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THE EFFECT OF MARKET SHOCKS ON THE VOLATILITY OF CORN PRICE

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Abstract: *The volatility of agricultural markets makes risk management for producers a challenge. Market shocks, such as the increased demand for corn-based ethanol in the mid-2000s and the recent COVID-19 disruption, only exacerbate the problem. The paper investigates the impact of these two shocks on corn price volatility using futures commodity prices. ARCH/GARCH estimations are compared for the ethanol pre-expansion and expansion periods and pre-COVID-19 shutdown and COVID-19 shutdown periods. The results indicate a high level of price volatility due to the shocks, thus worsening corn producers' price risk situation.*

Keywords: *Ethanol, Price volatility, COVID-19, ARCH, GARCH, Corn*

JEL Classification: *Q12, Q14, P32*

1. INTRODUCTION

Agricultural commodity prices are susceptible to market shocks due to their inherently short-run inelastic supply and demand nature. The US corn market has experienced two significant shocks since the mid-2000s. The first was in 2006 due to the sudden increased demand for corn for corn-based ethanol production. Ethanol production increased from 14.53 million barrels to 63.47 million barrels between 2005 and 2008 on the back of government subsidies provisioned by the American Jobs Creation Act of 2004, the Energy Policy Act of 2005, and the Energy Independence and Security Act of 2007. The second and more recent shock was due to the spread of coronavirus disease 2019 (COVID-19). The virus was

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identified in 2019, but it was not until March 2020 that the World Health Organization (WHO) declared it a pandemic. The pandemic caused many industry entities, such as financial institutions, agricultural service providers, and government offices like the USDA/FSA that provide direct service to farmers, to shut down partially or entirely, thus disrupting their operation. It is worth noting that there was an initial short-term 11% fall in the price of corn in March 2020 after the pandemic declaration due to a decline in fuel demand associated with the stay-at-home orders. However, shortly thereafter corn prices increased significantly due to supply chain bottlenecks and trade restrictions. In a typical year in the US, corn prices continue to rise from November through March until June/July of the following year. Figure 1 shows this base trend and the significant price increase in the periods associated with the two shocks examined. For instance, in the 2005-06 pre-ethanol expansion period, the price increase was 40%, while it was 107% in 2007-08 expansion period. Similarly, corn prices increased by 31% and 84% in 2018-19 pre-pandemic period and 2020-21 COVID-19 shutdown period, respectively.

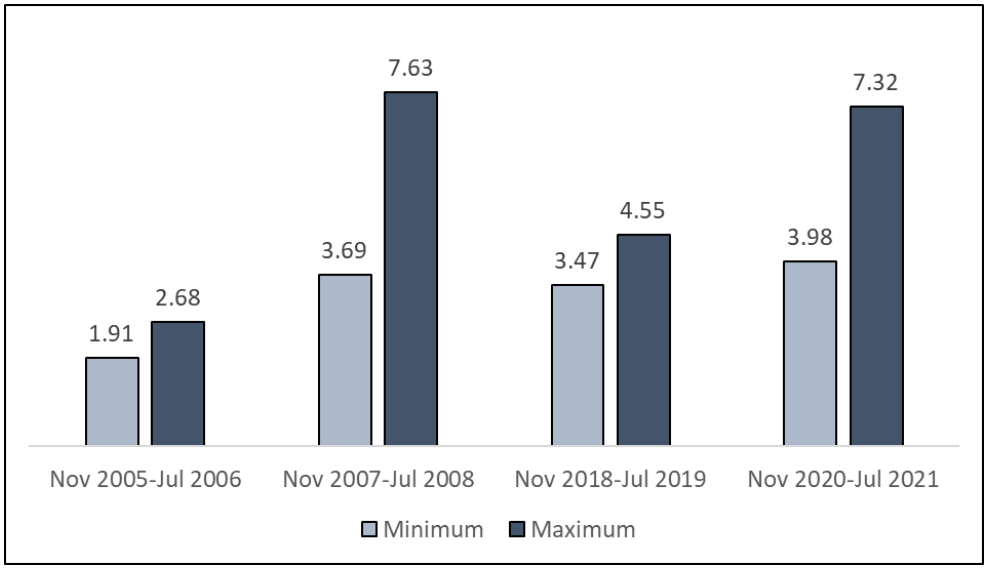

Figure 1 Minimum and Maximum Corn Prices by Period

Studying the impact of the increase in volatility due to market shocks is appropriate as it exacerbates the price risk producers face. Since much of the US ethanol production expansion began in 2006/07 and peaked in 2007/08, this study compares volatility between 2005-2006 (pre-expansion), 2006-2007 (initial expansion), and 2007-2008 (aggressive expansion). Likewise, because the

COVID-19 pandemic declaration was issued in March 2020, the potential impact of COVID-19 disruption is investigated by comparing price volatility between the pre-pandemic period (March 2018-July 2019) and the pandemic period (March 2020-May 2021).

This paper uses the ARCH/GARCH model to measure the intensity and persistence of the volatility in corn prices caused by the two identified shocks. The analysis indicates pronounced and long-lasting price volatility during the two shock periods, and especially during the pandemic.

The next section of the paper presents the relationship between ethanol production and corn prices, and the disruptive effect of changes in driving/food distribution on corn prices due to COVID-19.

2. RELATED LITERATURE

2.1. Ethanol Production and Corn Price

The ethanol industry's competition with other buyers in the corn market has positively impacted corn prices for producers (Baker and Zahniser, 2007) at both the national and local levels. At the national level, Park and Fortenbery (2007) estimated that in the short-run, ceteris paribus, a 1% increase in ethanol production would increase corn prices by 0.16%. At the local level, McNew and Griffith (2005) estimated the short-run local price impact of twelve new ethanol plants that opened between 2001 and 2002 to be an increase of between 4.6 and 19.3 cents per bushel. Behnke and Fortenbery (2011) used a longer time frame than that of McNew and Griffith to examine the impact of ethanol production on local basis across several Midwestern states. They found that ethanol production within a 50-mile region of a county centroid has a positive, yet small, impact on corn prices, and the estimated impact of a 50 million gallon per year (mgy) plant is a 0.425 cent per bushel increase. Olson et al. (2007), focusing only on South Dakota, found the impact on corn prices from ethanol production differed across districts and by plant size in 2005; their results suggest that an additional 40 mgy ethanol plant would increase corn price by $0.06 to $0.16 per bushel and by $0.04 to $0.27 per bushel for a 100 mgy plant. The above findings all suggest that the opening of ethanol plants in a region positively impacts local corn prices for producers, but these impacts may dissipate over time.

2.2. COVID-19 Impact on Corn

Prior to 2006 the relationship between ethanol and gasoline was substitutionary (Tenkorang et al., 2015; Luchansky and Monks, 2009; and Rask, 1998), but is now complementary due to the significant increase in ethanol production and the ethanol blend wall. The lockdown due to the COVID-19 pandemic resulted in a sharp decline in gasoline consumption in the US. The Energy Information Administration estimated that weekly finished motor gasoline supplied (a proxy for consumption) fell from over 9 million barrels per day in March 2020 to about 5 million barrels per day in May 2020. Due to their complementary relationship, the drastic decline in gasoline consumption led to a severe reduction in ethanol consumption and, subsequently, a drastic decrease in the demand for corn. In addition to the demand shock, supply chain disruption and export restrictions (Gutierrez et al., 2022) also increased the volatility in corn prices. Corn prices, like other feedstock, are affected by oil price volatility. It is generally undisputed that agricultural products and energy prices are very volatile, resulting in the exclusion of both from the core inflation. Moreover, energy price changes directly impact agricultural commodity prices. Energy prices affect the cost of fertilizer, equipment operation, and transportation of commodities. An extensive review of biofuel-food price relationship literature by Serra and Zilberman in 2013 shows that 12 of the 51 studies they reviewed found transmission of volatility from energy prices to feedstock prices. Also, a recent IMF study shows that a 10 percent increase in oil prices results in a two percent increase in agricultural commodities prices (Bogmans et al., 2022). Hence, the COVID-19 driven heightened oil price volatility transmitted to corn and other agricultural commodity prices.

3. METHODS & DATA

3.1. Estimation Approach: ARCH/GARCH

While heteroscedasticity makes least squares estimates inefficient, this varying variance provides a valuable volatility measure for risk analysis in time series data (Engel, 2001). The most common model used in Serra and Zilberman (2013) reviews is Autoregressive Conditional Heteroscedastic (ARCH) model, as well as its generalized version, GARCH, which was developed by Engel (1982) and Bollerslev (1986). GARCH is commonly used to analyze financial time series data because the data is inherently volatile. As noted earlier, agricultural

commodity prices also exhibit varying volatility because of their short-run inelastic demand and supply. Therefore, we take advantage of the ARCH/GARCH to test whether corn price volatility due to corn demand shock caused by the rapid expansion of ethanol and the COVID-19 disruption differs from the base price volatility of prior years. Since the data to estimate an ARCH/GARCH model must exhibit an ARCH effect (heterogeneity), residuals from the conditional mean model below (equation 1) are tested statistically for heterogeneity.

$$P_{c,t} = \boldsymbol{\mu} + \varepsilon_t \tag{1}$$

For the variance equation, we use a standard GARCH model, GARCH (1,1), with the price of oil to control for energy price volatility, and it is expressed as

$$\sigma_t^2 = \boldsymbol{\gamma_0} + \boldsymbol{\gamma_1}\varepsilon_{t-1}^2 + \boldsymbol{\delta_1}\sigma_{t-1}^2 + \boldsymbol{\alpha_1}P_{oil,t}^2 \tag{2}$$

where $\varepsilon_t = \sigma_t v_t$ and $v_t = i.i.d.\, N(0,1)$

The ARCH error coefficient ($\boldsymbol{\gamma_1}$) measures the intensity of volatility reaction to market movement; hence, it determines whether the previous day's corn price information affects today's corn price volatility. It is expected to be greater than zero. The GARCH lag coefficient ($\boldsymbol{\delta_1}$) measures how long changes in volatility would affect future volatility (Campbell et al., 1996). That is, does the previous day's volatility of corn price affect today's corn price volatility? Therefore, it is a measure of the persistence of volatility. $\boldsymbol{\delta_1}$ is expected to be greater or equal to zero. The relative sizes of $\boldsymbol{\gamma_1}$and $\boldsymbol{\delta_1}$ also have interesting and significant interpretations. If $\boldsymbol{\gamma_1}$ is relatively large, volatilities are essentially spikes that dissipate quickly (Tian and Guo, 2005). The constant ($\boldsymbol{\gamma_0}$) measures long-run average volatility (Engle, 2001). The ARCH and GARCH coefficients are measures of internal shocks, while that of the oil price serves as an external shock.

3.2. Data

Because corn prices follow a seasonal pattern, the same period (March Year 1 – May Year 2) was used for each marketing period to eliminate the influence of seasonality on the volatility comparison. The comparisons of the coefficients are between 2005-2006 (pre-ethanol expansion), 2006-2007 (initial expansion), and 2007-2008 (aggressive expansion). Likewise comparisons are made between 2018- 2019 (pre-COVID shutdown) and 2020-2021 (covid shutdown). The pre-ethanol expansion and the pre-COVID periods used are considered typical years for corn price volatility. The

standard deviation values show higher volatility in corn prices during the ethanol expansion and COVID-19 pandemic periods than their corresponding non-shock periods (Table 1).

Table 1 Descriptive Statistics of Daily settlement Corn Futures Prices

Variable	Mean	Std. Dev.	Range	Kurtosis	Skewness
Corn Futures Price (cents per bushel)					
Pcorn5_6	214.62	14.04	73.75	-0.329	0.258
Pcorn6_7	304.46	71.75	216.25	-1.632	0.231
Pcorn7_8	423.40	90.11	308.75	-0.781	0.788
Pcorn18_19	369.24	14.90	78.25	-0.130	0.026
Pcorn20_21	426.07	114.67	470.00	0.348	1.060
Crude Oil Price (USD per barrel)					
Poil5_6	60.57	5.89	28.37	-0.408	-0.011
Poil_6_7	64.67	6.13	26.55	-0.907	0.178
Poil_7_8	84.17	17.79	69.70	-0.764	0.430
Poil_18_19	63.18	7.21	31.80	-0.522	-0.576
Poil_20_21	43.51	13.81	103.72	3.018	-0.726

Source: Yahoo Finance (original data: CME Group)
Also, the Augmented Dickey-Fuller (ADF) unit root test rejects stationarity for all the corn price series; therefore, their first differenced values were used.

4. RESULTS

We examined the potential impact of increased ethanol production and COVID-19 pandemic related shocks on the volatility of corn prices and present the ARCH/GARCH estimation results below.

4.1. GARCH Estimation

Except for 2018-19 (the pre-COVID-19 period), the LM tests for ARCH disturbances indicate the presence of heteroscedasticity in all study periods at lag 1. Further investigation shows the 2018-19 series has an ARCH effect at lag 3; hence, lag t-3 was used in its model estimation instead of t-1.

Table 2 GARCH Estimation Results for Corn Price

Variable	Ethanol Expansion			COVID-19 Shutdown	
	Pre-Expansion 2005-06	Initial-Expansion 2006-07	Aggressive-Expansion 2007-08	Pre-Shut Down 2018-19[a]	Shut Down 2020-21
Oil Price	-0.00006	-0.0007	0.0003**	0.000041	0.00097**
ARCH0 (γ_0)	0.3888*	0.3900	4.096	6.6857**	0.4479
ARCH1 (γ_1)	0.1050***	0.0483**	0.0995*	0.1360**	0.1053***
GARCH1(δ_1)	0.8733***	0.9474***	0.8487***	0.5493***	0.9026***
Portmanteau Q statistic	54.47*	29.87	37.46	27.13	50.57

a – ARCH and GARCH at lags 3; ***p value <0.01, **p value <0.05, *p value < 0.1

Post-estimation tests using the Portmanteau test for white noise show that the remaining residuals are not serially correlated at the 5 percent test level (Table 2).

4.2. ARCH/GARCH Results

The estimation results show that oil price, acting as an external shock, only had a statistically significant impact on corn price volatility during the aggressive ethanol expansion period and COVID-19 shut-down period, which suggests the price of oil exacerbates volatility in corn prices during periods of internal market shocks.

The ARCH and GARCH coefficients are positive and statistically significant in all periods. Accordingly, information from the previous day's corn price and the previous day's corn price volatility influences the current day's volatility. While the sizes of these coefficients are relevant, their relative sizes are even more relevant. The GARCH coefficients are significantly larger than the ARCH coefficients, implying that corn price volatility is highly persistent, *i.e.*, the effects of the shock induced price volatility lingered for a considerable time before returning to the mean volatility. Comparison of coefficients between periods shows that the size of the shocks in the ethanol expansion periods was less than in the pre-expansion period; however, it doubled between the initial and aggressive expansion periods. On the other hand, the initial shock was associated with a more remarkable persistence than the pre-shock.

The two right columns of Table 2 show the impact of the COVID-19 shutdown on corn price volatility. Although the intensity of the COVID volatility was slightly less than the pre-COVID volatility, it was significantly more persistent. The sum of the ARCH and GARCH coefficients confirms this; the pre-

shutdown value of 0.686 is less than one; hence a shock reverts to the mean volatility very fast, while the sum for the COVID period is about 1.00; therefore, the covid shock did not dissipate over the study period.

5. CONCLUSION

Unlike opportunities available in the financial markets, the highly perishable nature of agricultural products provides limited time for producers to exploit the volatility of the agricultural commodities market. Producers can, however, use the commodities futures market to manage their price risk. As shown in this study market shocks, such as the rapid ethanol expansion and COVID-19 disruptions, can heighten the price risk farmers face. Therefore, it was valuable to determine the potential volatility change resulting from the two shocks by comparing volatilities before and during the shocks. Corn is traded daily on the CME Group futures market, and the prices are inherently volatile; hence, an ARCH/GARCH model was appropriate for the data. The study examined both the intensity and persistence of shocks.

Evaluation of the results indicates that, overall, volatility in corn price is influenced significantly more by volatility from previous periods than by new price information. The initial ethanol expansion in 2006-07 and COVID-19 shutdown in 2021 had remarkable positive price impacts on volatility for the producer, with the latter not dissipating during the study period. Overall, the study results show the focus should be on the duration of a shock rather than on its size. The results illustrate how the unintended consequences of government policies and black swan events like COVID-19 greatly inhibit the ability of agricultural producers to manage price risk. Farmers need to understand the effects of such shocks and take proactive measures to mitigate their risk exposure and the impact of an inevitable "bust" in corn prices, however long it may take. Finally, the intensity and persistence of the recent volatility identified in the two shocks examined calls for further research to estimate the duration of the volatility, to determine whether it is a shock or a structural shift, and to assess the impact it may have on livestock production where corn is a feedstock.

