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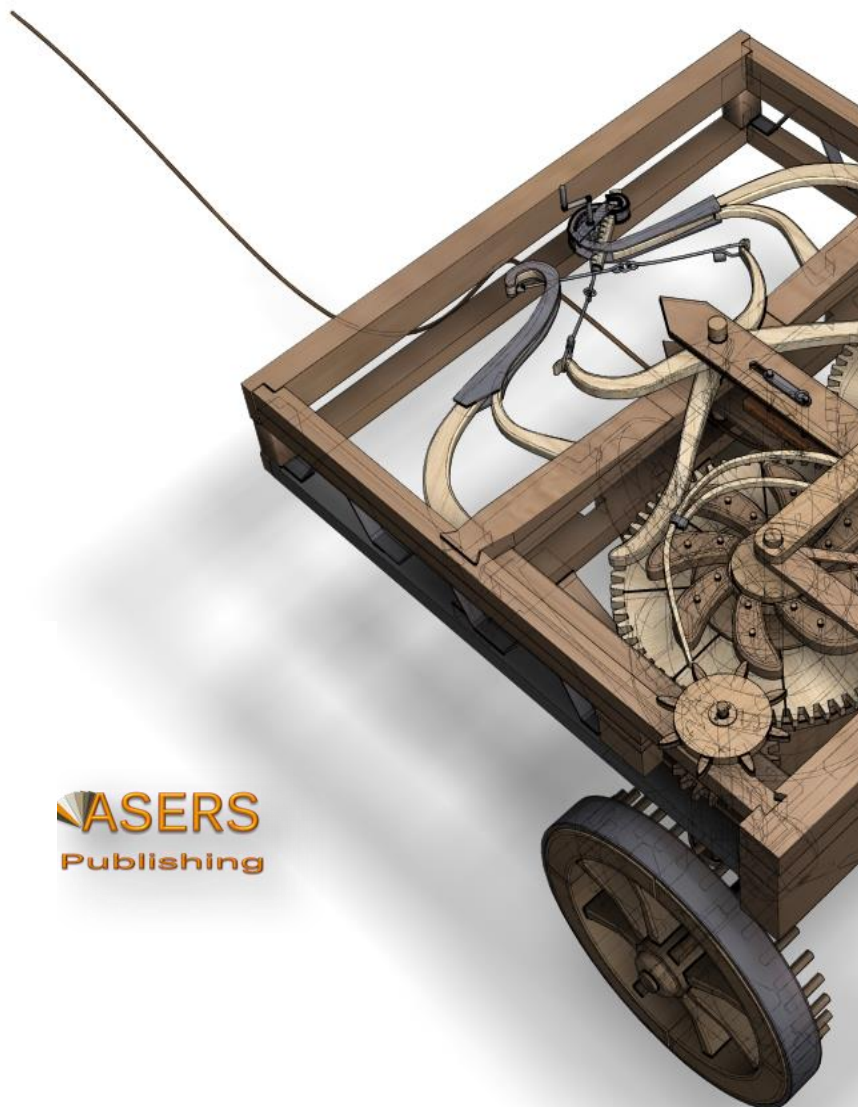
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Table of Contents

| | | |
|----|---|-----|
| 1 | Philosophical Discourses on Economic Governance: An African Perspectives Emerson Abraham JACKSON | 207 |
| 2 | Role of Legal Certainty in Providing Economic Security: Ukraine's Experience Hanna OSTAPENKO | 215 |
| 3 | Does Economic Literacy Affect Inflation Expectations? An Experimental Survey Approach Irfan Ali KC | 223 |
| 4 | Payment for Non-Standard Forms of Labor and their Impact on the Economy and Social Status of Employees Oleg YAROSHENKO, Olena LUTSENKO, Nataliia MELNYCHUK, Ivan ZHYGALKIN, Oleksandr DEMENKO | 233 |
| 5 | Environmental Concerns, Sustainable Consumption, and COVID-19 Fear in Online Consumers: A Research Exploration Wong Ming WONG, Mingjing QU, Chanidapha NUNUALVUTTIWONG, Kobkullaya NGAMCHAROENMONGKHON | 246 |
| 6 | Exploring the Influence Dynamism of Economic Factors on Fluctuation of Exchange Rate - An Empirical Investigation for India Using ARDL Model Sathish PACHIYAPPAN, Ananya JAIN, V John Paul RAJ, Saravanan VELLAIYAN | 258 |
| 7 | The Impact of Corruption on the Economic Security of the State Anatoly MAZARAKI, Tetiana MELNYK, Lyudmila SEROVA | 269 |
| 8 | The Process of Economic Transition from Central Planning to a Market Economy: The Former Soviet Union Countries vs China Aleksandar VASILEV | 283 |
| 9 | G. Boole, Not J. M. Keynes, Is the Founder of the Logical Approach to Probability Michael BRADY | 288 |
| 10 | Did the Economic Reforms Change the Macroeconomic Drivers of the Indian Economy in the Post-Reform Era? An ARDL Bounds Test Approach Pujari Sudharsana REDDY, Chaya BAGRECHA, Muthu Gopala KRISHNAN | 295 |
| 11 | YouTube as a Source of Information for Agribusiness: Audience Perspective and Content Video Analysis Desak Dwi Asthri CAHYANI, Gede Mekse Korri ARISENA | 317 |
| 12 | Features of Reforming Economic Legislation in the Conditions of Russian Aggression: Theoretical and Legal Aspects Anatolii SHEVCHENKO, Serhiy VYKHRYST, Iuliia OSTAPENKO, Svitlana BOBROVNYK, Oleksandr LOSHCHYKHIN | 326 |

