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# THE INTEGRATION OF CROATIA IN THE EU INPUT-OUTPUT PRODUCTION NETWORK

Relatore: Chiar.mo
Prof. Raffaele Giammetti

Tesi di Laurea di:
Dario Marchetti

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## ABSTRACT

L'obiettivo di questa tesi è indagare qualora la Croazia e le sue industrie abbiano beneficiato dell'ingresso nell'Unione Europea in termini di connessioni con le industrie del resto dei Paesi del Mondo tramite l'ingresso e lo sviluppo delle industrie Croate nelle catene globali del valore (GVCs). Ovvero, la ricerca è volta alla raccolta di dati che possano svelare se e quanto l'ingresso di questa piccola economia nell'Unione Europea l'abbia resa più rilevante nel panorama di un'economia mondiale che va sempre più globalizzandosi. La ricerca prende le mosse da una revisione accurata della storia economica più recente della Croazia, dalla formazione della Repubblica Federale Socialista di Yugoslavia all'entrata della Croazia in UE come singolo paese, e procede poi alla sua sezione sperimentale che si articola in due parti. Nella prima parte, vengono presi in esame i dati sul commercio internazionale di beni intermedi provenienti dalle Tavole Input-Output Globali (WIOD) annuali del 2004 (anno in cui la Croazia richede l'ingresso in Unione Europea) e del 2014 (anno in cui il Paese viene dichiarato membro) e si analizzano accuratamente la rilevanza dei nodi Croati del network mondiale e la loro evoluzione nel decennio attraverso le principali tecniche tradizionali e più moderne della network analysis (in and out-degree centrality, eigenvector centrality, PageRank centrality, modularity class). I dati mostrano diversi aspetti dell'evoluzione. In termini di grado totale di connessione, i settori Croati sembrano

aver aumentato moderatamente la loro rilevanza nel network, specialmente relativamente a industrie come il commercio all'ingrosso, il manifatturiero di cibo e tabacco e l'edilizia. Differentemente, in termini di PageRank, la rilevanza dei settori Croati sembra essere diminuita nel tempo relativamente ad altri settori di altri paesi nel network globale. In generale, la performance delle industrie Croate non può ritenersi soddisfacente e si può evidenziare un ampio margine di miglioramento della performance del Paese nell'economia globale tramite il sostegno dell'Unione Europea. Nella seconda parte, alla luce del recente attacco subito dall'Ucraina da parte della Russia, la ricerca si focalizza sull'individuare gli effetti sulla Croazia di una cessazione dei suoi commerci di beni intermedi e finali con la Russia e con la Cina, attraverso la tecnica di analisi dell'estrazione ipotetica (HE). La sezione si apre con un'ampia revisione della metodologia dell'HE e della relativa letteratura e procede all'applicazione della tecnica sulla tavola WIOD annuale del 2014, per calcolare le perdite in termini di valore aggiunto che i tre paesi si troverebbero eventualmente a fronteggiare. I risultati mostrano che le perdite più ingenti verrebbero sostenute dalla Croazia, e in particolare da industrie come il manifatturiero, il mobile e il settore energetico. Perdite minori in questi settori vengono evidenziate anche nell'economia Russa e in quella Cinese, e si nota una presenza piuttosto rilevante di alcuni settori Sloveni tra quelli più colpiti dalle perdite. La ricerca si conclude con delle considerazioni sui suoi limiti e alcuni

suggerimenti di politica economica per le istituzioni Croate alla luce dei risultati delle analisi.

# INTRODUCTION

> "First of all, [Croatia will bring to the Union] what other countries have also brought – market enlargement, cultural wealth, environmental beauty and, […] a certain optimism. It is a fact that the country wants to join the EU, despite the crisis, showing that there is confidence in the Union. And this is because we in Croatia, […] value greatly the most important role of the EU as a peacemaker, the original idea of those who founded the Union after the Second World War. We have just come out of a war, and [therefore] such security means a lot to us. That is also why, in addition, we will encourage and help our neighbors to join the EU as soon as possible"

These the words (Corritore, 2013) with which former Croatian President Josipovic welcomed the official entrance of Croatia in the European Union.

As many historians report, while joining the EU, Croatia was given by former chief analyst of Croatian Presidency Joivic the denomination of Euro-indifferent country, an expression which summarizes the common sense of indifference that was among the Croatian citizens while their country was joining EU (Martino, 2013). In other words, Croatians saw the EU joining process as inevitable, but weren't particularly enthusiastic of it, as it could be seen from the EU referendum[1] results in which

[1] The referendum on the EU accession of Croatia was held on the 22nd of January 2012, six months after the conclusion of the country's membership negotiations. Republic of Croatia's Constitution requires, in fact, a referendum on membership to political unions that reduce national sovereignty.

Croatian citizens expressed their will to join the Union, but the affluency level only reached the 43% of total registered voters. The access of a small open economy, still in some way recovering from the war, like Croatia, to the European Union, is an interesting phenomenon that can raise hope and enthusiasm but can also spark many doubts and concerns. At the time of requesting to join EU, which is still regarded as an underdeveloped country in Europe today, most of Croatian firms were less competitive than their European counterparts and many were concerned about their survival in the single market. What did EU do for Croatia? What were the biggest benefits that the EU accession yielded to this Country over the years? These are complex, question whose debated answer would not only concern economics, but also politics, philosophy and sociological studies. For this research, the focus will be on the effect that Croatia's accession to EU had on the country's position in global value chains (GVCs). Was EU able to project Croatia into the global markets, bettering the position in which it was before? Were Croatian industries more globally interconnected after the EU accession procedures of Croatia was completed? Part of this research is aimed at finding out.

This thesis is divided into three chapters. The first chapter offers to the reader a quick yet detailed overlook on the most recent history of Croatia, and a glance to its position in the World economy today. The scope of this chapter is to give the reader a grasp of how historical events in the last decades took a toll on Croatia's economy, in preparation for the experimental sections of the work.

The second chapter bears an input-output network analysis aimed at understanding the position of Croatian industries in the World input-output network, and how it changed from 2004 (the year after which Croatia filed its EU membership application) to 2014 (the year after Croatia obtained its membership). The analyses are performed on the tables part of the World Input Output Database (WIOD) which is a series of yearly tables carrying data on inter-countries industries' exchange of intermediate and final goods. These analyses offer to the reader an overview of what Croatia looks like in the universe of GVCs, how relevant it is, and which are its most interconnected industries. The results, considering some of the examined indicators, shown that during the 2004–2014-time span, most of Croatian sectors seem to have slightly improved their performance in terms of connections, although it has to be said that the position in the global input-output network of Croatian economy as a whole did not substantially change. It appears that the sectors that showed the most connections enlargement were wholesale trade, manufacturing food and tobacco products, and construction of buildings and civil engineering. Considering other indicators, it has been shown that many sectors faced losses in terms of relevance in the global network. This can be explained considering how little Croatian sectors were able to grow in that time span relatively to other country-sectors in the World economy, such as the ones from developing countries, that faced major growth processes. It can be said that although it was possible to expect a better performance there is still room for improvement in how Croatian industries

could use the advantage of being part of the European Union to become more relevant in the World economy.

The third chapter, instead, was inspired by the most recent geo-political events that concerned Europe since Russia first attacked Ukraine in February 2022. What would happen to Croatian industries in a scenario in which it would stop trading with Russia and China due to the ongoing war between Russia and Ukraine and the political tensions between the USA, the EU, Russia, and China? What loss in value-added would this trade disruption determine? And which country would be the most hurt? The answers to these question stem from the results of an analysis named hypothetical extraction analysis, which is also performed on WIOD, and yields as result the loss in terms of value-added that every country-sector in the table would suffer if the concerned countries were to stop trading completely. At the end of both chapters, the results are carefully analyzed and commented. The results of the analyses shown that in the three cases, Croatia would be the worse-off country although many Russian and Chinese sectors would face some minor losses too. The worse outcome would be generally faced by Croatian sectors like machinery and equipment, electrical equipment and manufacturing products. This probably can be explained by the fact that a trade disruption between Croatia, Russia and China would shake the initial stages of the GVCs that involve Croatian enterprises, causing supply-side issues for Croatian industries. Interestingly, the results shown the involvement of some Slovenian sectors that sometimes even exceed in terms of

losses in value-added some sectors of the three considered countries. The conclusions offer an overview on the general results of the work and states the main limits of the research.

# CHAPTER I – CROATIA: HISTORY AND IDENTITY, ECONOMIC HISTORY, SITUATION TODAY

*"With the accession of Croatia in the European Union, Italians and Croatians now share a future in united Europe. Deep roots unite these two populations and assign to us to remember tragedies and division caused by totalitarism in the last century"*

Giorgio Napolitano

## I.1 – INTRODUCTION TO THE CHAPTER

This chapter aims at providing an accurate yet synthetic review of Croatian history and economic history, to better understand the current position of the Country in the worldwide scenery from an economic and political perspective.

Blessed with a gentle climate, a fertile soil, and an enviable strategic position and conformation of its territory, the origins of Croatia are ancient and noble, dating back to the VIII sec BC. The following sections will, though, provide a review of the most recent economic history of Croatia, especially trying to highlight the underlying conditions of the formation of Croatian industries. The history of the independent country, to which we refer to as Croatia today, starts at the beginning of the 1990's with the end of the Croatian war, one of the series of distinct yet related armed conflicts to which we refer as Yugoslav War, which took place in the territories of the Republics belonging to the former Socialist Federal Republic of Yugoslavia (SFR Yugoslavia) and resulting in its break-up.

## I.2 – THE SFR YUGOSLAVIA AND THE YUGOSLAV WARS

### I.2.1 – SFR Yugoslavia: rise and fall

The social and economic experience of the SFR Yugoslavia starts in 1945 at the end of the Second World War, when the Yugoslavia (formerly a Kingdom), didn't enter the Warsaw Pact, and chose to actuate a peculiar form of socialism which was based on the workers' self-management. This economic system was substantially different from the economic system of USSR and other Eastern European Republics of that time, and extensively debated by economists and historians. Considering that factories were nationalized, and a part of their profits was granted to the workers; private shops could still exist and hire up to four people, and land was partially collectivized and partially nationalized; Kornai (1992) stated that 'market socialism' is an accurate term for describing the economic system that was in force at that time. Roemer (1994), instead, sustained that the Yugoslav system of company management wasn't run on true market principles, but were still subject to an inefficient political control that created the inefficiencies that ultimately caused the collapse of the system.

The economic experience of Yugoslavian 'market socialism' peaked in the 1960's, when SFR Yugoslavia strengthened its leadership of the Non-Aligned Movement and it was in the position of trading with both the Eastern and the Western markets which even amounted to most of its total trade, when the

exchanges with the Non-Aligned Movement only added up to 15% of the trade (Woodward, 1995).

During the 1970's, the economic system was reformed towards liberalism, allowing the minority presence of foreign investors in companies, although this would be a considerable exception to the philosophical principles of Marxist socialism. Singleton (1989) reports that German investors were especially keen on investing in the Balkans and even added up to the 25% of total FDIs, but the generally Yugoslavian companies were considered extremely inefficient and not well organized.

Also, in the 70's, the deruralization and the urbanization processes increased the overcrowding of the larger cities and a massive emigration abroad, especially towards West Germany (Zivic et al., 2005). Although the migrations processes were then institutionalized in the economy and provided foreign capital and currency to the company while keeping the concerning levels of unemployment under control, they were clear signs of the illnesses of the Balkan economy. Dragutin and Zoran (1996) underline that:

> "[...] during the 1970s, when the domestic market was for the most part satisfied, great fissures became apparent in the established system and developmental orientation: poor quality, low productivity, insufficient industrial structure in relation to export opportunities, mono-centric spatial arrangement."

Bodsuszynski (2010), underlined how the petrol crises contributed to increase vertiginously the foreign public debt up until 20$ billion. Under the eye of the IMF and the Paris Club of Creditors, the Yugoslavian Governments put in place harsh austerity and protectionist measures to salvage the economy that ultimately collapsed during the 1980's.

Between the 1979 and the 1985, the Yugoslavian dinar was depreciated from 15 to 1$ to 1370 to 1$; net personal income plunged by almost 20%; 1.3 million people were unemployed – mostly people under 25 years of age and women; the public debt was estimated at 40$ billion and constantly increasing, because of the non-aligned position of the Government which allowed Yugoslavia to get loans both from the Western countries and the Eastern economies at different conditions (Chossudovsky, 2014).

In 1989, the Yugoslavian Prime Minister Ante Markovic tried again to stabilize the economic situation of the country exchanging more loans with a series of harsh reformations, including further devaluations of the currency, wage freezes, and privatizations. Alongside with the increasing ethnic tensions among Serbs and the other Balkan populations, these conditions threw the country into chaos.

### I.2.2 – War and post-war recovery

Franjo Tudman, elected in 1990, purported a Croatian secessionist referendum from SFR Yugoslavia, which was boycotted by Serbs in Krajina region.

In 1991, the Croat Government started an arms race, endowing the Police with an increasing amount of gunnery, and creating de facto a Croat army. After the referendum results were published, on June 25th, 1991, Croatian independence was declared. The Croatian Independence war, a bloody, cruel, murderous 4-year long conflict, was just like that started. The war in Croatia ended in summer 1995, with the victory of the Croat army which was ratified with Dayton Agreements in December 1995.

Devastated by the conflicts, during the 90's Croatia had to tirelessly work to rebuild its economy and the industry. It wasn't easy to recover from the destruction that the war: Dragutin and Zoran (1996) reported that:

> "The fall in basic industrial production is also quite marked, [...] it has fallen by 43 percent from 1990 to 1994. However, the vitality of the Croatian economy has halted this process, and at the beginning of 1995 the volume of industrial production has finally shown growth […]. Similar tendencies are visible in other Eastern European countries as well"

Countless actions were taken in Croatia by several IGOs and NGOs to help the country to start the recovery process, and the social fragmentation, corruption, and unrest brought by the conflict got in the way of the reconstruction slowing it down. Even after 10 years from the end of the war, many sectors and areas were still at sea (Jovanovic, 2006).

It's important to mention Croatia Social and Economic Recovery Project (CSERP), a substantial multisectoral program that supported “areas of special state concern”, that is areas in Croatia that were particularly affected by the war, in their socio-economic development. Word Bank’s officials (2011) reported that in early 2000, most war-affected areas were still struggling with their development and growth, especially when facing the return to Croatia of war refugees. CSERP was implemented in 2005, despite of the insufficient administrative capacity of subcentral bodies, when it came to the recovery planning and implementation. After 5 years, in 2010, CSERP was closed with satisfactory results: 427 sub-projects have been completed, 84.000 Croatian residents directly benefitted of the sub-projects, 1.341 new jobs were created, several geographical areas were demined and made ready for agriculture, extensive training was offered to Croatian officials and public administration members (World Bank, 2011). It still must be remembered that, in the public eye, reconstruction in Croatia has been slow, difficult, and generally not satisfying.

### I.3 – THE 2000S AND 2010S: TOWARDS THE EUROPEAN UNION

Benczes (2014) reported that the war related economic recession was finally over in Croatia in 1999, and growth took off in 2000. Some years of economic growth followed, powered by the newly privatized banks, able to provide increasing credit, capital investments, an increase in consumes and a stable currency.

Moreover, unemployment, traditional thorn in Croatia's side since the SFR Yugoslavia times, began to decrease after slowly but steadily 2002 (John, 2014).

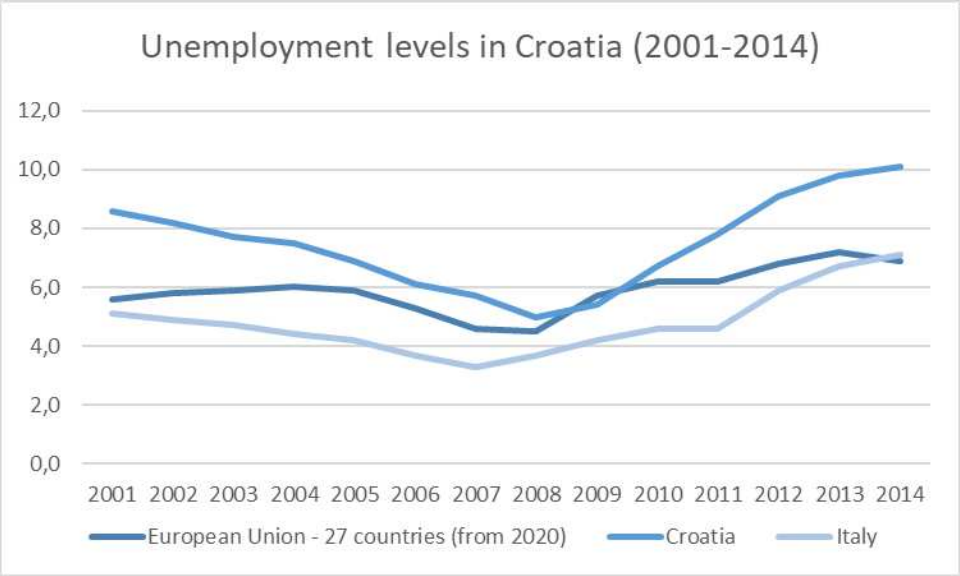



*Fig. I.1 – Unemployment levels in Croatia and EU in 2001-2014 in comparison.*

*(Source: Eurostat, 2022)*

As the graph shows, unemployment rates in Croatia started to rose again after the financial crisis that struck the Eurozone in 2007-2008.

In 2003, Croatian public officials initiated the process of application for the EU membership, to be granted the Candidate country status later in 2004. The ideal of an economic integration towards Europe was in fact already in the plans of Prime Minister Ante Markovic, which was preparing documents to apply for EEC membership back in the 80's, before the outbreak of the war.

In the public eye of Croatians, joining the EU meant the possibility to hope for a different future of peace, freedom, and economic prosperity. Joining the EU was the tangible action taken collectively to make a deep cut with the past, gifting the new Croatian generation with a radical, positive change. On the other hand, Croatian enterprises were extremely fearful of their lack of efficiency compared to their European counterparts, that would have been in the position of providing a tough, if not fatal competition. The negotiations were long, and at times, not easy.

The European Commission (2007) expressed the need to solve many issues. Firstly, for Croatia to join the EU and its human rights inspired principles, a total cooperation with the International Criminal Tribunal for the Former Yugoslavia was needed. The Croatian Government was forced to extradite many of its citizens to meet the requests of the European Union (European Commission, 2008).

Secondly, issues related to sea border disputes with Slovenia, which even vetoed the entrance of Croatia in the EU in 2008 took a year to be solved[2]. Lastly, to join EU, a huge effort on the side of Croatia was required in terms of digitalization and modernization of the public administration and the justice system.