BIBLIOGRAPHY

1. Baker, A. and Zahniser, S. (2007), "Ethanol Reshapes the Corn Market," *Amber Waves*. United States Department of Agriculture. Economic Research Service.
2. Behnke, K. and Fortenbery, T.R. (2011), "The Impact of Ethanol Production on Local Corn Basis," *Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management*. St. Louis, MO. [http://www.farmdoc.uiuc.edu/nccc134].
3. Bogmans, C., Pescatori, A., and Prifti, E. (2022), "Global Food Prices to Remain Elevated Amid War, Costly Energy, La Niña
4. Bollerslev, T. (1986), "Generalized Autoregressive Conditional Heteroskedasticity," *Journal of Econometrics*, Vol. 31, No. 11, pp. 307-327.
5. Campbell, J.Y., Lo, A.W., and MacKinlay, AC (1996), The Econometrics of Financial Markets 2nd edition. Princeton University Press, Princeton, New Jersey
6. Engel, R.F. (1982), "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation," *Econometrica*, Vol. 50, No. 4, pp. 987-1008
7. Engle, R. (2001), "GARCH 101: The Use of ARCH/GARCH Models in Applied Econometrics," *Journal of Economic Perspectives*, Vol. 15, pp. 157-168. http://www.cmat.edu.uy/~mordecki/hk/engle.pdf http://dx.doi.org/10.1257/jep.15.4.157
8. EIA (2006), *Energy Policy Act 2005 Summary*. Energy Information Administration Annual Energy Outlook 2006. http://www.eia.gov/oiaf/aeo/otheranalysis/aeo_2006analysispapers/epa2005_summary.html#1 [accessed December 17, 2011]
9. EIA (2008), *Energy Independence and Security Act of 2007: Summary of Provisions*. Energy Information Administration Annual Energy 0Outlook 2008. http://www.eia.gov/oiaf/aeo/otheranalysis/aeo_2008analysispapers/eisa.html [accessed December 17, 2011]
10. Luchansky, M.S., Monks, J. (2009), "Supply and demand elasticities in the US ethanol fuel market," *Energy Econ*. Vol. 31, pp. 403–410.
11. McNew, K. and Griffith, D. (2005), "Measuring the Impact of Ethanol Plants on Local Grain Prices," *Review of Agricultural Economics*, Vol. 27, No. 2, pp. 164-180.
12. Olson, A., Klein, N., and Taylor, G. (2007), "The Impact of Increased Ethanol Production on Corn Basis in South Dakota," *Agricultural and Applied Economic Association*, 2007 Annual Meeting, Portland, Oregon, July 29 – August 1, 2007.
13. Park, H. and Fortenbery, T.R. (2007), "The Effect of Ethanol Production on the US National Corn Price," *Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management*. Chicago, IL. [http://www.farmdoc.uiuc.edu/nccc134].
14. Rask, K. (1998), "Clean air and renewable fuels: the market for fuel ethanol in the US. from 1984 to 1993," *Energy Econ*. Vol. 20, pp. 325–345.

15. Serra, T. and Zilberman, D. (2013), "Biofuel-related price transmission literature: A review," *Energy Economics*, Vol. 37, pp. 141-151.
16. Tenkorang, F. A., Dority O'Callaghan, B. L., Bridges, D. E., Lam, E. (2015), "Relationship between Ethanol and Gasoline: AIDS Approach," *Energy Economics*, Vol. 50, pp. 63-69.
17. Tian, G. G., and Guo, M. (2005), "Intraday data and volatility models: evidence from Chinese stocks," *Proceedings of the Australian Conference of Economists: ACE05*. http://researchdirect.uws.edu.au/islandora/object/uws:7343 [Accessed January 20, 2015]
18. Wright, B.D. (2011), "The Economics of Grain Price Volatility," *Applied Economic Perspectives and Policy*, Vol. 33, No. 1, pp. 32-58.

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A QUALITATIVE ANALYSIS OF CLOUD ADOPTION IN THE PUBLIC AND THE PRIVATE SECTORS FROM CYBER SECURITY VENDORS' PERSPECTIVE

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Abstract: *My research explores new marketing trends in the private and public sectors concerning the adoption of native cloud applications from cybersecurity vendors. Semi-structured interviews were conducted with two marketing leaders from cybersecurity companies. One company sells to the public sector, the other to the private sector. Following qualitative and content analysis, the results showed many advantages for both sectors of shifting to native cloud applications. In the public sector, there is reluctance to adopt cloud applications primarily because of security challenges and a lack of ecosystem integration alternatives. Offering diverse deployment types was found more effective when selling to the public sector. Applying wide and flexible online marketing techniques and strategies is more effective with customers in the private sector. On-premises deployment is used more frequently in the public sector, where both the lack of ecosystem integrations in cloud applications and perceived security challenges inhibit customer adoption of native cloud applications.*

Keywords: *cloud, cloud security, cybersecurity, SaaS, hybrid cloud, on-premises, native cloud, cloud adoption, migration to the cloud, cloud computing, ecosystem integrations, cost saving, value proposition*

1. INTRODUCTION

Over the last decade, organizations have shifted business applications from on-premises to the cloud. Boillat and Legner (2013) pointed out the affect of cloud computing on the business models of enterprise software vendors when moving from on-premises software to cloud services. Many enterprise software vendors saw an opportunity to increase their customers' success and to reduce costs. For example, the following studies discuss the advantages of moving to the cloud (FutureScape, I.D.C., 2022; Pugh, 2021; Chowdhury, 2018; Egbert, 2015; Walther

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et al., 2012). However, customers in both the public and private sectors, for differing reasons, are not all ready to shift to the cloud.

The goal of my research is to identify ways for vendors to convince customers to shift to native cloud applications and to avoid losing them as customers when development of an on-premises version is discontinued in favor of a native cloud platform. The study explores interesting marketing trends in the public and private sectors from cybersecurity vendors, which may fuel further research about value proposition plans when shifting clients from on-premises to the cloud.

Qualitative research consisted of interviews with two marketing leaders from cybersecurity companies, of which one sells to the private sector and the other to the public sector. Each interview took about 45 minutes and included ten open questions, which are detailed in Appendix A. The data analysis consisted of eight steps: reading and organizing the data; defining the unit of analysis; creation of codes and categories; selecting quotes and memos reminders; validation and verification; coding all text to its associated category; identification of themes, summarizing results: themes, their relations to categories and selected quotes and discussions.

Results show that first, both sectors perceive an advantage when using cloud-based software. Second, those vendors who sell to the private sector make greater use of online marketing strategies to get new leads. Third, the public sector is reluctant to shift to the cloud because of security concerns and a lack of ecosystem integrations, and fourth, vendors who sell to this sector can address the latter barrier for the meantime by offering diverse deployment solutions. However, to allow the public sector to leverage the advantages of cloud applications, vendors should continue their efforts to develop other comprehensive cloud offerings and additional ecosystem integrations using hybrid modes.

This paper describes the methods, instruments used, and the eight steps of the content analysis stage. It presents the results; previous studies and literature related to the results; the meaning of the results; limitations of the research; and concludes with the contribution and implications of this paper and suggestions for future research.

2. LITERATURE REVIEW

Customers from both the public and private sectors have already raised challenges and gaps in their business environment, delaying them from adopting various cloud software solutions. For example, research by Shultz (2016) examined

the question of security for application providers and found that security concerns were the most commonly cited reasons that enterprises were not interested in SaaS.

Many other studies refer to additional challenges, including small organizations that are not ready for the move, regulations readiness, training, and resources gaps (Ivan & Ille, 2021; Griffith & Stewart 2020; Meersman & Mulchahey, 2019; Taylor, 2018; Gumbi & Mnkandla, 2015; Gai, 2014; Boillat & Legner, 2013; Bhayal, 2011).

Salih et al. (2021) researched and analyzed the 16 critical success factors that impact cloud ERP adoption and identified 12 influence drivers related to security, usability, and vendors. They focused primarily on ERP adoption and not cybersecurity software and did not differentiate sector types. Gai (2014) examined how to leverage private cloud computing in financial services, focusing mainly on financial services and private cloud and not native cloud and security solutions. Dimitrakos (2014) detailed innovation versus cyber security challenges and predicted that the cloud aggregation ecosystem would be the main innovation after 2020, raising new security challenges. The migration process to the cloud, and specifically security software, was not covered. Bhayal (2011) pointed out security challenges in cloud computing, such as protecting data privacy from breaches and suggested how to avoid third party audits by applying data integrity check solutions. However, neither security software migration to the cloud nor ecosystem considerations nor sector-type differentiation were covered in the research. In addition, many security vendors operate their solutions exclusively on-site, so in some circumstances, integration with such security tools would not be feasible in the cloud.

Boillat and Legner (2013) pointed out the affect of cloud computing on business models of enterprise software vendors when moving from on-premises software to cloud services. They suggested two options for business models, SaaS, and SaaS+PaaS, and found that vendors using PaaS compensate for the over simplicity and lack of ecosystem integrations in SaaS mode. They did not research security vendors and did not differentiate between vendors who sell to the private or the public sector.

Tawfique and Vejseli (2018) researched the decision to migrate to the cloud, focusing on the security aspects from the consumer perspective. They concluded that some organizations hesitate to make this move because of security concerns and prefer to keep their existing security tools on-site.

Concerning the public sector, the former US CIO, Vivek Kundra, published (2011) the Federal cloud computing strategy. With this strategy, he highlighted the importance of cloud adoption. The main reasons were cost-saving, reducing cost

from 80 billion to 20 billion dollars in the long-term, efficiency and consolidation of data servers. The Federal Risk and Authorization Management Program (FedRAMP) was established one year after a joint effort by the NIST (National Institute of Standards and Technology, 2004, 2006, 2011, 2014, 2015, 2016, 2018, 2019) and the US CIO office to create and gather all frameworks, security guidelines, and requirements for the federal and public sector and then certify as many software and cloud vendors as possible according to the federal needs.

Figliola and Fischer (2015) pointed out many challenges concerning the implementation of the U.S. government cloud adoption plan. For example, the FedRAMP process takes lots of time, and there are only a few certified vendors to select. Another concern raised was portability, the potential for getting locked into a specific vendor's product and being dependent on them for any changes. They also identified the lack of staff with expertise in cloud solutions and implementation guidelines which were later improved over the years by the N.I.S.T. and FedRAMP. Taylor (2018) used the ECMF (Enterprise Cloud Migration Framework), which consists of five steps and nine attributes, in order to identify challenges and barriers of cloud adoption within the government space. Neither security software migration nor ecosystem integrations were covered in the research.

Both the private and the public sectors see advantages in shifting to the cloud. These advantages were also deduced from the content analysis in this paper and align with previous cloud adoption studies: (FutureScape, I.D.C., 2022; Pugh, 2021; Chowdhury, 2018; Egbert, 2015; Walther et al., 2012).

3. METHODS

3.1.Primary Aim

This analysis aimed to identify and explore marketing trends, from the vendors' perspective, concerning the willingness of customers in the public and private sectors to shift to a cloud application. I contacted two participants in Israel via LinkedIn and interviewed them via Zoom. The requirements for the sample were to have at least three years of experience working at a cybersecurity vendor that develops cybersecurity solutions; to be over the age of 18, and to be involved with business and marketing activity within their organization. I also aimed to have at least one participant from a company selling security solutions to the private sector and another selling security solutions to the public sector.

3.2.Participants Profile

Participant 1 is an executive sales and marketing leader in a cybersecurity company that sells security solutions to customers in the public sector and has over twenty years of experience, including about ten years in cybersecurity. Participant 2 is a digital marketing manager with six years of experience, more than three years of which is in the field of cybersecurity, who works at a cybersecurity vendor that sells security solutions to the private sector. Both interviewees are over the age of 18. They are thoroughly involved in and familiar with their companies' core business processes, marketing activity, and strategy. They both volunteered and signed a consent form to participate in this assignment. Their identity will be kept confidential and anonymous. For the interview questionnaire, see Appendix A.

3.3.Summary of the Content Analysis

The main steps for this content analysis are adopted from well-known sources, including (LibGuides N.C.U., 2022; Creswell, 2014; Zhang, et al., 2005; Mayring, 2004; O'Connor & Gibson, 2003).

Step 1: Read and Organize the Data

The data were collected, prepared, and organized, then holistic and floating reading was performed over the data. Both interviews were conducted with Zoom recording and took about 45 minutes. A transcript of the recording was exported and translated, and participants' identities were disguised.

Step 2: Define Units of Analysis

I minimized the data, defined the units of analysis, and detected ideas and concepts in words and phrases. Both participants' responses, comments and phrases were marked with different colors related to a specific code. Table A in the results section presents the Units of Analysis.

Step 3: Create and Refine Codes and Categories

I created and refined codes and categories for all the ideas and concepts, reviewed all answers during the interview, created codes for the replies from both participants, and selected participants' quotes related to the project's aim. Table B in the results section presents the defined codes and categories.

Step 4: Select Quotes and Memos

I wrote memos for each participant's answers so as to not forget them when gathering all of the information at the end and selected essential quotes.

Step 5: Validation and Verification

I tested codes, performed validation and correction, checked, and verified for consistency.

Step 6: Code All Text Associated to Categories and Verification

After rereading the data and the relevant associated categories, as presented in Table B, I coded all text from both interviews and verified it.

Step 7: Identify Themes and Relations to Categories and Selected Quotes

I identified themes and then defined the relations between categories and themes. For the results of this step, see Table C and Table D.

Step 8: Summarize Findings and Discussions

I documented the results summary, findings, conclusions, and discussions in both the following sections of this article and in Table E.

4. RESULTS

Following the content analysis, 81 codes were created. Eight major categories associated with the codes were identified: Shift to Cloud Factors, Encouragement of Cloud, Concerns About Cloud, Value of On-Premises, Deployment Types, Diverse Deployment Offerings, Conventional Marketing Techniques, and Online Marketing Techniques. See Table A for the full relationships between defined codes and categories.

The main themes which were identified:

- There are advantages to using the native cloud for both the public and the private sectors
- On-premises deployment is used more frequently in the public sector, where both the lack of ecosystem integrations in cloud applications and perceived security challenges inhibit customers from shifting to the cloud
- Diverse deployment types are effective when selling to the public sector
- Applying wide and flexible online marketing techniques and strategies are more effective with customers in the private sector

For the results of identified themes and their relation to categories, see Table B.

For the relationships between themes and categories, see Table C.

During the interview, I wrote memos and selected meaningful quotes, then summarized the full details of both the related quotes with the themes and related categories in Table D and Table E summarizes codes, categories, themes, selected quotes, and their relations.

Table A: Units of Analysis

Units of Analysis :				
both on-premises Hybrid and native cloud option	security that they are expecting	use PPC	simplify the general complexity using our software	He can rest assured that he receives all the support that he needs
encourage them to use the cloud	high level of service.	adds on Google. And also they hire a Co-manager. In addition, we have APM account	scale their network secured in minutes	deployed easily.
security preferences.	cost saving in terms	professional conventions.	PPC, SEO media buying, and affiliates.	it's straightforward
specific security restrictions.	lot of kind of sink cost,	focus on a particular industry,	We use a wide variety of social networks to reach potential customers in the private sector.	very user-friendly
Price	enjoy access from everywhere	e public security domain	Conventions	many competitors. Some are very small as startups, some are medium, and Some
we are capable to support all options and all varieties with our product	features that only if they are on the cloud	our portfolio product can fit also wide range of industries	use a lot LinkedIn the most, and Twitter and Facebook also	They have many solutions, on-prem and cloud and integrations and everything, and enjoy stability, as they have existed for
cloud SaaS native only	It's for sure more efficient in the cloud.	Recently we are exploring a different market different opportunity. But	main reason is fear	many years in the market
promote our cloud solution	integrating with different kinds of database sources with on-premises mode with cloud much less.	all industries they don't really contact with the military, governments, or other public sectors, because most are not interested	reasons, including pricing	Yes to his customers to suggest to them our
on-premises only because of government and public sector customers	and can connect with others,	Of course, we want a realistic solution	fear of security	help him quickly
many of them stay in on-premises mode, and we keep them like that	save money and time.	in some cases, we are bringing some more value. So the answer	we sometimes see organizations that decided not to go on cloud but change their opinion after a year.	a customer point of view
These customers would not move quickly to native cloud applications if ever, and we don't intend to push them	easily with simplicity,	adding third-party partners to partner with us.	the on-premises contains more features	from our point of view, we come and decide to explore
Understanding customers' needs are crucial to us	securing against cyber security threats	we use project companies. So basically, it's been done by the system integrator we partner with	fifty users a minimum up to two, twenty, five hundred uh.	a decision to move forward
the marketing is aligned with all their need and requests	On the network.	it's not built-in with the cloud	the challenge of security concern to move to the cloud	simplicity,
on our marketing case by case.	long-term savings	There is a lot of strength in connecting with other systems.	However, most companies today understand that the cloud is the new future. It's easier in some situations and safer than on-premises.	ease of use
Linkedin and organization connections techniques	buy something that can that is like a one-stop shop	We do have some built in integrations with our cloud solution but customer demanding more , it's not enough what we have	fast deployment and	cost saving
It's the customer's decision. We do not stick to something specific.	excellent service	. For example, they don't have Cosby	accessibility anywhetre ,still	we will surely make our best in order to fit to the right environment
If the customer decides on something specific, we will deploy it.	account manager	Yes, the solution is limited some on the development, but it's not live for the customers in production mode.	always available twenty-four hours, seven days	we try to provide added value features on the cloud all time to differentiate our product than other competitors
We check customers' needs very carefully.	point of contact	ability to quickly detect and defend the unified network and cyber security tools.		

