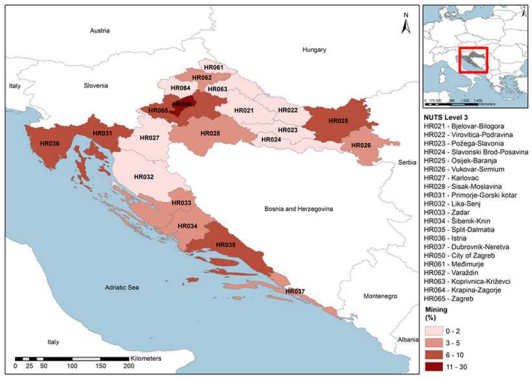
Source: Croatian Bureau of Statistics. Gross Value Added for Republic of Croatia, at NUTS 2013 – 2nd Level and by Counties, 2018 (ESA 2010).

Figure 4. Domestic Product for Republic of Croatia by Counties, 2018

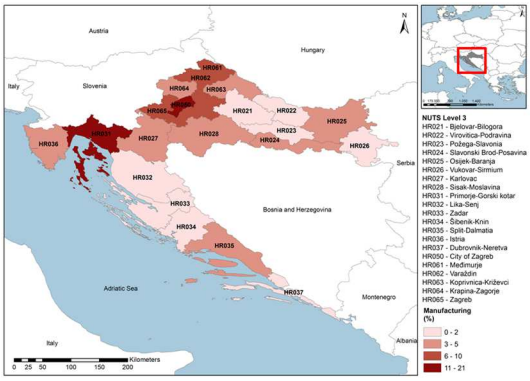
Agriculture, forestry and fishing



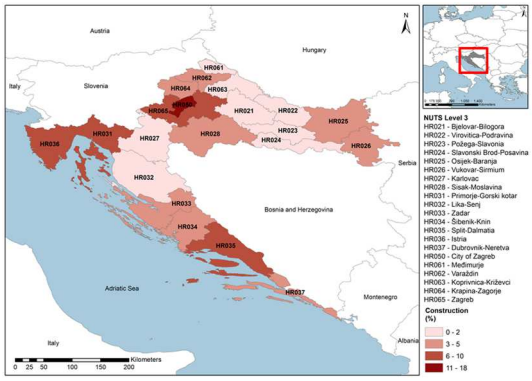
Mining and quarrying



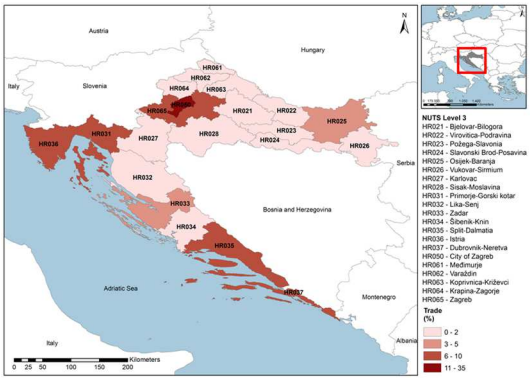
Manufacturing



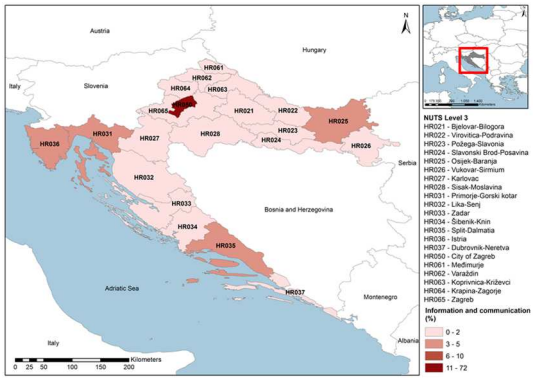
Construction



Wholesale and retail trade, transportation, storage,accommodation and food service activities



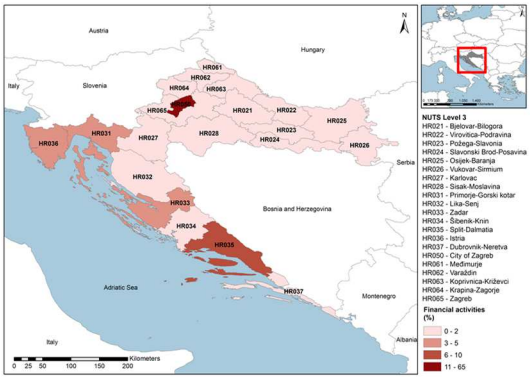
Information and communication



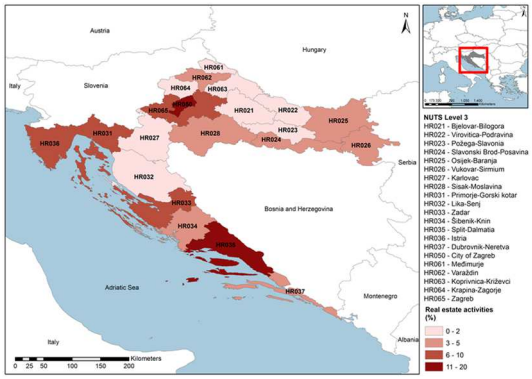
Source: Croatian Bureau of Statistics. Gross Value Added for Republic of Croatia by Counties, 2018.

Figure 4. Domestic Product for Republic of Croatia by Counties, 2018 (Cont.)

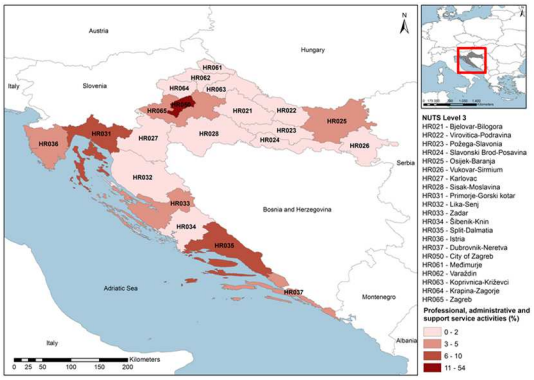
Financial and insurance activities



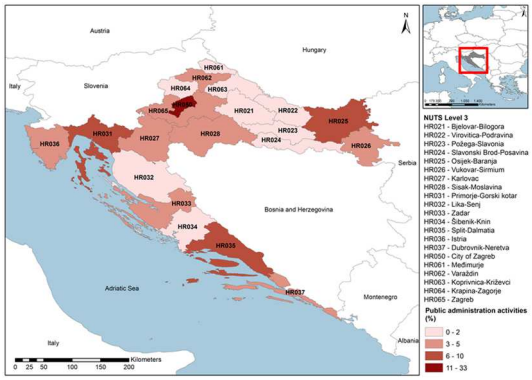
Real estate activities



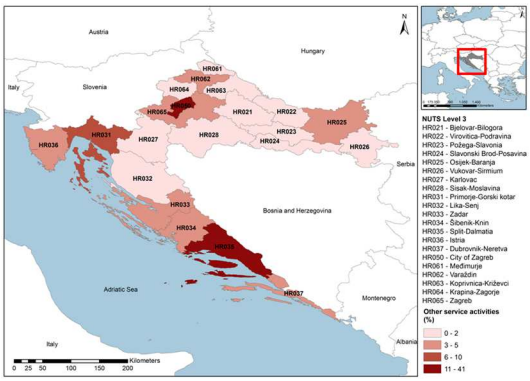
Professional, scientific, technical, administrative and support service activities



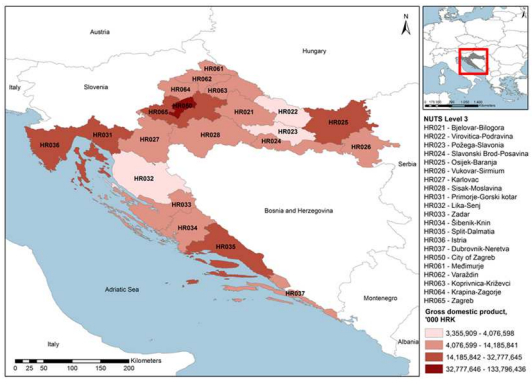
Public administration and defence, education, human health and social work activities



Other service activities



Gross value added



Source: Croatian Bureau of Statistics. Gross Value Added for Republic of Croatia by Counties, 2018.