Aligned to all the criteria requested by the Union, on December 9th, 2011, Croatia signed the Bruxelles Treaty. The country was declared an official member on July 1st, 2013. Leiour et al., (2009) forecasted a 2.6% increase in consumption

[2] *Croazia, porte aperte in Europa, Corriere della Sera, 13 settembre 2009.*

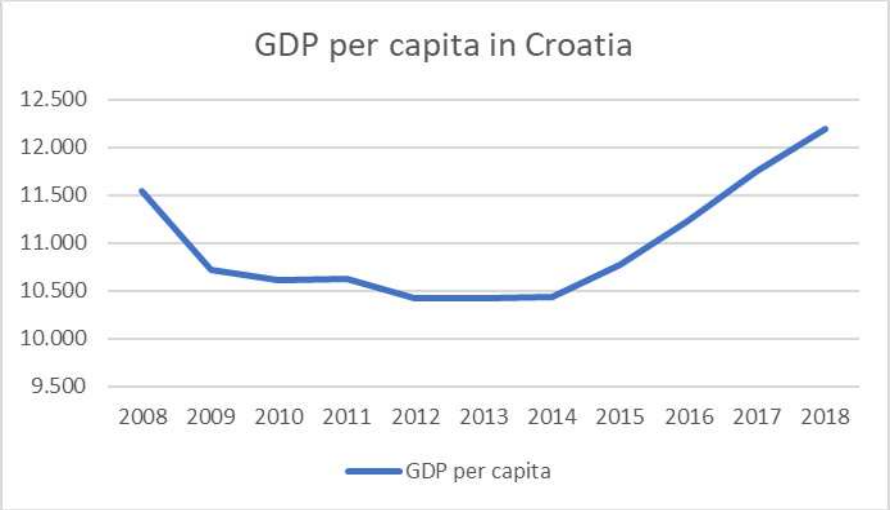


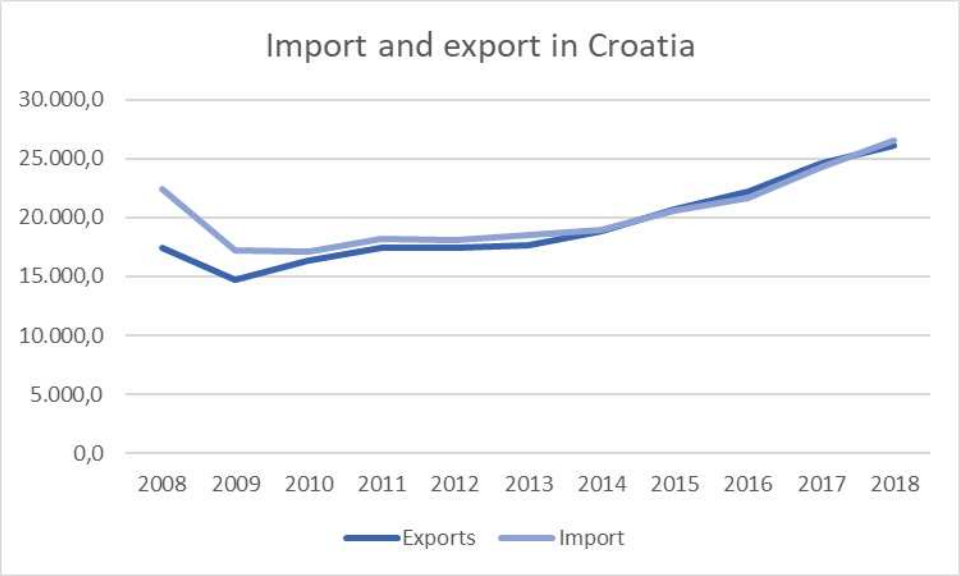

*Fig I.2 – GDP per capita in Croatia over the years. (Source: Eurostat)*

per capita and an 8% increase in GDP per Capita in Croatia after joining the EU, with negligible consequences for the other European economies. Looking at the time series in Fig. I.2 it is possible to notice that GDP per capita effectively increased in the years following the EU membership, although at first slowly because of the still ongoing recovery process from the 2008 crisis. Leiour et al., (2009) expressed concerns regarding the surprisingly low levels of Croatian exports prior to the entrance in the EU:

> "Despite Croatia's rather strong economic growth in recent years, its export performance has been perceived as disappointing. {…} The small size of the Croatian economy could imply much higher trade openness. Nevertheless, due to high exports of services (tourism), Croatian exports are close to 50% as share

of GDP if both goods and services are accounted for. That is slightly lower than it is for new EU member states in Central and Eastern Europe."

It is possible to notice from the following graph:




*(Fig I.3 – Imports and Exports in Croatia, over the years in million euro. Source: Eurostat)*

that exports have effectively grown over the years since Croatia's entrance in EU, although imports seem to have grown just as much, evening the balance of payments. The excessive tertiary-tourism component in export revealed itself extremely risky for the Croatian economy. In 2020, due to the harsh contraction in tourism demand caused by the pandemic, Croatian GDP dropped by 10,7%. These issues will also be further considered at the end of the second chapter.

## I.4 – CROATIA TODAY: THE ENTRANCE IN THE EUROZONE, FINAL CONSIDERATION AND CONCLUSIONS

While this research is being written, Croatia is getting ready to say its farewells to the Kuna and welcome euros in the pockets of Croatians. In the latest times, EU officials stated that Croatia reached all the criteria set for membership in the Eurozone, which include legislation compatibility with the issues concerning the independence of the central bank, price stability and inflation levels comparable to the euro area, fiscal stability and durable convergence with the EU.

Monetary policy in Croatia in the last years was based on a nominal exchange rate anchored to the Euro, in which small fluctuations were permitted to discourage speculations. This choice is an evident indicator of the high levels of euroization that Croatia was already reaching in the 2010's while negotiating its entrance.

Such a strategic choice implies the sacrifice of a considerable space for active monetary policy maneuvers. (Bokan et al., 2009). The crisis of 2008 represented a wakeup call for Croatian authorities: as a small, open economy, Croatia suffered from the increasing risk aversion that, after the fear and uncertainty that sparked among investors after the financial market break down, caused the cost of borrowing money to concerningly increase as it was stated by Bokan et al., (2009). A vigorous political determination from the part of the Croatia's institution to join the euro was reported by EU officials.

# CHAPTER II: NETWORK ANALYSIS: DATA, METHODOLOGY, AND COMMENT TO THE RESULTS

*"Learning how to see means understanding how everything connects with everything else"*

Leonardo da Vinci

## II.1 – THE NETWORK ANALYSIS

### II.1.1 – Network analysis and international trade

To assess the current position of the Croatian economy in a global setting, it is necessary to inspect Croatia's position and relevance in global value chains (GVCs), and it has been thoroughly demonstrated that network analysis provides a wide range of techniques that represent useful tool when approaching the study of the connections between different countries in the World within the huge and complex networks that international production has created (Zaclicever, 2020).

Since the early 2000, the body economic literature exploring the application of network analysis to the study of international trade and Global Value Chains (GVCs) has been ever increasing. Zaclicever (2020) reviews the most important and original applications of these techniques such as Zhu et al., (2018) comparing across countries GVCs through similarity measures based on networks; Amador and Cabral (2018) that analyzed international flows of value added from a binary-network perspective underlying the most dynamic aspects of GVCs; and Benedictis and Tajoli (2016) that analyzed the change in Italy's comparative advantages

through the representation of its economy in World trade networks. Zaclicever (2020) underlines that network-based measures are crucial to assess the relevance of countries as users and suppliers of intermediate inputs from other countries in each network, looking at weighted in-going and out-going links, which represent connections.

II.1.2 – Network analysis: specificities and techniques

The US National Council of Research define network science as “"the study of network representations of physical, biological, and social phenomena leading to predictive models of these phenomena”. Network analysis is a branch of network science which examines complex relationships, and it can be applied to many different fields such as statistics, physics, data mining, sociology, and so on.

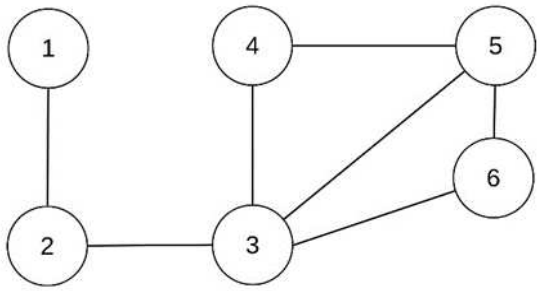



*Fig. II.1 – Simplified representation of a non-oriented network*

Fig. II.1 depicts the simplest representation of a network, which is composed by a set of points (that we will refer to as nodes) and which are connected by lines (that we will refer to as edges, or links). As it has been stated before, network analysis has been thoroughly applied to the study of economic phenomena. It is possible to imagine, for example, the World economy as a network in which the countries are nodes and the import-export relationships are links. From a financial point of view, we can hypothesize a network of banks in which the nodes represent each bank institute, and the links are the cash flows that occur in between them.

An important element that must be underlined is that not all the edges or links, that is not all the relationships between the nodes, have the same weight. It is possible to simplify the networks representing them through adjacency matrices assigning the same value to every edge in the graph, but in most of the economic applications of network science, the weight of the edges must be thoroughly considered.

Furthermore, a distinction must be made between graphs with oriented edges and graphs with non-oriented edges. A non-oriented graph is a set of nodes linked by edges in which the relationship i–j has the same meaning of the relationship j–i. Differently, in oriented graphs, connections have a particular direction which expresses their specific significance.

Now, it is important to explain how a network and its level of connection can be measured, and this can be also done narrowing the analysis to the single nodes and edges.

The degree of connection of a node, that may be referred to simply as degree, is equal to the number of edges that belong to that node. Clearly, in an oriented network, it will be necessary to distinguish between the number of edges that enter the node (which may be referred to as in-degree) and the number of edges that point out of the node (which may be referred to as out-degree). In the case of an oriented network, the degree of the non-oriented network will correspond to the sum of the in-degree and the out-degree, which may be referred to as total degree.

To assess the relevance of single nodes within a network, network analysis provides a set of measurement tools that allow scholars to compare the importance of certain nodes to others, among which are extremely relevant the so called "centrality measures".

As it has been stated by Boldi and Vigna (2013) "every node […] has some degree of influence or importance within the social domain under consideration, and one expects such importance to surface in the structure of the social network".

The simplest centrality measure that is possible to define is the so-called 'degree centrality' which simply states that the centrality of a node is positively related to the number of connections that the node holds. In other words, the more connections the node has, the more central it will be regarded as. Another approach

that can be followed relates the centrality is negatively related to the distance that separates the examined node from the other nodes in the network. This measure, defined as 'closeness centrality', states in other words that the smaller the average distance between the node and each other node in the network is, the more central the node itself will be.

As far as this research goes, the centrality measures that have been used are more sophisticated than those aforementioned, and they are linked to the closeness between the node itself and the 'important' nodes in the network. In fact, to be regarded as 'central', therefore, to be assigned a higher level of centrality, the node has to be closer not to any node in the network, but to the importance of the nodes that the considered node is closed to or connected with. Two important measures will be hereinafter analyzed: PageRank centrality and Eigenvector centrality, which both have been used for the purpose of this research.

To define PageRank centrality, it is necessary to first define Katz centrality, of whom PageRank constitutes a brilliant amelioration. Katz centrality computes evaluates the node in two phases: firstly, it computes the number of the immediate neighbors that the node has (which are defines 'first-degree neighbors'), and secondly, it also considers all the other nodes in the network which are connected to the node of interest through the aforementioned first-degree neighbors (Aggarwal, 2011). The distant connections taken into account are penalized by an attenuation factor $\alpha$, where $0 < \alpha < 1$. In this way, the link paths connecting the

second-degree nodes would be weighed with a weigh of $\alpha^{t,}$ where t is the length of the path that is being examined (Boldi and Vigna, 2013). As it has been stated before PageRank centrality is an adjustment of Katz centrality, which has been formulated by Sergey Brin and Larry Page (1998). Although extremely sophisticated and interesting, Katz centrality is, in fact, not totally unbiased. One if its biggest shortcomings is that a node endowed with a high level of centrality, and which is connected to a multitude of many other nodes, will confer a high level of centrality to all the nodes it is linked to. It is then clear that the centrality that a node gets from an important vertex which is though extensively linked to others, should be depreciated with no doubt. Brin and Page (1998) conceived an indicator that could achieve this objective based on three fundamental factors. PageRank, as a centrality measure, was specifically conceived to examine web graphs, and introduced by Brin and Page (1998) specifically to be implemented to Google search engine, which they founded one year earlier in 1997 (Boldi and Vigna, 2013). In fact, the PageRank of a node is based on the number of connections that the node holds, the centrality of the nodes it is linked to, and the propensity of the linked nodes to be linked to other nodes. In this way, the centrality that stems from the connections that come from nodes which are highly endowed with connections is accordingly penalized. In other words, a node is important and has a high level of PageRank centrality if it has many connections, and if it relates to important nodes which are regarded as link parsimonious.

Eigenvector is a measure of ancient pedigree, studies about which were initiated by Leontief (1941); Seeley (1949). Also referred to as 'eigencentrality' or 'prestige score', Eigenvector can be defined as an extension of the meaning of the degree centrality. In-degree centrality, as aforementioned, is based on the simple idea that the centrality of a node increases the more links point towards the node itself. Eigenvector goes beyond this idea and considers the relevance disparities of the nodes in a certain network. Therefore, it values more the centrality which is conferred to the node by nodes that have a high level of centrality for themselves. In other words, a node is relevant when it can boast links to other nodes which are regarded as relevant. That's the improvement that eigencentrality shows compared to the simple in-degree centrality measure: a node which is endowed with a high number of links could score low on Eigenvector; on the other hand, nodes with a high prestige score could hold a surprisingly low number of connections. Further ameliorations of the eigenvector centrality are found in Dietzenbacher (1992) and will be explained later in the research.

The formalization of the calculations performed to get the centrality measures of the nodes of interest will be, instead, thoroughly explained and discussed in subsection II.3.2 – Analysis and data elaboration.

Another useful technique concerns the division of the whole network in different communities, being a community defined as a network inside the network. This application results to be particularly interesting when applied to trade relations

between industries, as it will be furtherly shown in this research. At the basis of the partition of the network in communities stands the principle of modularity maximization. The definition of modularity states that this measure should be calculated as the difference between the quantity of edges that link the nodes belonging to the given community and the expected number of edges that would have been found between the same nodes whether the edges were randomly distributed (Brandes et al., 2008). Subjecting this criterion to a maximization condition, the network is partitioned in different communities that can be observed and analyzed more closely.

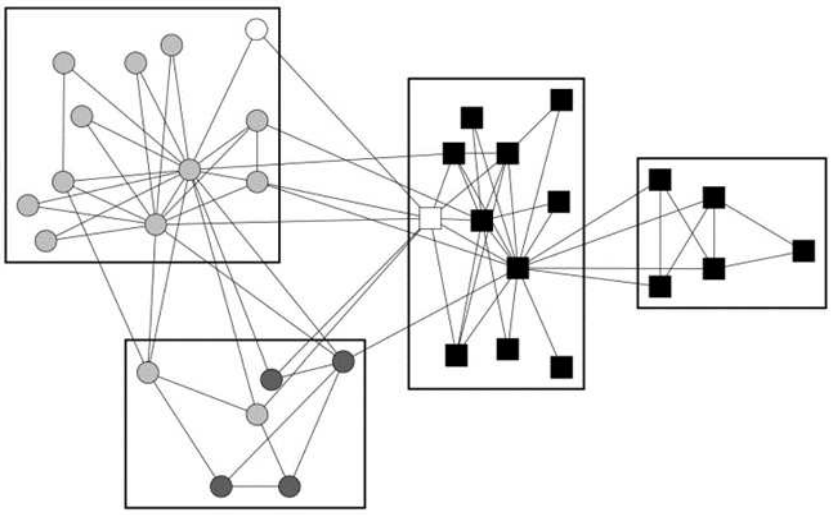


*Fig. II.2 – Partition of a network according to different interpretations of clustering, and by modularity maximization criterion. (Source: Brandes et al., 2008)*

It must be underlined that Brandes et al., (2008) demonstrated that networks can be clustered through many different iterative methods and compared them to

the criterion of maximization of modularity. In the figure it is possible to see how the network would be differently clustered according to the modularity optimization (blocks), according to the 'greedy clustering' (colors) and according to the observation of the partition that specifically happened in reality, as far as the example in question goes. For a deeper explanation of the other methods this research refers to Brandes et al., 2008.

## II.2 – DATA: THE WORLD INPUT OUTPUT DATABASE (WIOD)

### II.2.1 – The WIOD and Global Value Chains (GVCs)

The previously defined analysis techniques will be in this paper applied to de data provided by the World Input Output Database (WIOD) to analyze country specific issues of Croatia. The rationale behind this reasoning is that the World economic and production system can be defined as a network of industries that are connected to each other by input-output production links (Giammetti et al., 2020). The recent availability of the global input-output tables provided by WIOD have been widely used in economic literature for many applications, namely in Giammetti et al., (2020)'s construction of the European production network (EPN).

WIOD was the outcome of the collaboration of twelve research institutes lead by University of Groningen, carried out from 2009 to 2012 in the context of a European Commission funded project in the field of socio-economic sciences and humanities (7th Framework). The WIOD was in fact specifically conceived as an

adequation of statistical frameworks available before to the radical changes that the uprising of GVCs (Timmer et al., 2015) brought into the Worldwide economic system.

GVCs refers to the activities that are performed from the pre-production phases, through the actual production, and to the post-production stage considering that those activities are engaged in different countries around the globe (Kim et al., 2021). Timmer et al., (2015) underlines that the production processes started to be fragmented by firms across different States thanks to the sharp decrease in coordination costs and transportation costs brought by the technological progress of the last decades. Gereffi (1994), in his pioneering research in this field, stated that the exchange of information, know-how, technology, capital and people brought by the uprising of GVCs also substantially benefitted the economic growth of the developing economies in which multinational enterprises (MNEs) internationalized stages of their value chains (mainly production and assembly, at least in the earliest phases) while undertaking GVCs. Furthermore, the lockdowns put in place by State governments across the World to mitigate the effect of the pandemic, that in the early stages of the COVID-19 outbreak seemed to call for a turnaround towards autarky and self-sufficiency, do not seem to have stopped the increase in the global economy of GVCs, which, on the contrary, "played an essential role in driving a recovery from the COVID-19 induced global trade collapse" (World Bank, 2022).

After the earliest works on GVCs were published by sociologists (cfr. Gereffi, 1994) or business management sciences scholars, eventually economists understood that GVCs could not be framed in the models available before (as Heckscher-Ohlin-Samuelson, New Trade Theory and New New Trade Theory) and the study and build of World input-output tables started, providing a new proper analytical framework to GVCs field research. The solution to the problem was to develop a brand-new approach to international transactions data collection, inspired to the one already performed on domestic transaction for a long time (Grossman and Rossi-Hansberg, 2008). The first efforts in this direction were made by researchers combining international trade statistics and input-output tables from the Global Trade and Analysis Project (GTAP) into global input-output tables. WIOD constitutes an alternative to these, endowed with many improvements: differently from GTAP, WIOD is not a proprietary database, it is grounded on official statistics, and it provides annual time series that allow researchers to use it to analyze long-term trends (Timmer et al., 2015).

### II.2.2 – The structure of WIOD

For this research, it will now be presented more accurately the central part of the WIOD, which is the time-series of global input-output tables. Timmer (2015) defines a World input-output table as "a set of national input–output tables that are connected with each other by bilateral international trade flows", therefore

providing a general outlook of the transactions that occur between industries and final users in the Worldwide economy across countries.

