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Cold Retrospectives about the Impact of the COVID-19 Pandemic on International Trade in Europe

Abstract. *This paper presents a retrospective analysis of the impact of the COVID-19 pandemic on international trade dynamics across three European countries with different levels of restrictions: Italy, Hungary, and Finland. The study examines the effects of COVID-19-related factors (cases, deaths, and containment measures) alongside key economic indicators (GDP, unemployment, and inflation) on exports and imports during the pandemic period (2020–2021). Initially, regression models were employed to identify the primary determinants of trade fluctuations at the country level. To further enhance the analysis, a Time-Varying Parameter Vector Autoregressive (TVP-VAR) model was introduced, allowing for a dynamic assessment of the evolving relationships between trade flows and the influencing factors over time. The TVP-VAR results reveal shifting parameter estimates, highlighting the changing roles of COVID-19 cases, deaths, and policy stringency in trade dynamics. Findings indicate that imports were more sensitive than exports to pandemic-related disruptions, while GDP remained the most influential economic determinant. These insights contribute to the understanding of how international trade adapted during the health crisis, providing implications for future economic resilience in the face of global disruptions.*

Keywords: *international trade, COVID-19, economic interdependencies, TVP-VAR model, dynamic analysis, European economies, Italy, Hungary, Finland.*

JEL Classification: F10, F18, F40.

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1. Introduction

The COVID-19 virus outbreak and the associated health crisis highly disturbed economic activities at global level with various disruptions in economies and societies. The COVID-19 health crisis's effects were unforeseen and unequalled and manifested at different levels: world, country, industry, organisational and individual levels (Tudorache & Nicolescu, 2023; Tudorache, 2024a). The consequences were related to the launch of a global economic crisis that included numerous industries and economic activities. One of the affected domains was international trade impacted at global, country and company level, as global supply chains were disrupted during the COVID-19 health crisis (Lebastard et al., 2023a). Therefore, the study of the impact of COVID-19 health crisis on international trade activities became of interest for academia, for practitioners and for policy makers. Even from the beginning of the health crisis, researchers tried to analyse and forecast the influence of the COVID-19 on international trade flows using simulations (Baldwin & Tomiura, 2020) with only a few studies using real data (Hayakawa & Mukunoki, 2020; Bas et al., 2022). In this context, calls for conducting more researches based on real data appeared (Espitia et al., 2021) and for investigating the effects of COVID-19 health crisis in diverse aspects of the economies and societies (Lucio et al., 2022) and at different levels (Zahra, 2021).

While prior studies have primarily relied solely on regression models to examine the effects of COVID-19-related factors on trade, such approaches assume fixed relationships between variables over time. However, the unprecedented nature of the pandemic suggests that these relationships were likely time-dependent, evolving alongside changing health and economic conditions, policy responses, and global supply chain disruptions. Also, a more flexible and dynamic econometric approach is necessary to capture how the impact of COVID-19 on trade evolved throughout the crisis. To address this, the present study after conducting regression analyses, also introduces a Time-Varying Parameter Vector Autoregressive (TVP-VAR) model, a model that allows parameter estimates to change over time. This methodological enhancement provides a more nuanced understanding of the shifting influence of COVID-19 cases, deaths, and government-imposed restrictions on exports and imports.

The present paper includes a study that on the one hand, tries to answer to the above demands and on the other hand, represents a research that allows for cold retrospectives on the influence of the COVID-19 health crisis. The focus of the paper is on the impact of the COVID-19 health crisis on the international trade. The research questions that the present study tries to answer are: *RQ1: What was the impact of the COVID-19 health crisis on international trade at country level?* and *RQ2: Are there any differences in the way in which international trade was influenced by the COVID-19 conditions in countries with different intensities of the containment measures?*

In order to answer the research questions, the present research investigated the effect of health-related factors (COVID-19 cases and deaths and the governmental

restrictions) and economic factors (GDP, unemployment and inflation) on exports and imports at country level.

The paper is organised as follows: the literature review looks at studies that specifically analysed the influence of the COVID-19 health crisis on international trade. The Methodology presents details on country selection, data collection and the analysis methods used. The Results and discussions detail the country level results for all countries and makes a comparative analysis between countries. The paper ends with the Conclusion that includes the main findings of the present research, the contributions of the study, its limitations and suggestions for future research.

2. Literature review

At a general level, the literature agrees that health crises have negative effects on the economy, due to diminishing aggregate demand that occurs because lower spendings of companies and individuals in conditions of decreasing incomes and a higher perceived economic uncertainty (Correia et al., 2022). In the specific case of the COVID-19 health crisis, among others, global economic relations and flows have been affected by the COVID-19 outbreak (Lebastard et al., 2023b). Global value chains as part of the global supply have been disrupted by the COVID-19 health crisis and international trade as part of global supply chains has been affected (Zahra, 2021), becoming a topic of interest for researchers. At the onset of the COVID-19 crisis restrictive measures taken by authorities (lockdowns, border closures) had a negative impact on international trade and researchers tried to forecast the evolution of international trade in the COVID-19 situation mainly based on simulations with assumed conditions (Baldwin & Tomiura, 2020). Hayakawa and Mukunoki (2020, 2021) used real data and investigated the impact of COVID-19 health crisis on foreign trade of countries considering the COVID-19 burden (number of cases and deaths) and discovered negative influences of the COVID-19 burden on exports and imports of developing countries, whose exports were strongly disturbed by the COVID-19 health crisis.

Other studies about the influences of COVID-19 on international trade were conducted in different countries and at different levels. For instance, Megits et al. (2020) found that trade exchanges between Central and Eastern Europe and China were unfavourable influenced by the evolution of the Coronavirus. Espitia et al. (2021) discovered that specific features at economic sector level (the possibility to work remote, the type of goods: durable or not, the degree of integration of the sector in the global value chains) were responsible for either escalating or diminishing the negative impact of the COVID-19 on international trade. In an investigation of the countries from Commonwealth, Khorana et al. (2021) analysed the relationships between bilateral trade flows and COVID-19 incidence, based on a gravity model. They found that for more developed countries, the number of COVID-19 cases in both the importing and in the exporting country had negative impacts on imports, but positive impacts on exports. Also looking at the bilateral foreign trade of Romania for 2020, Tudorache and Nicolescu (2022) identified negative effects of

the COVID-19 burden on the country's main trade relationships. Some studies found that containment measures taken during the COVID-19 pandemic with the purpose to decrease its effects, negatively impacted the evolution of international trade in different countries: Greece and Italy (Tudorache, 2024b) or Spain (Lucio et al., 2022).