Table 5. Estimated Interregional Trade Flows in 2018 (‘000 Kuna)

Origin	Destination																					DOMSALES
		R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	
R01	Bjelovar-Bilogora	5,420	115	47	81	174	69	82	134	308	29	96	48	222	227	93	2,582	131	229	237	89	292	10,703
R02	Virovitica-Podravina	77	3,431	29	40	148	50	28	56	128	11	42	21	99	97	42	1,102	52	92	89	30	102	5,766
R03	Požega-Slavonia	44	30	2,934	112	170	59	30	60	143	13	46	21	111	111	43	1,260	41	67	40	31	104	5,471
R04	Slavonski Brod-Posavina	74	55	122	6,466	532	193	59	133	245	25	89	43	198	183	89	2,055	78	136	68	66	205	11,113
R05	Osijek-Baranja	168	179	173	524	17,966	1,052	133	261	649	61	238	121	579	508	291	4,480	175	311	206	145	464	28,684
R06	Vukovar-Sirmium	66	60	59	173	1,113	6,958	54	97	314	22	99	46	242	212	113	2,644	74	132	77	58	198	12,812
R07	Karlovac	72	36	31	62	133	59	6,140	115	455	45	118	54	229	277	95	2,982	90	151	74	115	376	11,710
R08	Sisak-Moslavina	165	97	91	161	361	156	126	8,235	527	49	149	79	328	284	135	4,553	170	271	146	169	511	16,763
R09	Primorje-Gorski kotar	356	193	192	350	923	430	509	481	33,205	253	752	378	1,525	3,616	635	7,988	422	705	403	431	1,174	54,925
R10	Lika-Senj	29	19	14	25	59	23	46	39	203	2,691	119	46	186	109	49	1,116	43	66	31	39	108	5,058
R11	Zadar	85	49	47	91	228	99	123	127	455	114	13,791	274	862	317	239	2,713	118	213	107	114	309	20,478
R12	Šibenik-Knin	56	32	31	62	147	64	77	79	291	59	335	7,492	945	199	185	1,783	80	133	65	77	195	12,389
R13	Split-Dalmatia	183	107	104	201	520	230	219	249	871	181	879	753	34,901	699	900	5,284	244	416	219	226	600	47,986
R14	Istria	235	131	125	260	594	276	306	351	2,604	109	330	158	726	22,957	323	5,609	264	480	248	276	768	37,129
R15	Dubrovnik-Neretva	117	69	68	137	395	171	116	157	296	45	190	108	687	216	13,070	2,663	141	238	131	122	336	19,471
R16	City of Zagreb	1,858	837	834	1,698	3,404	1,698	2,398	2,971	6,460	753	2,039	1,062	3,860	4,770	1,718	123,857	2,432	3,975	1,957	2,679	9,450	180,711
R17	Međimurje	101	60	40	77	168	75	84	115	297	35	115	57	254	236	123	2,295	6,404	860	200	111	287	11,995
R18	Varaždin	172	93	64	128	285	120	138	192	493	56	171	93	388	392	192	4,374	834	11,373	324	214	472	20,567
R19	Koprivnica-Križevci	195	112	38	67	211	70	69	95	281	29	105	54	245	218	110	2,239	206	345	5,337	80	246	10,353
R20	Krapina-Zagorje	76	37	37	69	153	67	104	130	311	37	117	52	236	228	109	2,903	110	233	85	5,665	439	11,198
R21	Zagreb	289	118	112	233	479	203	401	471	990	119	335	164	697	700	294	10,405	332	551	280	480	17,420	35,072
	DOMDEM	9,838	5,860	5,192	11,018	28,164	12,122	11,243	14,547	49,526	4,735	20,154	11,125	47,521	36,558	18,848	194,888	12,441	20,977	10,325	11,218	34,055	570,355
	DOMIMP	3,438	2,029	1,914	4,109	9,688	4,236	4,164	6,837	20,026	1,538	6,157	3,626	14,185	12,302	5,509	55,165	5,122	8,714	3,559	4,717	12,158	189,193

Source: Interregional Input-Output System for Croatia, 2018.

3. Regionalization Procedure

Step 13. The 65 trade matrices estimated are consistent with the national supply and demand in each commodity. The trade matrices, after the inclusion of the import row, $\mathbf{TRADE}^{*i}_{s,d}$, consider the sales of each Croatian region to the other Croatian regions and the purchases of each of them both from domestic and foreign supply regions. However, from these matrices, we cannot know if the sales were purchased by industries (intermediate consumption) or by final users in the other regions.

In order to deal with this issue, we have used a regionalization strategy proposed originally by Chenery (1956) and Moses (1955). We have applied the same regional proportion in acquiring inputs for all commodities and final products by all final users within a given region. In other words, we have used the same trade coefficients for all commodities or final users in the destination. The idea behind this procedure is that users in a specific region face the supply of a "pool good" composed of fixed shares of related goods from the different sourcing regions.

In order to have the completed inter-regional system, we need the regional value-added components (VA^R). In the interregional input-output system, the total regional output (x^R) should be equivalent to the total demand of each region (DT^R). This balance checking can be done using the accounting identities of the input-output model.

Figure 5 represents the interregional input-output system for Croatia with *n*-commodity and *n*-sector (n =65) and *r*-regions (r =21).

Figure 5. Structure of the Interregional Flows Database

		Processing sectors							*Final demand*					*Total output*
		11	$\cdots$	rn	$\ldots$	$r1$	$\cdots$	rn						
Processing sectors	11	z_{11}^{11}	$\cdots$	z_{1n}^{11}		z_{11}^{1r}	$\cdots$	z_{1n}^{1r}	$\mathbf{c}_1^{1\bullet}$	$\mathbf{np}_1^{1\bullet}$	$\mathbf{i}_1^{1\bullet}$	$\mathbf{g}_1^{1\bullet}$	$\mathbf{e}_1^{1\bullet}$	x_1^1
	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\cdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
	$1n$	z_{n1}^{11}	$\cdots$	z_{nn}^{11}		z_{n1}^{1r}	$\cdots$	z_{nn}^{1r}	$\mathbf{c}_n^{1\bullet}$	$\mathbf{np}_n^{1\bullet}$	$\mathbf{i}_n^{1\bullet}$	$\mathbf{g}_n^{1\bullet}$	$\mathbf{e}_n^{1\bullet}$	x_n^1
	$\vdots$		$\vdots$		$\ddots$		$\vdots$		$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
	$r1$	z_{11}^{r1}	$\cdots$	z_{1n}^{r1}		z_{11}^{rr}	$\cdots$	z_{1n}^{rr}	$\mathbf{c}_1^{r\bullet}$	$\mathbf{np}_1^{r\bullet}$	$\mathbf{i}_1^{r\bullet}$	$\mathbf{g}_1^{r\bullet}$	$\mathbf{e}_1^{r\bullet}$	x_1^r
	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\cdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
	rn	z_{n1}^{r1}	$\cdots$	z_{nn}^{r1}		z_{n1}^{rr}	$\cdots$	z_{nn}^{rr}	$\mathbf{c}_n^{r\bullet}$	$\mathbf{np}_n^{r\bullet}$	$\mathbf{i}_n^{r\bullet}$	$\mathbf{g}_n^{r\bullet}$	$\mathbf{e}_n^{r\bullet}$	x_n^r
Imports		m_1^1	$\cdots$	m_n^1	$\cdots$	m_1^r	$\cdots$	m_n^r	$m_c^\bullet$	$m_{np}^\bullet$	$m_c^\bullet$	$m_g^\bullet$	$m_e^\bullet$	m
Indirect taxes		t_1^1	$\cdots$	t_n^1	$\cdots$	t_1^r	$\cdots$	t_n^r	$t_c^\bullet$	$t_{np}^\bullet$	$t_c^\bullet$	$t_g^\bullet$	$t_e^\bullet$	t
Labor payments		l_1^1	$\cdots$	l_n^1	$\cdots$	l_1^r	$\cdots$	l_n^r						
Other payments		n_1^1	$\cdots$	n_n^1	$\cdots$	n_1^r	$\cdots$	n_n^r						n
Outlays		x_1^1	$\cdots$	x_n^1	$\cdots$	x_1^r	$\cdots$	x_n^r	c	np	i	g	e	
Employment		L_1^1	$\cdots$	L_n^1	$\cdots$	L_1^r	$\cdots$	L_n^r						