For demonstration, in Figure II.3 a simplified WIOT table is depicted. The table contains K industries and N countries, which constitute together the entire World economy. The rows in the WIOT the value (in USD) of the m-nth country's k-nth industry output to another industry for intermediate use (Z block matrices in the picture), or to final use (F block matrices), either within the same country or

| | INTERMEDIATE USE (*K* columns per country) | FINAL USE (*C* columns per country) | Total |
|---|---|---|---|
| | 1 … N | 1 … N | |
| K industries, country 1<br>…<br>K industries, country N | $\mathbf{Z^{11}\ Z^{1\cdots}\ Z^{1N}}$<br>$\mathbf{Z^{\cdots 1}\ Z^{\cdots}\ Z^{\cdots N}}$<br>$\mathbf{Z^{N1}\ Z^{N\cdots}\ Z^{NN}}$ | $\mathbf{F^{11}\ F^{1\cdots}\ F^{1N}}$<br>$\mathbf{F^{\cdots 1}\ F^{\cdots}\ F^{\cdots N}}$<br>$\mathbf{F^{N1}\ F^{N\cdots}\ F^{NN}}$ | $\mathbf{x^{1}}$<br>$\mathbf{x^{\cdots}}$<br>$\mathbf{x^{N}}$ |
| Value added | $\mathbf{(v^1)'(v^2)'(v^N)'}$ | | |
| Output | $\mathbf{(x^1)'(x^2)'(x^N)'}$ | | |

*Fig. II.3 – Word Input-Output Table with K industries and N countries (source: Los et al., 2013 in Giammetti, 2020).*

abroad (Giammetti, 2020). All the IO are based on an accounting identity principle by which the "total use of output in a row equals total output of the same industry as indicated by the sum of inputs in the respective column in the left-hand part of the table", as Giammetti (2020) has stated.

In the columns, instead, express the advancement level of the technologies of production indicating the needed amounts of intermediate inputs for each

production. Value added (v), which express the direct contribution of each domestic factor to output, is found between the total output and total intermediate inputs.

In a different representation (Fig. II.4) provided by Timmer et al., (2015) it is possible to highlight different aspects. In this schematization we can see clearly how, as previously stated, each industry's gross output (at the end of each column) will be equal to the sum of all the employment of that specific industry's output (Timmer et al., 2015). As far as the value added goes, we can see that at the interception between the total output final output value row and the sum of the total value-added column, the World GDP is found.

| | | **Final products of a GVC identified by country-industry of completion** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Country 1 | | | … | Country M | | | |
| | | | Industry 1 | … | Industry N | | Industry 1 | … | Industry N | **Value added** |
| **Value added from country-industries partecipating in global value chains** | Country 1 | Industry 1 | | | | | | | | |
| | | … | | | | | | | | |
| | | Industry N | | | | | | | | |
| | … | | | | | | | | | |
| | Country M | Industry 1 | | | | | | | | |
| | | … | | | | | | | | |
| | | Industry N | | | | | | | | |
| **Total final output value** | | | | | | | | | | **WORLD GDP** |

*Fig. II.4 – Schematic Outline of a three countries WIOT (Source: Timmer et al., 2015).*

The values contained in each cell of the WIOTs are expressed in millions of USD, to which all the other currencies were converted using market exchange rates.

As far as the international trade flows go, they are expressed according to 'free on board' prices, increased with estimated international trade and transport margins (Timmer et al., 2015).

The richness and variety of data found in WIOD allow researchers to perform several kinds of analyses that may comprehend country specific issues; size, patterns and treatment of re-exports; product and import price deflators (Miller and Blair, 2009).

## II.3 – EMPIRIC RESEARCH

### II.3.1 – Introduction to the paragraph

In this section, the empirical work that has been performed for the purpose of this research will be explained in its methodology and results. First, the manipulations applied to the WIOD tables will be defended and justified. Secondly, the research will briefly focus on the software used and the methodology. Lastly, the set of obtained results will be commented and examined. The research's limits will be stated and room for further developments will be shown.

II.3.2 – Hypotheses, selection of data and manipulation of the World Input-Output Tables (WIOTs)

As aforementioned, the aim of this research is to assess the position of Croatian economy in the World economic system and GVCs using data from the WIOD. Considering the quantity of data present in the WIOD *(supra)* it was necessary to make a series of choice prior to the data elaboration.

Firstly, it was necessary to choose which of all the annual WIOTs provided by the WIOD, and the choice fell on WIOT of 2004 and WIOT of 2014. The rationale behind this choice is rooted in the most recent macro-events in the history of Croatia, which was reviewed in Chapter I. As it was already stated, Croatia was able to apply for EU membership during the winter of 2003, and the European Council granted Croatia the status of official candidate on the 19th of June 2004.

After the long years of negotiations, in which the Croatian institutions worked tirelessly to meet the criteria required to join the European Union, on the 1st of July of 2013, Croatia finally became the 28th member of EU. The data contained in the two chosen WIOTs, 2004 and 2014, can be hypothesized to show the improvement in the presence of Croatia in the World economic system through GVCs, given that European Union is based on the principle of trade liberalization and economic integration.

This research also used a selected part of the WIOTs of 2004 and 2014. To exactly create the production network that was needed to examine the position of

Croatia in GVCs, the tables have been pruned of the section concerning the final uses of the goods (block F matrices in Fig. II.3), the value-added rows and the column of the totals. The resulting table only contained the part concerning the input-output production relations (block Z matrices in Fig. II.3), to which network analysis techniques have been applied to.

Another important issue concerns the removal of the Rest of the World (ROW) node from the table prior to the network analysis. As of WIOT 2004 and 2014, the tables contain 56 industries which are named by the International Standard Industrial Classification Revision 4 (ISIC Rev. 4) of 41 countries (namely, EU 27 before the Croatia's entry in the European Union, EU 28 prior to Brexit happening, which would be Belgium, Bulgaria, Czech Republic, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden, United Kingdom; and 13 other major economies, which would be Australia, Brazil, Canada, China, India, Indonesia, Japan, Mexico, Russia, South Korea, Taiwan, Turkey and the USA. This set of economies was calculated to amount to the 85% of the World GDP in 2008, at current exchange rates. To have a full model of the World economy, the non-covered countries' economies were estimated into a single node which has been defined Rest of the World (ROW) (Timmer et al., 2015). As aforementioned, ROW was excluded from the considered data for the analysis. The rationale behind this is

that the node would be too big and mislead the analysis process providing distorted results.

Now, when assessing the position of Croatia in the global production network, the exclusion of ROW constitutes a serious issue that must be, at least, carefully pondered. In fact, the WIOTs includes ROW countries that are extremely important when considering Croatian economy.

| Partner | Trade Balance | Import Share (%) | Export Share (%) |
|---|---|---|---|
| **Italy** | -1507319,03 | 13,89 | 13,96 |
| **Germany** | -2081393,90 | 15,46 | 13,17 |
| **Slovenia** | -1399557,75 | 11,55 | 10,75 |
| **Bosnia-Herzegovina** | 922525,23 | 2,79 | 9,99 |
| **Austria** | -799327,57 | 6,45 | 5,91 |
| **Serbia, FR** | 234864,96 | 2,38 | 5,29 |
| **Hungary** | -1658200,48 | 8,44 | 4,14 |
| **North America** | 291217,45 | 0,76 | 2,95 |
| **France** | -278371,65 | 2,73 | 2,85 |
| **United States** | 272796,65 | 0,67 | 2,70 |

*Fig. II.5 – Top 10 Croatian export partners for intermediate goods with their import share in year 2019 (Source: World Bank Gorup[3])*

Fig. II.5 clearly shows the relevance of the production relations that Croatia entails with Bosnia and Hercegovina and Serbian Federation. Lower in the chart, also North Macedonia (export 0,81%, import 0.3%), Albania (export 0,52%, import 0.04%), Montenegro (export 1,36%, import 0,04%) appear, for a total of 5,57% of

[3]https://wits.worldbank.org/CountryProfile/en/Country/HRV/Year/2019/TradeFlow/EXPIMP/Partner/by-country# (17/06/2020 – 17.09)

total import shares and 17,97% of total export shares. All these countries are included in the ROW by WIOD and therefore excluded by this analysis.

## II.3.2 – Analysis and data elaboration

### *II.3.2.a – In-degree and out-degree*

In this section, the methodology and the instruments used to get the results will be thoroughly explained and discussed as aforementioned in section II.1.1 – Network analysis and international trade.

Firstly, the research will focus on the in-degree and the out-degree centrality measures. As aforementioned, these calculations are based on the weighted adjacency matrix Z which has been used to define regular binary adjacency matrix D (Cerina et al., 2015 in Giammetti et al., 2020) where:

$$D_{ij} = D_{ji} = 0 \; if \; Z_{ij} > 0 \; or \; Z_{ji} < 0 \; and \; D_{ij} = D_{ji} = 0 \; otherwise$$

and, accordingly to the directions of the connections, the in-degree and the out-degree of each sector, defined as:

$$d_i^{in} = \sum_{i \neq j} d_{ij} \; and \; d_i^{out} = \sum_{i \neq j} d_{ij} \;\; for \; each \; node \; i$$

In other words, the "in (out)-degree of a node *I* represents the number of buyers (suppliers) sectors linked to sector *i*" (Giammetti et al., 2020).

*II.3.2.b – Eigenvector centrality and PageRank Centrality.*

As it was already stated, in-degree and out-degree are rough and preliminary measures which present many shortcomings and limits. Therefore, to truly understand how important a node can be defined, or to which degree a specific sector may be involved in GVCs (Giammetti et al., 2020), more complex centrality measures are needed. Two important and innovative measures are going to be used: Eigenvector and PageRank. Both centrality measures were already introduced in section II.1.2 – Network analysis: specificities and techniques: in this section, they are going to be examined from a more formal point of view. Before getting to Eigenvector centrality and PageRank, we need to identify the original measures of input-output traditional economic literature, which date to Rasmussen (1956). Giammetti et al., (2020) and Miller and Blair (2009) provide an accurate review of the building process of this measure.

It useful to start from this simple accounting equation, expressed as:

$$x = Zi + f \qquad [1]$$

where we define:

$$Z = n \, x \, n$$

as the transaction matrix displaying the industry flows of an economy with $n$ industries and $n$ sectors; $f$ as the final industry demands vector; $x$ as the vector of the industry's gross output; and $i$ as the summation vector.

$$x = \begin{matrix} x_1 \\ \vdots \\ x_n \end{matrix}; \qquad Z = \begin{matrix} z_{11} & \cdots & z_{1n} \\ \vdots & \ddots & \vdots \\ z_{1n} & \cdots & z_{nn} \end{matrix}; \qquad f = \begin{matrix} f_1 \\ \vdots \\ f_n \end{matrix}$$

In fact, we know that since $n$ sectors participate in the economy where interindustry sales are considered ($z_{ij} - sector\ i\ sells\ to\ sector\ j$) and final sales are considered ($f_{ij} - sector\ i\ sells\ to\ final\ user$), then [1] for sector *I* will be:

$$x_i = z_{i1} + z_{i2} + \cdots + z_{in} + f_1 = \sum_{j=1}^{n} z_{ij} + f_1$$

Which calculated from sectors *I* to $n$, will result in equation [1]. Now, taking the assumptions of fixed input structures, constant returns to scale, and a Leontief production function (that is, inputs are used by each sector in fixed proportions), we can define the interindustry flow from sector *I* to sector *j* in $t_0$ (current year) depends totally on the output in $t_0$ of sector j, expressed with the technical coefficient:

$$a_{ij} = \frac{z_{ij}}{z_j} \qquad [2]$$

input in USD for of *I* for each unit of gross output of *j*. Therefore, hypothesizing one sector in the economy, and reconsidering [1], it is going to be:

$$x = z + f;$$

and, substituting [2] in the equation,

$$x = a \cdot x + f$$

$$x - a \cdot x = f$$

$$(1 - a)\, x = f$$

$$x = (1 - a)^{-1} \cdot f$$

$$x = \frac{1}{1 - a} \cdot f$$

Relaxing the single sector economy assumption and bringing this model back to a multi-sector industry structure, we will have:

$$A = Z\, \hat{x}^{-1}$$

Which is obtained in other words dividing each column of Z by the gross outputs.

Now, if the technical coefficients are known, we will have that each single row will be:

$$\begin{array}{c} x_i = a_{i1}x_1 + \cdots + \cdots + x_{1n}x_n + f_1 \\ \vdots \qquad\qquad\qquad\qquad\qquad\qquad \vdots \\ x_n = a_{n1}x_1 + \cdots + \cdots + x_{nj}x_j + f_n \end{array}$$

And therefore, we can state that:

$$x = Ax + f$$

Obtained plugging in in the accounting equation:

$$Ai = Zi$$

Now it is possible to solve for $x$:

$$x - Ax = f$$

$$(I - A)\, x = f$$

$$x = \ (I - A)^{-1} = Lf$$

In fact, where $I$ is the identity matrix, and since:

$$L \equiv (I - A)^{-1} L$$

$L$ is the Leontief inverse or multiplier matrix, also defined as total requirement matrix (Miller and Blair, 2009).

first one to propose to use the $L$ matrix column sums to identify the most important industries in the economy and rank the industries by their relevance was Rasmussen (1956). Laumas (1976) proposed the key sector measure to make up for the lack of consideration of the weight of the industries in Rasmussen (1956), that assigned to all industries the same weight, although assigning weights arbitrarily and assuming the same importance of all the neighboring industries[4].

[4] For a deeper examination of the previous methods, please refer to Giammetti et al., (2020).

The Eigenvector centrality, that has been used for the purpose of this research deviates from this measures that belong to input-output traditional economic literature. Instead, it can be comparable to the Eigenvector method of backward linkages, proposed by Dietzenbacher (1992). Luo (2013) underlines the rationale behind this method, by which the inputs from a sector that has a weak pulling power should be penalized compared to the inputs from stronger sectors.

The stronger industries will therefore be granted more weight in the calculations (Giammetti et al., 2020). To rank the sector by their relevance it is necessary to compute a sector power indicator, which will be equal to the eigenvector that corresponds to dominant eigenvalue that is calculated on A, the technical coefficient matrix (*supra*). Giammetti et al., (2020) have stated that:

> "In the input–output literature, Dietzenbacher method is de facto in line with the eigenvector centrality, one of the best known "influence measures" employed in network theory and social network analysis, according to which nodes are […] central in the network if their connections in the network are themselves well-connected nodes"

being this the rationale behind the choice of Eigenvector centrality as the measurement used on this research.

As far as PageRank centrality is concerned, it is important to underline how its fame and fortune stemmed from the necessity of overcoming the overestimation of the relevance of peripheral industries that Dietzenbacher (1992) measure suffers

from given that it does not depreciate distant connections, being in fact preferred in input-output research (Acemoglu et al., 2012; Carvalho, 2014; Cerina et al., 2015; Giammetti et al., 2020). In fact, PageRank not only considers the quality of the connection of the sectors, but also depreciates distant connections through a damping factor. The calculation for PageRank, iterated for each node *I*, can be expressed by the following equation:

$$PR(i;t+1) = \frac{1-d}{N} + d \sum_{j \in M(i)} \frac{PR(j;t)w_{ij}}{S(j)}$$

where we define $N$ as the total number of sectors (or nodes); $d = 0.85$ as the damping factor; *M* as the suppliers, or in-neighbors of sector $i$; $w_{ij}$ as the weight of the link connecting sector $i$ and sector $j$; and $S(j)$ as the sum of the outgoing edges' weights, corresponding to the total output delivered by sector $j$. The time step $t+1$ indicates that the algorithm starts at $t_0$ assuming the following probability distribution:

$$PR(i;0) = \frac{1}{N}$$

II.3.3 – Comment to the analysis results

In this section, the results of the analyses will be shown and discussed, starting from the results from in-degree and out-degree analyses

| ID | IN-DEG 2004 | IN-DEG 2014 | Δ% | OUT-DEG 2004 | OUT-DEG 2014 | Δ% |
|---|---|---|---|---|---|---|
| HRV_A01 | 1772,46 | 1775,17 | 0,15% | 1659,34 | 1736,85 | 4,67% |
| HRV_A02 | 156,15 | 134,57 | -13,82% | 213,77 | 288,14 | 34,79% |
| HRV_A03 | 71,17 | 127,94 | 79,77% | 17,72 | 56,44 | 218,51% |
| HRV_B | 1730,14 | 2089,54 | 20,77% | 1739,28 | 2296,84 | 32,06% |
| HRV_C10-12 | 2947,30 | 4172,92 | 41,58% | 676,60 | 1046,99 | 54,74% |
| HRV_C13-15 | 517,36 | 626,72 | 21,14% | 151,62 | 206,58 | 36,25% |
| HRV_C16 | 329,38 | 513,97 | 56,04% | 260,80 | 345,68 | 32,54% |
| HRV_C17 | 219,04 | 310,17 | 41,60% | 235,37 | 292,80 | 24,40% |
| HRV_C18 | 219,03 | 369,09 | 68,52% | 203,34 | 295,63 | 45,39% |
| HRV_C19 | 62,19 | 23,69 | -61,91% | 56,12 | 18,69 | -66,70% |
| HRV_C20 | 394,16 | 694,56 | 76,21% | 453,43 | 639,51 | 41,04% |
| HRV_C21 | 510,17 | 413,67 | -18,92% | 336,84 | 185,44 | -44,95% |
| HRV_C22 | 297,69 | 512,52 | 72,17% | 225,59 | 372,88 | 65,29% |
| HRV_C23 | 682,69 | 688,17 | 0,80% | 776,96 | 699,27 | -10,00% |
| HRV_C24 | 247,90 | 340,93 | 37,53% | 194,34 | 270,32 | 39,09% |
| HRV_C25 | 651,31 | 1019,50 | 56,53% | 796,48 | 1049,52 | 31,77% |
| HRV_C26 | 178,56 | 254,84 | 42,72% | 225,15 | 236,98 | 5,25% |
| HRV_C27 | 594,30 | 655,73 | 10,34% | 372,75 | 441,35 | 18,40% |
| HRV_C28 | 456,26 | 528,13 | 15,75% | 336,06 | 438,21 | 30,39% |
| HRV_C29 | 95,92 | 98,41 | 2,60% | 108,90 | 90,61 | -16,80% |
| HRV_C30 | 589,94 | 307,54 | -47,87% | 117,04 | 137,46 | 17,44% |
| HRV_C31-32 | 280,18 | 377,61 | 34,78% | 200,53 | 236,95 | 18,16% |
| HRV_C33 | 232,88 | 336,21 | 44,37% | 223,00 | 358,28 | 60,66% |
| HRV_D35 | 1553,50 | 2250,34 | 44,86% | 1770,68 | 2832,53 | 59,97% |
| HRV_E36 | 173,07 | 132,95 | -23,18% | 180,60 | 228,13 | 26,32% |
| HRV_E37-39 | 162,01 | 306,58 | 89,23% | 302,63 | 493,25 | 62,99% |
| HRV_F | 4582,66 | 3982,43 | -13,10% | 1180,05 | 1128,24 | -4,39% |
| HRV_G45 | 396,01 | 394,97 | -0,26% | 646,03 | 554,28 | -14,20% |
| HRV_G46 | 2257,58 | 2250,44 | -0,32% | 4264,55 | 4893,45 | 14,75% |
| HRV_G47 | 1256,18 | 2011,38 | 60,12% | 1928,07 | 2620,36 | 35,91% |
| HRV_H49 | 766,19 | 1198,62 | 56,44% | 448,07 | 579,07 | 29,24% |

| | | | | | | |
|---|---|---|---|---|---|---|
| **HRV_H50** | 227,18 | 202,91 | -10,68% | 131,98 | 114,47 | -13,27% |
| **HRV_H51** | 191,78 | 184,98 | -3,54% | 112,17 | 119,41 | 6,45% |
| **HRV_H52** | 540,01 | 603,26 | 11,71% | 606,83 | 785,78 | 29,49% |
| **HRV_H53** | 86,08 | 103,80 | 20,59% | 245,01 | 319,92 | 30,57% |
| **HRV_I** | 947,49 | 1565,44 | 65,22% | 259,30 | 472,58 | 82,25% |
| **HRV_J58** | 302,61 | 243,02 | -19,69% | 260,23 | 193,66 | -25,58% |
| **HRV_J59-60** | 212,72 | 288,03 | 35,40% | 238,65 | 323,87 | 35,71% |
| **HRV_J61** | 714,13 | 842,57 | 17,98% | 987,61 | 1063,17 | 7,65% |
| **HRV_J62-63** | 127,81 | 355,37 | 178,05% | 174,30 | 478,17 | 174,34% |
| **HRV_K64** | 601,56 | 792,77 | 31,78% | 1294,09 | 1673,18 | 29,29% |
| **HRV_K65** | 343,21 | 474,87 | 38,36% | 414,97 | 580,36 | 39,86% |
| **HRV_K66** | 79,66 | 203,18 | 155,05% | 205,81 | 335,64 | 63,08% |
| **HRV_L68** | 557,60 | 538,45 | -3,43% | 1297,52 | 2145,42 | 65,35% |
| **HRV_M69** | 498,25 | 624,92 | 25,42% | 869,31 | 1575,33 | 81,22% |
| **HRV_M71** | 570,69 | 740,09 | 29,68% | 995,55 | 1329,36 | 33,53% |
| **HRV_M72** | 77,84 | 94,13 | 20,93% | 169,17 | 196,97 | 16,43% |
| **HRV_M73** | 117,89 | 473,42 | 301,58% | 225,94 | 673,38 | 198,04% |
| **HRV_M74** | 67,52 | 91,81 | 35,98% | 161,76 | 238,10 | 47,19% |
| **HRV_N** | 403,41 | 929,94 | 130,52% | 614,98 | 1367,87 | 122,43% |
| **HRV_O84** | 1401,98 | 2179,27 | 55,44% | 112,68 | 95,57 | -15,18% |
| **HRV_P85** | 299,59 | 484,08 | 61,58% | 289,11 | 467,87 | 61,83% |
| **HRV_Q** | 642,21 | 1114,65 | 73,56% | 102,78 | 179,79 | 74,93% |
| **HRV_R-S** | 823,07 | 1101,15 | 33,79% | 391,08 | 712,22 | 82,12% |
| **HRV_T** | 0,37 | 32,13 | 8512,17% | 7,49 | 30,00 | 300,66% |