Table B: Finalizing Codes and Categories for Concepts and Ideas

Code	Categories	Code	Categories
Security Restrictions	Concerns About Cloud	Using Conventions Both for Public and Private Sectors	Conventional Marketing Techniques
Security Preference		Using LinkedIn for Both Public and Private Sectors	
Trust in Cloud		Conventions (Public sector)	
Security Fears (mainly Public sector)		Tenders(Public sector)	
Breached Risk (mainly Public sector)		LinkedIn Direct (Public sector)	
Data Privacy Risk (mainly Public sector)		Future Efforts	
Lack of Integrations (native cloud for private)		Pricing Decision	Shift to Cloud Factors
On-premises Deployment	Deployment Types	Pricing Model	
Cloud Deployment		Fast Deployment	
Native Cloud Deployment		Accessibility Anywhere	
Hybrid deployment		High Level of Service	
Using PPC for Private Sectors	Online Marketing Techniques	Cost Saving	
Using Google AdWords for Private Sectors		No HW Needed	
Using SEO Media for Private Sectors		No Maintenance Needed	
Using Affiliates for Private Sectors		No Upgrades	
Simplicity Messages for Private Sectors		Cloud Efficiency	
Efficiency Messages for Private Sectors		Easy With Simplicity	
Using LinkedIn Twitter and Facebook for Private Sectors		Long Term Saving	
Account Manager		User friendly UI	
Co-Manager		Simplicity	
ABM Account		Ease of Use	
Affiliate Specialist		Cost Saving	
Product Management		UI Accessible from Outside	
Product Marketing Manager		Using Extended Features	
PPC		Customer's Decision	Diverse Deployment Offerings
PR team		Marketing Alignment	
On-premises Mainly Federal and Government	Value of On- Premises	Customer's First Approach	
On-premises -Significant Payment		Customer Needs	
Compliance (mainly important for public sector)		Case by Case Deployment Decision	
More Features and Functionalities in On- Premises (mainly for the public sector)		Comply Customer Needs	
Lower Scaling (native cloud)-up to certain amount of users		Flexibility Solution	
Higher Scaling for Public (support more users)		Competency Solution	
Military and Government		Customer's View (Public sector)	
Support in Scale		Customer's Decision (public sector)	
Not built-in Integration		Explore New Markets	
Using System Integrator		Product Fit	
Using Customizations		Realistic Solution	
Limited Ecosystem Integration on Cloud			
Cloud Encouragement	Encouragement of cloud		
Cloud SaaS			
Cloud Promotion			
Good Security Also in Cloud			
One Stop Shop			
Shifting Customer's to Cloud			

Table C: Relations Between Categories and Themes

Categories	Themes
Shift to Cloud Factors	1. There are advantages to using the native cloud for both the public and the private sectors
Encouragement of Cloud	
Concerns About Cloud	2. On-premises deployment is used more frequently in the public sector, where both the lack of ecosystem integrations in cloud applications and perceived security challenges inhibit customers from shifting to the cloud
Value of On-Premises	
Deployment Types	3. Diverse deployment types are effective when selling to the public sector
Diverse Deployment Offerings	
Conventional Marketing Techniques	4. Applying wide and flexible online marketing techniques and strategies is more effective with customers in the private sector
Online Marketing Techniques	

Table D: Relations Between Themes Categories and Selected Quotes

Themes : Relations to Categories and Selected Quotes	
1. There are advantages to using the native cloud for both the public and the private sectors	**3.Diverse deployment-types are effective when selling to the public sector**
Relation to Categories	**Relation to Categories**
Shift to Cloud Factors	Deployment Types
Encouragement of Cloud	Diverse Deployment Offerings
Selected Quotes:	**Selected Quotes:**
" Most of the companies today understand that the cloud is the new future it's easier and in some situation safer then on premises." " It's for sure more efficient in the cloud" "He can rest assured that he receives all the support that he need." "we try to provide added value features on the cloud all time to differentiate our product than other competitors"	"We're able to support all options and all varieties with our product for the public sector" "we see sometimes organizations that decided not to go on cloud but after a year they change their opinion in public sector" "but we in our case are much more flexible" "Our competitors have lots of solutions, on-prem and cloud and integrations" "We will surely make our best in order to fit to the right environment."
2. On-premises deployment is used more frequently in the public sector, where both the lack of ecosystem integrations in cloud applications and perceived security challenges inhibit customers from shifting to the cloud	
Relation to Categories	**4. Applying wide and flexible online marketing techniques and strategies are more effective with customers in the private sector**
Concerns About Cloud	**Relation to Categories**
Value of On-Premises	Conventional Marketing Techniques
Selected Quotes:	Online Marketing Techniques
"Many of them stay in on-premises mode and we keep them like that" "We are open to integrating with different kind of sources of the database with on-premises mode with cloud much less." "There is a lot of strength to connect with other systems" "We use system integrators for customizations" "the on-prem version contain more features." "We do have some built in integrations with our cloud solution but customer demanding more ,it's not enough what we have"	**Selected Quotes:** "We use a wide variety of social networks to reach potential customers in the private sector"

Table E: Summary- Codes, Categories Themes, Selected Quotes, and Their Relations

Code	Categories	Themes : Relations to Categories and Selected Quotes
Security Restrictions	Concerns About Cloud	**1.There are advantages to using the native cloud for both the public and the private sectors**
Security Preference		**Relation to Categories**
Trust in Cloud		Shift to Cloud Factors
Security Fears (mainly Public sector)		Encouragement of Cloud
Breached Risk (mainly Public sector)		**Selected Quotes:**
Data Privacy Risk (mainly Public sector)		"We explain how to simplify the general complexity using our software" " Most of the companies today understand that the cloud is the new future it's easier and in some situation safer then on premises." " It's for sure more efficient in the cloud" "He can rest assured that he receives all the support that he need." "we try to provide added value features on the cloud all time to differentiate our product than other competitors"
Lack of Integrations (native cloud for private)		
On-premises Deployment	Deployment Types	**2. On-premises deployment is used more frequently in the public sector, where both the lack of ecosystem integrations in cloud applications and perceived security challenges inhibit customers from shifting to the cloud**
Cloud Deployment		**Relation to Categories**
Native Cloud Deployment		Concerns About Cloud
Hybrid Deployment		Value of On-Premises
Using PPC for Private Sectors	Online Marketing Techniques	**Selected Quotes:**
Using Google AdWords for Private Sectors		
Using SEO Media for Private Sectors		"Many of them stay in on-premises mode and we keep them like that" "We are open to integrating with different kind of sources of the database with on-premises mode with cloud much less." "There is a lot of strength to connect with other systems" "We use system integrators for customizations" "the on-prem version contain more features." "We do have some built in integrations with our cloud solution but customer demanding more ,it's not enough what we have"
Using Affiliates for Private Sectors		
Simplicity Messages for Private Sectors		
Efficiency Messages for Private Sectors		
Using LinkedIn Twitter and Facebook for Private Sectors		
Account Manager		
Co-Manager		
ABM Account		
Affiliate Specialist		
Product Management		**3.Diverse deployment-types are effective when selling to the public sector**
Product Marketing Manager		**Relation to Categories**
PPC		Deployment Types
PR Team		Diverse Deployment Offerings
Using Conventions Both for Public and Private Sectors	Conventional Marketing Techniques	**Selected Quotes:**
Using LinkedIn for Both Public and Private Sectors		"We're able to support all options and all varieties with our product for the public sector" "we see sometimes organizations that decided not to go on cloud but after a year they change their opinion in public sector" "but we in our case are much more flexible" "Our competitors have lots of solutions, on-prem and cloud and integrations" "We will surely make our best in order to fit to the right environment." **4.Applying wide and flexible online marketing techniques and strategies are more effective with customers in the private sector** **Relation to Categories** Conventional Marketing Techniques Online Marketing Techniques **Selected Quotes:** "We use a wide variety of social networks to reach potential customers in the private
Conventions (Public sector)		
Tenders(Public sector)		
LinkedIn Direct (Public sector)		
Future Efforts		
Pricing Decision		
Pricing Model		
Fast Deployment		
Accessibility Anywhere		

High Level of Service	Shift to Cloud Factors	
Cost Saving		
No HW Needed		
No Maintenance Needed		
No Upgrades		
Cloud Efficiency		
Easy with Simplicity		
Long Term Saving		
User Friendly UI		
Simplicity		
Ease of Use		
Cost Saving		
UI Accessible from Outside		
Using Extended Features		
On-premises Mainly Federal and Government	Value of On-Premises	
On-premises -Significant Payment		
Compliance (mainly important for public sector)		
More Features and Functionalities in On-Premises (mainly for public		
Lower Scaling (native cloud)-up to certain amount of users		
Higher Scaling for Public (support more users)		
Military and Government		
Support in Scale		
Not Built-in Integration		
Using System Integrator		
Using Customizations		
Limited Ecosystem Integration on Cloud		
Cloud Encouragement	Encouragement of Cloud	
Cloud SaaS		
Cloud Promotion		
Good Security also in Cloud		
One Stop Shop		
Shifting Customer's to Cloud		
Customer's Decision	Diverse Deployment Offerings	
Marketing Alignment		
Customer's First Approach		
Customer Needs		
Case by Case Deployment Decision		
Comply Customer Needs		
Flexibility Solution		
Competency Solution		
Customer's View (Public sector)		
Customer's Decision (public sector)		
Explore New Markets		
Product Fit		
Realistic Solution		

5. DISCUSSION

This study aimed to explore new marketing trends in private and public sectors concerning cloud adoption and willingness to shift from on-premises to native cloud applications from the perspective of cybersecurity vendors.

The results showed significant perception trends from the perspective of cybersecurity vendors. It seems that when a security vendor sells to the public sector, the vendor offers a diverse selection of types of deployments. The vendor encourages the customer to shift to the cloud but does not insist; the decision is left to the customer, who can decide to deploy in either on-premises or cloud mode. Such an offering has advantages and disadvantages. By letting the customer choose the deployment type, the vendor retains customer loyalty, especially if this is a top revenue and strategic account. On the other hand, the vendor invests more in developing two versions of the same product in parallel, one as a native cloud and another for on-premises, which increases the cost of development, support and sales for the security vendor. By investing resources in two platforms, over time, the quality of the vendor's product may also decline compared to other pure SaaS and native cloud vendors who devote their efforts to just one platform.

The literature shows the importance of finding solutions for security gaps by having more FedRAMP-certified vendors (Figliola & Fischer, 2015). My results identified a significant theme. The on-premises theme also aligns with previous studies mentioned in the literature review. Vendors who leverage these findings by increasing their cloud capabilities with more ecosystem integrations and comprehensive cloud offerings may increase their public sector customers' motivation to shift from on-premises to the cloud.

Based on the security vendors' perspective, another theme finding was that security vendors who sell to the private sector leverage more social networks and diverse marketing strategies. This sector also seems to adopt faster cloud and multitenancy. These findings make sense since the private sector is more open to online SaaS products and innovations to save costs and is not constrained by so many security regulations as the public sector.

Since both vendors have thousands of customers, the findings cover trends across a significantly large number of customers from the private and public sectors. However, further research with more vendors can assist in exploring more important trends.

6. CONCLUSIONS

The interviews and content analysis raised some interesting marketing trends and approaches. It was valuable to get perspectives from both the public and private sectors since interviewees are in the same software industry but sell to different sectors.

I detected some interesting trends:

☑ First, both participants raised perceptions of the advantages of native cloud applications in the public and private sectors. This position is also supported by the literature today, for example, with the following studies: (Pugh, 2021; Chowdhury, 2018; Egbert, 2015; Walther et al., 2012).

☑ Second, the importance and value of on-premises deployment for the public sector were highlighted several times, as well as trust and security concerns in cloud aspects. A central theme was that on-premises deployment type is used more frequently by the public sector, and lack of ecosystem integrations in cloud and security challenges inhibit customers from shifting to the cloud. A significant implication is that security vendors should focus more on this customer objection and consider extending their cloud integration offerings and comprehensive offerings on the cloud.

☑ Third, I found that security vendors who sell to the public sector use diverse deployment types offered for their customers, which seem very effective and assist in retaining enterprise customers. However, vendors should consider that developing two product lines in parallel may be inefficient and increase costs.

☑ Fourth, using social networks and online strategies to get more leads seems to work better when marketing to the private sector than the public sector, which adopts more conventional methods of getting leads, such as tenders, conventions, LinkedIn, and more direct contact.

Although the study covers trends across a large number of customers, since both vendors each have thousands of customers, it is still limited since it was conducted with just 2 vendors so further research building on this study should analyze more vendors' perspectives from various organizations. Also, additional research from the perspective of customers will allow the correlation of data with vendors' perspectives and create value proposition plans for vendors wishing to shift their customers from on-premises deployment to native or hybrid cloud.

REFERENCES

1. Bhayal, S., 2011. A study of security in cloud computing. California State University, Long Beach.
2. Boillat, T. and Legner, C., 2013. From on-premise software to cloud services: the impact of cloud computing on enterprise software vendors' business models. Journal of theoretical and applied electronic commerce research, 8(3), pp.39-58.
3. Boyens, J., Paulsen, C., Moorthy, R., Bartol, N. and Shankles, S.A., 2015. Supply chain risk management practices for federal information systems and organizations. N.I.S.T. Special Publication, 800(161), p.32.
4. Carter, L. and Bélanger, F., 2005. The utilization of e-government services: citizen trust, innovation and acceptance factors. Information systems journal, 15(1), pp.5-25.
5. Chandramouli, R. and Chandramouli, R., 2016. Secure virtual network configuration for virtual machine (vm) protection. N.I.S.T. Special Publication, 800, p.125B.
6. Chowdhury, N., 2018. Factors influencing the adoption of cloud computing driven by big data technology: a quantitative study (Doctoral dissertation, Capella University).
7. Creswell, J.W., 2014. Qualitative, quantitative and mixed methods approaches.
8. Diaz, A.A. 2022, Organizational Paradoxes of Cloud Adoption in the Federal Government: A Quantitative Study of the Organizational Change Challenges Impacting Cloud Adoption, The George Washington University.
9. Dimitrakos, T., 2014, August. Cloud Security Challenges and Guidelines. In EIT ICT Labs Symposium on Trusted Cloud and Future Enterprises.
10. Disterer, G. ISO/IEC 27000, 27001 and 27002 for information security management". 2013.
11. Egbert, M., 2015. Driving Public Cloud Adoption through Qualitative and Quantitative Modeling (Doctoral dissertation, Pace University).
12. Fagan, M., Megas, K., Scarfone, K. and Smith, M., 2019. Core cybersecurity feature baseline for securable IoT devices: A starting point for IoT device manufacturers (No. N.I.S.T. Internal or Interagency Report (N.I.S.T.I.R.) 8259 (Draft)). National Institute of Standards and Technology.
13. Figliola, P.M. and Fischer, E.A., 2015, January. Overview and issues for implementation of the federal cloud computing initiative: Implications for federal information technology reform management. Library of Congress, Congressional Research Service.
14. FutureScape, I.D.C., 2022. I.D.C. FutureScape: Worldwide I.T. industry 2022 predictions.
15. Gai, K., 2014. A review of leveraging private cloud computing in financial service institutions: Value propositions and current performances. Int. J. Comput. Appl., 95(3), pp.40-44.
16. Griffith, L.D. 2020, Strategies Federal Government I.T. Project Managers Use to Migrate I.T. Systems to the Cloud, Walden University.
17. Gumbi, L.N. and Mnkandla, E., 2015. Investigating South African Vendors' cloud computing value proposition to small, medium and micro enterprises: a case of the

City of Tshwane Metropolitan Municipality. The African Journal of Information Systems, 7(4), p.1.