z_{ij}^{rs}, with $i, j = 1, \ldots, n$ and $r, s = 1, \ldots, r$ represents interindustry sales from industry *i* in region *r* to industry *j* in region *s*

m_i^s and t_i^s with $i = 1, \ldots, n, c, i, g, e$ represent, respectively, imports and indirect taxes payments in region *s*

l_i^s and L_i^s with $i = 1, \ldots, n$ and $s = 1, \ldots, r$ represent, respectively, payments by sectors for labor services, and the total number of workers in region *s*

n_j^s, with $j = 1, \ldots, n$ and $s = 1, \ldots, r$ represents payments by sectors for all other value-added items in region *s*

$c_i^{r\bullet}$, $np_i^{r\bullet}$, $i_i^{r\bullet}$, $g_i^{r\bullet}$, and $e_i^{r\bullet}$ with $i = 1, \ldots, n$ and $r = 1, \ldots, r$ represent the regional components of final demand, $f_i^{r\bullet}$, respectively, household purchases, NPIH purchases, investment purchases, government purchases, and exports from region *r*

x_i^r, with $i = 1, \ldots, n$ and $r = 1, \ldots, r$ is the total sectoral output in region *r*

4. Structural Analysis

To illustrate the potential use of the IIOM-HRV, we provide a few examples of input-output techniques.

4.1. Linkages Structure

The conventional input-output model is given by

$$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{f} \tag{1}$$

and

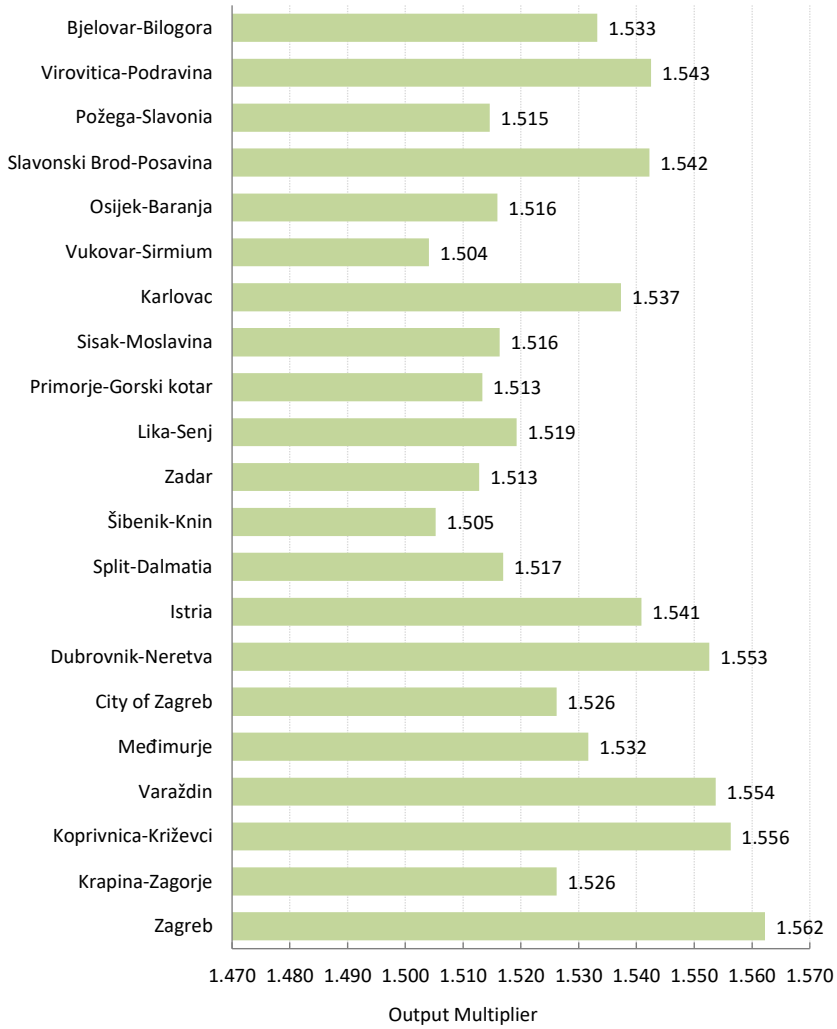
$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} = \mathbf{B}\mathbf{f} \tag{2}$$

where **x** and **f** are respectively the vectors of gross output and final demand; **A** is a matrix with the input-output coefficients a_{ij} defined as the amount of product *i* required per unit of product *j* (in monetary terms) – $i, j = 1, \dots, n$; and **B** is known as the Leontief inverse.

The column multipliers derived from **B** were computed (Miller and Blair, 2009). An output multiplier is defined for each sector *j*, in each region *r*, as the total value of production in all sectors and in all regions of the economy that is necessary to satisfy a currency unit of final demand for sector *j*'s output. Figure 6 shows the output multiplier for the Croatian regions.

The multiplier effect can be decomposed into intraregional (internal multiplier) and interregional (external multiplier) effects, the former representing the impacts on the outputs of sectors within the region where the final demand change was generated, and the latter showing the impacts on the other regions of the system (interregional spillover effects). Figure 7 shows the intraregional and interregional shares for the average total output multipliers of the 21 regions of Croatia (the total output multiplier effect net of the initial change). The entries are shown in percentage terms, providing insights into the degree of dependence of each region on the other regions.