*(Fig. II.6 – In and out-degrees for Croatian sectors in 2004 and 2014, with their percentage variation. Values are in millions USD, percentage).*

As it is possible to see by looking at the following table, all Croatian sectors, or, the Croatian nodes of the world input-output network, seem to have performed well in the examined period, for most of them showing improvement in both in-degree and out-degree measures. As it was explained before, an increase of the in(out)-degree

means an increase of the links pointing in (out) of the node, which translates in this case in an increase of commercial input-output relations or, in other words, an increase in supplies (sales).

It is possible to perform a comparison on the in-degrees and out-degrees of the top 10 Croatian sectors and look at the changes that occurred in the years by looking at the following table:

| IN-DEGREE 2004 | IN-DEGREE 2014 | OUT-DEGREE 2004 | OUT-DEGREE 2014 |
|---|---|---|---|
| **HRV_F** | HRV_C10-C12 | HRV_G46 | HRV_G46 |
| **HRV_C10-C12** | HRV_F | HRV_G47 | HRV_D35 |
| **HRV_G46** | HRV_G46 | HRV_D35 | HRV_G47 |
| **HRV_A01** | HRV_D35 | HRV_B | HRV_B |
| **HRV_B** | HRV_O84 | HRV_A01 | HRV_L68 |
| **HRV_D35** | HRV_B | HRV_L68 | HRV_A01 |
| **HRV_O84** | HRV_G47 | HRV_K64 | HRV_K64 |
| **HRV_G47** | HRV_A01 | HRV_F | HRV_M69_M70 |
| **HRV_I** | HRV_I | HRV_M71 | HRV_N |
| **HRV_R_S** | HRV_H49 | HRV_J61 | HRV_M71 |

*Fig. II.7 – Top 10 Croatian sectors ranked by their 2004 and 2014 in-degrees and out-degrees.*

It is possible to notice the consistency of a few Croatian sectors that maintained very high position overtime, such as HRV_G46, wholesale trade; HRV_F, construction of building and civil engineering; HRV_C10_C12, manufacturing food and tobacco products; which consistently obtained extremely high position both in in-degree and out-degree. If we rank all the nodes in the network by total degree, the first Croatian sector in the chart is HRV_G46, which

ranks 1237th (over 2254 sectors in total), followed by HRV_C10-C12 (1392nd worldwide) and HRV_F (1405th globally). We can therefore conclude that these sectors represent the strongest and most globally present in the Croatian economy now as they did in 2004. The overall position of Croatian sectors in GVCs doesn't seem to have changed a lot.

As far as the examined 10-years' time span performance, we can see that some sectors performed extremely well as others, instead, seem to have lost a considerable number of connections.

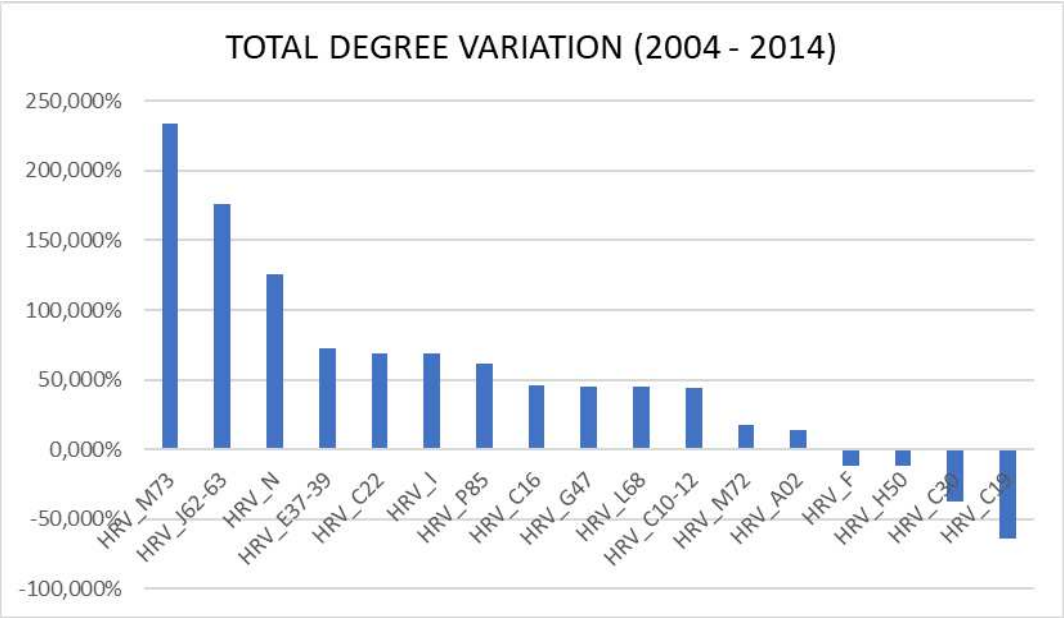



*Fig. II.8 – Best and worst Croatian sectors in terms of total degree variation in 2004 – 2014.*

The sectors that improved its presence the most over these years were HRV_M73, advertising, marketing research and opinion polling; and

HRV_J62_J63, computer programming, consultancy and related activities, data processing and managing activities, information service activities, web portals and news agencies activities. It must be said that since the late 90's, despite being devastated by the recent conflicts in the Balkans, Croatia purported its digitalization progress with high efforts. As of now, among all the European countries, Croatia was awarded with a Network Readiness Index of 4.22, which is even slightly higher than the Italian one (4.63)[5].

On the other hand, the sectors which seem to have lost a big number of connections are HRV_C29 manufacturing of motor vehicles, coachwork, manufacture or part and accessories for motor vehicles; HRV_C30, manufacturing of ships, boats, pleasure and sporting boats, floating structures, locomotives and rolling stock. The manufacturing crisis in Croatia can be partially explained by the extensive migration of low-skilled labor force, fleeing to Germany and EIRE looking for higher wages and better living conditions (World Bank, 2022)[6]. Vidovic (2014) stated that the heavy recession that struck the Eurozone in 2008 was still raging in Croatia six years later, showing an ever decreasing in the country's productive output, depressed household consumption and a concerning increase in

[5] For comparison, the first ranking country worldwide is Sweden (5.94) and the last is Haiti (2.27) in the used classification. Croatia ranked 41st worldwide in 2021. For further information, please refer to https://networkreadinessindex.org/.

[6] For accurate time series and specifications, please refer to World Bank https://data.worldbank.org/.

public debt. The bigger picture seems to show a country that substantially managed to maintain its position in GVCs over the years and that seems to have been helped in the process by joining the European Union, although many economic, political and social issue are still present damping its possibility to economically thrive.

As far as the other considered measures go, we can look at the results from in the following summary table, which contains the eigenvector centrality values I and the PageRank values (PR) for both years, and the modularity classification of 2014:

| ID | e 2014 | e 2004 | Δ% | PR 2014 | PR 2004 | Δ% | class 2014 |
|---|---|---|---|---|---|---|---|
| HRV_A01 | 0,925328 | 0,919481 | 0,58% | 0,000405 | 0,00044 | -7,95% | 9 |
| HRV_A02 | 0,8525 | 0,83504 | 1,75% | 0,000085 | 0,000095 | -10,53% | 9 |
| HRV_A03 | 0,808088 | 0,791368 | 1,67% | 0,000082 | 0,00008 | 2,50% | 9 |
| HRV_B | 0,962793 | 0,963318 | -0,05% | 0,000161 | 0,000146 | 10,27% | 8 |
| HRV_C10-C12 | 0,979238 | 0,98381 | -0,46% | 0,000813 | 0,00077 | 5,58% | 9 |
| HRV_C13-C15 | 0,973384 | 0,977496 | -0,41% | 0,000149 | 0,000162 | -8,02% | 9 |
| HRV_C16 | 0,971564 | 0,972946 | -0,14% | 0,000144 | 0,000147 | -2,04% | 9 |
| HRV_C17 | 0,967786 | 0,970553 | -0,28% | 0,00011 | 0,000113 | -2,65% | 9 |
| HRV_C18 | 0,966567 | 0,969381 | -0,28% | 0,00013 | 0,000122 | 6,56% | 9 |
| HRV_C19 | 0,940556 | 0,940171 | 0,04% | 0,000069 | 0,000072 | -4,17% | 9 |
| HRV_C20 | 0,977011 | 0,980649 | -0,36% | 0,000142 | 0,000128 | 10,94% | 9 |
| HRV_C21 | 0,975643 | 0,976551 | -0,09% | 0,000122 | 0,000154 | -20,78% | 9 |
| HRV_C22 | 0,970206 | 0,972552 | -0,23% | 0,000115 | 0,00011 | 4,55% | 9 |
| HRV_C23 | 0,974741 | 0,979296 | -0,46% | 0,000155 | 0,000202 | -23,27% | 9 |
| HRV_C24 | 0,970192 | 0,974357 | -0,42% | 0,000101 | 0,000103 | -1,94% | 9 |
| HRV_C25 | 0,976555 | 0,981564 | -0,50% | 0,00018 | 0,000169 | 6,51% | 9 |
| HRV_C26 | 0,970966 | 0,971988 | -0,10% | 0,000097 | 0,000093 | 4,30% | 9 |
| HRV_C27 | 0,973833 | 0,977108 | -0,33% | 0,000142 | 0,000166 | -14,46% | 9 |
| HRV_C28 | 0,972022 | 0,975736 | -0,37% | 0,000149 | 0,000173 | -13,87% | 9 |
| HRV_C29 | 0,969133 | 0,97188 | -0,27% | 0,000077 | 0,000083 | -7,23% | 9 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **HRV_C30** | 0,972028 | 0,974381 | -0,24% | 0,000105 | 0,000173 | -39,31% | 9 |
| **HRV_C31_C32** | 0,978781 | 0,984725 | -0,59% | 0,000109 | 0,000116 | -6,03% | 9 |
| **HRV_C33** | 0,970929 | 0,972858 | -0,19% | 0,000111 | 0,000115 | -3,48% | 9 |
| **HRV_D35** | 0,974741 | 0,979296 | -0,46% | 0,000285 | 0,000265 | 7,55% | 9 |
| **HRV_E36** | 0,970209 | 0,973467 | -0,33% | 0,000088 | 0,000115 | -23,48% | 9 |
| **HRV_E37-E39** | 0,974175 | 0,976093 | -0,19% | 0,000113 | 0,000103 | 9,71% | 9 |
| **HRV_F** | 0,980597 | 0,985622 | -0,50% | 0,000516 | 0,00081 | -36,30% | 9 |
| **HRV_G45** | 0,963709 | 0,964706 | -0,10% | 0,000189 | 0,000209 | -9,57% | 9 |
| **HRV_G46** | 0,975647 | 0,978894 | -0,32% | 0,000496 | 0,000643 | -22,86% | 9 |
| **HRV_G47** | 0,973839 | 0,976632 | -0,28% | 0,000275 | 0,000234 | 17,52% | 9 |
| **HRV_H49** | 0,97323 | 0,976912 | -0,37% | 0,000305 | 0,000291 | 4,81% | 9 |
| **HRV_H50** | 0,946493 | 0,947131 | -0,06% | 0,000089 | 0,000103 | -13,59% | 9 |
| **HRV_H51** | 0,930097 | 0,930316 | -0,02% | 0,000105 | 0,000125 | -16,00% | 9 |
| **HRV_H52** | 0,976563 | 0,980658 | -0,41% | 0,000198 | 0,000243 | -18,52% | 9 |
| **HRV_H53** | 0,942188 | 0,944593 | -0,24% | 0,000096 | 0,000101 | -4,95% | 9 |
| **HRV_I** | 0,982408 | 0,986994 | -0,46% | 0,000532 | 0,000495 | 7,47% | 9 |
| **HRV_J58** | 0,96343 | 0,967598 | -0,42% | 0,000111 | 0,000144 | -22,92% | 9 |
| **HRV_J59_J60** | 0,952115 | 0,951822 | 0,03% | 0,000133 | 0,000126 | 5,56% | 9 |
| **HRV_J61** | 0,957942 | 0,958489 | -0,05% | 0,000199 | 0,000218 | -8,72% | 9 |
| **HRV_J62_J63** | 0,956234 | 0,9581 | -0,19% | 0,000128 | 0,000103 | 24,27% | 9 |
| **HRV_K64** | 0,938373 | 0,940264 | -0,19% | 0,000208 | 0,000229 | -9,17% | 9 |
| **HRV_K65** | 0,938373 | 0,940264 | -0,19% | 0,000151 | 0,000159 | -5,03% | 9 |
| **HRV_K66** | 0,934764 | 0,934932 | -0,02% | 0,000091 | 0,000082 | 10,98% | 9 |
| **HRV_L68** | 0,977017 | 0,981115 | -0,41% | 0,000144 | 0,000199 | -27,64% | 9 |
| **HRV_M69_M70** | 0,980591 | 0,98432 | -0,37% | 0,000218 | 0,000231 | -5,63% | 9 |
| **HRV_M71** | 0,971107 | 0,974807 | -0,37% | 0,000196 | 0,000238 | -17,65% | 9 |
| **HRV_M72** | 0,969615 | 0,972382 | -0,28% | 0,000086 | 0,00009 | -4,44% | 9 |
| **HRV_M73** | 0,951442 | 0,952913 | -0,15% | 0,00013 | 0,000093 | 39,78% | 9 |
| **HRV_M74_M75** | 0,965986 | 0,968722 | -0,27% | 0,000083 | 0,000084 | -1,19% | 9 |
| **HRV_N** | 0,972315 | 0,975148 | -0,28% | 0,000224 | 0,000192 | 16,67% | 9 |
| **HRV_O84** | 0,977466 | 0,978846 | -0,14% | 0,000705 | 0,000715 | -1,40% | 9 |
| **HRV_P85** | 0,968402 | 0,969364 | -0,10% | 0,00017 | 0,000174 | -2,30% | 9 |
| **HRV_Q** | 0,978825 | 0,982918 | -0,41% | 0,00025 | 0,000243 | 2,88% | 9 |
| **HRV_R_S** | 0,982408 | 0,983833 | -0,14% | 0,000401 | 0,000433 | -7,39% | 9 |

*Fig. II.9 – Eigenvector and PageRank values for Croatian sectors in 2004 and 2014, with their percentage variation. Modularity classification value 2014.*

The decrease shown over the years, in the Eigenvector values and in the PageRank values, must be carefully pondered considering the formal definitions of the two centrality measures. As it was meticulously explained in the previous sections, differently from the degree centralities, Eigenvector and PageRank are endowed with damping factors that penalize distant connections or links from non-relevant nodes in the network. This can suggest that over the years, Croatian nodes have in fact maintained and increased their connections, but the connections could be distant or with sectors from countries that are less central and relevant compared to others in the network.

According to these measurements, Croatian sectors were ranked. The following table shows the top 10 of this ranking:

| e 2004 | e 2014 | PR 2004 | PR 2014 |
|---|---|---|---|
| **HRV_I** | HRV_I | HRV_F | HRV_C10-C12 |
| **HRV_F** | HRV_R_S | HRV_C10-C12 | HRV_O84 |
| **HRV_C31_C32** | HRV_F | HRV_O84 | HRV_I |
| **HRV_M69_M70** | HRV_M69_M70 | HRV_G46 | HRV_F |
| **HRV_R_S** | HRV_C10-C12 | HRV_I | HRV_G46 |
| **HRV_C10-C12** | HRV_Q | HRV_A01 | HRV_A01 |
| **HRV_Q** | HRV_C31_C32 | HRV_R_S | HRV_R_S |
| **HRV_C25** | HRV_O84 | HRV_H49 | HRV_H49 |
| **HRV_L68** | HRV_L68 | HRV_D35 | HRV_D35 |
| **HRV_H52** | HRV_C20 | HRV_H52 | HRV_G47 |

*Fig. II.9 – Croatian sectors ranked by their 2004 and 2014 PageRank and Eigenvector centralities.*

The sector HRV_C10-C12, manufacturing food and tobacco products, seems to perform well also in the chart provided by the less edifying results of Eigenvector and PageRank. This sector ranks, by PageRank, 283rd worldwide setting itself way above the World average. The first placements according to both measures seem to be coherent, and we find approximately the same sectors showing minor changes. The high centrality of HRV_I, accommodation and food services; and HRV_R_S, other services, in 2014, underlines how the tourism industry is still extremely fundamental for the thriving and the stability of Croatian economy. Tourism, as aforementioned in the previous chapter, constitutes the principal source of income for the coastal regions of Croatia (as Split-Dalmatia and Dubrovnik-Neretva) which are the most developed regions in Croatia itself.