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Theodore Metaxas

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Elia Fiorenza

University of Calabria, Italy

| | | |
|----|---|-----|
| 13 | An Empirical Study on developing the Tourism Potentials of Fairs and Festivals in Odisha in India Rojalin MOHANTY, Ansuman SAMAL | 335 |
| 14 | The Relationship between Environmental, Social, Governance, and Export Performance in Manufacturing Companies: A Literature Review Yan Li, Jilian Li | 345 |
| 15 | COVID-19 Pandemic and Foreign Trade Behavior in the Democratic Republic of Congo: A Non-Parametric Test Approach by Comparison of Means Yannick LUBONGO MBILU, Logas LOWENGA KOYAMODJA, Junior KANA KIWE, Oscar MUDIANDAMBU KITADI, Angel NGOYA KALENDA, Floribert NTUNGILA NKAMA | 357 |
| 16 | Inflation Persistence and Implications for the Euro Area Rajmund MIRDALA | 364 |
| 17 | Using Markusen's Typology as a Starting Point to Examine the Case of the Center for Defense Space and Security Cluster: The State-Anchor Type of Cluster Vasileios KYRIAZIS, Theodore METAXAS | 378 |
| 18 | Stock Market Performance during COVID-19 Pandemic: A Systematic Literature Review Pingkan Mayosi FITRIANA, Jumadil SAPUTRA, Zairihan Abdul HALIM | 393 |
| 19 | Modern Approaches to Reforms in the Economy: Performance Measurement Development in the Armed Forces of Ukraine Vadym PAKHOLCHUK, Kira HORIACHEVA, Yuliia TURCHENKO, Oles KOVAL | 407 |
| 20 | The Moderating Effect of Digitalization on the Relationship between Corruption and Domestic Resource Mobilization: Evidence from Developing Countries Talatu JALLOH, Emerson A. JACKSON | 423 |
| 21 | Marketing Audit as a Tool for Assessing Business Performance Iryna FESHCHUR, Nataliia HURZHYI, Yuliia KUZMINSKA, Olena DANCHENKO, Yuliia HORIASHCHENKO | 438 |
| 22 | A Review and Comparative Analysis of Digital Literacy Frameworks – Where Are We Heading and Why? Yoo-Taek LEE, Mina FANEA-IVANOVICI | 457 |
| 23 | Management Accounting of Payment Risks of Online Trade during Military Operations Maksym SEMENIKHIN, Olena FOMINA, Oksana AKSYONOVA, Alona KHMELIUK | 473 |
| 24 | Did Russia's Invasion of Ukraine Induce Herding Behavior in Indian Stock Market? Tabassum KHAN, Natchimuthu NATCHIMUTHU, Krishna TA | 484 |

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Theoretical and Practical Research in Economic Fields

Many economists today are concerned by the proliferation of journals and the concomitant labyrinth of research to be conquered in order to reach the specific information they require. To combat this tendency, **Theoretical and Practical Research in Economic Fields** has been conceived and designed outside the realm of the traditional economics journal. It consists of concise communications that provide a means of rapid and efficient dissemination of new results, models, and methods in all fields of economic research.