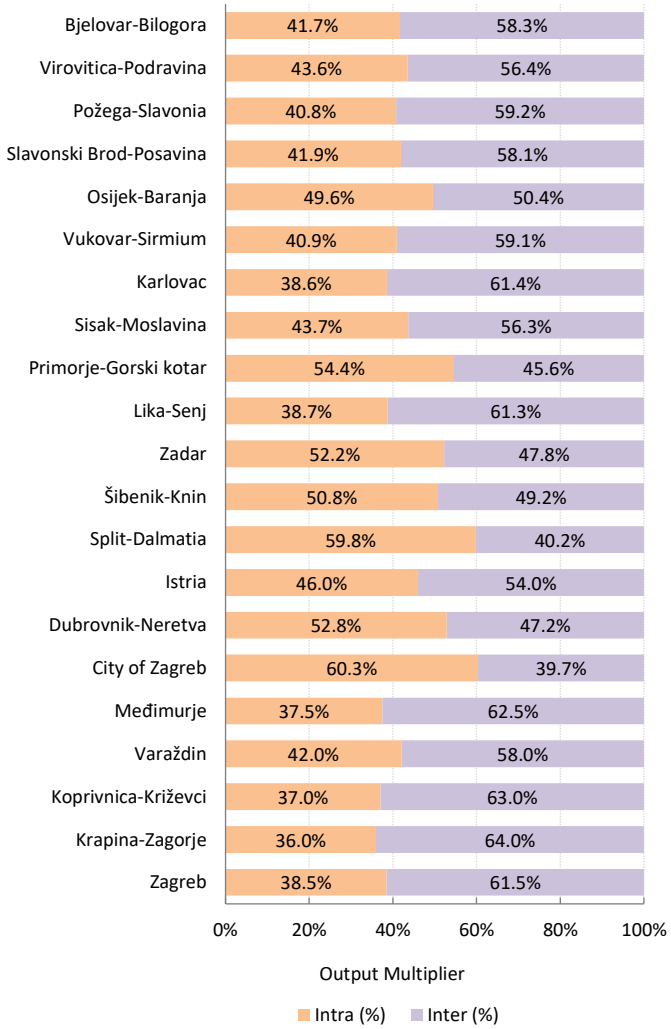
Figure 6. Output Multiplier: Croatia, 2018



Note: The regional output multiplier is obtained by weighting region-sectoral multipliers by final demand.

Source: Interregional Input-Output System for Croatia, 2018.

Figure 7. Regional Percentage Distribution of the Net Output Multipliers: Croatia, 2018



Source: Interregional Input-Output System for Croatia, 2018.

4.2. Regional Propagation of Final Demand Shocks

Considering the systems Equations (1) and (2) in an interregional context, with *r* different regions, so that:

$$\mathbf{x} = \begin{bmatrix} \mathbf{x}^1 \\ \vdots \\ \mathbf{x}^{\mathrm{R}} \end{bmatrix}; \mathbf{A} = \begin{bmatrix} \mathbf{A}^{11} & \cdots & \mathbf{A}^{1\mathrm{R}} \\ \vdots & \ddots & \vdots \\ \mathbf{A}^{\mathrm{R}1} & \cdots & \mathbf{A}^{\mathrm{RR}} \end{bmatrix}; \mathbf{f} = \begin{bmatrix} \mathbf{f}^1 \\ \vdots \\ \mathbf{f}^{\mathrm{R}} \end{bmatrix}; \text{ and } \mathbf{B} = \begin{bmatrix} \mathbf{B}^{11} & \cdots & \mathbf{B}^{1\mathrm{R}} \\ \vdots & \ddots & \vdots \\ \mathbf{B}^{\mathrm{R}1} & \cdots & \mathbf{B}^{\mathrm{RR}} \end{bmatrix} \tag{3}$$

and

$$\begin{aligned} \mathbf{x}^1 &= \mathbf{B}^{11}\mathbf{f}^1 + \cdots + \mathbf{B}^{1\mathrm{R}}\mathbf{f}^{\mathrm{R}} \\ &\vdots \\ \mathbf{x}^{\mathrm{R}} &= \mathbf{B}^{\mathrm{R}1}\mathbf{f}^1 + \cdots + \mathbf{B}^{\mathrm{RR}}\mathbf{f}^{\mathrm{R}} \end{aligned} \tag{4}$$

Furthermore, we may consider different components of $\mathbf{f}$, which include demands originating in the specific regions, *V,* and abroad, *e*. We obtain information on final demand from origin *s* in the IIOM-HRV, allowing us to treat $\mathbf{V}$ as a matrix that provides the monetary values of final demand expenditures from the domestic regions in Croatia and the foreign region.

$$\mathbf{V} = \begin{bmatrix} \mathbf{V}^{11} & \cdots & \mathbf{V}^{1\mathrm{R}} \\ \vdots & \ddots & \vdots \\ \mathbf{V}^{\mathrm{R}1} & \cdots & \mathbf{V}^{\mathrm{RR}} \end{bmatrix}; \text{ and } \mathbf{e} = \begin{bmatrix} \mathbf{e}^1 \\ \vdots \\ \mathbf{e}^{\mathrm{R}} \end{bmatrix} \tag{5}$$

Thus, we can re-write Equation (4) as:

$$\begin{aligned} \mathbf{x^1} &= \mathbf{B^{11}}(\mathbf{V^{11}} + \cdots + \mathbf{V^{R1}} + \mathbf{e^1}) + \cdots + \mathbf{B^{1R}}(\mathbf{V^{1R}} + \cdots + \mathbf{V^{RR}} + \mathbf{e^R}) \\ &\vdots \\ \mathbf{x^R} &= \mathbf{B^{R1}}(\mathbf{V^{11}} + \cdots + \mathbf{V^{R1}} + \mathbf{e^1}) + \cdots + \mathbf{B^{RR}}(\mathbf{V^{1R}} + \cdots + \mathbf{V^{RR}} + \mathbf{e^R}) \end{aligned} \tag{6}$$

From Equation (6), we can compute the contribution of final demand from different origins on regional output. It is clear from (6) that regional output depends, among others, on demand originating in the region and on the degree of interregional integration, also on demand from outside the region.

In what follows, interdependence among sectors in different regions is considered through the analysis of the complete intermediate input portion of the interregional input-output table. Based on the system (4), the Leontief inverse matrix will be considered, and some summary interpretations of the economy's structure derived from it will be provided. To illustrate the nature of interregional linkages in Croatia, we analyze the structure of the Croatian economy derived from the Leontief inverse (multipliers) matrix, focusing on the database for 2018.

Following Equation (6), regional output (for each region) is decomposed, and the contributions of the components of final demand from different areas are calculated. The results are presented in Table 6. As expected, the main contributions to the final demand of a region are given by itself, so the highest values in the table are on the diagonal. In addition, the importance of City of Zagreb (R16), Primorje-Gorski Kotar (R09), Split-Dalmatia (R13), Istria (R14), and Zagreb (R21) for the Croatian economy is verified, with the final demand originating in these regions generating the largest contribution to the output of the other regions. The final demand for City of Zagreb (R16) contributes to 27.95% of the Croatian output, and, at the regional level, it contributes mainly to City of Zagreb (R16), 48.59%, Sisak-Moslavina (R08), 25.45%, and Zagreb (R21), 25.39%. Final demand originating in Split-Dalmatia (R13) contributes to 6.92% of total national output. The importance of the rest of the world's demand for Croatian production is worth noting, with a contribution of 21.45%.

Table 6. Components of Decomposition of Regional Output Based on the Sources of Final Demand: Croatia, 2018 (in %)