Some more explanations can be provided by looking at the results of the modularity class clustering. As it is shown in Fig. II.8 all the Croatian sectors except for HRV_B are together in modularity class 9, in which, looking at the analysis result for the whole 2014 WIOT is also possible to find all the Italian sectors belonging in the WIOT. Considering this strong input-output relations that link Italy and Croatia (which were not clustered together in 2004 WIOT) is possible to hypothesize that this new links that Croatia has gained have been depreciated by the decline of the Italian presence in the World economy that occurred over the years. It is no wonder that HRV_B, broadly coal mining, gas, petroleum extraction, remained in class 8 where it also was in 2008, along with Lithuania, Latvia, Estonia,

Czech Republic, and, obviously, Russia. This clearly shows the Croatian dependence from Russia and its resources, which was extremely felt since the Russian aggression over Ukraine started and the related European sanctions against Russia were put in place.

Some interesting conclusions were drawn from a similar analysis conducted by Vidakovic Perusko et al., (2018), in which the authors conducted a descriptive assessment the position of Croatia in GVCs using WIOTs, which seem to confirm the results of this research. Vidakovic Perusko et al., (2018), in fact, state that the position of Croatia in GVCs didn't substantially change over the years, considering the 2000–2014-time span. This result also appears in this paper that showed that the highest-ranking Croatian sectors in degree, PageRank and Eigenvector centrality didn't change over the years. Also, in both research two Croatian sectors are highlighted for their good performance in 2014: HRV_G46 and HRV_C10-C12. The authors stated that:

> "[…] the analysis of the structure of value added in exports in manufacturing sector shows that the share of domestic value added in gross exports in 2014 was high in the production of food, beverages and tobacco industry [which would be HRV_C10-C12], pharmaceutical products, and computers and electronics [which are contained in HRV_G46]. Moreover, the pharmaceutical industry is the only industry that significantly increased the share of domestic value added in exports from 2000 to 2014."

Furthermore, it must be said that the authors shared the same concerns in assessing Croatia's position in GVCs, considering the absence of some of its important partners:

> "An issue with assessing Croatian value-added trade is that WIOD does not include Bosnia and Herzegovina, Serbia and Montenegro, which are countries that belong to the group of Croatia's major trading partners. These countries are included as a part of the "Rest of the world" component."

It is also evident that Croatian economy's growth is driven for its majority by domestic demand, and that most of the foreign contribution from final demand comes from Germany and Italy (Vidakovic Perusko et al., 2018), as aforementioned.

II.3.4 – Concluding remarks and further developments

Croatia is the most relying country on tourism in the European Union. In 2019, it amounted to the 20% of total Croatian GDP. When lockdowns put in place by most of the countries in the World decimated arrivals in Croatia in 2020 and 2021, Croatians eventually understood how risky is to let something so volatile like tourism play a so huge role in the country's economic stability (Croatian Ministry of Tourism, 2019). The extremely good performance of the food, beverage and tobacco industry is only a glimpse of what Croatia would be able to produce and export. In Dubrovnik-Neretva County and Split-Dalmatia County, the public

officials relentlessly tried to increase the production of agricultural products, given a fertile soil and optimal climatic conditions, but locals continue to rely on the tourism industry as workers or landlords. As far as the industry goes, would be extremely helpful for Croatia to reinforce its industry and agriculture relying on cheaper inputs (found on the global market through GVCs) to satisfy an even larger part of the demand of Croatia's buyer countries (Vidakovic Perusko et al., 2018).

# CHAPTER III – SCENARIO ANALYSIS ON FUTURE RELATIONS BETWEEN CROATIA, RUSSIA, AND CHINA: A HYPOTHETICAL EXTRACTION EXERCISE.

*"This is not just about Ukraine: this is a clash of two worlds, two polar set of values"*

Kyiv Independent

## III.1 – INTRODUCTION TO THE CHAPTER AND GENERAL REMARKS

In this last chapter, the research focuses on a scenario analysis of the hypothetical situations in which Croatia stops trading intermediate and final goods with Russia, with China, and with Russia and China. This hypothesis stems from the current geo-political situation in the World, which sees the Western countries (EU, NATO and other smaller countries) strongly condemning and taking strong action against Russian attacks on Ukraine, with China playing a somewhat neutral role while profiting from the situation.

As it was underlined in section II.3.3 – Comment to the analysis results, Croatia displays a huge economic dependence on Russia, especially as far as the energy sector (coal, gas and petroleum extraction and refinement) is concerned. As far as China goes, it can be extremely interesting to see how the complete suspension of trade between economies of such different magnitude can affect them and the rest of the World's country-sectors. In the following sections, the current

geopolitical situation will be carefully analyzed; the most important literature on hypothetical extraction will be reviewed; the methodology will be explained, and the results will be commented and analyzed.

## III.2 – CHINA, RUSSIA: TWO FRIGHTENING FORCES FROM CROATIA'S PERSPECTIVE

### III.2.1 – Russia attacks Ukraine: a short political and economic analysis of the ongoing conflict

The large scale, violent, bloody, destructive attack moved to most of the Ukrainian biggest cities, and to the majority of the Ukrainian territories located in the Donbass region is the result of the never solved, bitter, tense conflict in which Ukraine and Russia have been locked since 2014, when, as a retaliation against a popular uprising against the current Kremlin-friendly leader Yanukovych, Russia attacked Ukraine for the first time, backing up the forces of the eastern-Ukrainian separatist movement and annexing Crimea (Singh, 2022). Blanchfield (2018) stated that the Russian annexation of Crimea represented the most severe breach of borders in post-World War II Europe. Kruk (2019) reports that Russian annexation of Crimea was achieved through an illegal referendum executed when the Russian military forces had already occupied the region, while the Russian government and secret services relentlessly worked to monopolize the information space, feeding the public eye with an extremely blurred and minimize image of what the Crimean

situation was. Kruk (2019) claims that Russian military operation in Crimea violated, among others, the Non-intervention provisions in the UN Charter, the 1990 Paris Charter, and the 1997 Treaty of Friendship, Cooperation and Partnership between Russia and Ukraine. Former President of European Council Herman Van Rompuy expressed himself on the issue in the following terms:

> "[…] Our goal is to stop Russian action against Ukraine, to restore Ukraine's sovereignty – and to achieve this we need a negotiated solution [...]"

These propositions were put into place in June 2014, when the EU started to introduce sanctions on the region of Crimea itself, including import ban on Crimean goods, restrictions on trade and investment, and ban on tourism services supply in Crimea, which concerned all EU physical persons and EU based companies.

Signed in 2015, Minsk II, a reviewed and updated version of the sadly ineffective Minsk Protocol, drafted in 2014 through the mediation of France and Germany, contained several measures including a ceasefire and a withdrawal of heavy weapons from the front line, resulted in the halting of large-scale conflicts, although tension levels remained high in the region and no progress was made on the side of political settlement (Singh, 2022): a fragile equilibrium, which was destined to break down five years later.

Singh (2022) reports that the situation aggravated in early 2021, when actual Ukrainian president Volodymyr Zelenskyy started pressuring actual US

President Joe Biden into allowing Ukraine to join NATO. After massing up to 100.000 troops near the Ukrainian border, on February 21st, 2022, actual Russian President Vladimir Putin ordered said troops into the eastern region of Donbass, starting three days later, on the 24th of February 2022, through a land, air and sea attack, the armed conflict still ongoing today, as this research is being written.

Reactions of contempt and condemnation from western officials were decisive to say the least. Psaropoulos (2022) reports that on the day immediately after the ordering of troops into Donbass, the US placed full blocking sanctions on VEB bank and PSB bank, Germany halted the certification processes of the Nord Steam 2 pipeline, and the EU froze the asset of 351 Duma members. From that moment on, Russian harsh attacks on Ukrainian military and offensive over civilians have alternated with economic sanctions from EU, the US and other western economies. From an economic perspective, it was clear from the start that energy, gas, and oil industries, in the consumption of which European countries extensively relied on Russia, were going to be crucial. On the 8th of March 2022, the European Commission unveiled REPowerEU, a strategic plan to cut European dependence on importations of Russian natural gas by two-thirds by 2023. Similar objectives were stated by the International Energy Agency (IEA), whereas US imposed a ban on imports of Russian crude oil. The EU banned Russian oil and derived

products with a later-issued package of sanctions against Russia on the 31st of May 2022, with an exception on pipeline oil to preserve the oil supply of land-locked member countries (Psaropoulos, 2022). As a result of this, global commodity markets were put in trouble and prices skyrocketed to unforeseen levels (Shandilya, 2022). Shandilya (2022) also reports that Russia holds the World's greatest natural gas reserves, and supplies 35% of Europe's consumption, which a large fraction of this percentage's shipment going through Ukraine to reach central and western Europe.

As aforementioned in section II.1.1 – Network analysis and international trade, the rise of GVCs enhanced the propagation of economic shocks among World's countries through the global network of businesses and financial enterprises. Winkler and Wuester (2022) underlined that, being Russia major supplier of commodities and exporter of primary and intermediate goods, the disruptions of its trade will especially affect regional economies that are highly reliant on it, not only through energy, but also through metals and fertilizers, that are purchased by many countries from Russia and therefore utilized in the production of mainly transport equipment, electronics, machinery. In other words, the upstream position of Russia in the GVCs that include it will determine that disruption of Russian trade will affect its importers economy (the biggest of which are EU, China, Japan and South Korea), in their process of supplying primary and

intermediate goods that they use in the production of GVCs goods that they are exporters of.

III.2.2 – Croatian and Balkan perspectives on the war in Ukraine

Morcos and Saric (2022) have underlined how the outbreak of conflicts in Ukraine sparked of a deep uneasiness and concern in the western Balkans, a region that experienced a very similar situation not many years ago, as we saw in Chapter I, and in which the ethnic tension between Serbia and Croatia, Kosovo, and Bosnia and Herzegovina is still not completely smoothed over. Except for Croatia, which is now a NATO and EU member state, western Balkan countries remain under a strong Russian influence, due to Russian investments in strategic sectors in the region (especially energy) which were capitalized on in a party patronage and corruption system. Morcos and Saric (2022) have also highlighted how Russia strengthened military ties and trade of military goods (including weapons, planes, and air-defense systems) with its traditionally ally, Serbia, which shares with Russia the Orthodox faith and a sense of agreement over the instance of countries reclaiming lands which it considers rightfully theirs, which would be eastern Ukrainian territories in the case of Russia and Kosovo in the case of Serbia. Saric and Morcos (2022) even report how current Russian President Putin himself often brought to the table the example of Kosovo to justify the Russian attacks on Donetsk and Luhansk.

It is clear how the invasion of Ukraine exasperated the clash of pro-Russian and pro-NATO voices in the Balkans, where we can see NATO members Croatia, Albania, North Macedonia and NATO candidate Kosovo quickly aligning themselves with the West with sanctions and declarations, whereas Serbia and Bosnia and Herzegovina didn't, remaining the only European countries off of Russia's hostile countries-list.

The instability that could be brought in Bosnia and Herzegovina, which has a tripartite Presidency system to represent the major ethnic groups inhabiting, can be extremely dangerous. This is no secret to EU officials, which deployed 500 more troops of the EU's peacekeeping force in the country. The precarious economic situation, corruption, failed reforms are taking a serious toll on the future of Croatia's closest neighbor, and this concerning situation is being widely overlooked by the international community (Karcic, 2022). The influence of Serbia prevented the pro-NATO part of the country to implement sanctions and condemn the war. The same situation happened in Montenegro, where sanctions were immediately declared but still not put in place due to political in-fighting going on in the country (Saric and Morcos, 2022).

From a more economic perspective, it has been reported by Vujasin (2022) that EU pledged to include the western Balkan countries in joint purchases of liquid pipeline gas, alongside with Moldova, Ukraine and

Georgia, allowing them to contain costs of the energy supply for the upcoming winter.

Although Croatia is already enjoying the protection and the benefits of being an EU and a NATO member, the war in Ukraine seems to have sparked deep concerns also in Zagreb. Robertson et al., (2022), reported the main instances stated by current Croatian Prime Minister Plenkovic in an interview carried out during the EU summit held in March 2022 in Versailles. Plenkovic expressed concerns for three main issues: the humanitarian tragedy of Ukrainian victims, the difficult-to-manage heavy refugee flow now happening from East to West, and the unprecedented skyrocketing of energy prices, which can be tricky to deal with for a small, open economy like Croatia is. Plenkovic advocated for the cooperation of European countries to provide quick and efficient solutions to these widely shared problems.

*III.2.2.a – Russia and Croatia: an overlook on trade*

In this subsection, the concerns of Croatian officials over trade disruptions of the EU with Russia will be backed up by data regarding trade between the two countries. Firstly, it is important to have a look of the flow of goods from Russia to Croatia, which is shown in the following table.

| PRODUCT (HS4 classification) | TRADE VALUE | % OF TRADE VALUE |
|---|---|---|
| **Crude Petroleum** | $ 343.859.732,00 | 53,17% |
| **Raw Aluminum** | $ 71.393.458,00 | 11,04% |
| **Coal Tar Oil** | $ 68.616.223,00 | 10,61% |
| **Refined Petroleum** | $ 60.858.055,00 | 9,41% |
| **Coal Briquettes** | $ 30.838.246,00 | 4,77% |
| **Refined Copper** | $ 17.897.142,00 | 2,77% |
| **Potassic Fertilizers** | $ 8.336.208,00 | 1,29% |
| **Aluminum Wire** | $ 6.559.093,00 | 1,01% |
| **Passenger and Cargo Ships** | $ 5.891.957,00 | 0,91% |
| **Combustion Engines** | $ 5.362.987,00 | 0,83% |

*Fig. III.1 – Main Russian export goods in Croatia with their total trade value percentage share in year 2020 (Source: World Bank Gorup[7])*

The concerns of current Croatian President Plenkovic don't appear groundless. Croatia purchased over 343 million USD in crude petroleum in 2020 from Russia, which represent the largest share of total trade from Russia to Croatia, which roughly amounts, in total, to 647 million USD. Adding up all the petroleum-related products to this percentage, we can state that Russian exports of energy in Croatia, in 2020, amounted to over 481 million USD, which represents the 74% of the total Russia's exports in Croatia.

Looking at the other side, the situation looks obviously different, but some considerations can be made:

[7]https://wits.worldbank.org/CountryProfile/en/Country/HRV/Year/2019/TradeFlow/EXPIMP/Partner/by-country# (08/08/2022 – 12.12)

| PRODUCT (HS4 classification) | TRADE VALUE | % OF TRADE VALUE |
|---|---|---|
| **Packaged Medicaments** | $ 91.863.706,00 | 39% |
| **Soybeans** | $ 35.423.843,00 | 15% |
| **Knit Socks and Hosiery** | $ 10.089.945,00 | 4% |
| **Shaving Products** | $ 9.633.868,00 | 4% |
| **Metal Molds** | $ 8.931.056,00 | 4% |
| **Special Purpose Ships** | $ 8.496.724,00 | 4% |
| **Mineral Carvings** | $ 6.974.206,00 | 3% |
| **Pulley Systems** | $ 4.180.226,00 | 2% |
| **Passenger and Cargo Ships** | $ 4.164.294,00 | 2% |

*Fig. III.1 – Main Croatia export goods in Russia with their total trade value percentage share in year 2020 (Source: World Bank Gorup[8])*

As we can see, and not surprisingly considering the dimensions of both countries, Croatian exports towards Russia are smaller than Russian exports towards Croatia. In total, they amounted to over 236 million USD, which is roughly the 36% of the total from the counterpart. Croatian export towards Russia fell sharply in 2013, and from that moment on they have been on a low yet steady rise, at least until the outbreak of the War in Ukraine. As of 2021, Croatian export in Russia added up to 205 million USD, representing the 1.1% of total Croatian exports. In 2013, this percentage was 2.9% (Petricic, 2022). Petricic (2022) concludes that, overall, Croatian exports are not relevantly reliant on Russia, therefore it is possible to say that a trade disruption would

[8]https://wits.worldbank.org/CountryProfile/en/Country/HRV/Year/2019/TradeFlow/EXPIMP/Partner/by-country# (08/08/2022 – 19.39)

not impact Croatia on the export side as much as it could impact it on the import side, if at all.

In another article, Petricic (2022) underlined, instead, that the war in Ukraine disrupted the Croatian capital markets, generating, since the invasion, a series of turbulent weeks due to the high levels of uncertainty, inflation, and interest rate spikes from which the Croatian financial markets only partially recovered.

III.2.3 – China, the West, and the Balkans: endangered relationships

Onnis (2022) underlines that the crisis related to Russian attacks on Ukraine struck a China already in a difficult socio-economic situation. The zero-cases policy that current Chinese Prime Minister Xi Jinping adopted to deal with the Covid-19 pandemic is reveling its inefficiency and failures, blocking the national economy, putting the country's position in the global market in serious risk and generating high levels of social tensions and instabilities. Current Chinese Vice Minister of Foreign Affairs Le Yucheng, as Onnis (2022) reported, has expressed, since the beginning of the war, the will of the Chinese government to strengthen its set of global partnerships, maintaining a sort of neutral position. The Vice Minister stated that:

> "[…] China, as always, will strengthen its strategic coordination with the Russian counterpart, realizing an advantageous cooperation for everyone and will jointly safeguard the common interests of both sides."

As Onnis (2022) underlines, the choice to not condemn Russian invasion is clear, yet China does not seem in the position to break up its connections with the West, and Beijing will soon have to find a way to manage its future relationships with Washington and Bruxelles. On another note, Maizland (2022) reports that experts have underlined how, anyway, China and Russia are not formal allies, and the war in Ukraine is exposing all the limits of their relationships.

Despite not condemning the invasion, China has not defended Russia in the battlefield at all, nor it has boycotted the western sanctions in a transparent way. Stronski and Ng (2022) stated that the Sino-Russian strategic partnership stems from their common objective to challenge and overthrow the western dominated principles of the international system. Although, due to economic and geo-politic reasons, this relationship is affected by an asymmetry of power enjoyed by China (Stronski and Ng, 2018), endowing it with the possibility of set the course of the relationship with Russia, which will be left with the only possibility of reacting.

Anyway, as of today, Russia and China's bonds are strong, are here to stay in the short-medium run and the West must start to ponder how to deal with it. Le Corre (2022) depicts a not very edifying image of what Chinese relationships with European countries have been in the last few years, especially from 2020, when

Chinese FDIs in Europe heavily dropped and didn't significantly bounce back in 2021. The situation looks even worse for 2022, due to the heavy lockdowns that the Chinese government is keeping on and the war in Ukraine, that seems to have disrupted all the projects related to the Belt and Road Initiative (BRI)[9], in which Ukraine was regarded as a key-country.

Le Corre (2022) underlines that not only Ukraine-related projects are at standstill, but that the Ukrainian war could also jeopardize projects between Russia and China and projects between Russia and EU. In fact, EU countries are now so focused on the situation in Ukraine, assisting their neighbors, dealing with the aftermath of sanctions against Moscow and providing humanitarian helps to victims and refugees, and therefore are now unlikely to conclude business agreements with China. A hypothetical trade disruption with China could bring further problems in the Balkans, as Albania, Bosnia and Hercegovina, Macedonia, Montenegro, and Serbia, welcomed China-funded projects in highways, energy, and railways for a rough total value of $6.3 billion USD.