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COVID-19 Pandemic and Foreign Trade Behavior in the Democratic Republic of Congo: A Non-Parametric Test Approach by Comparison of Means

Yannick LUBONGO MBILU

The Public Economics Research Unit, Institute of Economic and Social Research
Faculty of Economics and Management, University of Kinshasa, DR. Congo
yannick.mbilu@unikin.ac.cd, yannickmbilu@gmail.com

Logas LOWENGA KOYAMODJA

The Quantitative Economics Research Unit, Institute of Economic and Social Research
Faculty of Economics and Management, University of Kinshasa, DR. Congo
logas.lowenga@unikin.ac.cd

Junior KANA KIWE

The Quantitative Economics Research Unit, Institute of Economic and Social Research
Faculty of Economics and Management, University of Kinshasa, DR. Congo
juniorkana@gmail.com

Oscar MUDIANDAMBU KITADI

Faculty of Social, Administrative and Political Sciences
University of Kinshasa, DR. Congo
osmudiandambu@gmail.com

Angel NGOYA KALENDA

Faculty of Economics and Management
University of Kinshasa, DR. Congo
angelngoya@gmail.com

Floribert NTUNGILA NKAMA

The Public and Industrial Economic Research Unit, Institute of Economic and Social Research
Faculty of Economics and Management, University of Kinshasa, DR. Congo
floribert.ntungila@unikin.ac.cd

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Abstract: *This paper analyzes the behavior of foreign trade indicators, specifically exports and imports in the Democratic Republic of Congo (DRC) during the COVID-19 pandemic. This health crisis was labelled a "pandemic" by the World Health Organization because it affected all mankind to varying degrees. It also examines the evolution of international reserves during the same period, while taking stock of some macroeconomic indicators for the DRC.*

Non-parametric tests reveal differences in the means between the period of the COVID-19 surge and the period of the COVID-19 decline, to verify the significance of the negative or positive influence of imports and exports in the DRC.

It was found that during the year most affected by the pandemic, 2020 compared to the previous year, 2019, both exports and imports fell on average annually, respectively (in millions of USD) by 1,078.6 versus 1,098.6 and by 988.8 versus 1,149.1. This can be justified by the various measures taken by the government to contain the COVID-19 pandemic. Subsequently, these same indicators (in millions of USD) will increase between 2021 and 2022, respectively from 1,742.5 to 2,368.4 for exports and from 1,520.4 to 1,920.1 for imports. This increase is

the result of the urgent stimulus measures taken by the government to enable the economy to cope with the multiple economic consequences of the COVID-19 pandemic. These observations were also verified by statistical tests: these show differences for independent and matched samples at the 0.05 threshold. There is a considerable difference in exports in millions of USD between those during the absence of COVID-19 and those during the presence of COVID-19.

These observations were also verified by statistical tests: these provide differences for independent and matched samples at the 0.05 level. There is a considerable difference in exports (in millions of USD) between those made in the period before and those made during the COVID-19 pandemic.

Keywords: non-parametric tests; COVID-19 pandemic; imports; exports; international reserves; comparison of means.

JEL classification: C12; C14.

Introduction

Keynesians consider the economy to be unstable in the sense that the information transmitted by prices is generally not in line with reality. Most often the economy is confronted with crisis situations (underemployment of factors, involuntary unemployment). These are known as supply or demand shocks, which lead to fluctuations in consumption, production, employment and inflation, exports, and imports in various directions. Thus, a crisis occurs and economic activity stops growing.

Foreign trade includes all activities related to imports and exports of a country. We can include the different stages of import-export operations: country studies, prospecting, negotiation, sales, logistics, transport, etc. However, in the face of economic fluctuations, it generally behaves according to a bullish or bearish dynamic.

The recent COVID-19 pandemic has had consequences far beyond the health sphere. It has profoundly disrupted the global economy, sometimes with unprecedented devastating consequences for the well-being of nations, particularly for their international trade.

As in the rest of the world, the Congolese authorities have taken several measures to limit and contain COVID-19 pandemic on the well-being of the population and the national economy. Among these measures, the "containment" which appeared as the most emblematic of this crisis since it was set up as the ultimate bulwark for the preservation of humanity. It has come at the cost of an unprecedented recession: it is often referred to as a "boondoggle" whose effects have reduced the factors of accumulation of production and accelerated what Pinshi refers to as "a self-inflicted recession" (Pinshi 2020).

In addition to these sectoral effects, there has also been a deterioration in consumer and business confidence, which has been forced to rely on weaker demand and thus reduce spending and investment. This has led to business closures and job losses (Gopinath 2020). Problems in production and supply chains and in both domestic and international trade were also mentioned.