Regional Output	Origin of Final Demand																					Total
	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	EXP	
R01 Bjelovar-Bilogora	34.72	0.73	0.37	0.71	1.50	0.63	0.67	1.06	2.99	0.28	1.01	0.52	2.38	2.13	0.98	24.66	0.90	1.56	1.36	0.71	2.34	17.80	100.00
R02 Virovitica-Podravina	0.92	37.92	0.37	0.60	1.95	0.69	0.42	0.76	2.19	0.19	0.76	0.37	1.81	1.58	0.75	18.37	0.68	1.12	0.97	0.44	1.50	25.62	100.00
R03 Požega-Slavonia	0.64	0.44	34.95	1.59	2.41	0.89	0.48	0.87	2.58	0.23	0.87	0.41	2.12	1.88	0.81	22.65	0.63	0.98	0.56	0.49	1.65	21.87	100.00
R04 Slavonski Brod-Posavina	0.56	0.41	0.80	36.29	3.65	1.40	0.46	0.93	2.09	0.24	0.86	0.42	1.94	1.61	0.87	14.36	0.56	0.97	0.50	0.51	1.57	29.01	100.00
R05 Osijek-Baranja	0.48	0.46	0.45	2.12	42.08	2.55	0.43	0.74	2.28	0.21	0.87	0.44	2.11	1.70	1.00	16.45	0.52	0.86	0.52	0.45	1.46	21.80	100.00
R06 Vukovar-Sirmium	0.44	0.36	0.36	3.01	6.12	34.18	0.39	0.64	2.51	0.18	0.82	0.38	2.00	1.68	0.89	22.16	0.51	0.85	0.46	0.42	1.49	20.16	100.00
R07 Karlovac	0.51	0.26	0.23	0.82	1.06	0.47	32.80	0.77	3.27	0.33	0.97	0.45	1.97	2.05	0.81	23.42	0.58	0.97	0.48	0.68	2.42	24.66	100.00
R08 Sisak-Moslavina	0.79	0.43	0.42	1.13	1.83	0.76	0.65	29.74	2.78	0.27	0.96	0.48	2.14	1.78	0.88	25.45	0.79	1.27	0.67	0.78	2.52	23.49	100.00
R09 Primorje-Gorski kotar	0.65	0.35	0.34	0.70	1.68	0.75	0.83	0.81	44.59	0.43	1.37	0.68	2.88	5.63	1.24	15.39	0.73	1.19	0.67	0.72	2.09	16.28	100.00
R10 Lika-Senj	0.54	0.30	0.26	1.21	1.25	0.50	0.77	0.72	3.91	40.98	2.30	0.90	3.85	2.23	1.07	23.54	0.70	1.18	0.54	0.66	2.02	10.56	100.00
R11 Zadar	0.47	0.27	0.25	0.59	1.22	0.54	0.58	0.66	2.27	0.53	54.54	1.27	4.32	1.61	1.21	14.56	0.59	1.04	0.53	0.57	1.57	10.83	100.00
R12 Šibenik-Knin	0.55	0.31	0.28	0.86	1.42	0.62	0.63	0.74	2.56	0.49	2.77	49.26	7.76	1.76	1.61	16.85	0.70	1.17	0.59	0.63	1.76	6.68	100.00
R13 Split-Dalmatia	0.45	0.26	0.24	0.50	1.24	0.55	0.49	0.59	1.94	0.38	1.85	1.47	58.19	1.53	1.83	12.29	0.55	0.92	0.49	0.50	1.38	12.34	100.00
R14 Istria	0.69	0.39	0.36	0.76	1.75	0.80	0.83	0.99	6.04	0.30	0.95	0.45	2.11	45.55	0.90	16.19	0.74	1.32	0.69	0.76	2.17	15.24	100.00
R15 Dubrovnik-Neretva	0.78	0.46	0.43	0.91	2.52	1.12	0.72	1.02	1.88	0.29	1.17	0.63	3.96	1.36	55.78	16.02	0.91	1.50	0.82	0.78	2.05	4.91	100.00
R16 City of Zagreb	0.89	0.42	0.38	0.82	1.69	0.80	1.01	1.23	3.17	0.37	1.15	0.57	2.27	2.39	0.97	48.59	1.05	1.66	0.84	1.10	3.93	24.71	100.00
R17 Međimurje	0.59	0.36	0.25	0.51	1.12	0.50	0.51	0.73	2.07	0.25	0.84	0.42	1.90	1.58	0.88	15.33	28.57	3.60	0.96	0.62	1.74	36.68	100.00
R18 Varaždin	0.62	0.34	0.24	0.52	1.13	0.49	0.51	0.71	2.06	0.24	0.78	0.41	1.79	1.57	0.82	17.47	2.23	28.54	0.96	0.68	1.77	36.10	100.00
R19 Koprivnica-Križevci	1.18	0.69	0.29	0.56	1.58	0.57	0.54	0.73	2.44	0.25	0.96	0.50	2.26	1.84	0.98	19.19	1.23	2.05	29.56	0.60	1.88	30.12	100.00
R20 Krapina-Zagorje	0.53	0.27	0.25	0.49	1.11	0.50	0.63	0.82	2.24	0.28	0.90	0.42	1.90	1.69	0.86	20.94	0.67	1.28	0.52	29.09	2.63	31.98	100.00
R21 Zagreb	0.70	0.31	0.29	0.62	1.30	0.57	0.88	1.02	2.56	0.33	0.98	0.49	2.11	1.92	0.87	25.39	0.77	1.22	0.63	1.00	31.85	24.19	100.00
Total	1.31	0.79	0.69	1.49	3.81	1.62	1.44	1.81	6.65	0.68	2.95	1.58	6.92	5.06	2.73	27.95	1.54	2.51	1.29	1.41	4.36	21.45	100.00

Source: Interregional Input-Output System for Croatia, 2018.

5. Concluding Remarks

In this paper, we developed an interregional input-output system for Croatia, providing the numerical basis for developing analytical frameworks to impact analysis. Dealing with sustainable development of territories, in the spirit of the UN SDGs, requires support, among others, from advanced spatial modeling. Multiregional input-output analysis is part of a multidisciplinary scientific toolbox that has proven its validity and applicability worldwide, involving researchers and practitioners from different areas, such as regional scientists, planners, economists, geographers, social scientists, transportation experts, and environmental scientists.

Availability of Data and Material

The datasets generated and/or analyzed during the current study follow as supplementary file.

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Appendix

Table A1. List of Commodity

COM	Commodity	Commodity (Label)
COM_01	CPA_A01	Products of agriculture, hunting and related services
COM_02	CPA_A02	Products of forestry, logging and related services
COM_03	CPA_A03	Fish and other fishing products; aquaculture products; support services to fishing
COM_04	CPA_B	Mining and quarrying
COM_05	CPA_C10-12	Food, beverages and tobacco products
COM_06	CPA_C13-15	Textiles, wearing apparel, leather and related products
COM_07	CPA_C16	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials
COM_08	CPA_C17	Paper and paper products
COM_09	CPA_C18	Printing and recording services
COM_10	CPA_C19	Coke and refined petroleum products
COM_11	CPA_C20	Chemicals and chemical products
COM_12	CPA_C21	Basic pharmaceutical products and pharmaceutical preparations
COM_13	CPA_C22	Rubber and plastic products
COM_14	CPA_C23	Other non-metallic mineral products
COM_15	CPA_C24	Basic metals
COM_16	CPA_C25	Fabricated metal products, except machinery and equipment
COM_17	CPA_C26	Computer, electronic and optical products
COM_18	CPA_C27	Electrical equipment
COM_19	CPA_C28	Machinery and equipment n.e.c.
COM_20	CPA_C29	Motor vehicles, trailers and semi-trailers
COM_21	CPA_C30	Other transport equipment
COM_22	CPA_C31_32	Furniture and other manufactured goods
COM_23	CPA_C33	Repair and installation services of machinery and equipment
COM_24	CPA_D	Electricity, gas, steam and air conditioning
COM_25	CPA_E36	Natural water; water treatment and supply services
COM_26	CPA_E37-39	Sewerage services; sewage sludge; waste collection, treatment and disposal services; materials recovery services; remediation services and other waste management services
COM_27	CPA_F	Constructions and construction works
COM_28	CPA_G45	Wholesale and retail trade and repair services of motor vehicles and motorcycles
COM_29	CPA_G46	Wholesale trade services, except of motor vehicles and motorcycles
COM_30	CPA_G47	Retail trade services, except of motor vehicles and motorcycles
COM_31	CPA_H49	Land transport services and transport services via pipelines
COM_32	CPA_H50	Water transport services
COM_33	CPA_H51	Air transport services
COM_34	CPA_H52	Warehousing and support services for transportation
COM_35	CPA_H53	Postal and courier services

Table A1. List of Commodity (cont.)