China's investments in the western Balkans also involved Croatia, especially in the last years. A specific mention can be made about China Road and Bridge

[9] Belt and Road Initiative (BRI), announced by Current Chinese President Xi Jinping was a strategic initiative of China with the purpose of enhancing its commercial relationships with the Eurasian and European countries. Starting with the development of logistics and transportation infrastructures, this initiative aims to improve China's position in worldwide commercial relationships, through the smoothing of FDIs and trade flows in and out of China.

Corporations-built Peliesac Bridge, which was open for traffic on the 26th of July 2022, as this research is being written. This bridge will connect Dubrovnik-Neretva County (the southeastern semi-exclave of Croatia) to the rest of Croatian territory), allowing, for the first time, travelers to move across Croatia avoiding passing the Bosnia and Hercegovina's coastal strip and city of Neum and its related border controls.

The construction of the bridge was delayed by disappointment expressed Bosnian public officials towards the construction of the bridge, that were concerned that the bridge would have physically prevent large ships from reaching Neum port, which is the only Bosnia and Hercegovina's access to the sea, as Marsic (2018) reported. This problem was simply resolved by designing a higher bridge. The final estimation of the bridge's cost was 420 million euros, and in June 2017 the European Commission pledged to finance the 85% of the total amount. The Croatian Government entered into the contract of construction with the aforementioned China Road and Bridge Corporation, which won the tender with an offer of 2 billion HRK, roughly corresponding to 270 million euros, which completed it only four years later. Pelijesac Bridge, as Chastand (2022) underlined, is not the only major infrastructure project inaugurated in 2022. Chastand (2022) reports that also a highway in Montenegro and a high-speed trainline in Serbia built alongside with Pelijesac Bridge over the last few years, and underlines that these

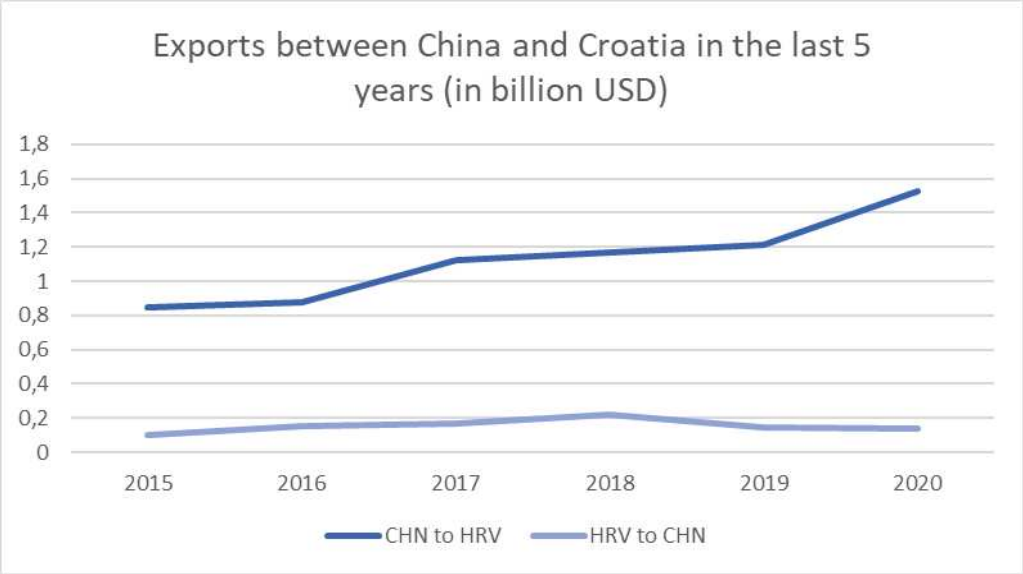
projects were the tangible manifestation of a clear intent on Beijing's side to increase its soft power in the western Balkans at Bruxelles' expense.

Despite of it, in general, we can say that China's relationships with the West and Balkan countries are now definitely in jeopardy after the last major geo-political events. Moreover, it is important to remember that Chinese imperialist stances are keeping on creatin frictions with the West. As Le Corre (2022) reported, China sanctioned with "coercive economic measures" the EU member state Lithuania for opening a Taiwan office, with the EU suing China over this before WTO claiming the sanctions discriminatory. Lithuania, which later withdrew from all the BRI related projects, is only an example of these dynamics. On the 2nd and 3rd August 2022 tensions between China and the United States spiked to an incredibly high level following the visit to Taiwan's capital, Taipei, of the Current American Speaker of the White House Nancy Pelosi, seen by China's Government as an American attack on China's power over Taiwan. This could push China closer to Russia in the Ukraine war related East versus West conflict.

*III.2.3.a – China and Croatia: an overlook on trade*

As we did for Russia in section III.2.2.a – Russia and Croatia: an overlook on trade, we will now perform the same analyses on trade relationships between Croatia and China.

China's export in Croatia totaled in 2020 1.5 billion USD and have been steadily increasing over the course of the last 3 years, whereas Croatia's exports towards China have been slightly declining already since a few years ago, as it is possible to see from the graph below.




*(Fig III.1 – Imports and Exports in Croatia, over the years in billion USD. Source: OEC[10])*

As it is possible to see from the graph, in 2020 Chinese exports to Croatia reached over 1.5 billion USD, almost doubling the amount they reached in 2015. As it is possible to see from the table below, the main Chinese

[10] https://oec.world/en/profile/bilateralcountry/chn/partner/hrv?compareExports0=comparisonOption1&dynamicBilateralTradeSelector=year2019&geomapMeasureSelector=geomapBalanceOption2&measureBilateralTradeSelector=vizValueOption2 18/08/2022 – 15.34

products exported in Croatia were special purpose ships, electric generating sets and computers.

| PRODUCT (HS4) | TRADE VALUE | % OF TRADE VALUE |
|---|---|---|
| **Special Purpose Ships** | $ 186.555.916,00 | 12% |
| **Electric Generating Sets** | $ 75.432.712,00 | 5% |
| **Computers** | $ 64.688.994,00 | 4% |
| **Broadcasting Equipment** | $ 52.181.595,00 | 3% |
| **Iron Structures** | $ 49.866.459,00 | 3% |
| **Other Electrical Mach.** | $ 42.740.190,00 | 3% |
| **Air Conditioners** | $ 42.088.056,00 | 3% |
| **Other Cloth Articles** | $ 34.814.577,00 | 2% |
| **Non-Knit Active Wear** | $ 27.206.267,00 | 2% |
| **Light Fixtures** | $ 27.137.603,00 | 2% |
| **Dom. Electric Housewares** | $ 25.931.941,00 | 2% |

*Fig. III.2 – Main Chinese export goods in Croatia with their total trade value percentage share in year 2020 (Source: World Bank Gorup[11])*

Selo Sabic (2017) forecasted an increase in Chinese exports towards Croatia following the entrance of the country in the 16+1 cooperation project. As Selo Sabic (2017) explains, 16+1 cooperation is part of the Chinese *go global strategy*. Specifically, China initiated a series of cooperation projects with a total of sixteen states, of which eleven are members of the EU (Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia) and the remaining five are western Balkan

[11] https://wits.worldbank.org/CountryProfile/en/Country/HRV/Year/2019/TradeFlow/EXPIMP/Partner/by-country# (17/08/2022 – 14.23)

states (Albania, Bosnia and Hercegovina, Macedonia, Montenegro, and Serbia[12]). The author concludes their analysis saying that although some small steps of trade integration between the two countries will be made (which can be consistent with the trade data aforementioned) Croatian governments in the past and present have demonstrated scarce interest in the economic cooperation with China, a condition that furtherly diminishes the appeal of an already small and not very vivacious market in the eye of Chinese investors.

Le Corre (2022) also underlined that apparently none of the projects concerned the EU member state in 16+1 went beyond declarations and pledges; also, Lithuania has already withdrawn from the projects following the sanctions relative to the Taiwan office opening incident.

On the other side, some interesting data can be withdrawn from the overlook of Croatian exports in China. It is not surprising, given the dimensions of the two countries, that the volume of Croatian exports towards China is extremely small when compared to its Chinese counterpart's exports towards itself. In 2020, Croatian exports towards China reached 138 million

[12] It is important to remember that all these western Balkan countries expressed at some point interest, some also formally, to join the European Union as actual members. It also has to be remembered that China does not recognize Kosovo as an independent country, but it has trade relationships with it.

USD, roughly 9% of Chinese exports in Croatia. As it is possible to see from the following table:

| PRODUCT (HS4) | TRADE VALUE | % OF TRADE VALUE |
|---|---|---|
| **Sawn Wood** | $ 25.487.531,00 | 18% |
| **Electrical Resistors** | $ 22.835.320,00 | 17% |
| **Special motor vehicles** | $ 12.652.427,00 | 9% |
| **Rubberworking Machinery** | $ 7.881.801,00 | 6% |
| **Animal Food** | $ 6.137.558,00 | 4% |
| **Other Plastic Sheetings** | $ 5.725.368,00 | 4% |
| **Marble, Travertine** | $ 4.844.901,00 | 4% |
| **Organo-Sulfur Compounds** | $ 4.447.377,00 | 3% |
| **Aluminium Foil** | $ 3.577.183,00 | 3% |
| **Centrifuges** | $ 3.353.411,00 | 2% |

*Fig. III.3 – Main Croatian export goods in China with their total trade value percentage share in year 2020 (Source: World Bank Gorup[13])*

the main products that Croatia exports in China are sawn wood, electrical resistors and special purpose motor vehicles. The extensive exports of sawn wood are not surprising considering the long-standing, ancient tradition of forest management in Croatia, a country whose land is covered, for almost 50% of its total extension (2,759,039.05 hectares), by the most self-sustaining, healthy and rich forests of Europe[14]. In 2018, Croatia ranked 18th worldwide (on a total of 131 countries) as sawn wood exporter, followed by much larger countries such as Indonesia (ranked

[13] https://wits.worldbank.org/CountryProfile/en/Country/HRV/Year/2019/TradeFlow/EXPIMP/Partner/by-country# (17/08/2022 – 17.30)

[14] http://www.china-ceecforestry.org/country/croatia/ (18/08/2022 – 16.40)

21st), Ukraine (ranked 26th) and Spain (ranked 33rd)[15]. Despite electrical resistors being its 3rd ranked export product in China, Croatia ranks only 36th among all 53 China's electrical resistors suppliers. All in all, like in the situation with Russia, it is possible to hypothesize that an eventual trade disruption with China would hurt Croatia more significantly on the import size than on the exports size. China is surely not among Croatia's main export markets, nor a country which Croatian exports particularly rely on.

## III.3 – HYPOTHETICAL EXTRACTION: BRIEF LITERATURE REVIEW, METHODOLOGY AND SIGNIFICANCE.

### III.3.1 – Methodology and significance of the hypothetical extraction method

In this section, the research will focus on the methodology through which hypothetical extraction exercises are carried out, their significance, and will review some relevant literature concerning this topic.

In the beginning, it will be necessary to provide a formalization of the hypothetical extraction method and an analysis of its significance. Many of the concepts in this section will be recalled from section II.3.2 – Analysis and data elaboration in the previous chapter. In general, it is possible to say that the aim of

[15] https://wits.worldbank.org/trade/comtrade/en/country/ALL/year/2018/tradeflow/Exports/partner/WLD/product/440799# (18/08/2022 – 18.00)

the hypothetical extraction technique is to quantify the loss in terms of output that would be suffered by an *n*-sectors economy in the case in which a particular industry was not to exist (Giammetti et al., 2019). Giammetti et al., (2019) underlined how this method can be used to identify the key-sectors in the country economy facing relatively higher risks and higher losses in comparison with the others in the case a particular event of trade shocks or disruptions.

Let's now recall the matrix **A**, whose significance was thoroughly explained in section II.3.2 – Analysis and data elaboration of the previous chapter. From a mathematical point of view, the extraction of industry *k* from the global network signifies that the *kth*-row and the *kth*-column of matrix $\boldsymbol{A}$, must be set equal to zero, and we can name this new resulting matrix $\boldsymbol{A}*$ (Giammetti et al., 2019).

In the same fashion, it will be necessary to set equal to zero also the final demand vector for goods and services provided by industry *k*, which will logically result in vector $\boldsymbol{f}*$.

Formally, let vector $\boldsymbol{f}*$ be:

$$f_k = 0$$

This leads to the conclusion that the new final vector of gross outputs (formerly known as vector $\boldsymbol{x}$ will now be vector $\boldsymbol{x}*$, expressed as:

$$x* = (I - A*)^{-1} f*$$

And the difference between the former vector and the new one will be defined as:

$$s' = (x - x*)$$

As it was shown in Dietzenbacher and van der Linden (2002) which used the new variant of the hypothetical extraction technique to describe the interdependencies of the production network of the European community, this method can be extended to the analysis of a multi-country input-output network, composed by *N*-countries that are each endowed with *n*-production sectors (Giammetti et al., 2019).

Chen et al., (2018) used this technique and applied it to the case of Brexit to analyze the loss in terms of GDP in the case of a total disruption of trade between the EU and the United Kingdom. Starting from this work, Giammetti et al., (2019) (2021) used the method instead to unveil the key-sectors facing risks in the Brexit unfolding. In this research, as aforementioned, the focus will be on trade disruptions between Croatia, Russia and China. Therefore, it can be useful to carry on the formalization using this example.

In the following picture, the example of a three-country and one-sector WIOT is reported. In particular, the countries that were chosen are Croatia (HRV), Russia (RUS) and the Rest of the World (ROW). The panels that are highlighted in blue are the one that would be involved in the case of a trade disruption between

Croatia and Russia, that is the trade of goods of final and intermediate use between the two countries.

| | | Intermediate use | | | Final demand | | | Gross output |
|---|---|---|---|---|---|---|---|---|
| | | **HRV** | **RUS** | **ROW** | **HRV** | **RUS** | **ROW** | |
| | | **industry** | **industry** | **industry** | **industry** | **industry** | **industry** | |
| **HRV** | **Industry** | Intermediate use of domestic output | Intermediate use by RUS of exports from HRV | Intermediate use by ROW of exports from HRV | Final use of domestic output | Final use by RUS of exports from HRV | Final use by ROW of exports from HRV | x hrv |
| **RUS** | **Industry** | Intermediate use by HRV of exports from RUS | Intermediate use of domestic output | Intermediate use by ROW of exports from RUS | Final use by HRV of exports from RUS | Final use of domestic output | Final use by ROW of exports from RUS | x rus |
| **ROW** | **Industry** | Intermediate use by HRV of exports from ROW | Intermediate use by RUS of exports from ROW | Intermediate use of domestic output | Final use by HRV of exports from ROW | Final use by RUS of exports from ROW | Final use of domestic output | x row |
| **Value added** | | v hrv | v rus | v row | | | | |
| **Gross output** | | x hrv | x rus | x row | | | | |

*Fig. III.4 – WIOT representation of a three-country and one-sector economy. (Source: Giammetti et al., 2019 – edited).*

In the actual exercise, the 2014 version of WIOT was used with all the countries in it, which are a total of 44 economies. Giammetti et al., (2019) clearly explains the formalization behind the hypothetical extraction technique. Firstly, we will recall the coefficient $\boldsymbol{A}$ and final demand $\boldsymbol{F}$ partitioned matrices

$$A = \begin{matrix} A^{HH} & A^{HR} & A^{HW} \\ A^{RH} & A^{RR} & A^{RW} \\ A^{WH} & A^{WR} & A^{WW} \end{matrix} \quad ; \quad F = \begin{matrix} F^{HH} & F^{HR} & F^{HW} \\ F^{RH} & F^{RR} & F^{RW} \\ F^{WH} & F^{WR} & F^{WW} \end{matrix}$$

These matrices report the trade flows of intermediate and final goods between Croatia (indicated by the letter H), Russia (indicated by the letter R) and a general rest of the World region (indicated by the letter W). Due to the geo-politic reasons thoroughly explained in the previous sections, it is possible to hypothesize a harsh trade disruption between Croatia and Russia and this technique allows to understand how the various Croatian, Russian and global sectors would fare in this situation.

In the logic of the WIOT table, this means that Russia will stop importing intermediate and final goods delivered by every *ith*-sector of the Croatian economy.

Extracting trade flows between Russia and Croatia in this case, requires substituting the involved matrices with same-sized matrices that are equal to zero, creating the aforementioned $\boldsymbol{A}*$ and $\boldsymbol{F}*$ as it follows:

$$A* = \begin{matrix} A^{HH} & 0 & A^{HW} \\ 0 & A^{RR} & A^{RW} \\ A^{WH} & A^{WR} & A^{WW} \end{matrix} \quad ; \quad F* = \begin{matrix} F^{HH} & 0 & F^{HW} \\ 0 & F^{RR} & F^{RW} \\ F^{WH} & F^{WR} & F^{WW}. \end{matrix}$$

In other words, the *ith*-rows of the sub-matrix $A^{HR}$ and sub-matrix $F^{HR}$ are set to zero. This will result in the new final demand vector and the change in output expressed as it follows:

$$x* = (I - A*)^{-1} f*$$

$$s' = (x - x*)$$

The equation of the final use vector can be used to express change in GDP terms by pre-multiplying it by the value-added coefficient matrix $\hat{\mathbf{V}}$ which is a diagonal matrix containing on its main diagonal the following element:

$$\frac{v_j^s}{x_j^s}$$

Which expresses the value-added coefficient of the industry *j* in country *s*. This calculation leads to the new value-added vector ($\boldsymbol{v}*$), that in the same way of the final demand one ($\boldsymbol{x}*$), can be subtracted from its first version to calculate the change derived from the extraction, as it follows:

$$v* = \hat{\mathrm{V}}(I - A*)^{-1} f*$$

and therefore:

$$s' = (v - v*).$$

The change in value-added (or, in other words, the hypothetical loss in terms of value added, LiVA) will be the focus of this research. This formalization, retrieved in Giammetti et al., (2019) was also the technique used by Chen et al., (2018). The exact same proceedings will be performed on the trade flows between Croatia and China in this research.

Also, due to today's geo-politic conditions explained in the previous section, it would be shareable to hypothesize that China and Russia will tighten their

relationships soon, distancing themselves from the West. In this case, it is logic to hypothesize that Croatia will stop trading with them both simultaneously.

In this case, it is possible to rewrite the matrices as it follows (with the same indications, including C for China):

$$A = \begin{matrix} A^{HH} & A^{HR} & A^{HC} & A^{HW} \\ A^{RH} & A^{RR} & A^{RC} & A^{RW} \\ A^{CH} & A^{CR} & A^{CC} & A^{CW} \\ A^{WH} & A^{WR} & A^{WC} & A^{WW} \end{matrix} \quad ; \quad F = \begin{matrix} F^{HH} & F^{HR} & F^{HC} & F^{HW} \\ F^{RH} & F^{RR} & F^{RC} & F^{RW} \\ F^{CH} & F^{CR} & F^{CC} & F^{CW} \\ F^{WH} & F^{WR} & F^{WC} & F^{WW} \end{matrix}$$

Then it will be necessary to set the trade flows of interest equal to zero creating the new matrices:

$$A* = \begin{matrix} A^{HH} & A^{HR} & A^{HC} & A^{HW} \\ \boldsymbol{A^{RH}}* & A^{RR} & A^{RC} & A^{RW} \\ \boldsymbol{A^{CH}}* & A^{CR} & A^{CC} & A^{CW} \\ A^{WH} & A^{WR} & A^{WC} & A^{WW} \end{matrix} \quad ; \quad F* = \begin{matrix} F^{HH} & F^{HR} & F^{HC} & F^{HW} \\ \boldsymbol{F^{RH}}* & F^{RR} & F^{RC} & F^{RW} \\ \boldsymbol{F^{CH}}* & F^{CR} & F^{CC} & F^{CW} \\ F^{WH} & F^{WR} & F^{WC} & F^{WW} \end{matrix}$$

From this point, vector $\boldsymbol{x}*$ will be derived and the hypothetical loss of value added (LiVA) will be calculated in terms of $s' = (x - x*)$ with the same proceedings as before.