The DRC is a country with an economy that is still outward looking, disjointed and disintegrating. As a result, it is highly exposed to the ups and downs of international trade and has not been spared the horrors of the crisis caused by the COVID-19 pandemic, which has compromised its macroeconomic stability and growth. Indeed, the crisis has worsened the fiscal and foreign trade balances as in several other countries. Given that public debt has risen (to 83% of global GDP), as the IMF argues in its report on the effects of the COVID-19 pandemic (2020), it is seriously affecting the country's finances.

According to available data, for the period 2019-2020, exports and imports will decrease from 1,078.6 to 1,098.6 and from 988.8 to 1,149.1, respectively, as an annual average and in USD millions. Thereafter, between 2021 and 2022, these same indicators rise from 1,742.5 to 2,368.4 for exports and from 1,520.4 to 1,920.1 for imports in million USD, in DRC.

In addition to exports and imports, other macroeconomic aggregates also evolved differently and recorded fluctuations: GDP grew by 4.3 percent, CPI was 5.5 percent, government revenue and grants amounted to 10.8 percent of GDP, of which 9.5 percent was tax and non-tax revenue, and 1.3 percent was grants. Government expenditure amounted to 10.9 percent of GDP, of which capital expenditure was 2.1 percent. Two deficits were also recorded during the same period, respectively the budget balance of -0.2 percent and the current account balance of -3.5 percent. However, the DRC recorded an increase of 3.7 percent of GDP in net official reserves and 13.3 percent in public external debt.

Compared to 2019, fluctuations in 2020 are down for some indicators identified in 2019. Gross domestic production declined from 4.3% in 2019 to 3.9% in 2020. There was a slight decline in CPI of 5.0% and government revenue of 10.6% overall, including 9.1% in tax and non-tax revenue, including a slight increase of 1.5% in grants to 1.3% in 2019. Public expenditure decreased overall to 10.8%; a very slight increase in capital

expenditure following government interventions in the health sector to counter the health crisis. (Uhttp //: wto.org/COVID-19-fhtm).

1. The Problem

Since late 2019 and early 2020, the world has been dealing with the COVID-19 health crisis that started in Wuhan, People's Republic of China, and eventually reached almost every country in the world. Beyond its public health effects, COVID-19 pandemic has had a significant impact on global economy. In fact, the pandemic rapid spread across continents by the end of the first quarter of 2020 caused severe disruptions in global economic activity. Almost every country in the world has been affected (Mujani 2020).

The observation of economic life over a long period highlights a succession of phases during which economic activity is either growing or decreasing, this succession is caused by endogenous or exogenous multisectoral shocks, for the specific case: COVID-19 pandemic.

DRC being open to foreign trade is also experiencing a slowdown in its economic activity and is affected by global supply and demand imbalance. To this end, it is important to conduct a conjunctural analysis of the foreign trade macroeconomic aggregates to identify these different effects.

The objective of this study is to compare the DRC's means of foreign trade variables during the period before, during and after COVID-19 pandemic.

The study examines COVID-19 pandemic effects on the DRC's foreign trade. It hypothesizes that COVID-19 pandemic caused a slowdown in the pace of DRC's foreign trade, which it is still struggling to fully recover³.

2. Methodological Approach

The present study uses the analytical method, accompanied by the documentary technique and statistical analysis to establish the comparison of annual averages of imports, exports and international reserves before the COVID-19 pandemic and during the COVID-19 pandemic, periods during which several public measures were stopped.

The empirical analysis involved independent and paired Student's t-test sampling. It compares the period of presence and absence of the COVID-19 pandemic respectively, which declines an evolution of imports, exports as well as international reserves¹.

In the latter, we have measurements of the values of X in two independent samples E₁ and E₂ of sizes n₁ and n₂ respectively. We also want to compare the two experimental means, *i.e.* test the null hypothesis(H₀): $U_1 = U_2$

First, the values obtained in the sample pool are sorted in ascending order. For each value x_i from E₁ the number of values from and after E₂ in the ordered list is counted (those equal to x_i only count for 1 / 2). We note U₁ the sum of the numbers thus associated with the different values coming from E₁. The same is done by swapping the roles of the two samples, which gives the sum U₂. And U₁, the smaller of the two sums obtained.

$$U = \min \{U_1; U_2\}$$

The associated random variable is denoted U.

- For any n₁ and n₂ we read from the Mann and Whitney test tables the number M_a such that, under (H₀), $P(U \leq m_a) = \alpha$. (H₀) is rejected at the risk of error α if $u \leq m_a$. Otherwise, (H₀) is accepted.