Research gaps

Generally speaking, the literature recognises that the economic impact of health crises is not studied enough (Baldwin & Tomiura, 2020). From the beginning of the COVID-19 health crisis there were demands for research to be done at various levels (Zahra, 2021). Similarly, there were calls to analyse the influence of the COVID-19 health crisis in different domains of activities and different sectors, assuming differences that may be encountered between sectors (Lucio et al., 2022).

The present study wishes to respond to these calls and therefore, investigates and provides evidence about the impact of the COVID-19 health crisis on the foreign trade of countries, by: a) completing the literature about the economic effects of health crises, in general and about the effects of COVID-19 health crisis in particular and b) providing extra documentation and knowledge about the impact of the COVID-19 health crisis on the exports and imports of selected countries.

3. Model specification

This paper envisages to address the above mentioned research gaps, by investigating the influence of the COVID-19 health crisis on foreign trade. Given the research questions, this study looks at how health conditions and economic conditions during the two main years of the COVID-19 health crisis (2020-2021) (Tudorache, 2024a) influenced the international trade activities (exports and imports) in three European countries that employed different levels of restrictions.

3.1 Countries' selection

The containment measures imposed by governments to contain the spread of the COVID-19 virus (measured through the Stringency Index - SI) were used to identify in Europe which was the country with the strongest restrictions during the COVID-19 health crisis, which was the country with the most relaxed restrictions during the COVID-19 health crisis and also to identify one country with medium intensity of the restrictions. The SI represents a compounded measure that was developed and computed by Oxford Coronavirus Government Response Tracker (Hale et al., 2021), that is formed of nine indicators that characterised the authorities' responses to COVID-19. The SI was computed as a daily index, and took values from 0 to 100, where 100 corresponded to the strictest restrictions taken in a particular day. European countries were analysed looking at the strength of the restrictions taken by authorities during the COVID-19 health crisis and were grouped in three groups: high containment measures countries (H), medium containment measures countries (M) and low containment measures countries (L). Figure 1 presents the ranking of the European countries with the highest and the lowest

containment measures and Table 1 presents the countries that fit into the three groups (H, M, L). The three European countries selected for the analysis were Italy as the highest containment measures country, Hungary as a medium containment measures country and Finland as the lowest containment measures country.

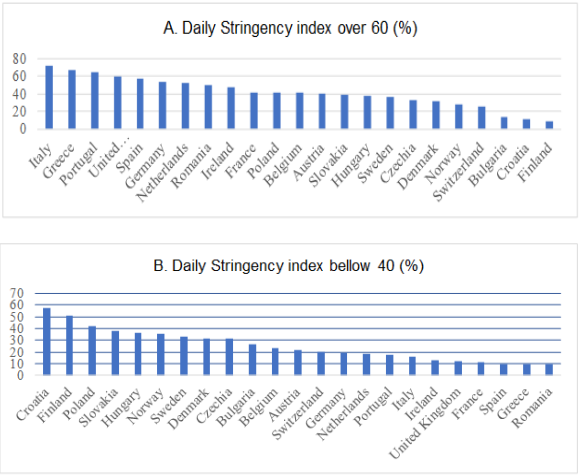

Figure 1. Percentages of daily Stringency Indexes with values over 60 (A) and with values below 40 (B) in European countries

Source: Authors based on data from Oxford Coronavirus Government Response Tracker, https://ourworldindata.org/metrics-explained-covid19-stringency-index.

Table 1. Countries' groups according to the level of stringency (H, M, L) using simultaneously two criteria

Level of stringency	Criterion 1: focus on high stringency		Criterion 2: focus on low stringency	
	Stringency Index with value over 60	Countries	Stringency Index with value bellow 40	Countries
High Stringency (containment measures) (H)	Over 60% of the daily Stringency Indexes	**IT**, UK, PT, GR/EE	Bellow 20% of the daily Stringency Indexes	**IT**, RO, ES, UK, FR, DE, CH, NL, GR/EE, IE
Medium Stringency (containment measures) (M)	Between 30-60% of the daily Stringency Indexes	RO, SE, ES, FR, DE, NL, BE, AT, DK, IE, PL, **HU**, CZ, SK	Between 20-40% of the daily Stringency Indexes	SE, BE, AT, NO, PT, DK, **HU**, CZ, BG, SK
Low Stringency (containment measures) (L)	Bellow 30% of the daily Stringency Indexes	CH, NO, **FI**, BG, HR	Over 40% of the daily Stringency Indexes	**FI**, PL, HR

Note: A country in order to be included in certain group, needed to fit at the same time, in the same category (H, M, L) based on both criteria considered. The bolded countries have been selected for analysis.

Source: Authors adapted from Tudorache (2024a).

3.2 Research methods and data collection

Two types of researches were conducted: regression analysis and dynamic analysis with TVP-VAR.

Regression analysis had the purpose to investigate the relations between total exports and total imports of a country as dependent variables and two categories of influencing factors as independent variables, as seen suitable in the literature: a) the health related factors and b) the economic factors.

The data was collected from international organisation's databases as following: the Eurostat interactive database for GDP, unemployment rate and inflation rate; European Centre for Disease Prevention and Control of EU for number of COVID-19 cases and number of COVID-19 deaths; Our World in Data - Oxford Coronavirus Government Response Tracker for the Stringency Index and the World Trade Organisation interactive data base for total exports and total imports. For all three countries, the data was collected for years 2020-2021, seen as the main years of the COVID-19 pandemic (Nesteruk, 2024; Tudorache & Nicolescu, 2023).