18. I.B.M. Launches Open Technology to Speed Response to Cyber Threats Across Clouds (2022). Available at: https://newsroom.ibm.com/2019-11-20-IBM-Launches-Open-Technology-to-Speed-Response-to-Cyber-Threats-Across-Clouds (Accessed: 27 April 2022).
19. Ivan, T.R. and Ille, E.E., 2021. Applying Multi-Criteria Decision-Making to the Technology Investment Decision-Making Process. Acquisition Research Program.
20. Joint Task Force, 2018. Risk Management Framework for Information Systems and Organizations: A System Life Cycle Approach for Security and Privacy. (National Institute of Standards and Technology, Gaithersburg, MD), N.I.S.T. Special Publication (S.P.) 800-37 Rev. 2. https://doi.org/10.6028/NIST.SP.800-37r2
21. Joint Task Force Transformation Initiative, 2011. Managing Information Security Risk: Organization, Mission, and Information System View. (National Institute of Standards and Technology, Gaithersburg, MD). N.I.S.T. Special Publication (S.P.) 800-39. https://doi.org/10.6028/NIST.SP.800-39
22. Kundra, V., 2011. Federal cloud computing strategy.
23. LibGuides: Chapter 4: Chapter 4: Analysis and Coding Example, 2022. Available at: https://library.ncu.edu/c.php?g=1007180&p=7392331 (Accessed: 24 November 2022).
24. Maurya, 2019. Fortinet tightens partnership with Google Cloud to provide advanced cloud security and accelerate the cloud on-ramp. GlobeNewswire News Room. Available at: https://www.globenewswire.com/news-release/2019/12/16/1961138/0/en/Fortinet-Tightens-Partnership-with-Google-Cloud-to-Provide-Advanced-Cloud-Security-and-Accelerate-the-Cloud-On-Ramp.html [Accessed April 28, 2022].
25. Mayring, P., 2004. Qualitative content analysis. A companion to qualitative research, 1(2), pp.159-176.
26. Meersman, M.W., 2019. Developing a Cloud Computing Risk Assessment Instrument for Small to Medium Sized Enterprises: A Qualitative Case Study Using a Delphi Technique (Doctoral dissertation, Northcentral University).
27. Metheny, M., 2017. Federal cloud computing: The definitive guide for cloud service providers. Syngress.
28. Mulchahey, K.E. 2019, Exploration of Complexities for Migration of Software-Licensing Models, Capella University.
29. National Institute of Standards and Technology, 2019. N.I.S.T. Privacy Risk Assessment Methodology (PRAM). (National Institute of Standards and Technology, Gaithersburg, MD). https://www.nist.gov/itl/applied-cybersecurity/privacy-engineering/resources
30. NIST FIPS, 199.National Institute of Standards and Technology, 2018. Framework for Improving Critical Infrastructure Cybersecurity, Version 1.1. (National Institute of Standards and Technology, Gaithersburg, MD). https://doi.org/10.6028/NIST.CSWP.04162018

31. O'Connor, H. and Gibson, N., 2003. A step-by-step guide to qualitative data analysis. *Pimatisiwin: A Journal of Indigenous and Aboriginal Community Health*, *1*(1), pp.63-90.
32. Peake, C., 2018. Accepting the Cloud: A Quantitative Predictive Analysis of Cloud Trust and Acceptance Among I.T. Security Professionals (Doctoral dissertation, Capella University).
33. Pub, F.I.P.S., 2004. Standards for security categorization of federal information and information systems.
34. Pugh, C.E. 2021, Regulatory Compliance and Total Cost Influence on the Adoption of Cloud Technology: A Quantitative Study, Capella University.
35. Rose, S., Borchert, O., Mitchell, S. and Connelly, S., 2019. Zero trust architecture. National Institute of Standards and Technology.
36. Ross, R., McEvilley, M. and Oren, J., 2016. Systems security engineering: Considerations for a multidisciplinary approach in the engineering of trustworthy secure systems (No. N.I.S.T. Special Publication (S.P.) 800-160 (Withdrawn)). National Institute of Standards and Technology.
37. Ross, R.S., Dempsey, K.L., Viscuso, P., Riddle, M. and Guissanie, G., 2016. Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations [including updates as of 01-14-2016].
38. Salih, S., Hamdan, M., Abdelmaboud, A., Abdelaziz, A., Abdelsalam, S., Althobaiti, M.M., Cheikhrouhou, O., Hamam, H. and Alotaibi, F., 2021. Prioritising Organisational Factors Impacting Cloud ERP Adoption and the Critical Issues Related to Security, Usability, and Vendors: A Systematic Literature Review. Sensors, 21(24), p.8391.
39. Shultz, A., 2016. Controlling the Emerging Data Dilemma: Building Policy for Unstructured Data Access. In Information Security Management Handbook, Volume 5 (pp. 229-242). Auerbach Publications.
40. Slade, E.L., Dwivedi, Y.K., Piercy, N.C. and Williams, M.D., 2015. Modeling consumers' adoption intentions of remote mobile payments in the United Kingdom: extending U.T.A.U.T. with innovativeness, risk, and trust. Psychology & Marketing, 32(8), pp.860-873.
41. Stewart, J.C.I., 2020. End-User Cloud Data Storage Experiences, Challenges, and Security Perceptions of the Emerging Technologies Security Tools among Small Businesses (Doctoral dissertation, Capella University).
42. Swanson, M., Hash, J. and Bowen, P., 2006. Guide for developing security plans for federal information systems (No. N.I.S.T. Special Publication (S.P.) 800-18 Rev. 1). National Institute of Standards and Technology.
43. Tawfique, K. and Vejseli, A., 2018. Decision to migrate to the Cloud: A focus on security from the consumer perspective.
44. Taylor, C.M., Sr. 2018, Identifying and Overcoming the Barriers to Cloud Adoption within the Government Space, The George Washington University.
45. The Smart Grid Interoperability Panel—Smart Grid Cybersecurity Committee, 2014. Guidelines for Smart Grid Cybersecurity: Volume 1 - Smart Grid Cybersecurity

Strategy, Architecture, and High-Level Requirements. (National Institute of Standards and Technology, Gaithersburg, MD), N.I.S.T. Interagency or Internal Report (I.R.) 7628, Rev. 1, Vol. 1. https://doi.org/10.6028/NIST.IR.7628r1

46. Venkatesh, V., Morris, M.G., Davis, G.B. and Davis, F.D., 2003. User acceptance of information technology: Toward a unified view. M.I.S. quarterly, pp.425-478.
47. Walther, S., Plank, A., Eymann, T., Singh, N. and Phadke, G., 2012. Success factors and value propositions of software as a service providers–a literature review and classification.
48. Zhang, Y., & Wildemuth, B. M., 2005. Qualitative analysis of content, 1-12.

APPENDIX A: INTERVIEWS QUESTIONNAIRE

1. Does your organization sell software security on the cloud, hybrid cloud (some components on-premises and some on the cloud), or native cloud applications to your customers? Could you describe the type of deployments offered today to your customers?
2. Does your organization have a clear marketing strategy plan for selling your cloud application\module solution to customers running a competitor solution that can be deployed just in on-premises mode?
3. Could you provide three main reasons for potential customers who decided not to purchase your cloud application module\solution?
4. Could you point out three main reasons why some of your customers decided to purchase your cloud module solution?
5. Do you see some of your on-premises competitors' solutions as direct competitors to your cloud module offering solution?
6. Does your organization try to shift customers who used to work in on-premises software (Yours or a competitor's) to your cloud application software?
7. What strategies does your organization use to get new leads for your cloud application module\solution?
8. Is your security product offered to a specific industry \sector? Do you think a security software solution such as a native cloud application module like yours should get sold to a particular industry?
9. Does your organization partner with various ecosystem integration third parties to improve your cloud application offering?
10. Does your organization provide on your cloud application platform extended features that can be used on cloud applications only or basic functionalities that can also be achieved with on-premises version, and just the U.I. is available on the cloud?

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EFFECTS OF INDEX ADDITIONS ON STOCK PRICE INFORMATIVENESS

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Abstract: *Passive fund management has expanded rapidly over the past decade and has become a preferred tactic amidst investors from developed and developing countries alike. Scholars tend to attribute such a change of an investment strategy to the increase in stock market efficiency. Nonetheless, some studies show a reverse causality.*
Our study aims to uncover whether there is a dependency between a stock's additions to an index and an increase/decrease in its price informativeness.
We centered our study around S&P 500 between January 1993 and December 2017. As a result, a sample of 1178 additions that occurred during the analysis period was gathered.
To test the null hypothesis, we applied the Harris and Gurel (1986) event study methodology using two different event windows to quantify for the non-stationarity effects.
The results suggest that a stock's addition to the S&P 500 Index affects the price informativeness in the event and post-event event windows, nonetheless, the effects of price informativeness over abnormal returns are only significant for the post-event window, whereas, for the ex-ante window, abnormal returns are arguably influenced by company-specific risk, suggesting more speculative practices rather than information-based decisions in the pre-event period.
In line with other academic literature on this subject, the change in abnormal returns around the event date is attributed to an increase in liquidity and analyst coverage.

Keywords: *Market Efficiency, index additions, indexing effect, investor awareness, price informativeness, event study, abnormal returns, price synchronicity*

1. INTRODUCTION

The publishing of the "Efficient Markets Hypothesis" back in 1970 (Fama, 1970) raised a giant question mark regarding the liveliness of the active portfolio management techniques. Over 50 years later statistics show that the US passive-

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active funds split is to reach parity by 2025[1], leading us to believe that markets become more informationally efficient.

On the verge of a rise in passive portfolio management techniques, this study aims to analyze whether a stock's addition to an index impacts its price informativeness, as well as how much of its abnormal returns are explained by company-specific factors.

The academic literature on index additions and deletions does not agree in opinion regarding the price impact of changes in index constituency. There are several more favored hypotheses meant to explain the increase in abnormal returns which follows the addition event, some of which being:

The *price pressure* hypothesis, proposed by Scholes in 1972, which states that in the short run, the demand curve has a downward slope. Consequently, short term reversals that occur around the event date will generate immediate reactions that will hold just until the passive investors adjust their portfolios. In so, prices will rebound to their pre-event values, once the buy-pressures ease. Evidence in support of this hypothesis can be found in Harris & Gurel's (1986) and Vespo's (2006) studies.

The *downward-sloping demand curve* hypothesis is mostly described in studies by Shleifer (1986), Harris and Gurel (1986), and Lynch and Mendenhall (1997). Their findings suggest that demand curves for stocks are downward sloping as the price of a stock rises sharply on its inclusion into the S&P 500. The addition event causes a spike in demand from index-tracking portfolio managers, who want/tend to buy stocks to mimic the index. This abnormal demand would be supplied at the excess price if the demand curve were horizontal. So, as the addition event should not convey any future information about the upcoming dividend stream, the observed price rise is interpreted as evidence of a downward sloping demand curve.

Merton's 1987 presentation of the extended CAPM model that incorporated the possibility of investors not having complete information about stocks was one of the first models to highlight the shadow cost of incomplete information.

According to Chen et al. (2004), a stock's addition to the S&P 500 increases *investor awareness* and will reduce the shadow cost associated with that stock. Chen et al. (2004) find evidence of this asymmetric price response for additions and deletions to the Index.

[1] According to PwC, there is a high chance that passively managed funds will reach parity with the actively managed ones by 2025, whereas a Moody's estimate suggests an earlier date – around 2021. Source: financialtimes.com

Although numerous studies analyze the effects of liquidity, transactional volumes and investor awareness on increases in abnormal returns post addition event, there are not many studies that analyze the effects of price informativeness. Despite this characteristic not being tested, studies suggest there might be a dependency between an increase in stock price informativeness and abnormal returns. For example, Chen, Noroha & Singal in their article "The price response to S&P 500 index additions and deletions: Evidence of asymmetry and a new Explanation" (2004) mention that a stock's addition to the S&P index indicates an increased belief in company's future and convey new information for the long term horizon.

Overall, the *price informativeness* hypothesis states that a stock's addition to an index is a market-wide signal that a certain company is likely to become a sector leader (Jain, 1987). In a 2003 article, Dennis et al. show that after a stock's inclusion to the S&P 500, analysts seem to (positively) review their estimates regarding company's future profits. Studies by Cai (2007) and Cai & Platikanova (2008) convey similar results.

Our contribution to the literature would be testing whether the change in abnormal return which follows a company's inclusion to an index can be explained through the change in its price informativeness.

In the first part of this article, we present the data sample and methodology.

We examine abnormal returns and price non-synchronicity for each stock. As additions and deletions for S&P 500 do not have a periodical characteristic, we focused on the individual analysis of each stock followed by a cross-sectional analysis of all additions to see the aggregate average effect of the event upon the stocks.

We first analyze the abnormal returns for the additions around the event day, followed by a larger window event of one-year post addition. We found that stocks react significantly to the event day – positive abnormal returns around the event day, which are, however, declining in the post-event window (Appendix 2).

2. HYPOTHESIS, VARIABLES, AND SAMPLE:

To better explain why our sample is not dated, and why we opted for a cross-sectional approach, we begin this part by explaining some of the particularities of S&P 500 index construction.

First, changes in the S& P500 structure are generally involuntary, and caused by events such as M&A's, bankruptcies or de-listings. Moreover, given that S&P 500 is a benchmark index, some companies get deleted once they no

longer represent the economy and/or the industry. As the index should always maintain its composition of 500 companies, additions are announced together with deletions. Furthermore, to become part of S&P 500, the stock must satisfy several eligibility criteria which are generally under the discretion of the Index Committee and include:

- *A market capitalization of over $5 billion*
- *HQ in the US*
- *The value of its market cap trade annually*
- *At least a quarter-million of its shares trade in each of the previous 6 months*
- *Most of the shares are held by the public*
- *Over 6 months since its IPO*
- *Four straight quarters of positive as-reported earnings.*

Having all the added stocks satisfy similar eligibility criteria gives us a rather homogenous sample.

Due to the non-periodical nature of the S&P 500 additions and deletions, we opted to work with a sample of additions that span on an interval of 24 years. Originally, we gathered close prices for 1178 series of stocks that had been added to S&P 500 from January 1993 to December 2017 using the Thompson Reuters Eikon platform. This data represents our main working sample. Supporting data, such as S&P 500 quotations as well as quotations for all industry indexes were subsequently gathered from TR Eikon for the periods of interest.

Not all the stocks proved eligible for our study. As a result, we had to individually check each stock to see whether it should be kept for further analysis or discarded. Eventually, we built our working sample of 428 additions of 372 companies. To be included in the final sample, any firm added to the S&P 500 index was required to have a history of 260 trading days before and after the addition. This screen was important for the event study methodology and the calculi of abnormal returns.

Our final working sample consists of 358 daily rentability series of companies that had been added to the S&P 500 index. A series of S&P 500 quotations, 11 series of quotations for sector indexes, as well as data for control variables, such as the number of analysts covering each stock, market capitalization of the stock, earning per share and trading volume.

Table 1. The final sample of additions to S&P 500

Year	# Additions
1997	18
1998	13
1999	22
2000	17
2001	12
2002	13
2003	9
2004	9
2005	14
2006	21
2007	25
2008	26
2009	24
2010	14
2011	12
2012	13
2013	15
2014	13
2015	15
2016	28
2017	25

The final sample only includes firms with all necessary data for at least one year continuously in each direction around the addition date from the Thomson Reuters Eikon.

a) A measure of price informativeness

As the goal of this paper is to verify whether the addition of a stock to the S&P 500 index plays an important role in generating higher stock price informativeness, our analysis starts by calculating the price non-synchronicity, which is a proxy for private information incorporated into the price of the analyzed security.

The variation of a stock return can be decomposed into market-related variation, industry-related variation, and firm-specific component. Our interest lies in the firm-specific variation, which represents price non-synchronicity. It is generally estimated as $1\text{-}R^2$, where the R^2 parameter is the R-squared from a CAPM regression. In our case, we generate the R-squared from Huton et. al.'s (2009) expanded market and industry model (eq. 1), which includes the lead and lag terms in order to allow for non-synchronous trading[2].

[2] Testing for zero lead and zero lag model doesn't significantly change the upcoming regression results.

$$r_{i,j,t} = \alpha_j + \beta_{1i,m} r_{m,t-1} + \beta_{2,i,j} r_{j,t-1} + \beta_{3,i,m} r_{m,t} + \beta_{4,j,i} r_{i,t} + \beta_{5,i,m} r_{m,t+1} + \beta_{6,i,j} r_{i,t+1} + \xi_{i,t} \quad (1)$$

Here, $r_{i,j,t}$ is the return of firm *i* in industry *j* at time *t*, $r_{m,t}$ is the market return at a time

t, and $r_{j,t}$ is the return of industry *j* at time *t*.

We further apply a logistic transformation to obtain a nearly normally distributed variable – Stock Price Synchronicity. A higher value of this variable indicates that a stock's price is more synchronized.

$$\varphi_j = log\left(\frac{R_j^2}{(1 - R_j^2)}\right) \quad 2)$$

This proxy for price informativeness has been first used by Roll (1988). His theoretical argumentation was that prices move upon new information, which is capitalized into prices. It happens in two ways - through a general re-evaluation of stock values, which mostly happens after the release of public information, and through risk arbitrageurs who hold private information regarding traded stocks. Since in his study Roll finds that firm-specific variance is not associated with publicly available news releases, he argues that it must be the privately possessed information that plays an important role in the capitalization of firm-specific information. Nonetheless, he admits that, yet another explanation of such findings is possible – occasional frenzy.