If n₁ and n₂ are large enough (≥ 20 in general), under (H₀), U approximately follows the normal distribution N(μ ; σ) with :

$$\mu = \frac{n_1 n_2}{2} \text{ et } \sigma = \frac{\sqrt{n_1 n_2 (n_1 + n_2 + 1)}}{12}$$

We read U_a in the normal distribution reduced deviation table such that $P(|N| \geq U_a) = \alpha$, calculate $\varepsilon = \frac{u - \mu}{\sigma}$, and reject (H₀) at risk of error α if $\varepsilon \notin]-U_a; U_a$. Otherwise, (H₀) is accepted.

We have measurements of the values of X in k independent samples, E₁, ..., E_k, of respective sizes [n] 1, ..., n_k. We wish to compare the k experimental means, *i.e.* test the null hypothesis (H₀): " $\mu_1 = \dots = \mu_k$."

The comparisons of means² for an independent sample, concern: (i) the normally distributed series, including the Z Test for a sample "n" greater than or equal to 30 observations (n \geq 30) and the T Test (Student) for

¹URL/<https://help.xlstat.com/fr/6759-quelle-est-la-difference-entre-tests-pour-echantillons>. Nonparametric tests. The difference between independent and paired sample tests, 2023.

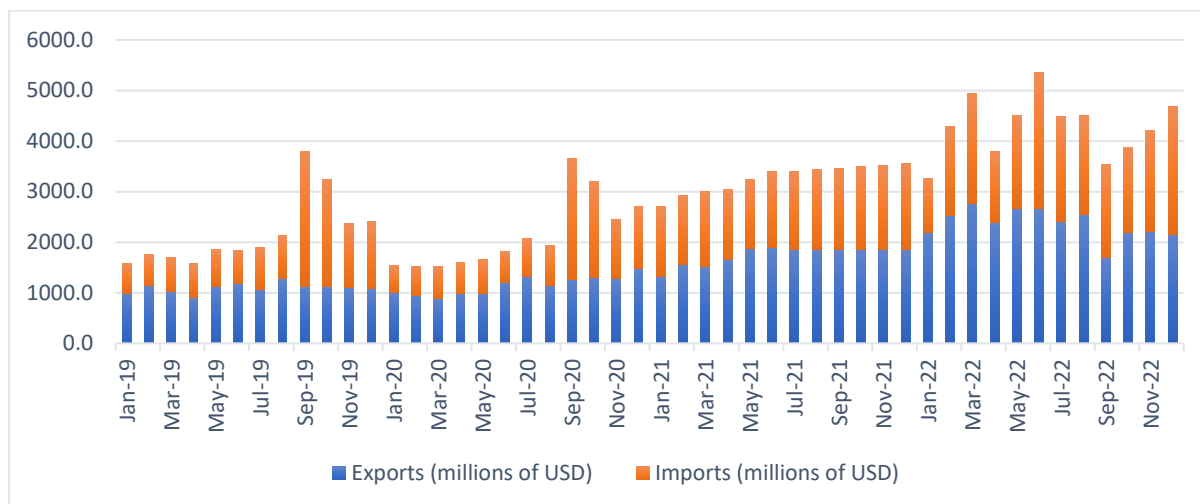
² Comparisons of these means, for an independent sample, concern: (i) the normally distributed series including the Z-test for a sample "n" greater than or equal to 30 observations (n \geq 30) and the T-test (Student) for a sample "n" less than 30

a sample "n" less than 30 observations ($n < 30$), and also (ii) the series in relation to the absence of normality, including the Test of (**Mann-Whitney, Kruskal-Wallis, Wald-Wolfowitz and Kolmogorov**), which make it possible to test the significance of the variables

3. Analysis Results

The graph below shows the monthly evolution of imports and exports in the DRC between January 2019 and December 2022. Considering this period, we observe a decline in imports and exports for the year 2020, after an upward trend in 2019. For the period 2021-2022, foreign trade remains on an upward trend.