COM	Commodity	Commodity (Label)
COM_36	CPA_I	Accommodation and food services
COM_37	CPA_J58	Publishing services
COM_38	CPA_J59_60	Motion picture, video and television programme production services, sound recording and music publishing; programming and broadcasting services
COM_39	CPA_J61	Telecommunications services
COM_40	CPA_J62_63	Computer programming, consultancy and related services; Information services
COM_41	CPA_K64	Financial services, except insurance and pension funding
COM_42	CPA_K65	Insurance, reinsurance and pension funding services, except compulsory social security
COM_43	CPA_K66	Services auxiliary to financial services and insurance services
COM_44	CPA_L68A	Imputed rents of owner-occupied dwellings
COM_45	CPA_L68B	Real estate services excluding imputed rents1)
COM_46	CPA_M69_70	Legal and accounting services; services of head offices; management consultancy services
COM_47	CPA_M71	Architectural and engineering services; technical testing and analysis services
COM_48	CPA_M72	Scientific research and development services
COM_49	CPA_M73	Advertising and market research services
COM_50	CPA_M74_75	Other professional, scientific and technical services and veterinary services
COM_51	CPA_N77	Rental and leasing services
COM_52	CPA_N78	Employment services
COM_53	CPA_N79	Travel agency, tour operator and other reservation services and related services
COM_54	CPA_N80-82	Security and investigation services; services to buildings and landscape; office administrative, office support and other business support services
COM_55	CPA_Q86	Human health services
COM_56	CPA_Q87_88	Residential care services; social work services without accommodation
COM_57	CPA_R90-92	Creative, arts, entertainment, library, archive, museum, other cultural services; gambling and betting services
COM_58	CPA_R93	Sporting services and amusement and recreation services
COM_59	CPA_S94	Services furnished by membership organisations
COM_60	CPA_S95	Repair services of computers and personal and household goods
COM_61	CPA_S96	Other personal services
COM_62	CPA_T	Services of households as employers; undifferentiated goods and services produced by households for own use
COM_63	CPA_U	Services provided by extraterritorial organisations and bodies
COM_64	CPA_O	Public administration and defence services; compulsory social security services
COM_65	CPA_P	Education services

Source: Croatian Bureau of Statistics. Supply and Use Tables for Croatia, 2018.

Table A2. List of Industry

IND	*Industry*	*Industry (Label)*
IND_01	A01	Crop and animal production, hunting and related service activities
IND_02	A02	Forestry and logging
IND_03	A03	Fishing and aquaculture
IND_04	B	Mining and quarrying
IND_05	C10-12	Manufacture of food products; beverages and tobacco products
IND_06	C13-15	Manufacture of textiles, wearing apparel, leather and related products
IND_07	C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
IND_08	C17	Manufacture of paper and paper products
IND_09	C18	Printing and reproduction of recorded media
IND_10	C19	Manufacture of coke and refined petroleum products
IND_11	C20	Manufacture of chemicals and chemical products
IND_12	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
IND_13	C22	Manufacture of rubber and plastic products
IND_14	C23	Manufacture of other non-metallic mineral products
IND_15	C24	Manufacture of basic metals
IND_16	C25	Manufacture of fabricated metal products, except machinery and equipment
IND_17	C26	Manufacture of computer, electronic and optical products
IND_18	C27	Manufacture of electrical equipment
IND_19	C28	Manufacture of machinery and equipment n.e.c.
IND_20	C29	Manufacture of motor vehicles, trailers and semi-trailers
IND_21	C30	Manufacture of other transport equipment
IND_22	C31_32	Manufacture of furniture; other manufacturing
IND_23	C33	Repair and installation of machinery and equipment
IND_24	D	Electricity, gas, steam and air conditioning supply
IND_25	E36	Water collection, treatment and supply
IND_26	E37-39	Sewerage, waste management, remediation activities
IND_27	F	Construction
IND_28	G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
IND_29	G46	Wholesale trade, except of motor vehicles and motorcycles
IND_30	G47	Retail trade, except of motor vehicles and motorcycles
IND_31	H49	Land transport and transport via pipelines
IND_32	H50	Water transport
IND_33	H51	Air transport
IND_34	H52	Warehousing and support activities for transportation
IND_35	H53	Postal and courier activities

Table A2. List of Industry (cont.)

IND	Industry	Industry (Label)
IND_36	I	Accommodation and food service activities
IND_37	J58	Publishing activities
IND_38	J59_60	Motion picture, video, television programme production; programming and broadcasting activities
IND_39	J61	Telecommunications
IND_40	J62_63	Computer programming, consultancy, and information service activities
IND_41	K64	Financial service activities, except insurance and pension funding
IND_42	K65	Insurance, reinsurance and pension funding, except compulsory social security
IND_43	K66	Activities auxiliary to financial services and insurance activities
IND_44	L68A	Imputed rents of owner-occupied dwellings
IND_45	L68B	Real estate activities excluding imputed rents
IND_46	M69_70	Legal and accounting activities; activities of head offices; management consultancy activities
IND_47	M71	Architectural and engineering activities; technical testing and analysis
IND_48	M72	Scientific research and development
IND_49	M73	Advertising and market research
IND_50	M74_75	Other professional, scientific and technical activities; veterinary activities
IND_51	N77	Rental and leasing activities
IND_52	N78	Employment activities
IND_53	N79	Travel agency, tour operator reservation service and related activities
IND_54	N80-82	Security and investigation, service and landscape, office administrative and support activities
IND_55	O	Public administration and defence; compulsory social security
IND_56	P	Education
IND_57	Q86	Human health activities
IND_58	Q87_88	Residential care activities and social work activities without accommodation
IND_59	R90-92	Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities
IND_60	R93	Sports activities and amusement and recreation activities
IND_61	S94	Activities of membership organisations
IND_62	S95	Repair of computers and personal and household goods
IND_63	S96	Other personal service activities
IND_64	T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
IND_65	U	Activities of extraterritorial organisations and bodies

Source: Croatian Bureau of Statistics. Supply and Use Tables for Croatia, 2018.

Table A3. Average Travel Time (in minutes)