Despite Roll's uncertainty back in 1988, there have been several papers that provide consistent evidence that supports the hypothesis that price non-synchronicity reflects private information. For example, Morck et. al. (2000) show that firm-specific return variation is higher in countries with well-developed financial systems, saying that in such countries traders are more determined to gather information on individual companies, and thus prices should reflect more firm-specific information. A study by Durnev et al. (2003) argues that stock price non-synchronicity is strongly correlated with the ability to predict the company's future earnings.

As stated by Amihud et al (2013), when stock prices move together, they are less likely to reflect firm-specific information. Barberis, Shleifer, and Wurgler (2004) attribute these phenomena to investors' sentiment, whereas Kyle and Xiong (2001) to market contagion. Nonetheless, all of them refer to less information being incorporated into the price of the security analyzed. A study by Veldkamp (2006)

shows how greater co-movement reflects less information on each company's fundamentals. The model developed by Veldkamp suggests a negative correlation between price synchronicity and informativeness, which serves as a basis for our empirical measure.

b) Abnormal returns

As a benchmark to assess the performance of each stock we used Jensen's Alpha – a CAPM based measure adjusted to risk. We chose this measure as some of its biases (unlike those for other measures) are small market capitalization and low PE which do not affect the S&P500 constituents.

We first estimated the market model for each stock in our sample for the period after the event (T+65 to T+260] to isolate values for α and β. The estimation for the market model using post-event data was done to avoid ex-post selection bias[3].

For each company *i* and each day *t* in our sample we calculated the abnormal returns:

$$AR_{it} = R_{it} - (\propto_i + \beta_m RM_{it} + \beta_s RS_{it}) \quad (3)$$

As our dependent variable could only be calculated for the event windows, we further aggregate abnormal returns for companies in our sample, over the time-periods included in each event window. This will allow us to draw an overall inference that our events of interest might have upon many other firms in the market that undergo similar changes. As we are not looking for time-series, but for the cross-sectional effects, we use the following mathematical calculations to aggregate abnormal returns (MacKinlay, 1997).

$$AAR_{Ti} = \frac{1}{T}\sum_{t_1}^{t_f} AR_{it} \quad (4)$$

$$CAR_{Ti} = \sum_{t=1}^{T} AR_{it} \quad (5)$$

Where AAR_i is the average abnormal return for the time-frame of the event spanning from t_0 to t_f; whereas CAR_i is the cumulative abnormal return for the time-frame of the event.

[3] Amihud et al (1997)mention Brown et al. (1995)study which discusses biases in event-study results, that occur when parameters are estimated using pre-event data while the test is conditional on ex-post information; thus, following Amihud et al. (1997), Brown et al (1995), and Copeland and Mayers (1982) example we estimated the beta parameters using post-event window.

As *CAR* is preferred on smaller event-windows, spanning days around the event day, our preference is for the *AAR*. Moreover, AAR seems like a better proxy, given that we want to analyze different sized event windows – 246 vs 80 vs 65 days.

We test the variance of these measures following the approach in MacKinlay ((1997, pp. 21-25)

$$Var(AAR_{t_0-t_f i}) = \frac{1}{T^2}\sum_{t_1}^{t_f} {\sigma^2}_{\varepsilon_i} \tag{6}$$

$$Var(CAR_{Ti}) = T\sum_{t_1}^{t_f} {\sigma^2}_{\varepsilon_i} \tag{7}$$

where Var(.) is the variance. For the variance estimators, we used the assumption that the event windows of securities do not overlap to set the covariance term to zero. The statistical significance is further tested using:

$$L_i = AAR_{t_0-t_f i}\left(Var\left(AAR_{t_0-t_f i}\right)\right)^{-05} \sim N(0,1) \tag{8}$$

$$CL_i = CAAR_{T,i}\left(Var(AAR_{Ti})\right)^{-05} \sim N(0,1) \tag{9}$$

Significance results for the AAR series are presented in Appendix 3.

c) Liquidity

Another variable of high importance for our study is stock liquidity, as there is strong evidence in the academic literature suggesting that liquidity directly affects securities prices. In Part I of their book "Market Liquidity" (Amihud, et al., 2013) authors show that liquidity is priced and illustrate a positive relation between securities' trading cost and expected returns.

Although liquidity is an elusive concept, which is rather hard to define, Amihud et. al. (2013) define a liquid security as a security which "*is characterized by the ability to buy or sell large amounts of it at low cost*". As can be noted in Appendix 1, we can see an abnormal rise in transaction volumes for the period around addition dates, a quality of the data that encourages us in pursuing liquidity as a variable for the model.

Following the methodology presented in Amihud's original article (2002) on illiquidity, we calculate the illiquidity as follows:

$$illiq_{j,t} = \frac{1}{D_{it}}\sum_{t=1}^{D_{it}}\left[\frac{|R_{i,t}|}{P_{i,t}VO_{i,t}}\right] \tag{10}$$

Where D_{it} is the number of days for which data is available for stock i in the event window.

We then added a constant and logged the result to reduce the impact of outliers. To modify the measure into a proxy that quantifies increases in liquidity, we multiplied the logged result by -1. In doing so, our final proxy for liquidity is the following:

$$liq_{j,t} = -log\left[1 + \frac{|R_{i,t}|}{P_{i,t}VO_{i,t}}\right] \quad (11)$$

The rationale behind including this in the model is that improved liquidity is expected to increase securities values.

In Appendix 1 we can see that trading volumes increase significantly around the event day and maintain a positive slope in the post-event-window, suggesting that stocks included in S&P 500 benefit from an increase in trading volumes post their addition.

d) Control variables

We used Thomson Reuter's Eikon to gather control variables of interest to us – the number of analysts covering the security at hand, earnings per share and market capitalization.

We use the number of analysts as a proxy for shadow costs, under the investor awareness hypothesis, to control whether abnormal returns could result from increased coverage by a higher number of analysts, whereas market capitalization, is, in our case a proxy meant to correct for the company's size.

Values for both, number of analysts and market capitalization are logged, to correct for the skewness of the distribution.

Descriptive statistics for the control variables are presented in APPENDIX 4. All the control variables increase gradually from the BF window to the AF window. No abnormal increases can be noted during the EV1 and EV2 windows.

3. SPECIFICATIONS AND TESTING

Our research hypothesis is that a stock's inclusion into the index would generate significant price impacts, which could be attributed to an increase in liquidity generated by larger trading volumes given by index mimicking trading techniques and an increase in analyst coverage. Consequently, the same event would lead to higher synchronicity with the stock market, and implicitly to a

decrease in price informativeness of the stock in the short event window, nonetheless, improving price informativeness effects in the longer ex-post period.

We begin by setting up an event study framework to test for the effects of stock's addition to the S&P 500 Index. The events studied are exogenous to the companies, as the transfer decision is made by the S&P Index Committee and not by the firm's management. As such, there is a lower chance that the increase in abnormal return is generated by company-specific information.

As we have mentioned before, there is no historical database for announcement days for index additions and/or deletions from the S&P 500, moreover, additions and deletions are rather sporadic, which is why our event study methodology is firm-specific and does not revolve around several given events. For each series of returns – *i* – we have a specific event day ED_i.

Following the arguments from Liu (2011),we built a long-term pre-event window starting 260 trading days before and ending at about 15 days before the event - called BF_i, and a post-event long-term widow beginning 15 days after the event and spanning to a year after to account for potential non-stationarity of the parameters.

We additionally test event windows right around the *ED*:

$EV1_i$ – 15 days before the addition day and 65 days after addition as presented in Liu (2011) to test for an increase in abnormal returns covering weeks ex-ante and ex-post addition day and $EV2_i$ – from the addition-day to 60 days ex-post. We use two different event windows to check if the abnormal returns that increase before the addition day can be explained through price informativeness or are purely speculative. Given that we don't know the announcement days, we will use estimation-period time-series standard deviation to estimate the *t-statistic* for the mean abnormal return, to test for possible clustering[4].

Table 2 Event-study framework

ED	The day when the stock is added to the S&P 500 index.	
EV1	[ED-15, ED+65] – Second event window, to test for the possibility of insider trading	Liu, 2011
EV2	[ED, ED+60] – First event window which tests only for the effects post addition	Cheung , 2010
BF	[ED-260, ED-15) – pre-event window	Liu, 2011

[4] Liu(2011) calls this "crude dependence adjustment" from Brown and Warner (1980). As suggested by Liu, we've tested the regressions grouping stocks that were added on the same day as a portfolio, but no significant changes in output statistics were noticed.

AF	(ED+15, ED+260] – post-event window	Liu, 2011

A higher average abnormal return in the EV1 as compared to EV2 window would suggest the presence of insider trading and information leaking just before the addition date, implying lower informational content of prices around the event date, and lower influence of price informativeness over abnormal returns.

Overall, our study is strongly related to Harris and Gurrel (1986) and Shleifer (1986) who also study the effects of stock additions to the S&P 500 Index. Their results suggest a temporary price increase post addition, which arguably, reflects increased interest from passive portfolio managers to these stocks.

We, therefore, expect that on our sample there would be a significant price appreciation following the stock's inclusion to the index, caused by an improvement in stock's liquidity (Amihud & Mendelson, 1986)

As mentioned in the previous section of this study, we began by firstly testing whether there is a change in price informativeness for our two separate timeframes: before and after the event day. To do this we test for the correlation between the stock rentability and the market index, on daily panel data with 93496 company-day observations, and by running a simple LS regression of rentabilities against the market index. In doing so, we see that the index is an important determinant for the price of the equities, with a *beta* coefficient that changes from 0.9536 in the before the window to 1.1583 in the after window. The R-squared statistic in the post-event window also improves – 27% against 20%. We additionally perform a single-factor, between-subjects, ANOVA test. We reject the equality hypothesis as both the standard ANOVA and the Welch ANOVA statistics are in excess of 80, whereas figure 1 illustrates the correlation between stock rentability and S&P 500 which increases in the ex-post window. The presented measures confirm our hypothesis of a change in price informativeness between the two sub-periods.

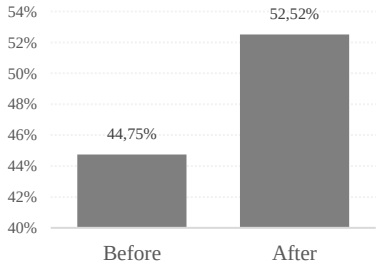


Figure 1 Correlation between stock rentability and S&P 500

Descriptive statistics for abnormal returns, stock illiquidity, and price non-synchronicity are reported in APPENDIX 3, for each of the 4 event windows. We will begin the specification testing by making two remarks concerning excess returns around the addition day. First, we can see that mean average abnormal returns for EV2 and AF are negative, suggesting that for those time intervals stocks were underpriced; both those intervals lie within the time-frame post addition, suggesting that after their inclusion to S&P500, stocks might have been undervalued. The second remark relates to the changes in the abnormal returns preceding the actual addition date. It can be noticed (APPENDIX 2) that a rise in abnormal returns occurs at about 15 days before T, which suggests a buildup of price pressure around the event day, relieved only after the stock is added to the index. An explanation of this characteristic can be found within a study by Madhavan and Ming (2003) – just before the pre-announcement of index changes, quasi-arbitrageurs enter the market by buying added stocks to flip them around on an effective day at more favorable prices.

The next step was running a simple regression between average abnormal returns and price non-synchronicity.

$$AAR_j = \alpha_j + \beta NS_j + \varepsilon_j \quad (12)$$

Table 3. Regression(12) results

VAR	BF	EV1	EV2	AF
NS	0.000143	0.000288	-0.000517	0.000155**
C	0.000795	0.000212	-6.85E-06	-0.000141
R-squared	0.000188	0.000665	0.00175	0.012479
Number of observations	358	358	358	358

Where the dependent variable is AAR - the average abnormal return for the period included in the event window and NS is the non-synchronicity measure averaged for the same time-interval. *, **, and *** indicate a two-tailed test significance level of less than 10%, 5%, and 1%, respectively

The first regression comes with a set of interesting findings. As suggested by the literature, we see that non-synchronicity does indeed affect the abnormal returns, but only in the AF window. A positive sign implies that an increase in price non-synchronicity will lead to higher abnormal returns, as the prices will convey more firm-specific information. Lack of significance for the other three windows, as well as a sign-reversal for the NS variable in the EV2 window, suggests the presence of increased pressure from the quasi-arbitrageurs negatively affecting abnormal returns and diminishing the role of informed trading right after the AD.

We subsequently add the Amihud ILLIQ measure to test for the impact of trading pressure as a determinant of abnormal returns.

$$AAR_j = \alpha_j + \beta_1 NS_j + \beta_2 ILLIQ_j + \varepsilon_j \quad (13)$$

Table 4. Regression (13) results

VAR	BF	EV1	EV2	AF
NS	0.000187	7.60E-05	-1.81E-04	0.000155**
ILLIQ	-63060.69*	372964***	6131139***	-150919**
C	0.000838	0.000268	-2.17E-05	-0.000145
R-squared	0.010348	0.03007	0.176369	0.024356
Number of observations	358	358	358	358

ILLIQ – Amihud illiquidity measure. *, **, and *** indicate a two-tailed test significance level of less than 10%, 5%, and 1%, respectively

Adding illiquidity to the model, improves the R-squared indicator (as expected). After analyzing Table 4, we can see that trading volumes play an important role in explaining abnormal returns. There is also a reversal of the coefficient's sign between the longer vs shorter event windows. This characteristic builds upon our argumentation of sing reversal in the NS variable for the outputs of eq. 12 and can be explained by the speculative characteristic of the market. As in the shorter run, passive investors tend to buy stocks of newly encompassed companies, thus driving the prices up. The difference in sign between the EV1 and EV2 windows can be explained, suggesting that quasi-arbitrageurs act upon firm-specific information ex-ante AD, whereas passive portfolio investors make their decisions based on market-wide information.

The sign reversal for ILLIQ in the shorter horizon can be explained through higher liquidity premium, which is characteristic for periods of higher uncertainty. (Amihud, 2002, p. 107)

We re-run the regression several more times to include the number of analysts, to control for increased coverage and market size – as a control variable for the company's size, to see if prices of bigger companies are more/less susceptible to inclusion in the S&P 500.

$$AAR_j = \alpha_j + \beta_1 NS_j + \beta_2 ILLIQ_j + \beta_3 MK_j + \beta_4 ANL_j + \varepsilon_j \quad (14)$$

Table 5. Regression (14) results

VAR	BF	EV1	EV2	AF
NS	0.000336	1.39E-04	-1.98E-04	0.00017**
ILLIQ	-51913.72	387233.7***	6057576***	-153753.9**
MK	1.98E-14***	1.45E-14	7.15E-15	8.22E-16**
ANL	3.76E-06	2.80E-06	6.21E-06	-9.34E-07
C	0.000494	1.62E-05	-1.99E-04	-0.00015
R-squared	0.033301	0.058268	0.183473	0.035683
Number of observations	358	358	358	358

Where MK – logged value for market capitalization, ANL – number of analysts covering the company. *, **, and *** indicate a two-tailed test significance level of less than 10%, 5%, and 1%, respectively

The results presented in **Table 5** suggest that the company size is an important determinant of abnormal return only for longer periods. For the both event windows the coefficients for market capitalization are insignificant, building on the idea that the increase in trading volumes and abnormal returns around the event day is given by buying pressure from the passive portfolio investors, adjusting their investments to mimic the S&P 500 index, as well as by the quasi-arbitrageurs suggested by Beneish and Whaley (1996) and Madhavan and Ming (2003)

Another interesting research hypothesis is whether the difference in abnormal returns between the two AF and BF windows is, in fact, caused by the change in price informativeness[5]. To test for this, we calculated the ΔAAR series, as presented below:

$$\Delta AAR_j = AAR_{j,AFTER} - AAR_{j,BEFORE} \quad (15)$$

[5] Amihud and Mendelsol and Lauterbach (1997) implement a similar methodology to test for the interaction of liquidity and efficiency improvements. They begin by estimating change measures for the AFTER and BEFORE periods analyzed, and then regressing the results in cross-sectional models.

We use a similar approach to calculate differences for other variables included in our estimation. The results are presented in **Table 6**.

Regression results suggest that the changes in abnormal returns that occurred between the first and the second estimation windows can be explained through changes in price informativeness, stock liquidity, and in analyst coverage, an increase in price synchronicity leading to an increase of abnormal returns, once again confirming our expectations that trading around the AD has more of a speculative characteristic.