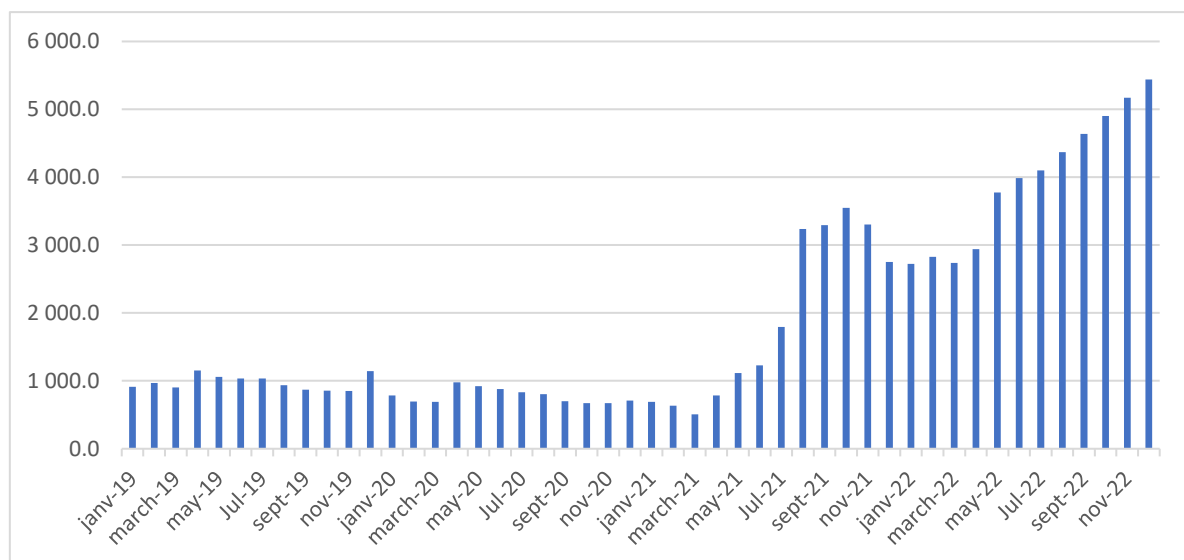
Graph 1. Monthly evolution of exports, imports (in millions of USD).



Source: Compiled by the authors, based on BCC data

The following graph shows that international reserves during the COVID-19 surge keep a fluctuating trend, and during the decline we observe an increase.

Graph 2. Monthly evolution of international reserves (in millions of USD).



Source: Compiled by the authors, based on BCC statistical data

This is justified by support from partners, rapid credit facilities, extended credit facilities from the IMF between 2021 and 2022 (in millions of USD), various aid received from the World Bank, ADB, the Kuwaiti Sovereign Wealth Fund, etc., as well as a new SDR allocation in 2021 for the DRC equivalent to 1.5 billion USD.

observations ($n < 30$), and also (ii) the series in relation to the absence of normality, including the W-test (Wilson's test or rank test) which allows to test the significance of the variables

The figure above shows that international reserves during the covid-19 surge keep a more or less fluctuating trend, and during the downturn an increase is observed. This is justified by the support of partners, rapid credit facilities, extended credit facilities of the IMF in millions of USD between 2021 and 2022, various aids from the World Bank, ADB, Kuwait Sovereign Wealth Fund, etc.), new SDR allocation in billion USD in 2021.

The table below provides information on the effectiveness of the effects of COVID-19 pandemic on exports, imports and foreign exchange reserves during the period of COVID-19 presence and absence.

Table 1. Comparison tests for comparison of means

| Null hypothesis | Wald Wolf witz | | Mann and Whitney | | Kolmogorov | | Kruskal Wallis | |
|---|----------------|-----------------|------------------|-----------------|------------|-----------------|----------------|-----------------|
| | Prob. | Decision | Prob. | Decision | Prob. | Decision | Prob. | Decision |
| G and S export is identical during the presence or absence of COVID-19. | 0,000 | RH ₀ | 0,000 | RH ₀ | 0,000 | RH ₀ | 0,000 | RH ₀ |
| Import of G and S in million USD is identical during the presence or absence of COVID-19 | 0,062 | AH ₀ | 0,003 | RH ₀ | 0,000 | RH ₀ | 0,003 | RH ₀ |
| International reserve in millions of USD is the same during the presence or absence of COVID-19 | 0,071 | AH ₀ | 0,501 | AH ₀ | 0,36 | RH ₀ | 0,488 | AH ₀ |

Source: Estimates made by the authors on the basis of statistical data from the BCC

The result of these analyses (Table 1), according to the non-parametric tests, is that there is a significant difference between exports during the period in the absence of COVID-19 and exports during the period in the presence of COVID-19, in the sense of a decrease in millions of USD.

Also, for imports, there is also a significant difference during the period of COVID-19 pandemic presence, namely a decrease compared to the periods of absence or decrease of COVID-19.

As for international reserves, they did not decrease significantly during the COVID-19 pandemic presence and absence periods. They have maintained a more or less constant trend, sometimes even showing a slight increase following support from the DRC's traditional partners, which has been effective through rapid credit facilities (*i.e.* USD 730 million between 2019 and 2020), extended credit facilities (*i.e.* around USD 600 million between 2021 and 2022), various aid measures from the World Bank, the ADB, the Kuwaiti Sovereign Wealth Fund, and a new SDR allocation (*i.e.* USD 1.5 billion in August 2021).