In the present research, four regression models were tested, each of them twice, once for total exports and once for total imports, resulting in eight sub-models included in the investigation. The models had as dependent variables the total exports and the total imports of a country and as independent variables two categories of factors: a) health related factors - the number of COVID-19 cases and the number of COVID-19 deaths (Hayakawa & Mukunoki, 2020, 2021) and the intensity of the restriction measures (Lucio et al., 2022) and b) economic factors: GDP (Karam & Zaki, 2015; Whitten et al., 2020) and unemployment and inflation (Okpe & Ikpesu, 2021; Ahmed & Nasser, 2023).

The regression equations for the four regression models are the following:

Model 1:

$$logExp_{i,t} = \beta_0 + \beta_1 logCovCas_{i,t} + \beta_2 logCovDeaths_{i,t} + \varepsilon_{i,t} \quad (1a)$$

$$logImp_{i,t} = \beta_0 + \beta_1 logCovCas_{i,t} + \beta_2 logCovDeaths_{i,t} + \varepsilon_{i,t} \quad (1b)$$

Model 2:

$$logExp_{i,t} = \beta_0 + \beta_1 logCovCas_{i,t} + \beta_2 logCovDeaths_{i,t} + \beta_3 StrIn_{i,t} + \varepsilon_{i,t} \quad (2a)$$

$$logImp_{i,t} = \beta_0 + \beta_1 logCovCas_{i,t} + \beta_2 logCovDeaths_{i,t} + \beta_3 StrIn_{i,t} + \varepsilon_{i,t} \quad (2b)$$

Model 3:

$$logExp_{i,t} = \beta_0 + \beta_1 logCovCas_{i,t} + \beta_2 logCovDeaths_{i,t} + \beta_3 GDP_{i,t} + \varepsilon_{i,t} \quad (3a)$$

$$logImp_{i,t} = \beta_0 + \beta_1 logCovCas_{i,t} + \beta_2 logCovDeaths_{i,t} + \beta_3 GDP_{i,t} + \varepsilon_{i,t} \quad (3b)$$

Model 4:

$$logExp_{i,t} = \beta_0 + \beta_1 logCovCas_{i,t} + \beta_2 logCovDeaths_{i,t} + \beta_3 StrIn_{i,t} + \beta_4 logGDP_{i,t} + \beta_5 Unem_{i,t} + \beta_6 Infl_{i,t} + \varepsilon_{i,t} \quad (4a)$$

$$logImp_{i,t} = \beta_0 + \beta_1 logCovCas_{i,t} + \beta_2 logCovDeaths_{i,t} + \beta_3 StrIn_{i,t} + \beta_4 logGDP_{i,t} + \beta_5 Unem_{i,t} + \beta_6 Infl_{i,t} + \varepsilon_{i,t} \quad (4b)$$

where, β_0 is the intercept; $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ and β_6 are the regression coefficients for: the number of COVID-19 cases, the number of COVID-19 deaths, the Stringency Index, the GDP, the unemployment and the inflation and i and t subscripts represent the month and the country. ε_{it} is the error term.

Starting from the results of previous studies, the present research assumed a negative influence of COVID-19 burden on international trade components (Megits et al., 2020; Hayakawa & Mukunoki, 2020, 2021; Lebastard et al., 2023a) and also a negative influence of the SI on international trade (Lucio et al., 2022). The GDP was assumed to positively influence international trade (UNCTAD, 2023), as exports and imports are considered to depend on the growth of the GDP (Whitten et al., 2020). Unemployment was assumed to negatively influence international trade, as when there is high unemployment, both the domestic demand and the demand for the imported goods decrease (Ahmed & Nasser, 2023). Inflation is assumed to negatively influence exports, as higher prices in a country make the country's exports more expensive and less competitive in external markets (Okpe & Ikpesu, 2021). Also, inflation is assumed to positively influence imports, as high inflation in a country makes the goods that are imported from other countries to be cheaper than the domestic products (Okpe & Ikpesu, 2021).

The research hypothesised that the number of COVID-19 cases, the number of COVID-19 deaths, the restriction measures and the unemployment had a negative influence on both exports and imports during the COVID-19 period. The assumption was that the GDP positively influenced exports and imports, while inflation had a positive influence on imports and a negative influence on exports.

Dynamic analysis with TVP-VAR

To capture the dynamic effects of COVID-19-related factors on international trade, this study extends the regression framework with a Time-Varying Parameter Vector Autoregressive (TVP-VAR) model. The TVP-VAR model allows for time-dependent coefficients, making it particularly useful for studying structural changes during economic crises.

A standard Vector Autoregressive (VAR) model of order p, for an m-dimensional vector of endogenous variables $\boldsymbol{y_t}$, is given by:

$$y_t = c + \sum_{j=1}^{p} A_j y_{t-j} + u_t, u_t \sim N(0, \Sigma) \quad (5)$$

where:

- y_t is an $m \times 1$ vector of endogenous variables at time t, including Exports, Imports, COVID-19 cases, COVID-19 deaths, the Stringency Index, GDP, unemployment, and inflation.
- c is an $m \times 1$ vector of intercept terms.
- A_j are $m \times m$ coefficient matrices for lag j.

- u_t an $m \times 1$ vector of normally distributed shocks with covariance matrix Σ.

In the Time-Varying Parameter (TVP-VAR) model, the coefficient matrices $\boldsymbol{A_j}$ evolve over time, allowing for changing relationships between variables:

$$y_t = c_t + \sum_{j=1}^{p} A_j(t) y_{t-j} + u_t, u_t \sim N(0, \Sigma) \quad (6)$$

where the coefficients $A_j(t)$ follow a random walk process:

$$A_j(t) = A_j(t-1) + v_t, v_t \sim N(0, Q) \quad (7)$$

where:

- Q is the covariance matrix of the state disturbances.
- v_t represents time-dependent variations in the coefficients.