<u>III.3.2 – Hypothetical extraction: brief literature review and interesting examples</u>

The most complete review of the hypothetical extraction method is provided by Dietzenbacher and Lahr (2013) and Miller and Blair (2009). Miller and Blair (2009) provide an extensive review of the various methods both from a significance and a formal point of view, providing an overview of the mathematical foundations

of the theory and exploring extensions and new horizons for this nouvelle economic analysis technique.

Although this method is relatively new and not extremely famous, some interesting research on the field are found in the economic literature, and it is not wild to hypothesize that this number may grow due to the latest geo-politic macro events that could cause harsh trade disruptions, whose effects are possible to study and forecast through hypothetical extraction analysis techniques.

A brilliant example of this was brought by Chen et al., (2018), that, as aforementioned in the previous sections, studied the effects of the Brexit related possible trade disruption through hypothetical extraction analysis. The authors used the method to in fact quantify how much the UK's and EU's GDPs would have shifted in the case of a trade disruption among the macro-regions and concluded that in the long-run, considering various levels of trade disruption harshness, both the EU and the UK will face GDP losses and the situation will be particularly serious for Ireland, which is the country that trades the most with UK. Giammetti et al., (2019), (2021), remained on the field of Brexit, as aforementioned, to investigate on which, among all the sectors in the economy, would be the most impacted by the trade disruption and therefore what sectors of the European economy would be most at risk in the face of Brexit. The authors drawn many interesting conclusions from their study, which also included a careful and deep input-output analysis of the European production network, carried out with many

instruments and techniques of which some were utilized in the previous chapter of this research. Firstly, the authors concluded that the European production network is both symmetrically and asymmetrically connected and underlined that whereas most of the sectors are interconnected with each other, the main share of the trade flow is held by a few crucial nodes in the network. Secondly, the authors reported hypothetical extraction analysis yielded the result that the UK sectors would face less risks in the face of trade barriers compared to the EU sectors, because many vulnerable sectors are in the service industry, which, unlike the others that are subject to tariff and non-tariff barriers, can only be subject to non-tariff barriers.

These results are extremely interesting because they show that the interconnections among the nodes of a network can determine devastating effects not only for the node that is withdrawn from the network (in this case, UK leaving EU), but also for the rest of the nodes (in this case, the EU countries), which is somewhat counterintuitive considering that, in the public eye, Brexit was considered more risky and costly for UK than for the rest of Europe. A mention must also be given to the experience of Giammetti et al., (2020) which is exemplificative of the flexibility of hypothetical extraction techniques, which can be also applied to situations that are different from the one that were reported before. In this research, Giammetti et al., (2020), the authors investigate the impact of the Covid-19 related lockdown on the italian imput-output network, analyzing the structure of GVCs in Italy. Giammetti et al., (2020) underline that:

> "HE [hypothetical extraction] technique as this is widely used in the input–output literature to identify key sectors, […] to unveil the potential impact of total sectoral lockdowns, […] [it] quantifies how much the output of an n-sectors economy would decrease if a particular industry were not present or, in our case, locked".

In the research, Giammetti et al., (2020) extracted one at a time all the sectors of the Italian economy and compute the new value, concluding that the greater lockdown related losses in value would happen in wholesale trade, public administration, construction and retail trade. Due to not enough specific information on the sectors that would or wouldn't be subject to lockdown [16], the hypothetical extraction technique could not be appropriate to quantify the GDP losses in this case. Although, as carefully explained by Dietzenbacher and Lahr (2013) and aforementioned in this section, the hypothetical extraction method can be generalized to a multitude of occasions, including this case of partial extraction. The method in this case will not carry out a total extraction (setting vectors equal to zero, but decreasing the amount of an $\alpha \cdot 100$ percentage, expressing the new demand as:

[16] Giammetti et al., (2020) point out that the IMPD defines the list of industries which are vital to the economy and therefore will not be locked down, but not specifically enough. In fact, hypothetical extraction method requires the NACE industrial classification codes at 2-digits, which are not always present in the IMPD. This results in hypothetical extraction method not being well suited to simulate sectorial lockdowns in this case.

$$f_k * = (100 - \alpha) f_k$$

and not as:

$$f_k * = 0$$

as it was shown before.

The authors underlined how not all the sectors which bear a high epidemiological risk, hence are likely to be struck by lockdown regulations, will yield the same loss in economic terms in the case of being locked down. Giammetti et al., (2020) highlighted a high trade-off in sectors such as manufacturing, construction, public administration, wholesale retail trade, and food services; and stated that, due to this asymmetry, closing only half of wholesale retail trade and food services sectors, even in the case of leaving the entire rest of the economy open, would result in a serious loss of value-added.

This research shows the relevance of hypothetical extraction techniques in the analysis of the effect of trade disruptions also in a single country, and not only in international trade.

It is interesting to also mention the experience of Kecek et al., (2021) which applied the hypothetical extraction method to the study of the total direct, indirect and induced contribution effects of Croatian ICT sectors to the growth and development of the whole Croatian economy, in the 2010–2015-time frame. The interest of the authors stemmed from the fact that the relevance

of ICT sectors in the Croatian economy is lagging at lower levels compared to the other European countries, although nowadays it is impossible to deny the importance of information and communication technology in economic innovation, productivity, and ability to compete in an international environment. The empirical data produced by Kercek et al., (2020) that applied the hypothetical extraction to all eight ICT Croatian sectors included in Croatia's IOTs, shown that in the 2010–2013-time frame, the already low demand for ICT sectors' products in Croatia was also declining due to the economic crisis in the Eurozone. Nevertheless, in 2014-2015, the total effect of ICT sectors in Croatia's economy substantially grew in terms of employment, gross value-added and output. The authors hypothesized a correlation between this increase and external factors such as the economic recovery of the Eurozone and the completion of the procedures undertook by Croatia to enter EU.

## III.4 – COMMENTARY ON HYPOTHETICAL EXTRACTION ANALYSIS RESULTS

The source of this section's data elaborations was the 2014 WIOT. Hereafter, all the results that stemmed to the application of the hypothetical extraction method to the table will now be presented and commented. As aforementioned in section III.2 – China, Russia: two frightening forces from

Croatia's perspective, three scenarios have been considered. In the first scenario, it has been hypothesized a trade disruption between Croatia and Russia. In the second scenario, the extraction concerns trade between Croatia and China. Lastly, in the third scenario, the hypothesis is that Croatia stops trading with both China and Russia at the same time. Results will be presented through two main indicators: absolute hypothetical loss of value-added, marked as A_LiVA, which expresses the raw quantity of value-added lost in the trade disruption; relative hypothetical loss of value-added, labeled as R_Liva, which expresses the loss of value-added normalized by the original quantity of value-added that was produced before the trade disruption, which is marked instead as VA_0 (value-added in time zero). To provide a better understanding of the dynamics in the network, the hypothetical losses of value-added will also be aggregated by countries and sectors, in order to compute the aggregated relative hypothetical loss of value-added that the whole country (or the whole industry in the World economy) would face in the case of the considered trade disruptions. Lastly, some considerations are made about the economic and political implications of these results.

III.4.1 – Hypothetical extraction of trade between Croatia and Russia

The results yielded by the hypothetical extraction of trade between Croatia and Russia yielded the results presented in the following tables.

| SECTOR ID | A_LiVA_RUS | R_LiVA_RUS | SECTOR ID | A_LiVA_RUS | R_LiVA_RUS |
|---|---|---|---|---|---|
| **HRV_C29** | -0,836459 | -0,017414 | **HRV_M74_M75** | -0,328007 | -0,002190 |
| **HRV_C28** | -5,604068 | -0,017344 | **HRV_C26** | -0,440279 | -0,001910 |
| **HRV_C20** | -2,607053 | -0,010830 | **RUS_B** | -316,975861 | -0,001858 |
| **HRV_C25** | -5,452424 | -0,007134 | **HRV_M72** | -0,400957 | -0,001627 |
| **HRV_C27** | -1,052546 | -0,003830 | **HRV_C22** | -0,353894 | -0,001312 |
| **HRV_C24** | -0,339525 | -0,003447 | **HRV_H49** | -1,223948 | -0,001256 |
| **HRV_C31_C32** | -0,600475 | -0,002368 | **HRV_C16** | -0,269683 | -0,001112 |
| **HRV_G46** | -6,398054 | -0,002361 | **HRV_C17** | -0,145381 | -0,001101 |
| **HRV_C23** | -0,997088 | -0,002334 | **RUS_H49** | -76,680461 | -0,001089 |

*Fig. III.5 – World economy sectors and their absolute and relative hypothetical losses of value added.*

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This table shows the sectors of the World economy which would face the biggest loss in the case of a Croatia-Russia trade disruption. The most affected Croatian sectors manly belong to the C-group, and specifically we have C_29, motor vehicles; C_28, machinery and equipment; C_20, chemicals; C_25, metal products; C_27, electrical equipment, C_24, basic metals; C_31-32, furniture and other manufacturing products. A special mention must be made to the Russian sectors belonging in this chart. In the ranking list of most affected country-sectors not belonging to Croatia the ones that are found first is RUS_B, Russian mining and quarrying; and RUS_H49, Russian land and pipeline transport, which is consistent with the hypotheses made in the last sections. Croatia would be the most

hurt in the case of the trade disruption, and Russia would see some minor effects on mainly on the field of pipeline gas.

It is also interesting to rank the World countries by their country aggregate relative hypothetical loss of value-added (AR_LiVA). To create this chart, all the country-sectors in the World economy were aggregated by countries. The results show the following situation:

| COUNTRY | A_LiVA | VA_0 | AG_R_LiVA |
|---|---|---|---|
| HRV | -42,70110779 | 48159,98823 | -0,000886651125942 |
| RUS | -722,199898 | 1623896,157 | -0,000444732808129 |
| SVN | -1,218806846 | 42819,11383 | -0,000028464083832 |
| AUT | -7,250871544 | 389663,9292 | -0,000018608013214 |
| LTU | -0,320882366 | 43718,62636 | -0,000007339717488 |
| EST | -0,167815973 | 23393,74509 | -0,000007173540276 |
| HUN | -0,750400719 | 116649,4296 | -0,000006432956605 |
| SVK | -0,561751613 | 91105,6073 | -0,000006165938949 |
| CZE | -1,063522647 | 186073,3604 | -0,000005715609395 |
| LVA | -0,14789068 | 27753,61499 | -0,000005328699695 |

*Fig. III.6 – World countries with their absolute and aggregate relative hypothetical losses of value added.*

This table shows the absolute LiVA, the original value-added and the relative losses aggregated for each country. Not surprisingly, the most affected country in the extraction are Croatia and Russia. The third ranking country in the chart is Slovenia, which is not surprising. As it was already underlined in the previous sections and chapters, Slovenia plays a key role in Russian-Croatian commercial relations, especially when it comes to the energy sectors, in fact, in during 2021, it exported mineral fuels, oils and distillation products for an amount

over 608 million USD. It can be hypothesized that part of these goods is coming from Russia and transiting Slovenia (or Austria, the 4th ranking country in the chart) on their way to Croatia, or that Croatia hosts the transit of goods destined to these two countries. The rest of the most affected countries belongs to Central and Eastern Europe.

III.4.2 – Hypothetical extraction of trade between Croatia and China

In the same fashion of the previous section, now the results yielded by the hypothetical extraction of trade between Croatia and China will be presented.

| SECTOR ID | A_LiVA_CHN | R_LiVA_CHN | SECTOR ID | A_LiVA_CHN | R_LiVA_CHN |
|---|---|---|---|---|---|
| HRV_C28 | -6,77917474 | -0,02098102 | HRV_A02 | -1,74962111 | -0,006233 |
| HRV_C27 | -4,50369115 | -0,01638669 | HRV_T | -0,28252627 | -0,0051246 |
| HRV_C31_C32 | -3,10811538 | -0,01225455 | HRV_J58 | -0,717288 | -0,0039164 |
| HRV_C16 | -2,96419783 | -0,01221909 | HRV_G46 | -10,4402455 | -0,0038519 |
| HRV_C26 | -2,0997605 | -0,00910773 | HRV_M72 | -0,90080765 | -0,0036552 |
| HRV_C13-C15 | -3,24989994 | -0,00708739 | HRV_C21 | -1,68695977 | -0,0035108 |
| HRV_C29 | -0,32798583 | -0,00682829 | HRV_M74_M75 | -0,41779466 | -0,0027899 |
| HRV_R_S | -9,59451544 | -0,00661361 | HRV_C25 | -2,10880933 | -0,0027594 |
| HRV_H51 | -0,32790817 | -0,00639487 | HRV_M69_M70 | -3,27564498 | -0,002407 |

*Fig. III.8 – World economy sectors and their absolute and relative hypothetical losses of value added.*

As before, the table contains the absolute LiVA, the original value-added and the relative losses aggregated for each country. In this case, all the most affected sectors belong to the Croatian economy. In particularly, the results show a somewhat similar situation to the one before, since the Croatian sectors that show

the biggest relative losses are C_28, machinery and equipment; C_27, electrical equipment, C_31-32, furniture and other manufacturing products. The presence of C_16, wood and cork, is interesting and it could relate to the fact that sawn wood is the biggest Croatian exported product in China, as it was shown in the previous sections.

Since all the country-sectors in the previous table were Croatian, it can be interesting to show the chart of the country sectors most affected by a trade disruption between China and Croatia removing all the Croatian sectors from the list. In the following table, also the ranking of the original chart will be maintained.

| ORIGINAL RANKING | SECTOR ID | A_LiVA_CHN | R_LiVA_CHN |
|---|---|---|---|
| 39 | SVN_C19 | -0,001028308 | -0,000967542 |
| 55 | CHN_C31_C32 | -24,27495895 | -0,000343356 |
| 56 | SVN_C16 | -0,093727072 | -0,000285862 |
| 58 | SVN_B | -0,042119114 | -0,000246342 |
| 59 | CHN_C26 | -43,76693186 | -0,000167155 |
| 60 | SVN_C22 | -0,110074651 | -0,000161418 |
| 61 | CYP_C19 | -9,72125E-05 | -0,000150369 |
| 62 | SVN_C20 | -0,079325695 | -0,000147397 |
| 63 | SVN_M74_M75 | -0,073676379 | -0,000144498 |

*Fig. III.8 – World economy sectors and their absolute and relative hypothetical losses of value added, without Croatian sectors.*

Interestingly, the first non-Croatian most affected country-sector in the hypothetical extraction is not Chinese, but Slovenian. SVN_C19, Slovenian petroleum products, ranked 39$^{th}$; and SVN_B, Slovenian mining and quarrying, ranked 58$^{th}$, show that the country could, although mildly, suffer some value-added

losses in the case of a trade disruption between Croatia and China. As far as China is concerned, the most affected sector appears to be CHN_C31-32, Chinese furniture and other manufacturing products.

Looking at the country aggregations, the results shown differences and similarities compared with the situation from before:

| COUNTRY | A_LiVA | VA_0 | AG_R_LiVA |
|---|---|---|---|
| HRV | -89,67654333 | 48159,98823 | -0,00186205492637 |
| CHN | -586,8361942 | 10283983,05 | -0,00005706312345 |
| SVN | -1,738684287 | 42819,11383 | -0,00004060533092 |
| TWN | -6,907200246 | 510922,9452 | -0,00001351906449 |
| AUT | -3,350102803 | 389663,9292 | -0,00000859741575 |
| HUN | -0,895308193 | 116649,4296 | -0,00000767520420 |
| KOR | -9,160021044 | 1287093,385 | -0,00000711682707 |
| ROW | -55,0786746 | 10688523,59 | -0,00000515306666 |
| AUS | -5,591167527 | 1357150,479 | -0,00000411978451 |

*Fig. III.9 – World countries with their absolute and aggregate relative hypothetical losses of value added.*

Although some Slovenian sectors were more affected than Chinese ones, according to aggregate relative hypothetical loss of value added, China is still ranked 2nd right after Croatia, whereas Slovenia comes third. The rest of the chart displays the presence of Asian countries such as Taiwan and South Korea, and the presence in 9th position of the Rest of the World. As thoroughly explained in the previous chapter, WIOD as of today doesn't include the western Balkan countries of Serbia, Bosnia and Hercegovina, Montenegro, Albania and Kosovo, which are therefore included in the Rest of the World. These countries have relevant trade

relations with Croatia, and it can be hypothesized that their losses in a trade disruption between Croatia and China brought the Rest of the World in this high position in the chart.

III.4.3 – Hypothetical extraction of trade between Croatia and Russia and between Croatia and China at the same time

Lastly, the results for a contemporary extraction of trade between Croatia and

| COUNTRY/SECTOR | A_LiVA_CR | R_LiVA_CR | COUNTRY/SECTOR | A_LiVA_CR | R_LiVA_CR |
|---|---|---|---|---|---|
| **HRV_C20** | -14,28876 | -0,05936 | **HRV_G46** | -27,5477 | -0,01016 |
| **HRV_C28** | -16,79009 | -0,05196 | **HRV_A02** | -2,0815 | -0,00742 |
| **HRV_C29** | -1,38437 | -0,02882 | **HRV_H51** | -0,37717 | -0,00736 |
| **HRV_C27** | -7,13103 | -0,02595 | **HRV_R_S** | -10,5841 | -0,0073 |
| **HRV_C31_C32** | -4,68691 | -0,01848 | **HRV_M74_M75** | -0,98427 | -0,00657 |
| **HRV_C25** | -12,14569 | -0,01589 | **HRV_M72** | -1,60928 | -0,00653 |
| **HRV_C26** | -3,61280 | -0,01567 | **HRV_C21** | -3,01285 | -0,00627 |
| **HRV_C16** | -3,56163 | -0,01468 | **HRV_C23** | -2,54462 | -0,00596 |
| **HRV_C13-C15** | -5,10507 | -0,01113 | **HRV_T** | -0,30085 | -0,00546 |

Russia and Croatia and China will be presented. As of today, this could be the

*Fig. III.10 – World economy sectors and their absolute and relative hypothetical losses of value added.*

most probable scenario among all three presented, since the very last geo-political events seem to have made China and Russia closer than ever before, and if the situation in Ukraine will get to a level of tension in which Russia falls apart completely with the West, it is fair to hypothesize that China would be going to side with it.