Between 2021 and 2022, the Congo Central Bank's interventions on FOREX market (*i.e.* around USD 200 million) have also contributed to increase the DRC's international reserves³. This was already observed during previous interventions in 2009, which resulted in the DRC's international reserves crossing USD 1 billion threshold (with SDR allocations of around USD 620 million - in August 2009 - in addition to IMF's USD 200 million Exogenous Shocks Facility - in March 2009 - and USD 200 million World Bank support in response to 2008 financial crisis).

Conclusion

At the end of this reflection on the COVID-19 pandemic and DRC's foreign trade behavior according to a non-parametric approach and the comparison of means, it should be noted that the DRC remains open to foreign trade. As such, it has faced a slowdown in economic activity and an imbalance in global supply and demand throughout the crisis.

Based on the observations of the monthly evolution of exports and imports between 2019 and 2022, there is a decline in exports and imports during 2020, after a certain upward trend in 2019. For the period from 2021 to 2022, the DRC's foreign trade has maintained a growing trend, as have its international reserves, despite the health crisis that marked the study period.

For the year 2020, compared to 2019, the decline in exports and imports in million USD is noted, respectively falling to 1078.6 against 1098.6 and 988.8 against 1,149.1 in annual average. This can be explained by the various restrictive measures taken by the government to contain the health crisis in COVID-19, including containment, teleworking, reduction of work shifts, limitation of working days, closure of borders, etc.

³ Interview with experts (Monetary Policy and Foreign Trade) of the Central Bank of Congo, in Kinshasa, DR. Congo, March 2nd 2023.

Subsequently, these same indicators were also reported to rise between 2021 and 2022, from 1,742.5 to 2,368.4 for exports and from 1,520.4 to 1,920.1 for imports from the DRC.

According to non-parametric tests of differences between independent and matched samples, at the 0.05 level, there is a significant difference between exports during the period of absence of COVID-19 and those during the period of presence of COVID-19. Indeed, we note that exports in millions of USD fall considerably and that the same is true for imports. Thus, these results show that the COVID-19 pandemic has significantly influenced foreign trade, considering the variables exports and imports, and that international reserves have not significantly decreased because of the various interventions (Aid and support from traditional partners).

The scientific relevance of this study, from a theoretical point of view, is to present the profile of the economy of the DR Congo's economy as a country open to international trade on the one hand, and also to measure the cyclical effects of this COVID-19 health crisis on this economy through the aggregates of foreign trade, and possibly to propose contingency mechanisms and resilience to health crises.

Therefore, it is suggested that the Government should work more towards diversification of the economy and the intensification of international trade, in order to better finance and maintain the balance of international reserves in a context of exogenous shocks. This is the best way to effectively contribute to a more resilient economy, which is structurally dependent on bilateral and multilateral donors. The COVID-19 pandemic has had a strong impact on world trade and has revived arguments around the debate on a better localization for countries' economic activities. In fact, the decision to reterritorialize a country's economic activities would undoubtedly lead to the renunciation of benefitting the great international specialization advocated at the turn of the century without any certainty, as to a better resilience of the international value chains that are at the core of economic progress.

Credit Authorship Contribution Statement

Yannick Lubongo Mbilu: Conceptualization, Investigation, Methodology, Project administration, Supervision, Validation.

Logas Lowenga Koyamodja: Data curation, Methodology, Formal analysis.

Junior Kana Kiwe: Investigation, Data curation, Validation, Software.

Oscar Mudiandambu Kitadi: Writing-review, Visualization, Validation, Investigation.

Angel Ngoya Kalenda: Writing-review and editing, Visualization, Investigation.