Table 6. Regression results on difference values

	ΔAAR_{AF-BF}								
VAR	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
NS		-0.001029**	-0.00108**	-0.0014***				-0.000876*	-0.000859*
PHI	0.0002**				0.00025***	0.00024***	5.00E-05*		
ILLIQ			60554***				-61752.88***	-68288.47***	-66539.58***
LICH				-2668230***	-2629099***	-2731822***			
MK								7.05E-15**	6.40E-15***
ANL						-0.00013**	-0.000108**	-0.000127***	-0.000131**
EPS									6.78E-05
intercept	-0.00101	-0.001003	-0.001076	-0.001028	-0.00102	-0.000854	-0.000879	-0.000927	-0.000942
R-squared	0.007755	0.007754	0.017756	0.064951	0.065152	0.090517	0.043442	0.052172	0.053789

*, **, and *** indicate a two-tailed test significance level of less than 10%, 5%, and 1%, respectively

Interestingly enough, when checking for similar influences for the difference between EV1 and EV2, the coefficients for price informativeness, number of analysts, market capitalization or EPS are insignificant, suggesting that the increase in abnormal returns during the 15 days preceding the addition day is predominantly speculative, in line with Beneish and Whaley (1996). (see **Table 7**)

Table 7. Regression results for delta EV1-EV2

	$\Delta AAR_{EV1-EV2}$					
VAR	(1)	(2)	(3)	(4)	(5)	(6)
NS	4.03E-05	2.04E-05	4.69E-06	1.43E-05		
PHI					-0.000103	-9.32E-05
ILLIQ		75855***	77671**	77208***	79649***	78194**
LICH						
MK				6.71E-14	6.03E-14	
ANL			-0.000417	-0.000418	-0.000453	
EPS						
CRISIS					6.51E-05	0.00536
intercept	0.000582	0.000571	0.000552	0.000556	0.000516	0.044992

R-sqared	0.000156	0.004085	0.007748	0.009089	0.012137	0.006772

*, **, and *** indicate a two-tailed test significance level of less than 10%, 5%, and 1%, respectively

We decided to test if abnormal returns before and after the addition date could be caused by company-specific risk, as yet another proxy of price informativeness. For this, we estimated company-specific risk as presented in Morck et al. (???)

$$\varphi_j = \log(\sigma^2_{m,j}) - \log(\sigma^2_{m,j}) \quad (16)$$

Where $\log(\sigma^2_{m,j})$ is the logarithm of average explained sum of squares from the extended market and industry model used to estimate abnormal returns, whereas $\log(\sigma^2_{m,j})$ represents a firm-specific risk. Regression results are presented in the table below. We can see that firm-specific risk is an important determinant of abnormal returns ante-addition, when most of the trading is based on company-specific information; once the addition occurs, the role of specific risk in explaining abnormal returns diminishes, providing more support in favor of price pressure hypothesis.

Table 8. Regression results

VAR	BF	EV1	EV2	AF
LICH	-1891834***	-5772623***	-13311289***	443891.7***
MK	2.03E-14***	1.38E-14***	7.20E-15***	7.14E-16**
ANL	-7.04E-06	3.58E-06	8.75E-06	-7.58E-08
FSR	5.89E-04***	4.53E-05	-1.08E-04	-1.91E-05
C	0.002333	3.05E-04	-7.72E-04	-1.17E-04
R-squared	0.111565	0.128272	0.184417	0.032283
Number of observations	358	358	358	358

*, **, and *** indicate a two-tailed test significance level of less than 10%, 5%, and 1%, respectively

We concluded our study by controlling for companies that were added to the index during the 2007 Financial Crisis. To do that, we created a dummy variable CRISIS which equals 1 if the company's addition date is between January 2007 and December 2008. The results for these regressions as well as for regressions with analog proxies for price informativeness and liquidity are presented in Table 7.

The dummy variable is important for the time intervals that lay beyond the addition moment, implying that addition to the S&P 500 index during the crisis period had a more significant negative effect upon abnormal returns than during other periods.

4. CONCLUSIONS AND FUTURE RESEARCH

This paper provides empirical evidence in favor of the price pressure hypothesis in both pre- and post-event windows. Return reversal around index additions suggests that buying pressure temporarily shifts away from equilibrium, which is consistent with the short-term downward-sloping demand curve hypothesis.

One explanation of the Price pressure hypothesis(PPH) effects lay within market microstructure literature. When liquidity changes significantly due to the index revision news, the adjustment in liquidity between quasi-arbitrageurs and index-mimicking investors causes trading volume and stock prices to reverse back to their original level before the index adjustment takes place. Furthermore, our results remain robust after controlling for the impact of analyst coverage, company size and earnings per share.

We also find evidence supporting our test-hypothesis that price informativeness affects ex-post abnormal returns. The two-tailed test significance level of less than 1% for the price synchronicity proxy in the post-event window arguably implies there is a higher chance for stocks that incorporate more specific information to generate superior abnormal returns.

Moreover, testing for company-specific risk, we see that its significance decreases after the event day. If pre-addition, investors were willing to pay a higher risk premium for the stock, the coefficient's sign changes post-addition, suggesting that investors who buy the newly added stocks generally have a positive outlook of company's future, indirectly attributing it a lower idiosyncratic risk premium.

Our results show that market quality improves after additions. Cross-sectional analysis indicating that, in the longer run, stocks benefit from becoming part of the S&P 500 Index, offering more price informative stocks a chance to generate higher profits.

With regards to future research, we believe it would be interesting to see if our results are any different when testing using a panel-data approach and a different estimate for price informativeness (ex. Kalman filter).

We are also curious to extend our study to a cross-national level, to see if insider trading is more acute in developing countries, which could potentially result in a significant coefficient on event-windows just around the addition day.

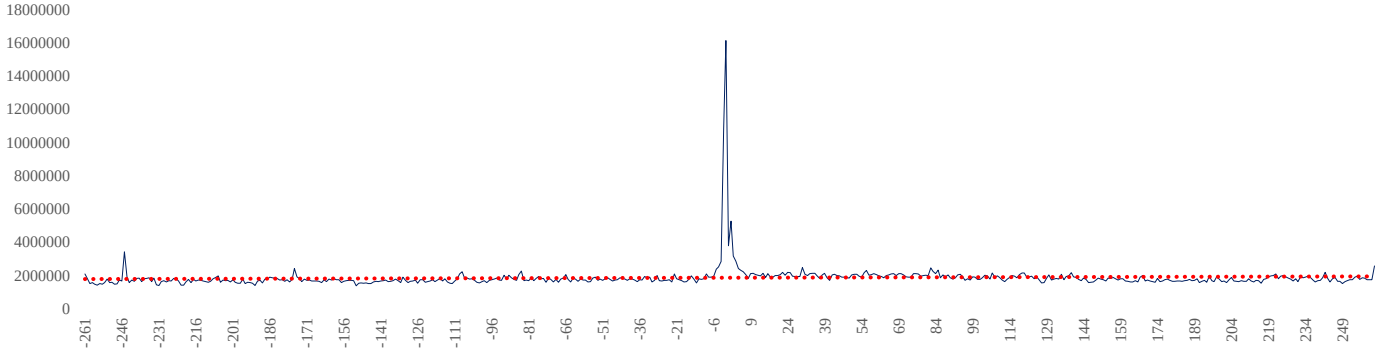
Table 9. Multiple regression results

	e1				e2			
VAR	BF	EV1	EV2	AF	BF	EV1	EV2	AF
NS	0.000377	-3.12E-04	5.51E-05	0.000109***				
ILLIQ	-51896.24	387039.2***	5871225***	380799***	-52631.66	426569.7***	5844371***	-149005.9**
MK	2.01E-14***	1.31E-14***	6.51E-15	6.94E-16*	1.98E-14***	1.28E-14***	6.43E-15	6.28E-16
ANL	3.95E-06	2.04E-06	5.73E-06	-1.02E-06	4.05E-06	2.20E-06	5.70E-06	-9.14E-07
CRISIS	7.03E-05	-9.77E-04***	-5.09E-04	-1.19E-04***	3.72E-05	-9.99E-04***	-5.20E-04	-1.37E-04***
intercept	0.000453	4.27E-04	-2.20E-04	-9.48E-05	0.000646	0.000404	-1.61E-04	-3.27E-05
R-squared	0.033445	0.076693	0.187782	0.056203	0.03306	0.083751	0.188086	0.051808

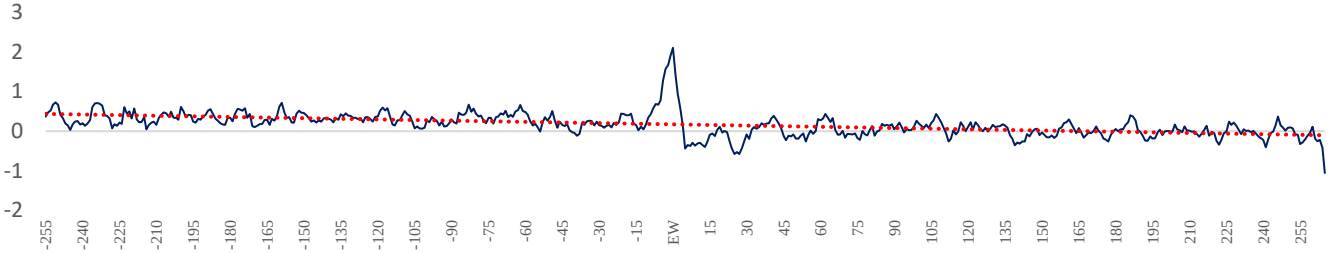
	e3				e4			
VAR	BF	EV1	EV2	AF	BF	EV1	EV2	AF
PHI	-0.000165**	-3.63E-05	-0.000101	-1.80E-05*	-0.00016**	-3.67E-05	-3.23E-05	-7.86E-06
LICH	-1367895**	-5760519***	-13221790***	380526**	-1355402**	-5734647***	-1.3E+07***	281569.6***
MK	2.02E-14	1.25E-14***	6.44E-15**	7.83E-16	2.11E-14	1.26E-14***	6.30E-15*	3.35E-16**
ANL	3.42E-06	1.03E-06	5.63E-06	-1.03E-06	3.47E-06	1.11E-06	4.61E-06	-1.02E-06
EPS					-9.27E-06	-1.03E-05	2.98E-05	1.36E-05***
CRISIS	6.80E-05	-0.000634	-0.000472	-0.00013**	6.45E-05	-0.000639	-0.000453	-1.25E-04*
intercept	0.000587	0.000319	-0.000162	-2.00E-05	0.000611	0.000345	-0.000232	-5.04E-05
R-squared	0.04036	0.1308127	0.187407	0.058681	0.04067	0.138118	0.188949	0.08292

*, **, and *** indicate a two-tailed test significance level of less than 10%, 5%, and 1%, respectively

APPENDIX 1. Average trading volume by days around ED



APPENDIX 2. Average Abnormal Returns by days around ED



APPENDIX 3. Descriptive statistics for AAR, ILLIQ, PHI

	Average Abnormal Returns				Amihud's Illiquidity				Stock Price Synchronicity			
	BF	EV1	EV2	AF	BF	EV1	EV2	AF	BF	EV1	EV2	AF
μ	0.000888***	0.00037***	-0.00022*	-5.10E-05***	1.12E-09***	1.63E-10***	-2.00E-11**	-2.28E-11***	0.7391***	1.3204***	1.0281***	1.0488***
Median	0.000598	0.000291	-0.0001	-3.27E-05	6.00E-10	6.61E-11	1.38E-12	2.24E-12	0.473065	0.780847	0.616175	0.639098
Max	0.010442	0.011058	0.008902	0.000849	5.03E-08	2.04E-08	7.25E-10	2.56E-10	5.113852	11.77612	8.132754	8.818650
Min	-0.00469	-0.00968	-0.01256	-0.00139	1.79E-11	-9.66E-10	-1.24E-09	-3.08E-09	-0.186391	0.036902	0.031048	0.32354
σ	0.001914***	0.002381***	0.002503***	0.000274***	3.06E-09***	1.10E-09***	1.71E-10***	1.98E-10***	0.7708***	1.551571***	1.1563***	1.1919***
Skew.	1.456414	0.237333	-0.60753	-0.41734	12.65462	17.37082	-2.89121	-11.3991	2.687006	2.977191	4.42372	3.049619
Kurtosis	8.195723	6.103445	6.91642	5.370896	192.4141	317.7211	20.90333	166.2515	12.44071	14.96340	12.20243	14.41018
JB	529.2448	147.0288	250.8194	94.24086	544730.8	1495491	5279.991	405297.9	1760.272	2663.783	1685.705	2852.266
P	0	0	0	0	0	0	0	0	0	0	0	0
∑	0.317898	0.132397	-0.07802	-0.01826	4.00E-07	5.82E-08	-7.15E-09	-8.18E-09	264.6048	472.7356	368.0901	375.4979
$\sum\varepsilon^2$	0.001308	0.002024	0.002236	2.68E-05	3.35E-15	4.33E-16	1.04E-17	1.40E-17	212.1198	859.4323	477.3575	507.1794

*, **, and *** indicate a two-tailed test significance level of less than 10%, 5%, and 1%, for the Empirical Distribution test.

APPENDIX 4. Descriptive statistics for control variables

	Number of Analysts				Market Capitalization				EPS			
	BF	EV1	EV2	AF	BF	EV1	EV2	AF	BF	EV1	EV2	AF
Mean	14.99681	15.85047	15.89939	16.38446	8.97E+09	1.17E+10	1.18E+10	1.34E+10	2.394752	2.692117	2.701803	2.802341
Median	14.84615	15.75316	15.81061	16.25304	5.89E+09	7.80E+09	7.72E+09	8.12E+09	1.676331	1.815237	1.818572	1.862636
Maximum	43.06883	44.49367	44.63636	45.01215	1.55E+11	4.62E+11	4.57E+11	5.90E+11	32.18682	31.18269	31.47423	29.52349
Minimum	0	0	0	0	1.19E+08	1.56E+08	1.59E+08	1.69E+08	-1.03029	-2.63211	-2.66474	-2.66911
Std. Dev.	8.085574	8.436643	8.458378	8.429665	1.44E+10	2.72E+10	2.71E+10	3.60E+10	3.116356	3.317795	3.335414	3.352578
Skewness	0.448455	0.471161	0.467345	0.427061	6.625908	13.24217	13.0215	12.49885	5.037026	4.270583	4.260943	3.71416
Kurtosis	3.554314	3.628322	3.621352	3.583491	59.69222	212.5346	206.7624	189.0457	40.65423	30.7668	30.75046	24.72854
Jarque-Bera	16.58303	19.13449	18.79086	15.96064	50561.8	665375.1	629444.1	525631.8	22663.31	12588.87	12570.43	7865.699
Probability	0.000251	0.00007	0.000083	0.000342	0	0	0	0	0	0	0	0
Sum	5368.858	5674.467	5691.982	5865.638	3.21E+12	4.20E+12	4.22E+12	4.80E+12	857.3212	963.7777	967.2454	1003.238
Sum Sq. Dev.	23339.41	25410.17	25541.26	25368.15	7.36E+22	2.65E+23	2.63E+23	4.64E+23	3467.069	3929.771	3971.621	4012.6

BIBLIOGRAPHY

1. Amihud, Y., 2002. Illiquidity and stock returns: cross-section and time-series effects. *Journal of Financial Markets*, Issue 5, pp. 31-56.
2. Amihud, Y. & Mendelson, H., 1986. Liquidity and stock return. *Financial Analysts Journal*, Volume 42, pp. 43-48.
3. Amihud, Y., Mendelson, H. & Lauterbach, B., 1997. Evidence from the Tel Aviv Stock Exchange. *Journal of Financial Economics*, Issue 45.
4. Amihud, Y., Mendelson, H. & Pedersen, L. H., 2013. *Market Liquidity. Asset Pricing, Risk and Crises.* New York: Cambridge University Press.
5. Barberis, N., Shleifer, A. & Wurgler, J., 2004. Comovement. *Journal of Financial Economics*, 75(2), pp. 283-317.
6. Beneish, M. & Whaley, R., 1996. An anatomy of the S&P Game - The Effects of Changing the Rules. *Journal of Finance*, pp. 1909-1930.
7. Bhushan, R., 1989. Firm characteristics and analyst following.. *Journal of Accounting and Economics*, pp. 255-274.
8. Brown, S., Goetzmann, W. & Ross, S., 1995. Survival. *Journal of Finance*, Issue 50, p. 853–73.
9. Cai, J., 2007. What's in the news? Information content of S&P 500 additions. *Financial Management*, pp. 113-124.
10. Callen, J. L. & Fang, X., 2015. Religion and Stock Price Crash Risk. *Journal of Financial and Quantitative Analysis*, pp. 169-195.
11. Chen, H., Noronha, G. & Singal, V., 2004. The price response to S&P 500 index additions and deletions: Evidence of asymmetry and a new explanation. *The Journal of Finance*, pp. 1901-1930.
12. Chen, H., Noronha, G. & Singal, V., 2006. Index changes and losses to index fund investors. *Financial Analysts Journal*, pp. 31-47.
13. Chopra, N., Lakonishok, J. & Ritter, J., 1992. Measuring Abnormal Performance: do the stock market overreact?. *Journal of Financial Economics*, pp. 235-268.
14. Cochrane, J., 1988. How Big is the Random Walk in GNP. *Journal of Political Economy*, pp. 893-920.
15. Cochrane, J., 1991. Volatility Tests and Efficient Markets. *Journal of Monetary Economics*, pp. 463-486.
16. Cooper, J., 1982. World Stock Markets: Some Random Walk Tests. *Applied Economics*, pp. 515-531.
17. Copeland, T. & Mayers, D., 1982. The value line enigma. *Journal of Financial Economics*, Issue 10, pp. 289-321.
18. Cragg, J. G. & Malkiel, B. G., 1968. The Consensus and Accuracy of Some Predictions of the Growth of Corporate Earnings. *Journal of Finance.*
19. Cunningham, S. W., 1973. The Predictability of British Stock Market Prices. *Journal of the Royal Statistical Society*, pp. 315-331.