REG	Counties (HR - NUTS 3)	*County seat*	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21
R01	Bjelovar-Bilogora	Bjelovar	0.00	61.10	117.80	126.32	171.00	188.50	95.10	80.13	161.27	172.90	230.20	248.05	286.15	198.83	434.30	72.45	90.00	81.27	43.73	96.85	81.78
R02	Virovitica-Podravina	Virovitica	60.43	0.00	91.90	129.47	108.07	135.88	148.23	100.80	214.40	226.03	283.33	301.18	339.28	251.95	487.43	126.25	110.62	109.68	62.37	149.97	134.92
R03	Požega-Slavonia	Požega	116.88	91.88	0.00	49.47	94.15	111.65	139.98	92.55	206.15	217.78	275.08	292.93	331.03	243.72	479.18	118.00	154.92	146.20	152.23	141.73	126.67
R04	Slavonski Brod-Posavina	Slavonski Brod	125.45	123.95	48.30	0.00	60.52	78.02	138.35	90.90	204.50	216.15	273.43	291.28	329.38	242.07	477.53	116.35	153.27	144.55	164.35	140.08	125.03
R05	Osijek-Baranja	Osijek	173.47	109.88	96.32	62.78	0.00	39.20	186.37	138.92	252.52	264.17	321.45	339.32	377.42	290.08	470.92	164.37	201.28	192.57	170.92	188.10	173.05
R06	Vukovar-Sirmium	Vukovar	188.22	135.53	111.07	77.52	35.62	0.00	201.10	153.67	267.27	278.90	336.20	354.05	392.15	304.82	485.40	179.12	216.03	207.30	196.57	202.85	187.78
R07	Karlovac	Karlovac	92.13	146.87	137.73	136.52	181.20	198.70	0.00	73.22	79.57	91.20	148.50	166.35	204.45	117.12	352.60	49.40	96.93	88.22	108.02	60.40	45.35
R08	Sisak-Moslavina	Sisak	79.88	102.08	92.95	91.73	136.42	153.92	74.02	0.00	140.17	151.82	209.10	226.97	265.07	177.73	413.20	57.18	101.88	93.17	112.95	75.75	60.70
R09	Primorje-Gorski Kotar	Rijeka	161.23	215.97	206.83	205.62	250.30	267.80	81.82	142.32	0.00	129.85	187.15	205.00	243.10	54.83	391.25	118.50	166.03	157.32	177.12	129.50	114.45
R10	Lika-Senj	Gospić	167.80	222.53	213.40	212.18	256.87	274.37	88.38	148.88	125.48	0.00	72.98	90.83	128.93	163.05	277.08	125.07	172.60	163.88	183.68	136.07	121.02
R11	Zadar	Zadar	225.40	280.13	271.00	269.78	314.47	331.97	145.98	206.48	183.08	74.08	0.00	62.60	100.70	220.65	248.85	182.67	230.20	221.48	241.28	193.67	178.62
R12	Šibenik-Knin	Šibenik	244.85	299.58	290.45	289.23	333.92	351.42	165.43	225.93	202.53	93.53	65.45	0.00	62.65	240.10	210.80	202.12	249.65	240.93	260.73	213.12	198.07
R13	Split-Dalmatia	Split	283.10	337.83	328.70	327.47	372.17	389.67	203.68	264.18	240.78	131.77	103.70	63.67	0.00	278.35	189.60	240.37	287.90	279.18	298.98	251.37	236.32
R14	Istria	Pazin	194.75	249.47	240.35	239.12	283.80	301.30	115.33	175.82	53.43	163.37	220.65	238.50	276.60	0.00	424.75	152.00	199.53	190.82	210.62	163.02	147.95
R15	Dubrovnik-Neretva	Dubrovnik	425.87	480.58	471.45	470.23	465.27	486.68	346.45	406.93	383.53	274.53	246.45	206.42	185.13	421.10	0.00	383.12	430.65	421.93	441.73	394.12	379.07
R16	City of Zagreb	City of Zagreb	72.30	127.00	117.87	116.63	161.33	178.83	47.25	58.67	113.42	125.05	182.35	200.20	238.30	150.98	386.45	0.00	77.08	68.37	88.17	48.85	34.18
R17	Međimurje	Čakovec	89.28	109.92	154.68	153.47	198.15	215.65	98.10	104.67	164.27	175.90	233.20	251.05	289.15	201.83	437.30	75.45	0.00	21.20	52.92	80.60	84.78
R18	Varaždin	Varaždin	80.77	109.20	146.15	144.93	189.62	207.12	89.58	96.15	155.73	167.37	224.67	242.52	280.62	193.30	428.77	66.92	20.15	0.00	50.43	64.87	76.25
R19	Koprivnica-Križevci	Koprivnica	44.40	61.87	151.92	164.75	166.88	194.70	109.38	115.95	175.55	187.18	244.48	262.33	300.43	213.12	448.58	86.73	52.90	50.18	0.00	101.10	96.07
R20	Krapina-Zagorje	Krapina	96.48	151.22	142.08	140.85	185.53	203.03	62.87	77.55	129.02	140.65	197.95	215.80	253.90	166.58	402.05	52.92	81.12	62.23	100.78	0.00	43.88
R21	Zagreb	Samobor	78.48	133.22	124.08	122.87	167.55	185.05	44.87	59.57	111.02	122.67	179.95	197.82	235.90	148.58	384.05	34.75	83.28	74.57	94.37	41.57	0.00

Source: Google Maps.

Table A4. Interregional Trade: Purchases Shares, 2019

Origin	Destination																					DOMSALES
	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	
R01 Bjelovar-Bilogora	55.09	1.96	0.90	0.73	0.62	0.57	0.73	0.92	0.62	0.60	0.48	0.44	0.47	0.62	0.49	1.32	1.05	1.09	2.29	0.80	0.86	**1.88**
R02 Virovitica-Podravina	0.78	58.54	0.56	0.37	0.53	0.41	0.25	0.39	0.26	0.23	0.21	0.19	0.21	0.27	0.22	0.57	0.42	0.44	0.87	0.27	0.30	**1.01**
R03 Požega-Slavonia	0.44	0.52	56.52	1.02	0.60	0.49	0.27	0.41	0.29	0.27	0.23	0.19	0.23	0.30	0.23	0.65	0.33	0.32	0.39	0.28	0.31	**0.96**
R04 Slavonski Brod-Posavina	0.75	0.94	2.34	58.68	1.89	1.59	0.53	0.91	0.50	0.53	0.44	0.39	0.42	0.50	0.47	1.05	0.62	0.65	0.66	0.59	0.60	**1.95**
R05 Osijek-Baranja	1.70	3.05	3.33	4.75	63.79	8.68	1.19	1.79	1.31	1.29	1.18	1.09	1.22	1.39	1.54	2.30	1.41	1.48	1.99	1.30	1.36	**5.03**
R06 Vukovar-Sirmium	0.67	1.02	1.14	1.57	3.95	57.39	0.48	0.66	0.63	0.47	0.49	0.41	0.51	0.58	0.60	1.36	0.59	0.63	0.75	0.52	0.58	**2.25**
R07 Karlovac	0.73	0.61	0.60	0.57	0.47	0.48	54.62	0.79	0.92	0.95	0.59	0.49	0.48	0.76	0.50	1.53	0.72	0.72	0.72	1.03	1.10	**2.05**
R08 Sisak-Moslavina	1.68	1.65	1.76	1.46	1.28	1.29	1.12	56.61	1.06	1.03	0.74	0.71	0.69	0.78	0.72	2.34	1.37	1.29	1.42	1.51	1.50	**2.94**
R09 Primorje-Gorski kotar	3.62	3.30	3.70	3.18	3.28	3.55	4.53	3.31	67.05	5.35	3.73	3.40	3.21	9.89	3.37	4.10	3.39	3.36	3.90	3.85	3.45	**9.63**
R10 Lika-Senj	0.29	0.32	0.27	0.23	0.21	0.19	0.41	0.27	0.41	56.84	0.59	0.41	0.39	0.30	0.26	0.57	0.34	0.32	0.30	0.34	0.32	**0.89**
R11 Zadar	0.87	0.83	0.90	0.83	0.81	0.82	1.09	0.87	0.92	2.41	68.43	2.46	1.81	0.87	1.27	1.39	0.95	1.02	1.04	1.02	0.91	**3.59**
R12 Šibenik-Knin	0.57	0.55	0.60	0.56	0.52	0.53	0.68	0.54	0.59	1.24	1.66	67.34	1.99	0.55	0.98	0.91	0.64	0.64	0.63	0.69	0.57	**2.17**
R13 Split-Dalmatia	1.86	1.83	2.00	1.82	1.85	1.90	1.95	1.71	1.76	3.82	4.36	6.77	73.44	1.91	4.77	2.71	1.96	1.98	2.12	2.01	1.76	**8.41**
R14 Istria	2.38	2.24	2.40	2.36	2.11	2.27	2.73	2.41	5.26	2.31	1.64	1.42	1.53	62.80	1.72	2.88	2.12	2.29	2.40	2.46	2.26	**6.51**
R15 Dubrovnik-Neretva	1.19	1.18	1.30	1.24	1.40	1.41	1.03	1.08	0.60	0.95	0.94	0.97	1.45	0.59	69.35	1.37	1.13	1.14	1.27	1.09	0.99	**3.41**
R16 City of Zagreb	18.89	14.28	16.06	15.41	12.08	14.01	21.33	20.42	13.04	15.91	10.12	9.55	8.12	13.05	9.11	63.55	19.55	18.95	18.96	23.88	27.75	**31.68**
R17 Međimurje	1.03	1.03	0.77	0.70	0.60	0.62	0.75	0.79	0.60	0.74	0.57	0.51	0.53	0.65	0.65	1.18	51.47	4.10	1.94	0.99	0.84	**2.10**
R18 Varaždin	1.75	1.59	1.23	1.17	1.01	0.99	1.23	1.32	1.00	1.17	0.85	0.84	0.82	1.07	1.02	2.24	6.70	54.21	3.13	1.91	1.39	**3.61**
R19 Koprivnica-Križevci	1.98	1.91	0.73	0.61	0.75	0.58	0.61	0.65	0.57	0.61	0.52	0.49	0.52	0.60	0.58	1.15	1.66	1.64	51.69	0.72	0.72	**1.82**
R20 Krapina-Zagorje	0.78	0.64	0.71	0.62	0.54	0.55	0.93	0.89	0.63	0.78	0.58	0.47	0.50	0.62	0.58	1.49	0.89	1.11	0.83	50.50	1.29	**1.96**
R21 Zagreb	2.93	2.02	2.16	2.12	1.70	1.68	3.57	3.24	2.00	2.51	1.66	1.47	1.47	1.91	1.56	5.34	2.67	2.63	2.71	4.27	51.15	**6.15**
DOMDEM	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source: Interregional Input-Output System for Croatia, 2019.