This structure ensures that economic relationships are allowed to evolve, reflecting shifts in how COVID-19 cases, deaths, and restrictions influenced trade. To estimate the time-varying coefficients, we express the TVP-VAR model in a state-space form. The state vector is defined as:

$$\alpha_t = vec\left(\left[c_t, A_1(t), \ldots, A_p(t)\right]'\right) \quad (8)$$

where α_t contains all the time-varying parameters. The model is then formulated as:
Observation Equation (links observed variables to the state vector)

$$y_t = Z_t \alpha_t + u_t, u_t \sim N(0, \Sigma) \quad (9)$$

where Z_t is a matrix selecting relevant parameters for the observed data.
State Transition Equation (describes how parameters evolve over time)

$$\alpha_t = \alpha_{t-1} + v_t, v_t \sim N(0, Q) \quad (10)$$

This setup is estimated using the Kalman filter, a recursive algorithm that updates state estimates based on new observations. The Kalman filter involves:

1. Prediction step: Forecasting $\boldsymbol{\alpha_t}$ based on past values.
2. Update step: Adjusting the estimate using new data, minimising mean squared error.
3. Smoothing step: Refining the estimates over the entire sample period.

The implementation follows the MLEModel framework from Statsmodels, where the transition matrix is set to an identity matrix (assuming a random walk), and the Kalman filter recursively updates the state estimates.

4. Results and discussions

4.1 Results of the regression analyses

This section presents first the results of the regression investigations on the influencing factors of exports and imports during the COVID-19 pandemic at country level and a comparative inquiry for the three countries analysed.

Regression for Italy

Table 2 introduces the evidence for the regression analysis for Italy, the European country that implemented the strongest containment measures during the COVID-19 pandemic. All four models that were tested were valid for both total exports and total imports of Italy with a 1% statistical significance. The explanatory values of the regression models were moderate to high, revealing that between 44%

to 79% of Italy's international trade variations during the COVID-19 main years were explained by the considered factors. The models with the highest explanatory values were Model 4 (with all considered factors), for both imports (79.1%) and exports (62%).

The measurement of the goodness-of-fit for the four tested models and the associated eight sub-models was done by using the Akaike Information Criterion (AIC), that is a frequently used tool to compare the performance of the regression models, with the minimum value of the AIC among different compared models, indicating the best fitted model (Cavanaugh & Neath, 2019). In case of Italy, Model 4 that included three health influencing factors and three economic factors was the best fitted for both total exports and total impots.

The factors with the strongest influence on Italian exports and imports during the COVID-19 health crisis were the number of COVID-19 deaths (negative), the level of containment measures (negative) and the GDP (positive).

Regression for Hungary

Hungary was the European country chosen to represent the group of countries that imposed medium restrictions during the COVID-19 health crisis. In case of Hungary, also all eight regression sub-models were valid with moderate (42%) to high (67%) explanatory values according to R^2. Model 4 had the highest explanatory value in case of imports (67%) and exports (49.8%), followed closely by Model 2. However, based on the AIC criterion the best fitted model to explain the variations in international trade, was Model 2 for both exports and imports, model that considered solely the health-related influencing factors (number of COVID-19 cases, number of COVID-19 deaths and the restrictions).

The interpretation of the regression coefficients exposes an unexpected positive influence of the number of COVID-19 cases on both exports and imports, and a negative but not statistically significant influence of the number of COVID-19 deaths on international trade. Only the containment measures (negative) and the GDP (positive) had the expected influences on exports and imports in Hungary during 2020-2021. See Table 3 for the results of the regression analysis for Hungary.

Regression for Finland

Finland is the European country that adopted the most relaxed restriction measures during the COVID-19 pandemic. The findings of the regression investigation for Finland are included in Table 4. Also, in case of Finland, all econometric models tested were valid at a strong 1% significance level. All four models had very high explanatory values of over 60% with Model 4 justifying 90% of imports' variations and 78% of exports' variations during 2020-2021. Using AIC criterion, Model 4 is also the best fitted model to explain the evolution of international trade in Finland.

The analysis of the statistical significance, the size and the sign of the regression coefficients showed that: a) the number of COVID-19 cases had an unexpected positive influence on Finnish international trade; b) the number of COVID-19 deaths had a negative influence on both exports and imports; c) the influence of the restrictions was also negative but small for both exports and imports and d) the GDP

had a large and positive impact on international trade and inflation had a positive impact on imports.

Table 2. Regression analysis - Italy

	ITALY							
	Model 1		Model 2		Model 3		Model 4	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
R Squared	0.441740	0.558997	0.497728	0.723228	0.502142	0.653765	0.620219	0.791958
F Statistic *[p-value]*	7.912803 *[0.002940]*	12.67557 *[0.000278]*	6.276026 *[0.003845]*	16.54948 *[0.000016]*	6.387819 *[0.003549]*	11.95866 *[0.000126]*	4.354916 *[0.008573]*	10.15127 *[0.000105]*
Akaike Information Criterion (AIC) for model fit	-0.642964	-0.875926	-0.661690	-1.254826	-0.670517	-1.030904	-0.680367	-1.279413
Regression coefficients								
Covid-19 cases	0.109445***	0.124401***	0.101461***	0.110707***	0.058724	0.060779*	0.066291^{+}	0.076489**
Covid-19 deaths	-0.091717***	-0.09317***	-0.052108	-0.025238	-0.051447	-0.042660	-0.021684	-0.016117
Stringency index	-	-	-0.005488^{+}	-0.009412***	-	-	-0.004898	-0.005632
GDP	-	-	-	-	1.034691^{+}	1.297861**	0.251386	0.074829
Unemployment	-	-	-	-	-	-	0.106417*	0.078552**
Inflation	-	-	-	-	-	-	0.013142	0.045220^{+}

Note: [ ] p-value in parentheses. The minimum value of AIC depicts the most fitted model (Cavanaugh & Neath, 2019).
*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.10; $^{+}$ p-value close, but higher than 0.10
Source: Authors' processing.