Floribert Ntungila Nkama: Concetualization, Visualisation, Validation, Formal analysis.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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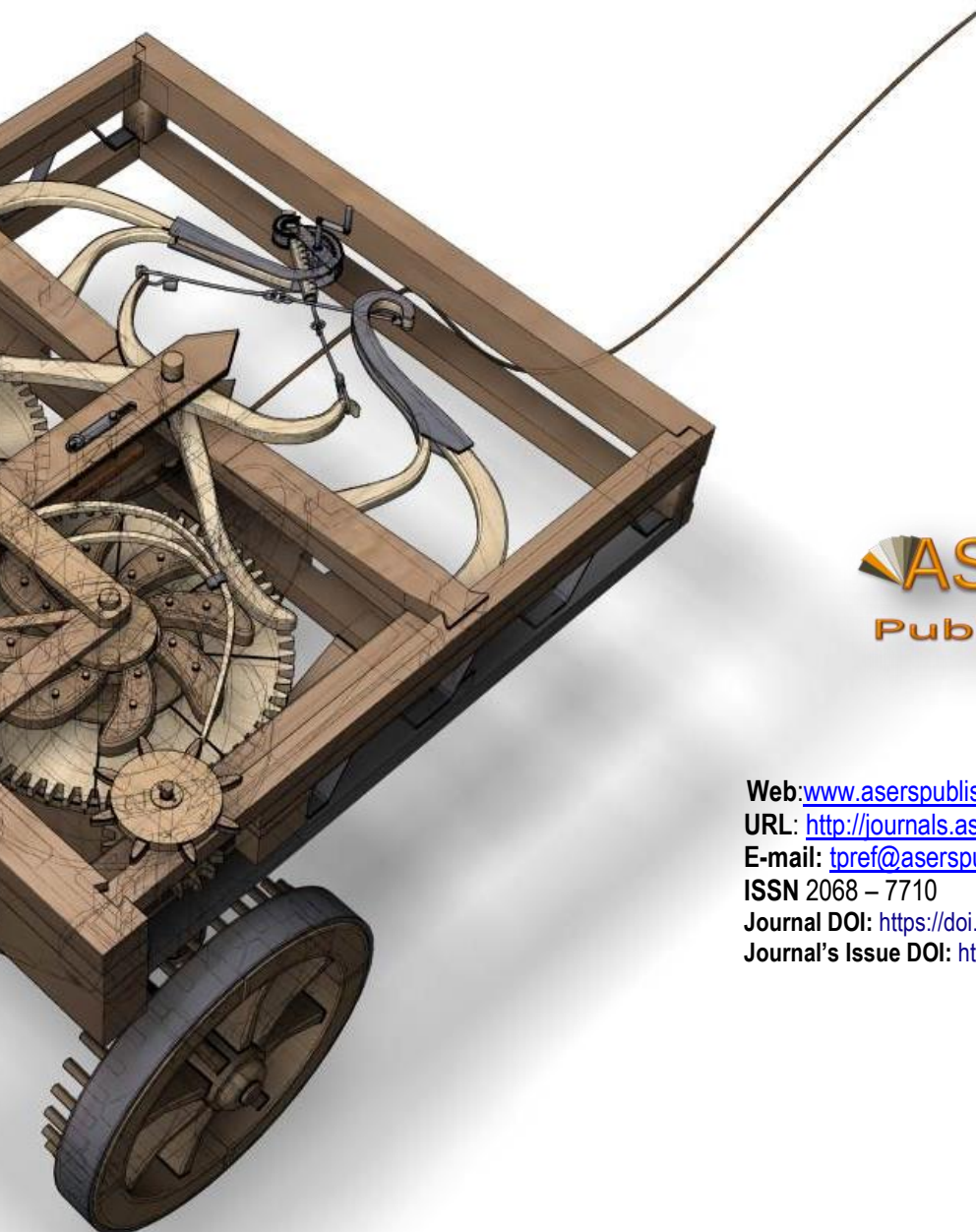
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List of acronyms

- AH_0 : Null hypothesis accepted
- APD [ODA] : Official Development Assistance
- G et S : Goods and Services
- ADB : African Development Bank
- BCC : Central Bank of Congo (DRC)
- CDF : Congolese francs
- COVID-19 : Coronavirus 2019 (full name)
- CR : Research Unit
- DGDA : DRC Customs and Excise Utility
- DGI : DRC Tax Utility
- DGRAD : DRC administrative and state revenue Utility
- SDR : Special Drawing Rights
- FASEG : Faculty of Economics and Management
- FMI [IMF] : International Monetary Fund
- H_0 : Null hypothesis
- H_1 : Alternative hypothesis
- Import-Export : Importation and Exportation
- IRES : Economic and Social Research Institute
- OMC [WTO] : World Trade Organisation
- PED : Developing countries
- PGAI : Aid and Investment Management Platform
- PIB [GDP] : Gross Domestic Product
- PMUAIC-19 : Multisectoral emergency mitigation programme for COVID-19
- Prob. : Probability
- DRC : Democratic Republic of Congo
- RH_0 : Null Hypothesis rejected
- UNIKIN : Université of Kinshasa
- USD : US Dollar

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