Let's now get a closer look to the results of the extraction in the same fashion of before. As it is shown in the previous table, the results call for a situation which is like the first case presented in terms of the sectors which appear, but similar to the second case presented in terms of the fact that only Croatian sectors appear in the first position of the list of the country-sectors ranked accordingly to their biggest relative loss of value-added. In the top ten of most affected sectors chart, the Croatian sectors C29, C28, C26, C25, and C31-32 appear. The biggest loss is faced by HRV_C20, chemicals, which wasn't in the most affected sectors in the hypothetical extraction with China and was facing smaller losses in the hypothetical extraction with Russia. As it was done in the previous case, to show more variety of countries affected by the hypothetical trade disruption, Croatian sectors were removed by list, and more sectors are shown with a specification of their original ranking.

| ORIGINAL RANKING | COUNTRY/SECTOR | A_LiVA_CR | R_LiVA_CR |
|---|---|---|---|
| **26** | SVN_C19 | -0,003942476 | -0,003709503 |
| **45** | RUS_B | -319,1811655 | -0,001870908 |
| **53** | SVN_C20 | -0,625062104 | -0,001161443 |
| **54** | RUS_H49 | -77,17555812 | -0,001095869 |
| **55** | CYP_C19 | -0,000703286 | -0,001087849 |
| **58** | RUS_C19 | -39,0830596 | -0,000680738 |
| **59** | SVN_B | -0,108235357 | -0,000633036 |
| **60** | RUS_G46 | -113,9290092 | -0,000603791 |
| **62** | RUS_C20 | -9,585068161 | -0,000509394 |
| **63** | RUS_D35 | -20,26513391 | -0,000472045 |
| **64** | SVN_C22 | -0,305215905 | -0,000447582 |

| | | | |
|---|---|---|---|
| **65** | SVN_C16 | -0,140816984 | -0,000429484 |
| **67** | SVN_C25 | -0,532053778 | -0,000390532 |
| **68** | CHN_C31_C32 | -24,36150969 | -0,00034458 |

*Fig. III.11 – World economy sectors and their absolute and relative hypothetical losses of value added, without Croatian sectors.*

Again, and even more interestingly, is Slovenian (and not Russian, or Chinese) the most affected country-sector in the contemporary hypothetical extractions of trade between Russia and Croatia and between China and Croatia, and it's the same sector which also appeared first for relative losses in the exercise with China, SVN_C19, Slovenian petroleum products, which ranks 26$^{th}$ in this case (in the previous case, it ranked 39$^{th}$).

The first Russian sector which appears ranks 45$^{th}$ overall, and it is RUS_B, Russian mining and quarrying, followed shortly by other Russian sectors as H49, land and pipeline transport; and C19, petroleum products. It is also possible to notice that China shows up low in this chart, at position 68$^{th}$, and it's CHN_C31-32, furniture and other manufacturing products. This country-sector faced the same loss in the hypothetical extraction of trade between Croatia and China, and this underlines the complete absence of relations between this Chinese sector and the whole Russian economy.

As before, now results from country aggregations will be shown.

| COUNTRY ID | A_LiVA | AG_R_LiVA | VA_0 |
|---|---|---|---|
| **HRV** | -202,5439703 | -0,0042056483 | 48159,98823 |
| **RUS** | -727,7093375 | -0,0004481255 | 1623896,157 |

| | | | |
|---|---|---|---|
| **SVN** | -4,960865556 | -0,0001158563 | 42819,11383 |
| **CHN** | -594,0230821 | -0,0000577620 | 10283983,05 |
| **HUN** | -2,726683333 | -0,0000233750 | 116649,4296 |
| **AUT** | -8,309673203 | -0,0000213252 | 389663,9292 |
| **TWN** | -7,388966362 | -0,0000144620 | 510922,9452 |
| **CZE** | -2,470977796 | -0,0000132796 | 186073,3604 |
| **SVK** | -1,182391944 | -0,0000129783 | 91105,6073 |

*Fig. III.12 – World countries with their absolute and aggregate relative hypothetical losses of value added.*

It is immediately noticeable how, in the case in which Croatia simultaneously stopped trading with China and Russia, Slovenia would relatively fare worse than China itself. In fact, Slovenia's aggregate relative hypothetical loss of value added in this case seems to be two times bigger than China's one. The rest of the most affected countries, as it is shown in the previous table, belongs to central and eastern Europe, with the exclusion of Taiwan.

Lastly, it can be also interesting, in this case, to show a different aspect of the situation aggregating the losses by World sectors and not by countries. The results are shown in the following table.

| SECTOR ID | A_LiVA | AG_R_LiVA | VA_0 |
|---|---|---|---|
| **B** | -409,7235634 | -0,0001225 | 3343567,514 |
| **C19** | -50,0975008 | -0,0000909 | 551399,0549 |
| **C20** | -69,6015451 | -0,0000717 | 970527,9173 |
| **C31_C32** | -32,0595727 | -0,0000710 | 451851,752 |
| **C13-C15** | -42,6853791 | -0,0000641 | 665828,861 |
| **C28** | -65,8432338 | -0,0000637 | 1033977,119 |
| **C26** | -67,4860148 | -0,0000605 | 1116178,227 |
| **C16** | -15,7248640 | -0,0000598 | 263068,0531 |
| **C27** | -30,6376118 | -0,0000580 | 527899,1426 |

| | | | |
|---|---|---|---|
| **C24** | -43,3555294 | -0,0000553 | 783953,7929 |
| **H49** | -105,9482149 | -0,0000530 | 1998603,613 |
| **C22** | -21,6428773 | -0,0000478 | 452931,2125 |
| **C25** | -33,5622093 | -0,0000447 | 750391,2256 |
| **C17** | -11,3797428 | -0,0000436 | 261273,4056 |
| **G46** | -200,4505410 | -0,0000420 | 4770060,954 |
| **A02** | -8,1832946 | -0,0000395 | 207188,6503 |

*Fig. III.12 – World economy sectors with their absolute and aggregate relative hypothetical losses of value added.*

From this chart, it appears obvious that the trade relations between Croatia and Russia and Croatia and China mainly concern the petroleum and energy sector. Although the relative losses do not seem to be relevant, the most affected World sectors appear to be B, mining and quarrying; C19, petroleum products; and C20, chemicals.

## III.5 – Conclusions, observations, and future developments: perspectives on the economic implications of a bigger, westerner Europe.

None of the losses shown by these results, in the whole section, appear to be particularly devastating or disruptive for the other countries. This is not a surprise considering the small dimensions of Croatia and of its economy, which before of the crisis was still affected by the devastation of the Yugoslavian wars. As for Croatia, it must be underlined that its economic and political relationship turned westwards since the 90's and especially after the country's accession to the European Union. As aforementioned, the analysis results in general to have

unveiled how the hypothetical extraction between, Croatia and Russia, between Croatia and China, and between Croatia and both countries at the same time would have negative, but not disruptive effects on Croatian economy itself and not relevant effects on the World economy.

Still, the effects would be not generally felt by the Croatian and World economy but would hit specific sectors mainly relating energy like mining, pipeline energy, petroleum and chemicals.

An interesting aspect appears to be the presence of Slovenian sectors among the most hit, sometimes even more than the concerned countries, although always at low quantities of lost value-added. It must be said that, just like its neighbor Croatia, Slovenia seems worried about harsh and prolonged trade disruptions with Russia especially when it comes to the energy sectors. As ANSA (2022) reports, in July 2022 Slovenia ratified, on the note of the EU 2017 Regulation on gas supplying security measures, an agreement on solidarity measures to stabilize the supply of gas to Slovenia. Ljubljana hopes to reach a similar agreement with Zagreb, securing gas supplies to protected clients also from Croatia in case of interruptions.

This can be regarded of an example of the interesting dynamic by which Russian attacks on Ukraine seem to have strengthened political and economic cooperation among the European countries, making Europe possibly bigger and more West-oriented and NATO-oriented than ever.

In the last few weeks, in fact, many were the countries that forwarded applications to join NATO and EU. Baccini (2022) reports that in May 2022, after respectively getting their national Parliaments' approval, current Swedish and Finnish ambassadors Axel Wernhoff and Klaus Korhonen presented official requests to join the alliance to current General Secretariat of NATO Jens Stoltenberg, and many more other countries, like Switzerland and Andorra, broke their ancient tradition of neutrality and to side with the West in condemning Russian attacks on Ukraine. Stoltenberg declared how important is to maintain peace and security in the Baltic region, after the behavior of Russia concerned even these two traditionally non-aligned countries to the point of deciding to join NATO in order to preserve their national security. Croatia was the last country to join EU, but it is important to remember that many countries until now have presented the application, and it can be hypothesized that the current geo-political situation in Europe could significantly speed up their journey into the Union. As of today, the European Commission[17] reports that Albania, North Macedonia, Montenegro, Serbia, Turkey and Ukraine are granted the status of candidate country, and they are undertaking the verification of their ability to apply European law. Unlike most of these countries, which started their application processes many years ago, Ukraine submitted its application for EU membership on the 28th of February 2022,

[17] https://ec.europa.eu/environment/enlarg/candidates.htm

and was granted the candidate status after an extremely short period of time, precisely on the 23rd of June 2022, by the unanimous agreement between all the 27 current European Member States. The quick decision Ukraine's application was made on the understanding that the European Commission will watch over Ukraine fulfilling some key steps as part of its journey. The European Union accepted and welcomed Ukraine's application for membership as part of the effort it is doing to help and support Ukraine's battle for its democracy and national sovereignty, European Commission[18] reports.

In a highly globalized World, in which government are presented with unprecedented challenges, the belonging in an important governmental organization like EU or NATO is vital for the welfare and the security of small economies, such as Croatia. This research presented Croatia's losses in the case of a trade disruption with Russia and China, but it is absolutely reasonable to hypothesize that Croatia's losses in the case of a trade disruption with EU or western countries in general would be far higher. As aforementioned in this chapter, not only we are facing a violent war over Ukrainian borders between Russia, but also a battle for soft power between the West (EU and NATO countries) and the East (Russia and China) in many regions of the World, such as the western Balkans.

[18]https://neighbourhood-enlargement.ec.europa.eu/european-neighbourhood-policy/countries-region/ukraine_en

Putin's regime has even been observed try to supersede EU's power and influence in many European Countries, especially taking advantage of the social disorder and unrest related to the rise of populist political movements. Lo (2022) underlined that Putin would rather have "a global disorder where Russia is central, rather than an order where Russia is peripheral" – this author states that Russia's attacks on Ukraine fulfill the objective of restoring Russia's influence after the Soviet Union's collapse, which opened the way to a new international order based on western liberalism which had Russia marginalized. In a world in which China's power, despite the last events, is constantly rising, the West needs to show unity and determination to stop Putin's strategic aggressions and his mission of regaining a Cold War-like influence sphere (Lo, 2022).

# CONCLUSIONS

> "When, if not now, will we create a sovereign Europe which is able to face conflicts in this multipolar World? When, if not now, will we put the differences that have been paralyzing us and dividing us for years aside? Who, if not us, will be able to defend European values both internally and externally? Europe is our future, and this future is in our hands".

This is a part of the speech held by current German Chancellor Scholtz on the 31st of August 2022, in Prague, in which he reflected on the strategic choice that Europe may make upon the eventual arrival of countries like Ukraine, Georgia, Moldova, and the western Balkans. Many countries are moving towards Europe as the situation in Ukraine doesn't seem to be close to a resolution and the center of Europe is moving eastwards (Liboeiro, 2022).

The results of this thesis seem to confirm that as much as Croatia could be hurt by a trade disruption with the East, the losses wouldn't be too dramatic, and it's reasonable to hypothesize that a trade disruption with the West would be far more devastating for Croatian economy. That being told, the results also showed that joining Europe didn't enhance the global connections of Croatian industries at a significative level.

As this research approaches to its end, though times seem to be ahead of Croatia and the whole European Union. It can be said that more can be done by the Union

to help Croatia to catch up with the most developed countries in Europe. Especially, as the last political events unveiled this aspect, on the energy sector. The results of the input-output analysis showed that the energy sector is the one in which Croatia could suffer the most, because it's still linked with Russia more than it's linked with Europe. The general picture shows that Europe must work on the energy sector in general, as winter is approaching and the situation in Ukraine is aggravating. Current German Chancellor Scholz went on in his speech:

> "In the energy industry, we are thinking to create a network and storage for an actual European internal market of energy that can supply European hydroelectric energy from the North, eolian energy from the coastal regions in the West and solar energy from the South, in a consistent, reliable way, both during the winter and the summer […] I'm thinking of an European network for hydrogen that can link producers and consumers triggering an European boom of electrolysis. That's because only through hydrogen Europe can become zero impact."

It is desirable that this vision can become reality, and not even in the long run. It is important for Europe to unite and face this global crisis, letting Russia and China understand that there are facing a unite and bound-together group of countries which is determined in finding innovative solutions to problems and in not backing up from their choice to support Ukrainian citizens in defending their country, democracy, unity, and freedom at all costs.

The biggest limits of this research are essentially two. Firstly, as it was already underlined in the previous chapters and in previous studies performed by other researchers on this subject (*cfr* Vidakovic Perusko et al., 2018) it is not easy to assess the position of Croatia in GVCs using data from the WIOD tables since this database does not include Serbia, Bosnia and Hercegovina, Montenegro, Albania, and North Macedonia (which are included in the ROW block) and therefore many links coming in and out of Croatia from and towards these countries are lost and cannot be considered, devaluating in some way the relevance of Croatian nodes in the network.

Secondly, it must be remarked that dealing with an ongoing situation like it has been done in this research with war in Ukraine frequently bear risks of misunderstanding events and processes which will appear clearer over time with perspective. Nevertheless, it is extremely interesting to face hot topics with results that could be inspirational for public officials in taking decisions: in this case, Croatian authorities (although they are not anymore totally sovereign anymore since they have joined the European Union and shared its destiny) would know the national and global consequences of choosing to stop trading completely with Russia, China or both; and, most importantly, they could get awareness of the internationally strong or weak industries of their economic system. Focusing on this topic, some humble and careful suggestions can be offered to Croatian authorities in terms of legislation and reformation,

stemming from the results of this thesis. As aforementioned in Chapter II, the most relevant Croatian country-sector in the global input-output network in 2014 appeared to be G46, wholesale trade, that ranked 1237$^{th}$ over the 2254 country-sectors composing the global input-output network, after a ten-year growth since 2004 in terms of global connections. This is not even an extremely disappointing performance for such a small-sized, underdeveloped economy in the Balkans that came out of war just ten years ago. Yet, the potential is high, and many things can be done on the public officials' side: as aforementioned in Chapter II, perhaps an investment in sectors like IT, or high technology in general could attract more firms into the country, creating more job prosperity and economic growth. This would be an extremely desirable condition for a country with an already small population (just over 4,07 million people in 2019) which is also suffering an extensive emigration of high-talented, highly educated youth towards Germany, Ireland and other parts of Europe and the World, in search of better jobs and higher salaries than the ones that they can find in their homeland. As far as the hypothetical extraction goes, it is desirable for Croatia (and for the European Union in helping succeed) to undertake the difficult task to cutting of the eastern countries from its GVCs, especially in the energy sectors. Croatia's Adriatic coast is often windswept by famous Bura, a strong wind coming from the North, which intuitively calls for exploring the possibility of creating and storing eolian energy, which would

serve at the same time European energetic independence and sustainability. As Rossi (2010) reported, the first wind farm was opened in Croatia in 2004, and since then, many other opened for a total of 1,94 GWh of wind power created in 2021 (Ivankovic, 2022). Ivankovic (2020) also reports that now Croatia generates 28.3% of its total consumptions of energy in renewable sources (with wind farms and solar farms) and this capacity is expected to double in the next years. The author hypothesizes that, at this rate, Croatia could meet 2050 EU's renewable energy targets no later than in 2035. But can Croatia improve this capacity to the point of supplying energy to the rest of the Union and other countries, like its Balkan neighbors? And can this process enhance its global connections and increasing its relevance in GVCs? These questions leave space open for further studies and research. As for now, there is a lot to do for Croatian and European public official to make Croatia the great small open economy that this country has the chances to be.

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## APPENDIX

| Goods | | Services | |
|---|---|---|---|
| ISIC Rev. 4 Code | Sector Legend | ISIC Rev. 4 Code | Sector Legend |
| A01 | Live Animals | D35 | Electricity & Gas |
| A02 | Forestry | E36 | Water Collection Activities |
| A03 | Fishing | E37-39 | Waste Collection Activities |
| B | Mining and quarrying | F | Construction |
| C10-12 | Food Product | G45 | Wholesale and retail trade |
| C13-15 | Textiles | G46 | Wholesale trade |
| C16 | Wood and Cork | G47 | Retail trade |
| C17 | Paper Products | H49 | Land & Pipeline transport |
| C18 | Printing and Media | H50 | Water transport |
| C19 | Petroleum Products | H51 | Air transport |
| C20 | Chemicals | H52 | Warehousing |
| C21 | Pharmaceutical | H53 | Postal |
| C22 | Rubber and Plastic | I | Accommodation & Food serv. |
| C23 | Other Non-metallic mineral | J58 | Publishing Act. |
| C24 | Basic Metals | J59-60 | Media Production |
| C25 | Metal products | J61 | Telecom |
| C26 | Electronics and Computers | J62-63 | Computer Programming |
| C27 | Electrical Equipment | K64 | Financial Services |
| C28 | Machinery & Equipment | K65 | Insurance |
| C29 | Motor vehicles | K66 | Auxiliary Financial Serv. |
| C30 | Transport equipment | L68 | Real Estate |
| C31-32 | Furniture & other manufac. | M69-70 | Legal and Accounting |
| C33 | Installation of machinery | M71 | Architectural and engineering act. |
| | | M72 | Scientific Research |
| | | M73 | Advertising and market research |
| | | M74-75 | Other professional activities |
| | | N | Administrative and support act. |
| | | O84 | Public admin and defence |
| | | P85 | Education |
| | | Q | Health |
| | | R-S | Other services |
| | | T | Activities of Households as Employers |
| | | U | Activities of Extraterritorial Org. |

**Table 1 – SECTORS IN WIOD**

| Country Name | ISO Code | Country Name | ISO Code |
|---|---|---|---|
| AUSTRALIA | AUS | IRELAND | IRL |
| AUSTRIA | AUT | ITALY | ITA |
| BELGIUM | BEL | JAPAN | JPN |
| BULGARIA | BGR | SOUTH KOREA | KOR |
| BRASIL | BRA | LITHUANIA | LTU |
| CANADA | CAN | LUXEMBOURG | LUX |
| SWITZERLAND | CHE | LATVIA | LVA |
| CHINA | CHN | MEXICO | MEX |
| CYPRUS | CYP | MALTA | MLT |
| CZECH REPUBLIC | CZE | NETHERLANDS | NLD |
| GERMANY | DEU | NORWAY | NOR |
| DENMARK | DNK | POLAND | POL |
| SPAIN | ESP | PORTUGAL | PRT |
| ESTONIA | EST | ROMANIA | ROU |
| FINLAND | FIN | RUSSIA | RUS |
| FRANCE | FRA | SLOVAKIA | SVK |
| UNITED KINGDOM | GBR | SLOVENIA | SVN |
| GREECE | GRC | SWEDEN | SWE |
| CROATIA | HRV | TURKEY | TUR |
| HUNGARY | HUN | TAIWAN | TWN |
| INDIA | IDN | UNITED STATES | USA |
| INDONESIA | IND | REST OF THE WORLD | ROW |

**TABLE 2 – COUNTRIES IN WIOD**

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