Table 3. Regression analysis - Hungary

	HUNGARY							
	Model 1		Model 2		Model 3		Model 4	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
R Squared	0.420955	0.468257	0.495984	0.635286	0.471405	0.625518	0.498052	0.670188
F Statistic *[p-value]*	6.906324 *[0.005569]*	8.365783 *[0.002478]*	5.904392 *[0.005463]*	10.45126 *[0.000330]*	5.350844 *[0.008213]*	10.02213 *[0.000415]*	2.480593 *[0.071906]*	5.080083 *[0.004959]*
Akaike Information Criterion (AIC) for model fit	-0.931019	-1.116298	-0.978883	-1.402436	-0.931267	-1.376005	-0.710266	-1.230300
Regression coefficients								
Covid-19 cases	0.066381***	0.069678***	0.051347**	0.048340**	0.048661*	2.512447*	0.051822*	0.040226*
Covid-19 deaths	-0.026172	-0.031815^{+}	-0.002508	0.001769	-0.016307	0.039918	-0.003200	-0.006366
Stringency index	-	-	-0.003388^{+}	-0.004809***	-	-	-0.003392	-0.001647
GDP	-	-	-	-	0.409633^{+}	0.687935**	-0.081654	0.200935
Unemployment	-	-	-	-	-	-	0.028181	-0.030508
Inflation	-	-	-	-	-	-	0.010189	0.024863

Note: [ ] p-value in parentheses. The minimum value of AIC depicts the most fitted model (Cavanaugh & Neath, 2019).
*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.10; $^{+}$p-value close, but higher than 0.10
Source: Authors' processing.

Table 4 Regression analysis - Finland

	FINLAND							
	Model 1		Model 2		Model 3		Model 4	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
R Squared	0.640055	0.669540	0.714763	0.788716	0.765029	0.769601	0.788892	0.901101
F Statistic *[p-value]*	16.89293 *[0.000061]*	19.24785 *[0.000027]*	15.03511 *[0.000038]*	22.39786 *[0.000003]*	19.53508 *[0.000007]*	20.04183 *[0.000006]*	9.342277 *[0.000230]*	22.77837 *[0.000001]*
Akaike Information Criterion (AIC) for model fit	-1.541549	-1.708942	-1.683270	-2.065317	-1.877130	-1.978707	-1.711494	-2.551693
Regression coefficients								
Covid-19 cases	0.124755***	0.137475***	0.096477***	0.103193***	0.068499**	0.089158***	0.057170*	0.064783***
Covid-19 deaths	-0.052317*	- 0.078997***	-0.020000	-0.039818^{+}	-0.026773	-0.057058**	-0.015739	-0.033089^{+}
Stringency index	-	-	-0.004547**	-0.005512***	-	-	-0.001283	-0.002955^{+}
GDP	-	-	-	-	1.453956***	1.248773**	0.932212^{+}	0.068371
Unemployment	-	-	-	-	-	-	-0.000911	-0.005700
Inflation	-	-	-	-	-	-	0.031439	0.068861***

Note: [ ] p-value in parentheses. The minimum value of AIC depicts the most fitted model (Cavanaugh & Neath, 2019)
*** p-value < 0.01; ** p-value < 0.05; * p-value < 0.10; $^{+}$p-value close, but higher than 0.10
Source: Authors' processing.

Comparative analysis

An interpretation of the results for the regression analyses included in Tables 2, 3 and 4 at country level reveals a number of similarities and differences between countries. In terms of similarities: a) in all three countries, regardless the intensity of the containment measures, imports were more influenced than exports by the considered factors during the COVID-19 health crisis; b) the three most influential factors were the same in all three countries: number of COVID-19 deaths, the intensity of the restrictions and the GDP; c) in all three countries, the hypotheses assuming that health related factors had a higher influence on international trade than economic factors, during the COVID-19 period, were accepted. In terms of differences, the level of influence of the factors considered, differed from one country to another. Finland, as the low containment measures country, illustrates the most relevant results, in terms of explanatory values, number of statistically significant coefficients, size of the regression coefficients and number of hypotheses that were verified.

4.2 Results of the TVP-VAR analysis

TVP VAR analysis for Italy

The Time-Varying Parameter Vector Autoregression (TVP-VAR) model for Italy illustrates how COVID-19 variables influenced trade dynamics in 2020–2021. As seen in the left panel of Figure 2, COVID-19 cases had a stable and positive impact on exports, suggesting the Italian economy adapted to disruptions quickly. COVID-19 deaths had a small but consistently negative impact, while the SI showed a moderate positive effect on exports. This may reflect a shift in production towards essential goods such as medical supplies and digital services during lockdowns.

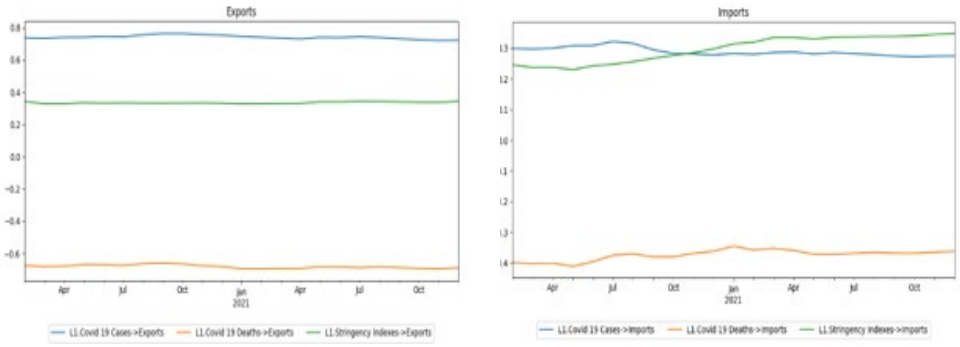

Figure 2. Dynamics of TVP-VAR parameters for Italy
Source: Authors' processing.

In the right panel of Figure 2, imports were also positively influenced by COVID-19 cases, with a slightly increasing trend over time. The impact of deaths remained negative yet minor, whereas the SI had a stronger and rising positive

influence. This indicates that tighter restrictions increased reliance on foreign goods, as domestic supply chains were constrained.

TVP-VAR analysis for Hungary

Figure 3 presents Hungary's TVP-VAR results using impulse response functions. Exports responded modestly positively to COVID-19 cases, suggesting resilience through policy adaptation. COVID-19 deaths had a stronger, consistently positive influence, likely due to increased demand for essential goods or favourable shifts in export structure. However, the SI had a persistent and significant negative impact on exports, indicating that containment policies limited trade capacity more than infections or fatalities.