20. Denis, D., McConnell, J., Ovtchinnikov, A. & Yu, Y., 2003. S&P 500 index additions and earnings expectations. *The Journal of Finance,* pp. 1821-1840.
21. Doukas, J., Kim, C. & Panzalis, C., 2010. Arbitrage Risk and Stock Mispricing. *Journal of financial and quantitative analysis,* pp. 907-934.
22. Durnev, A., Morck, R., Yeung, B. & Zarowin, P., 2003. Does Greater Firm-Specific Return Variation Mean More or Less Informed Stock Pricing?. *Journal of Accounting Research,* 41(5), pp. 797-836.
23. Fama, E., Fisher, L., Jensen, M. & Roll, R., 1969. The Adjustment of Stock Prices to New Information. *International Economic Review.*
24. Fama, E. & French, K., 1988. Permanent and Temporary Components of Stock Prices. *Journal of Political Economy,* pp. 246-273.
25. Firth, M., 1974. An Empirical Examination of the Applicability of Adopting the AICPA and NYSE Regulations on Free Share Distributions in the U.K. *Journal of Accounting Research.*
26. Firth, M., 1977. *The Valuation of Shares and the Efficient-Market Theory.* London: The Macmillan Press LTD.
27. Firth, M. A., 1972. The Performance of Shares Recommendations Made by Investment Analysts and the Effects on Market Efficiency. *Journal of Business Finance.*
28. French, K. & Roll, R., 1986. Stock Return and Variance: the Arrival of Information and Reaction of Traders. *Journal of Finance,* pp. 5-26.
29. Friend, I., Brown, F., Herman, E. & Vickers, D., 1962. *A Study of Mutual Funds,* Washington D.C.: U.S. Government Printing Office.
30. Gygax, A. & Otchere, I., 2010. Index composition changes and the cost of incumbency. *Journal of Banking & Finance,* pp. 2500-2509.
31. Harris, L. & Gurel, E., 1986. Price and volume effects associated with changes in the S&P 500 list: New evidence for the existence of price pressures. *The Journal of Finance,* pp. 815-829.
32. Hutton, A., Marcus, A. & Tehranian, H., 2009. Opaque Financial Reports, R, and Crash Risk. *Journal of Financial Economics,* pp. 67-86.
33. Jaffe, J., 1974. Special Information and Insider Trading. *Journal of Business.*
34. Jain, P., 1987. The Effect on Stock Price of Inclusion or Exclusion from the S&P 500. *Financial Analysts Journal,* pp. 58-65.
35. Jensen, M., 1968. The Performance of Mutual Funds in the Period 1945-1964. *Journal of Finance.*
36. Johnson, K. B., 1966. Stock Splits and Price Change. *Journal of Finance.*
37. Kendall, M., 1953. The Analysis of Economic Time-Series, Part I: Prices. *Journal of the Royal Statistical Society,* pp. 11-34.
38. Kim, J., Nelson, C. & Startz, R., 1991. Mean Reversion in Stock Prices? A reappraisal of the Empirical Evidence. *REVIEW OF eCONOMIC sTUDIES,* pp. 515-528.
39. Kyle, A. & Xiong, W., 2001. Kyle and Xiong. *The Journal of Finance,* 56(4), pp. 1401-1440.

40. Liu, S., 2011. The price effects of index additions: A new explanation. *Journal of Economics and Business,* pp. 152-165.
41. Lo, A. & MacKinlay, C., 1988. Stock Market Prices do not follow random walks: evidence from a simple specification test. *Review of Financial Studies,* pp. 41-66.
42. Lo, A. & MacKinlay, C., 1989. The size and power of the variance ratio test in finite samples. A Monte Carlo investigation. *Journal of Econometrics,* pp. 203-238.
43. Lorie, J. H. & Niederhoffer, V., 1968. Predictive and Statistical Properties of Insider Trading. *Journal of Law and Economics.*
44. MacKinlay, C., 1997. Event Studies in Economics and FInance. *Journal of Economic Literature,* 35(March), pp. 13-39.
45. Madhavan, A. & Ming, K., 2003. The Hidden Costs of Index Rebalancing. *The Journal of Investing,* Issue Fall, pp. 29-35.
46. Mase, B., 2006. Investor awareness and the long-term impact of FTSE 100 index redefinitions. *Applied Financial Economics,* pp. 1113-1118.
47. Merton, R. C., 1987. A simple model of capital market equilibrium with incomplete information. *The Journal of Finance,* pp. 483-510.
48. Moore, A. B., 1964. Some Characteristics of Changes in Common Stock Prices. În: *The Random Character of Stock Market Prices.* Cambridge: The MIT Press, pp. 139-161.
49. Morck, R., Yu, W. & Yin Yeung, B., 2000. The Information Content of Stock Markets: Why Do Emerging Markets Have Synchronous Stock Price Movements?. *Journal of Financial Economics,* Volume 58.
50. Niederhoffer, V. & Osbourne, M. F. M., 1966. Market Making and Reversal of the Stock Exchange. *Journal of the American Statistical Association.*
51. Roberts, H. V., 1959. Stock Market ”Patterns”and Financial Analysis: Methodological ”Suggestions”. *Journal of Finance,* pp. 1-10.
52. Roll, R., 1988. The International Crash of October 1987. *Financial Analysts Journal,* Issue September/October, pp. 19-35.
53. Rosenberg, B., Reid, K. & Lanstein, R., 1985. Persuasive evidence of market inefficiency. *Journal of Portfolio Management,* pp. 9-16.
54. Sharpe, W., 1963. A Simplified Model for Portfolio Analysis. *Management Science,* pp. 277-293.
55. Shleifer, A., 1986. Do demand curves for stocks slope down?. *The Journal of Finance,* pp. 579-590.
56. Stambaugh, R. F., 2014. Presidential address: Investment noise and trends. *The Journal of Finance,* Volume 69, pp. 1415-1453.
57. Todea, A. & Buglea, A., 2017. Individualism and stock price reaction to market-wide information. *Economics Letters,* 160(C), pp. 4-6.
58. Veldkamp, L., 2006. Information Markets and the Comovement of Asset Prices. *The Review of Economic Studies,* 73(3), pp. 823-845.
59. Vespro, C., 2006. Stock price and volume effects associated with compositional changes in European stock indices. *European Financial Management,* pp. 103-127.

60. Watts, R., 1973. The Information Content of Dividends. *Journal of Business.*
61. Weissensteiner, A., 2017. Correlated Noise: Why Passive Investment Might Improve Market Efficiency.

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BANK CREDIT AND SECTORAL GROWTH – EVIDENCE FROM INDIAN STATES

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Abstract: *The study examines the growth effect of bank credit and its variation among the states of India for three sectors namely Agriculture, Industry, and Services. The gross value added (GVA) of sectors is taken as a proxy of growth with sectoral credit as the explanatory variable in addition to five control variables. The data set of 24 states for the period 2004-05 up to 2021-22 sourced from the Reserve Bank of India website is analyzed using the Generalized Method of Moments (GMM). Findings reveal growth effect of credit varies among states and is positive for the industry and services sector. The results highlight the significance of bank credit in sectoral output and add to the existing literature on the relationship between bank credit and the growth of sectors at the state level of India.*

Keywords: *Bank credit, Gross value added, Growth effect, Sectoral output, Generalized Method of Moments*

JEL Classification: *G21*

1. INTRODUCTION

The finance growth nexus has been a subject of research since the work of Schumpeter (1911) who highlighted the role of financial intermediaries in economic growth. Most empirical studies focus on either testing the role of financial development in stimulating economic growth or examining the direction of causality between these two variables (Ang, 2008a). The short-run and long-run relationship between financial development and economic growth are well established in the literature. What is contested and debated has been the magnitude and direction of this causal relationship. Patrick (1966) identified two different patterns as an explanation for the direction of this causal relationship which he termed "supply leading" and "demand following". In the first of the patterns, he

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believed financial institutions through the creation of a variety of financial products and services facilitate economic growth. This has been supported by empirical findings from the works of Christopoulos & Tsionas (2004); Fry (1978); Miller (1998); Newlyn & Shaw (1975); Rajan & Zingales (1998). The second pattern which opines the development of the financial system to be a consequence of the process of economic growth has been supported by the works of Macesich & Goldsmith (1970; Pradhan (2010); Yu et al. (2012). In Patrick's view, the pattern shifts from "supply leading" to "demand following" with the subsequent economic development of a country. Thus, as an economy develops, the initial causality which runs from finance to growth is expected to be replaced by a causality that runs from growth to finance. A third view of bidirectional causality in the relationship has also emerged and was supported by the notable works of Bangake & Eggoh(2011), Blackburn & Hung (1998), and Calderón & Liu (2003)

Empirical findings on the relationship between financial development and growth are at best mixed. The results have been found to vary with regions. Hassan & Yu (2007) finds strong linkages between financial development and economic growth in high-income OECD countries but not in South Asian and Sub-Saharan African regions. The differing results on the nexus can be confounding. Arestis et al. (2014) conducted a meta-analysis of the literature on financial development and growth and found differing results of studies on similar cross-sections of data. He revealed that the most significant factors behind this are the choice of financial-variable proxies, the kind of data used as well as whether the study considered the issue of endogeneity. The differing results also highlight the limitations of statistical inference based on country cross-section studies which implicitly treat different economies as homogeneous entities.

The present study is distinct on the following counts. First, we study the relationship between bank credit and the growth of different sectors at the state level using a wide data set of 24 states which are scarce in the Indian context. Second, the findings of the cross-country studies on account of the heterogeneity among countries are likely to give biased results. State-level studies are less likely to be affected by heterogeneity in factors like capital flows, labor movement, legal code, and enforcement machinery (Ang, 2008b). Furthermore, we estimate the relationship by dividing the states into two relatively homogeneous sub-samples based on output to further eliminate the impact of endogeneity among the chosen variables. We address the issue of endogeneity by using the instrumental variables approach.

The rest of the paper is organized as follows Section II examines the findings of select literature on the finance growth nexus. Section III covers data analysis including the choice and description of variables, data sources, and summary statistics of the chosen variables. Section IV presents empirical analysis, discussion, and findings. Finally, the summary and concluding remarks are covered in Section V.

2. LITERATURE REVIEW

In this section, we review separately the theoretical and empirical literature available on the relationship between financial development and growth.

2.1.Theoretical underpinnings

The pioneering work of Schumpeter (1911) on the finance growth nexus was followed by the Keynesian view on the role of financial repression which believed state intervention/ interest rate ceilings were essential for promoting growth. Financial development for these proponents was a consequence of real growth. This viewpoint dominated most of the literature on the finance growth nexus for a few decades following the great recession. In the decade following the 1960's vital contributions in literature from Goldsmith (1969), McKinnon (1973) and Shaw (1973) revived the debate on the finance growth nexus. McKinnon and Shaw strongly advocated in favor of interest rate liberalization and argued on the harmful effects of financial repression for long-term growth. Their view on economic development believed financial intermediation and economic growth to be inextricably linked. Financial intermediation allows a higher rate of return to be earned on capital. This growth in turn allows the creation and sustenance of large financial structures. While Goldsmith used case studies and crude econometric methods for explaining the linkages Mc Kinnon and Shaw developed a theoretical framework to explain the growth-inducing effects of financial liberalization in contrast to financial repression. Their contribution was followed by numerous empirical studies examining this relationship. There is a broad consensus among scholars that the significance of the financial system lies in its ability to assist capital flows from savers to investors (Cameron, 1972). This resource flow from savers to investors was modeled by Harrison et al. (1999). The financial system aids economic growth in several other ways as noted by scholars. Greenwood & Smith (1997) observed that financial markets promote specialization and reduce transaction costs. Additionally, the cost of acquiring and analyzing information is

reduced by financial intermediaries (Boyd & Prescott, 1986). This relationship of financial development with technological innovation and capital accumulation has been captured and modeled by de la Fuente & Marín (1996).

In the early 1990s, literature on endogenous growth that positively links finance and growth emerged primarily from the discussion and findings of prior studies. One of the earliest proponents of the theory, King & Levine (1993), argued that the financial system in channelizing savings to their most productive uses increases the probability of successful innovation and technological progress. The theory emphasized the role of financial development in generating sustained growth. Greenwood and Joan (1990) developed an endogenous growth model implying that financial intermediation does not result in diminishing returns to capital. Bencivenga & Smith (1991) constructed an endogenous growth model linking financial development to corporate governance

2.2. Empirical evidence

The majority of the studies examining the finance growth nexus are cross-country studies. The commonly used tools in these studies have been VAR, VECM, GMM, ARDL, cointegration analysis, and granger causality tests. One of the earliest and most pioneering empirical studies to find a positive correlation between finance and growth was by Goldsmith (1969). The study was based on a cross-section of thirty-five developed, developing, and socialist countries for the period 1860-1963. A meta-analysis of 67 studies that have examined the effect of financial development on economic growth is a recent work by Valickova et al. (2014). The results imply a positive and significant relationship on the whole although individual results vary. The effect of finance on growth is overstated in cases where the issue of endogeneity has not been addressed. The effect is weaker in less developed countries and decreases worldwide after 1980. On the issue of causality, empirical findings are divided on the direction and nature of causality.

King and Levine (1993) used a large cross-section dataset of 80 countries over the period 1960-89 and found financial development to promote economic growth. Growth variables like per capita GDP and physical capital accumulation were found to be closely associated with financial development. Taking banking credit and deposits as measures of financial development, Aikaeli and Mbellenge (2015) found causality to run from finance to growth. A similar result was obtained by Yang and Yi (2008) who applied the exogeneity methodology for Korea for the period 1971 to 2002. Another study covering Korea, the Philippines, and Thailand by Nasir et al. (2018) has the same deduction. All these studies support the

statement that growth in financial services and products stimulates economic growth. Empirical studies supporting the "demand following" pattern are fewer. The supporters of this assertion believe that as the real sector grows, the increasing demand for financial services stimulates the financial sector (Balago, 2014). In a recent study of 24 African countries, Adusei (2014) finds economic growth promotes financial development. Demetriades and Hussein (1996) using a dataset of 16 countries found considerable evidence of bidirectional causality and some evidence of reverse causation. Iyoboyi (2013) in a study of Nigeria for the period 1981-2010 found a long-term relationship as well as bidirectional causality between financial deepening and economic growth.

A few studies have explored the linkages beyond the finance growth nexus and causality of the relationship. Hwang and Lee (2013) find financial development to mitigate cyclical fluctuations in GDP. Nikoloski (2012), Swamy and Dharani (2019) found the relationship to be inverted U-shaped. Marchionne and Niccoli (2011) referred to the proliferation of financial derivatives as toxic financial deepening. They found this to be destroying social capital measured as capital with financial institutions up to 0.8per cent annually.

In the Indian context, there have been some notable studies during the last two decades. In one of the first studies covering the states of India Arora (2009) found that post-liberalization credit to the less developed states had declined although banking reforms had succeeded in improving the efficiency of banks. Chakraborty (2008) found a stable long-run relationship between stock market capitalization, bank credit, and the growth of real GDP for India. Balasubramanian (2022) using long-term bank credit instead of total credit as a proxy for financial development finds both short and long-run relationships between financial development and economic growth. One of the most extensive studies at the sub-regional level was a district-level analysis of the relationship between credit availability and economic growth by Tiwary and Thampy (2014). It finds that credit from private and foreign banks has a significantly higher impact on economic growth as compared to state-owned banks. However, in rural areas, credit from state-owned banks significantly contributes to economic growth. Durafe and Jha (2018) in a study covering 23 Indian banks for the period 2000-13 find a positive correlation between bank credit and economic growth and bidirectional causality.