Table A5. Interregional Trade: Sales Shares, 2019

Origin	Destination																					DOMSALES
	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19	R20	R21	
R01 Bjelovar-Bilogora	50.64	1.07	0.44	0.75	1.62	0.64	0.76	1.25	2.88	0.27	0.90	0.45	2.07	2.12	0.87	24.12	1.23	2.14	2.21	0.83	2.72	**100.00**
R02 Virovitica-Podravina	1.34	59.49	0.50	0.70	2.57	0.87	0.49	0.98	2.22	0.19	0.73	0.36	1.71	1.69	0.73	19.10	0.90	1.59	1.55	0.53	1.76	**100.00**
R03 Požega-Slavonia	0.80	0.56	53.63	2.05	3.11	1.09	0.54	1.09	2.61	0.24	0.84	0.39	2.02	2.03	0.79	23.03	0.75	1.22	0.73	0.57	1.90	**100.00**
R04 Slavonski Brod-Posavina	0.67	0.49	1.10	58.18	4.79	1.73	0.53	1.19	2.21	0.22	0.80	0.39	1.78	1.65	0.80	18.49	0.70	1.23	0.61	0.59	1.84	**100.00**
R05 Osijek-Baranja	0.58	0.62	0.60	1.83	62.63	3.67	0.46	0.91	2.26	0.21	0.83	0.42	2.02	1.77	1.01	15.62	0.61	1.08	0.72	0.51	1.62	**100.00**
R06 Vukovar-Sirmium	0.52	0.47	0.46	1.35	8.68	54.30	0.42	0.75	2.45	0.17	0.77	0.36	1.89	1.66	0.89	20.64	0.58	1.03	0.60	0.46	1.55	**100.00**
R07 Karlovac	0.62	0.30	0.27	0.53	1.14	0.50	52.44	0.98	3.89	0.38	1.01	0.46	1.95	2.37	0.81	25.47	0.77	1.29	0.63	0.98	3.21	**100.00**
R08 Sisak-Moslavina	0.98	0.58	0.54	0.96	2.15	0.93	0.75	49.12	3.14	0.29	0.89	0.47	1.95	1.69	0.80	27.16	1.02	1.62	0.87	1.01	3.05	**100.00**
R09 Primorje-Gorski kotar	0.65	0.35	0.35	0.64	1.68	0.78	0.93	0.88	60.45	0.46	1.37	0.69	2.78	6.58	1.16	14.54	0.77	1.28	0.73	0.79	2.14	**100.00**
R10 Lika-Senj	0.57	0.37	0.28	0.50	1.17	0.46	0.90	0.78	4.02	53.20	2.34	0.91	3.67	2.16	0.97	22.05	0.84	1.31	0.61	0.76	2.13	**100.00**
R11 Zadar	0.42	0.24	0.23	0.45	1.12	0.48	0.60	0.62	2.22	0.56	67.35	1.34	4.21	1.55	1.17	13.25	0.58	1.04	0.52	0.56	1.51	**100.00**
R12 Šibenik-Knin	0.45	0.26	0.25	0.50	1.19	0.51	0.62	0.64	2.35	0.47	2.71	60.47	7.63	1.61	1.50	14.39	0.65	1.08	0.52	0.62	1.58	**100.00**
R13 Split-Dalmatia	0.38	0.22	0.22	0.42	1.08	0.48	0.46	0.52	1.81	0.38	1.83	1.57	72.73	1.46	1.87	11.01	0.51	0.87	0.46	0.47	1.25	**100.00**
R14 Istria	0.63	0.35	0.34	0.70	1.60	0.74	0.83	0.94	7.01	0.29	0.89	0.43	1.96	61.83	0.87	15.11	0.71	1.29	0.67	0.74	2.07	**100.00**
R15 Dubrovnik-Neretva	0.60	0.35	0.35	0.70	2.03	0.88	0.60	0.80	1.52	0.23	0.97	0.55	3.53	1.11	67.13	13.68	0.72	1.22	0.67	0.63	1.72	**100.00**
R16 City of Zagreb	1.03	0.46	0.46	0.94	1.88	0.94	1.33	1.64	3.57	0.42	1.13	0.59	2.14	2.64	0.95	68.54	1.35	2.20	1.08	1.48	5.23	**100.00**
R17 Međimurje	0.84	0.50	0.33	0.64	1.40	0.62	0.70	0.96	2.48	0.29	0.96	0.48	2.12	1.97	1.02	19.13	53.38	7.17	1.67	0.92	2.39	**100.00**
R18 Varaždin	0.84	0.45	0.31	0.62	1.38	0.58	0.67	0.93	2.40	0.27	0.83	0.45	1.89	1.91	0.93	21.27	4.05	55.29	1.57	1.04	2.30	**100.00**
R19 Koprivnica-Križevci	1.88	1.08	0.37	0.65	2.04	0.68	0.66	0.92	2.71	0.28	1.01	0.53	2.37	2.11	1.06	21.63	1.99	3.33	51.55	0.78	2.37	**100.00**
R20 Krapina-Zagorje	0.68	0.33	0.33	0.61	1.37	0.60	0.93	1.16	2.77	0.33	1.05	0.46	2.11	2.03	0.97	25.93	0.98	2.08	0.76	50.59	3.92	**100.00**
R21 Zagreb	0.82	0.34	0.32	0.67	1.36	0.58	1.14	1.34	2.82	0.34	0.96	0.47	1.99	2.00	0.84	29.67	0.95	1.57	0.80	1.37	49.67	**100.00**
DOMDEM	**1.72**	**1.03**	**0.91**	**1.93**	**4.94**	**2.13**	**1.97**	**2.55**	**8.68**	**0.83**	**3.53**	**1.95**	**8.33**	**6.41**	**3.30**	**34.17**	**2.18**	**3.68**	**1.81**	**1.97**	**5.97**	**100.00**

Source: Interregional Input-Output System for Croatia, 2019