On the import side, the initial positive response to COVID-19 cases faded over time, while the influence of deaths remained strongly positive. The negative effect of the SI persisted across the horizon but was less severe than for exports, hinting at government efforts to maintain vital supply chains during restrictions.

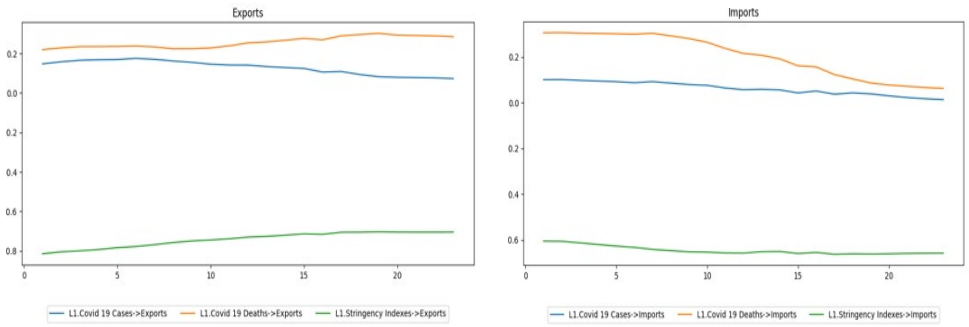

Figure 3. Dynamics of TVP-VAR parameters for Hungary
Source: Authors' processing.

TVP-VAR analysis for Finland

Figure 4 shows Finland's TVP-VAR results, which differ from the other cases. COVID-19 cases had a consistently positive effect on exports, suggesting that Finnish trade was relatively undisturbed by infection rates, possibly due to milder policy measures. The impact of deaths turned increasingly negative toward the end of the period, indicating delayed economic repercussions. The SI had a slight positive trend, though overall influence on exports remained limited.

Imports were initially driven upward by COVID-19 cases, but this effect weakened as domestic supply chains adapted. The impact of deaths grew increasingly negative, while the SI maintained a small and stable negative influence. These patterns highlight Finland's capacity to maintain trade flows despite pandemic-related challenges.

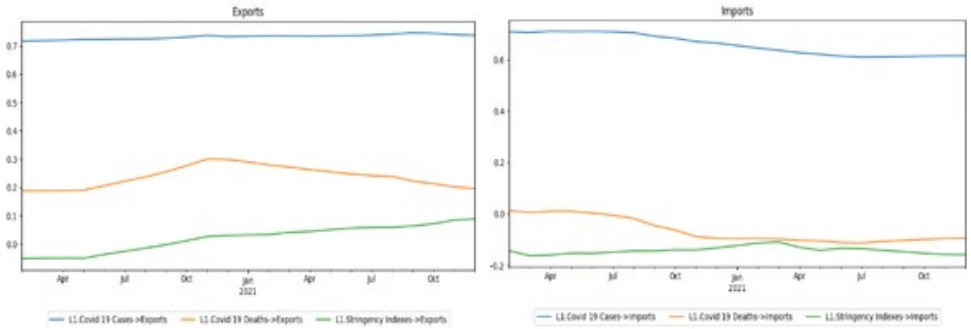

Figure 4. Dynamics of TVP-VAR parameters for Finland
Source: Authors' processing.

To conclude, compared to the regression models, the TVP-VAR results reveal dynamic relationships that were not captured in static analyses. The positive and stable impact of COVID-19 cases on exports and imports suggests an evolving adaptation process, whereas the negative effects of COVID-19 deaths remain rather marginal throughout the period. Moreover, the fact that SI effects changed over time indicates that containment policies had heterogeneous effects on trade, with imports becoming increasingly important as restrictions persisted.

5. Conclusions

The spread of the Coronavirus provoked an extensive health crisis that further triggered an economic crisis at global level that had unparalleled and unforeseen effects for the entire world (Tudorache & Nicolescu, 2023). The manifestation of the health crisis at multiple levels, demanded that research to be conducted in order to identify and characterise how COVID-19 outbreak and expansion impacted the economic life (Lucio et al., 2022). International trade was one activity seen to be highly affected by the COVID-19 crisis (Urgulu & Jindřichovská, 2022) and specialists (Mena et al., 2022) called for searching this impact and to find courses to construct a long term resilience of international trade. The present research envisaged to bring more evidence about the influence of COVID-19 health crisis on economic interdependencies, mainly on foreign trade at country level.

This paper had the purpose to investigate the economic influence of the COVID-19 health crisis on international trade and in order to do this, it looked at how health and economic conditions influenced the total exports and the total imports in Europe. The present research selected three European countries to be analysed: the country with the highest level of restrictions during the COVID-19 crisis, namely Italy, the country with the lowest level of restrictions, namely Finland and a country with a medium level of restrictions, for which Hungary was chosen. A quantitative research was employed using two research methods: the regression analysis and the Time-varying Parameter Vector Autoregression (TVP-VAR). Two categories of influencing factors were considered: health factors (number of COVID-

19 cases, number of COVID-19 deaths and the Stringency Index) and economic factors (GDP, unemployment and inflation).

The summary of the results include:

a. both health related variables and economic related variables impacted the evolution of foreign trade during the main years of the COVID-19 pandemic (2020-2021). The models that included both health-related and economic independent variables had higher explanatory values than the other models, suggesting that health and economic conditions impacted at the same time the countries' international trade during the COVID-19 health crisis.
b. the health conditions during the COVID-19 pandemic (COVID-19 cases, COVID-19 deaths and the strength of the containment measures) impacted foreign trade in all three countries during the two main years of the health crisis, 2020-2021. Among those factors, the Stringency Index negatively influenced total exports and total imports with a rather low quantitative impact. The COVID-19 cases, contrary to the expectations had a rather positive influence on international trade, while the COVID-19 deaths had a negative, but also small quantitative influence on the foreign trade of all three countries.
c. the economic conditions also influenced foreign trade during the COVID-19 pandemic with the GDP having the highest positive influence in all countries and with inflation influencing rather imports than exports in Italy and Finland.
d. in all analysed countries, total imports were more affected than total exports by the considered influencing factors during the COVID-19 health crisis.

The hypotheses related to the negative influence of COVID-19 deaths and of the restrictions and the hypotheses related to the positive influence of GDP on total exports and imports were accepted, while the others were only partially or not at all accepted. Some of the initial assumptions were verified by the research, while other results were unexpected. Possible explanations for the unforeseen results may be the following: a) COVID-19 evolved in waves and the increases and decreases were irregular and had different extents. Further these waves were not automatically and immediately transposed in the evolutions of exports and imports, due to the time lag between orders and the actual shipments of goods (Tudorache, 2024a); b) the restrictive measures adopted to contain the expansion of COVID-19 virus also came in waves, following the COVID-19 waves, but they were very high at the outset of the health crisis (in the first two quarters of 2020) with a trend towards relaxation with the passing of the time (in 2021-2023) with consequent different influences on the international trade from one period of time to another.

The inclusion of the TVP-VAR model provides a more nuanced understanding of the evolving impact of COVID-19 on trade. Unlike the static regression results, which assume fixed relationships, the time-varying approach reveals that the effects of COVID-19 cases, deaths, and containment measures were not uniform over time. These findings emphasise that trade resilience depended not only on pandemic severity but also on policy responses and the ability of businesses to adjust to changing conditions.

Another key insight from the TVP-VAR results is the dynamic role of containment measures in shaping trade flows. While in some cases restrictions initially hindered trade, their impact evolved over time. In Hungary and Italy, stricter policies eventually led to stronger reliance on imports, while in Finland, their effects remained limited. This suggests that as governments imposed and adjusted restrictions, economies found ways to adapt trade structures, mitigating the disruptions seen in early pandemic phases. These findings highlight the importance of flexible trade policies in responding to external shocks and reinforce the need for adaptive economic strategies in future crises.

The results of the present study, both the confirmatory and the contradictory ones, can be justified by the fact that the waves in which COVID-19 came had different periods of manifestation and different magnitudes from one country to another. At the beginning of the COVID-19 crisis, the consequences of restrictive measures on the way economies, companies and individuals reacted were very powerful, resulting also in a high negative impact on the foreign trade (Khorana et al., 2021). However, these very powerful early damaging impacts on international trade started to diminish and smoothen later on, when everybody became more accommodated with the COVID-19 (Hayakawa & Mukunoki, 2021). As in the subsequent waves of the COVID-19, authorities, economies and societies were more accustomed with COVID-19 and learned to deal with it, therefore companies started to find solutions to cope during the COVID-19 crisis. The effects of learning about the COVID-19 and the associated restrictive measures manifested at individual, company and economy levels and in the following periods of time and the later COVID-19 waves, economic activities and trading activities (including foreign trading) were better conducted by the economic actors (Tudorache & Nicolescu, 2023).

Generally, it can be stated that health crises that transform in global pandemics can seriously impact international trade between countries and policy makers both at international and at national level, need to consider measures in order to mitigate the negative effects of health crises and to assist and protect economies, industries and companies during such difficult times.

Contributions of the study

The present study has both theoretical and practical contributions. From a theoretical perspective this research contributes with the development and testing of new models to measure the way the COVID-19 conditions (health and economic) impacted international trade of a country. At the same time, this research completed existing literature and studies about the effects of health crises in general and the ones of the COVID-19 crisis in particular. In more concrete terms, this study brought specific evidence about the impact of the COVID-19 pandemic on international trade that supplemented the existing findings in other studies on similar topics conducted in the early period of the COVID-19 health crisis (Megits et al., 2020; Hayakawa & Mukunoki, 2020, 2021) and later on during the COVID-19 health crisis (Mena et al., 2022; Lebastard et al., 2023a, 2023b). The novelty of the present study is that it considered, analysed and compared the relationship between influential factors and

total exports and imports in three European countries selected according to the intensity of the containment measures that their governments employed during the main COVID-19 health crisis. Also, the paper contributed by combining static and dynamic models for the analysis of the relationships.

From a practical point of view, this new evidence may be used as lessons by authorities and policy makers in order to take better future measures to deal with the unfavourable influences of sanitary and health crises. For instance, policy makers may act in two directions: the first direction is to try to reduce the negative effects of sanitary crises on economies, industries and companies (by national and international collaboration and cooperation as suggested by United Nations - UNCTAD, 2023, Tudorache, 2024a) and the second direction is to sustain industries, companies and specific economic activities (such as international trade) during health crises (by offering financial support where needed).

Limitations and future research

The present study has certain limitations. One limitation refers to the fact that only total exports and total imports at country level were analysed during the COVID-19 health crisis, while industries have been affected differently by the COVID-19 health crisis. Therefore, future research may include analyses that consider also the international trade structures on economic sectors.

References

[1] Ahmed, H.A., Nasser, T. (2023), *Long-run relationship between the unemployment rate and the current account balance in the United States: An empirical analysis. Portuguese Economic Journal*, 22, 397-416, https://doi.org/10.1007/s10258-022-002.

[2] Baldwin, R., Tomiura, E. (2020), *Thinking ahead about the trade impact of COVID-19.* In Baldwin, R., Weder di Mauro, B. (eds.); *Economics in the Time of COVID-19*, CEPR Press: UK, 59-72.

[3] Bas, M., Fernandes, A., Paunov, C. (2022), *How Resilient Was Trade to COVID-19? Policy Research Working Paper 9975, World Bank Group*, https://documents1.worldbank.org/curated/en/776161647539747182/pdf/How-Resilient-Was-Trade-to-COVID-19.pdf [Accessed in 20 February 2023].

[4] Cavanaugh, J.E., Neath, A.A. (2019), *The Akaike information criterion: Background, derivation, properties, application, interpretation, and refinements. WIREs Computational Statistics*, 1460, DOI: https://doi.org/10.1002/wics.1460.

[5] Correia, S., Luck, S., Verner, E. (2022), *Pandemics depress the economy, public health interventions do not: evidence from the 1918 flu'*, *Journal* of *Economic History*, 82(4), 917-957, DOI:10.1017/S0022050722000407.

[6] European Centre for Disease Prevention and Control of EU (2024). [online], available at: https://www.ecdc.europa.eu/en/publications-data/data-national-14-day-notification-rate-covid-19. [Accessed in 8 February 2024].

[7] Eurostat. (2024), *Recovery Dashboard*, interactive database, https://ec.europa.eu/eurostat/data/database.

[8] Espitia, A., Mattoo, A., Rocha, N., Ruta, M., Winkler, D. (2021), *Pandemic trade: COVID-19, remote work and global value chains. Policy Research Working Paper 9508, January 2021, World Bank Group - Macroeconomics, Trade and Investment Global Practice*, https://documents1.worldbank.org/curated/en/843301610630752625/pdf/Pandemic-Trade-Covid-19-Remote-Work-and-Global-Value-Chains.pdf. [Accessed in 12 March 2021].

[9] Hale, T., Angrist, N., Goldszmidt, R. et al. (2021), *A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker). Nature Human Behaviour*, 5, 529-538, https://doi.org/10.1038/s41562-021-01079-8.

[10] Hayakawa, K., Mukunoki, H. (2020), *Impacts of Covid-19 on international trade: evidence from the first quarter of 2020*, IDE-JETRO Discussion Paper 791/2020, available at: https://ideas.repec.org/p/jet/dpaper/dpaper791.html.

[11] Hayakawa, K., Mukunoki, H. (2021), *Impacts of COVID-19 on Global Value Chains. Journal of Development Economics,* 59, 154-77, DOI: 10.1111/deve.12275.

[12] Karam, F., Zaki, C. (2015), *Trade volume and economic growth in the MENA region: Goods or services? Economic Modelling*, 45, 22-37, DOI: 10.1016/j.econmod.2014.10.038.

[13] Khorana, S., Martínez-Zarzoso, I., Ali, S. (2021), *The Impact of COVID-19 on the Global and Intra-Commonwealth Trade in Goods. International Trade Working Paper 2021/08*, *The Commonwealth*, https://www.thecommonwealth-ilibrary.org/index.php/comsec/catalog/book/333. [Accessed in 22 January 2022].

[14] Lebastard, L., Matani, M., Serafini, R. (2023a), *GVC exporter performance during the COVID-19 pandemic: the role of supply bottlenecks*. *European Central Bank Working paper series*, no. 2766/23, January 2023, https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2766~112996fbde.en.pdf. [Accessed in 2 April 2023].

[15] Lebastard, L., Matani, M., Serafini, R. (2023b), *Understanding the impact of Covid-19 supply disruptions on exporters in global value chains. The Centre of Economic Policy Research (CEPR)*, VoxEU Column, 24 March 2023, https://cepr.org/voxeu/columns/understanding-impact-covid-19-supply-disruptions-exporters-global-value-chains. [Accessed in 2 April 2023].

[16] Lucio, J., Minguez, R., Requena, F. (2022), *Impact of Covid-19 containment measures on trade. International Review of Economics and Finance*, 80, 766-778, https://doi.org/10.1016/j.iref.2022.02.051.

[17] Megits, N., Neskorodieva, I., Schuster, J. (2020), *Impact assessment of the COVID-19 on trade between Eastern Europe and China. Journal of Eastern European and Central Asian Research,* 7(3), 385-399, DOI: https://doi.org/10.15549/jeecar.v7i3.579.

[18] Mena, C., Karatzas, A., Hansen, C. (2022), *International trade resilience and the Covid-19 pandemic. Journal of Business Research*, 138, 77-91, https://doi.org/10.1016/j.jbusres.2021.08.064.

[19] Nesteruk I. (2024), *Trends of the COVID-19 dynamics in 2022 and 2023 vs. the population age, testing and vaccination levels. Frontiers in Big Data*, 6, 1355080, DOI: 10.3389/fdata.2023.1355080.

[20] Okpe, A.E., Ikpesu, F. (2021), *Effect of Inflation on Food Imports and Exports. The Journal of Developing Areas.* 55(4), 1-10, https://doi.org/10.1353/jda.2021.0075.

[21] Our World in Data. (2024). *Stringency Indexes*, available at: https://ourworldindata.org/covid-stringency-index. [Accessed in 10 November 2024].

[22] Tudorache, A.T., Nicolescu, L. (2022), *The Effects of the Covid-19 Crisis on Romania's Main Trading Relationships in 2020*, *Management Dynamics in the Knowledge Economy*, 10(9), 69-81, DOI: 10.2478/mdke-2022-0005.

[23] Tudorache, A.T., Nicolescu, L. (2023), *Insights about the Effects of COVID-19 on International Trade during the Main Pandemic Years in Romania and Poland. Sustainability*, 15, 8726, https://doi.org/10.3390/su15118726.

[24] Tudorache, A.T. (2024a), *The influence of the Covid-19 pandemic on international trade. Selected European countries*. Ph.D. Thesis, Bucharest University of Economic Studies Bucharest, Romania.

[25] Tudorache, A.T. (2024b), *The Association between the Health Crisis and Economic Evolutions at Country Level. A comparative Analysis. Review of International Comparative Management*, 25(1), 103-120, DOI: 10.24818/RMCI.2024.1.103.

[26] UNCTAD. (2023). *Key Statistics and Trends in International Trade - 2022*, United Nations, Geneva, Switzerland, https://unctad.org/system/files/official-document/ditctab2023d1_en.pdf. [Accessed in 10 April 2023].

[27] Urgulu, E., Jindřichovská, I. (2022), *Effect of COVID-19 on International Trade among the Visegrad Countries, Journal of Risk and Financial Management,* 15(2), 41, DOI: https://doi.org/10.3390/jrfm15020041.

[28] Zahra, S.A. (2021), *International entrepreneurship in the post Covid world. Journal of World Business*, 56(1), 101143, DOI: 10.1016/j.jwb.2020.101143.

[20] Whitten, G., Dai, X., Pang, Y. (2020), *Do political relations affect international trade? Evidence from China's twelve trading partners. Journal of Shipping* and *Trade,* 5, 1-24, DOI: https://doi.org/10.1186/s41072-020-00076-w.

[30] World Trade Organization [online]. Interactive database, available at: https://stats.wto.org/.