Although empirical studies on the linkages between financial development and growth exist, few scholars have attempted to examine the growth effect of bank credit. A recent contribution by Ho and Saadaoui (2021) found the growth

effect of bank credit to vary among ASEAN countries concerning their Credit to GDP ratio. Taking a threshold Credit to GDP ratio of 96.5 percent, the growth effect of credit for the countries with the higher threshold ratio was found to be four times as compared to countries with a lesser threshold ratio. In the context of India, sector studies at the state level examining the growth effect of banking credit are scarce. The study attempts to fill this gap. It extends to cover 24 states and examines the relationship between bank credit and economic growth of different sectors of the economy for the period 2004-05 up to 2021-22.

3. DATA AND METHODOLOGY

The study has two objectives. The first is to examine at the state level the growth effect of credit and its variation among sectors. The second is to examine growth effect variation among states.

3.1. Selection of variables

The sectors chosen for the study include Agriculture, Industry, and Services. The growth in gross value added (GVA) of the sectors as a proxy for growth is taken as the dependent variable. In literature, the commonly used variables as a proxy for financial growth/development have been bank credit or/and stock market capitalization (Aghion et al., 2005; Jayaratne & Strahan, 1996; Kendall, 2012). The study uses bank credit as a proxy for financial development and is taken as the explanatory variable. Additionally, five control variables expected to have an impact on the GVA of each sector have been included in the model. These are total credit extended by banks, state domestic product, capital expenditure, capital outlay, and the number of workers. The description of the variables is given in Table 1

Table 1: Description of variables taken in the study

S. No.	Variable	Description
1	GVA	Natural log of the gross value added of the sector
2	CR	Natural log of the bank credit extended to the sector
3	TC	Natural log of the total credit extended by banks
4	SDP	Natural log of the state domestic product
5	CE	Natural log of the capital expenditure
6	CLAY	Natural log of the capital outlay
7	WRKS	Natural log of the total workforce

3.2. Data sources and sample selection

Data for the study has been sourced from the Reserve Bank of India (RBI) database available on its website. The state-wise data is available from 2004-05 onwards and hence the period from 2004-05 is considered for the study. Data on the workforce is expressed as the number of workers while all other data has been taken at constant prices with the base year 2004-05.

The study covers 24 of the 29 states of India. Five states have been omitted. Four of these states namely Arunachal Pradesh, Mizoram, Sikkim, and Jammu and Kashmir have been excluded for missing or incomplete data for one or more variables. The fifth state omitted is Telangana on account of its recent formation in 2014. For the year 2021-22, these states combined accounted for 2.76 percent of the total bank credit and 2.33 percent of the combined GVA of all sectors. Hence, the omission of these states is unlikely to have a significant impact on the findings of the study.

3.3. Rationale for choice of control variables

Given the linkages among sectors, total credit, and SDP are likely to impact the output of all sectors. Similarly, an increased workforce contributes not only to the sector output they are employed in but indirectly adds to the output of other sectors through consumption demand. Capital expenditure differs from the capital outlay. While capital outlay is expenses incurred on existing assets, capital expenditure is expenses incurred on the creation of new physical assets. Both directly impact industry output and indirectly impact the output of other sectors.

3.4. Summary statistics

Preliminary to our examination of the growth/bank credit relationship, we present and discuss summary statistics of the variables. Table 2 captures the estimated growth figures of the variables for the period of study

Table 2: Compounded annual growth rates for the period 2004-05 to 2021-22

		Agriculture		**Industry**		**Services**			
S. No.	States	GVA	CR	GVA	CR	GVA	CR	Total Output	TC
1	Andhra Pradesh	3.96	17.67	6.18	9.27	8.24	13.51	6.88	13.50
2	Assam	2.63	23.65	7.92	13.55	6.96	20.61	6.50	19.59
3	Bihar	3.37	22.44	10.98	18.16	10.20	18.01	8.96	19.17
4	Chhattisgarh	5.70	20.46	6.41	18.49	8.48	21.53	7.14	20.44
5	Goa	-0.44	14.19	11.42	9.25	10.68	19.33	10.74	15.28
6	Gujrat	3.38	18.97	10.06	16.30	9.83	31.18	9.32	20.58
7	Haryana	3.41	18.40	7.24	16.90	10.74	28.92	8.45	21.73

		Agriculture		Industry		Services			
8	Himachal Pradesh	1.53	20.50	7.87	6.52	8.94	20.97	7.40	15.94
9	Jharkhand	5.09	20.00	3.25	13.09	9.91	17.63	6.39	16.62
10	Karnataka	3.63	16.93	7.08	15.38	9.38	19.75	7.98	17.93
11	Kerala	-1.54	20.77	6.36	12.63	8.54	17.37	7.15	17.19
12	Madhya Pradesh	8.47	18.83	7.29	16.01	8.28	19.38	8.07	18.44
13	Maharashtra	2.40	18.55	7.70	16.38	8.90	15.67	8.16	16.05
14	Manipur	6.16	13.66	3.22	9.68	8.06	22.48	6.10	23.85
15	Meghalaya	3.74	18.21	7.18	4.42	9.03	20.74	7.80	14.32
16	Nagaland	2.32	9.00	8.90	11.20	8.55	20.77	7.23	22.09
17	Odisha	0.67	19.18	7.52	15.63	8.21	17.07	6.93	16.94
18	Punjab	1.58	18.25	6.88	13.87	8.23	15.44	6.30	15.67
19	Rajasthan	3.92	20.78	7.36	15.09	8.69	21.66	7.39	19.78
20	Tamil Nadu	2.55	21.25	8.49	13.70	8.95	17.05	8.36	16.46
21	Tripura	4.00	25.45	11.21	17.38	9.49	20.25	9.12	20.99
22	Uttar Pradesh	3.79	18.97	7.04	13.80	8.18	19.45	6.90	17.93
23	Uttarakhand	1.59	19.46	13.29	17.00	11.18	20.11	10.93	19.21
24	West Bengal	2.31	16.79	6.32	13.55	8.09	16.75	6.82	15.32
	Average	3.26	18.01	7.29	14.40	8.60	16.59	7.46	16.07

Source: Authors' compilation (All figures are in percentage)

3.5. Sector output and credit

During the period of study, the annual growth rate in the output of agriculture for the states has been 3.26 percent which is significantly lower than the credit growth of 18.01 percent. Madhya Pradesh, Manipur, and Chhattisgarh have seen the highest growth in agriculture output while Kerela and Goa have recorded negative growth. Surprising is the low growth figures of 1.58 percent and 3.41 percent for Punjab and Haryana respectively counted amongst the most fertile states of India. These states after having witnessed significant growth in the period following the green revolution now see the growth rate plateauing. Compared to the single-digit low growth rate in agriculture output for all states, the growth rate of bank credit to the sector has been in double digits for all states except for Nagaland. This high growth rate can be attributed to the RBI's mandate requiring domestic banks to lend a minimum of 18 percent of their adjusted net bank credit towards agriculture. To assess the efficiency of credit utilization, we measure the credit elasticity of output for each sector and state. This is estimated in percentage as the ratio of change in output to change in credit. The number measures the response in output to change in bank credit. Thus, a higher elasticity would indicate higher responsiveness of output change to changes in bank credit. For all states, the ratio is a dismal 0.1641 or 16.41 percent indicating that the agriculture output increases by an average of 16.41 percent for every 100 percent increase in bank credit. Individually, the elasticity of agriculture bank credit is less than 0.5 for all

the states. The figure is low and in single digits for some of the large states like Odisha, Kerala, and Uttarakhand. This also holds for some of the most fertile states in the country like Haryana and Punjab. This largely reflects the inefficiencies in the utilization of bank credit and its impact on the agricultural output of states.

The output of the industrial sector has grown at 7.8 percent p.a. against the annual credit growth of 18.04 percent. The credit elasticity of industry output at 0.57 is higher as compared to the agriculture sector. Among the states that have done well in the utilization of industry credit include Goa, Himachal Pradesh, Meghalaya, Uttarakhand, and Gujarat. Excepting for Manipur, all northeastern states have credit elasticity more than the national average.

The services output for the period has grown at 8.99 percent p.a. which is marginally higher than the growth in industrial output. Amongst the sectors, the credit growth of this sector is the highest. All states have double-digit output growth but there are some exceptional performing states like Goa, Haryana, and Uttarakhand. The credit elasticity of services output for all states is 0.45 which is slightly lower than the corresponding figure for the industry sector. Haryana and Gujrat top the charts in output growth as well as the credit elasticity of growth for this sector. For Haryana, the city of Gurgaon has emerged as one of the biggest Information Technology hubs in the country over the years and is undoubtedly the biggest contributor to this growing number.

3.6. Performance of states on sectoral output

We estimate the performance of the states on output growth for each of the sectors as compared to the national average. Table 4 reports the categorization of these states.

Table 4: Comparative performance of states

States where annual output growth is more than the national average for the number of sectors	No of states	List of states
All three sectors	4	Gujrat, Bihar, Rajasthan, and Tripura
Two sectors	10	Goa, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Tamil Nadu, and Uttarakhand
One sector	7	Andhra Pradesh, Assam, Chhattisgarh, Manipur, Nagaland, Odisha, and Uttar Pradesh
None	3	Kerala, Punjab, West Bengal

Source: Authors compilation

Four states namely Gujarat, Bihar, Rajasthan, and Tripura have an annual growth rate in output more than the national average for all sectors. Tripura may be on the list because of the base effect, Gujarat was expected, but it is commendable for Bihar and Rajasthan to be a part of this group. The output and credit growth for both states has been impressive. These states were once part of the BIMARU states (an acronym for states Bihar, Madhya Pradesh, Andhra Pradesh, Rajasthan, and Uttar Pradesh). The other BIMARU states continue to lag primarily on account of weak output growth for both the industry and services sectors. Three states are lagging the average growth for all sectors of which Punjab is a surprise inclusion.

Finally, we examine the variations in the proportionate share of output and credit for each of the sectors. The proportionate share of agriculture output to the total output has decreased by almost 50per cent although credit share has increased from 12.14 percent to 15.55per cent during the period. This again highlights that despite an increasing credit flow, output has not been impacted. During the period, the proportionate share of industry output has increased marginally while there is a 20 percent increase in the proportionate share of services output. Bank credit to industry has decreased by 20 percent and there is a small increase in the proportionate share of services credit. One possible reason for these marginal changes could be the plethora of alternative sources of credit now available to these sectors, especially with the development of the financial markets and easy access to capital. The findings are reported in Table 5

Table 5: Proportionate change in output and credit of sectors

	2004-05	2021-22	2004-05	2021-22
	Output		Credit	
Agriculture	17.95	9.87	12.14	15.55
Industry	30.54	29.81	35.87	28.86
Services	51.51	60.32	52.02	55.59
	100.00	100.00	100.03	100.00

(All figures in percentage)

4. EMPIRICAL ANALYSIS, DISCUSSION, AND FINDINGS

In this section, we describe the estimation procedure and discuss the findings of the results.

4.1. Estimation procedure

The data consists of a cross-section of 24 states for the time from 2004-05 up to 2021-22. This befits the use of panel data estimation for the study. The

following eq.1 can be used to estimate the relationship between GVA of the sectors and bank credit.

$$GVA_{pit} = \alpha_0 + \beta_1 CR_{pit} + \gamma Z_{it} + \epsilon_{pit} \quad (1)$$

Where $\boldsymbol{GVA_{pit}}$ is the natural logarithm of gross value added, and p represents the sectors namely agriculture(A), industry(I), and services(S). CR_{pit} is bank credit of the ith state in the tth year for the pth sector. Z is the vector of the control variables that are believed to have an impact on GVA. e is the error term.

The short and long-run relationship between bank/private credit and economic growth is well accepted and established in the literature. Thus, it is reasonable to expect the current output to be influenced both by the current and lagged values of credit. We further believe output to be influenced by its past values. The modified eq 2 is now a dynamic one that will be employed in the estimation. It includes the current and lagged values of credit along with the lagged values of output as the explanatory variables.

$$GVA_{pit} = \alpha_0 + \beta_1 CR_{pit} + \beta_2 CR_{pi(t-1)} + \gamma Z_{it} + \epsilon_{pit} \quad (2)$$

In panel data modeling the simplest of approaches is to pool the data and run the ordinary least squares in estimating the equation (POLS). This approach ignores the heterogeneity of the cross-sectional units and is liable to give spurious results. These unobserved effects resulting from the heterogeneity among the states can be taken care of by using the more commonly used models namely the fixed effects and the random effects approach. The estimators of these models take care of the unobserved effects of the cross-section data. In our estimation eq 2, one problem persists. Since the model employs the lagged values of the explanatory and the dependent variable, the possibility of a simultaneous relationship between output and credit may cause the problem of endogeneity where the explanatory variables are correlated with the error term. Thus, in our estimation, we employ the generalized method of moments (GMM) as proposed by Blundell and Bond (1998). It serves two purposes. First, it addresses and resolves the issue of endogeneity. Second, it resolves the finite sample bias of our study due to the number of cross-sections being greater than the duration of the study (Baltagi, 2013; Nickell, 1981). The approach is akin to those employed by scholars including (Caporale et al., 2014; McCaig & Stengos, 2005; Rioja & Valev, 2003; Seifallah & Sami, 2014). The GMM model first differences the data to eliminate the cross-section fixed effects. These differenced variables are then used in the original equation as instruments. Thus equation 2 is estimated both at its original level and at the first

difference. This helps in resolving both the problem of cross-section fixed effects and endogeneity (Wooldridge, 2022). The robustness of the model requires the testing of no serial correlation among the residuals and ensuring the joint validity of the instruments. This is done by using specification tests. The Sargan test gives the overall validity of the instruments while we also test for no serial correlation between error terms. The results of eq. 2 are presented in Table 6.

Table 6 Result estimates of one-step GMM

	Dependent Variables		
	GVAA	**GVAI**	**GVAS**
$GVAA_{t-1}$	0.62*** (0.00)		
$GVAI_{t-1}$		0.67*** (0.00)	
$GVAS_{t-1}$			0.79*** (000)
ACR	0.17 (0.35)		
$LACR_{t-1}$	0.02 (0.76)		
ICR		0.03* (0.07)	
$LICR_{t-1}$		0.04*** (0.0101)	
SCR			0.01*** (0.0106)
SCR_{t-1}			0.021*** (0.0104)
TC	0.012** (0.06)	0.04*** (000)	0.06** (0.028)
SDP	0.03** (0.02)	0.24*** (0.001)	0.31*** (0.001)
CE	0.19 (0.21)	0.12 (0.43)	0.009 (0.54)
CLAY	0.06 (0.37)	0.26 (0.03) **	0.27 (0.24)
WRKRS	0.05 (0.45)	0.87*** (0.0021)	2.6** (0.03)
Diagnostic tests			
AR (1)	-7.9 (0.00)	-5.6 (0.00)	-13.1 (0.00)
AR (2)	-0.91 (0.32)	-2.7 (0.005)	-2.21 (0.02)
Sargan test	43.72 (0.026)	45.23 (0.039)	51.33 (0.045)
No of observations	432	432	432

Notes: Figures in parenthesis are the respective p values. ***, **, * denotes values significant at 1per cent, 5 percent, and 10 percent confidence levels respectively. GVAA, GVAI, and GVAS represent gross value added for sectors of Agriculture, Industry, and Services respectively.

4.2. Growth effect of sectoral credit

The results indicate the growth effect of agriculture credit to be positive but insignificant both at current and lagged values of credit. In India, given the vagaries of the monsoon and lack of proper irrigation facilities, agriculture continues to be a risky business. Although this risk is compensated by the minimum support price offered by the Government on a few crops, credit to this sector is crucial for ensuring the quality of the seeds, fertilizers, availability of irrigation facilities, and technology. The results seem to suggest that bank credit is not having the desired effect on the output of this sector, though productivity measured as output per unit area might have changed over the years. A recent study by Manoharan and Varkey (2021) finds a positive relationship between bank credit and the productivity of the sector. A possible reason for the increased productivity of the sector could be the reduced area of cultivation though the output may not have increased substantially. The growth effect of industry credit is significant at one lag period which is on expected lines. The majority of the credit extended to this sector goes into asset creation, the output effect of which may have a lagged effect. In developed countries, financial markets cater to a significant proportion of the credit needs of this sector. However, in India, this sector particularly with micro, small, and medium enterprises is still largely dependent on commercial banks for both their working capital and asset creation needs. The service sector's contribution to the GDP which is currently close to 60 percent has increased substantially over the last two decades. The significant role of banking credit in this growth is evident from the results of the output effect of services credit which is significant both at current and lagged values. Overall, the results highlight a significant role of banking credit in the growth of the sectors.

Among the control variables, total credit and SDP have a positive and significant impact on the output of all sectors. This is expected given the growing linkages among the sectors. These linkages exist as the output of a sector either end as final consumption or is an input to another sector. The capital outlay has a significant impact on industrial output. The current values of capital expenditure do not have a significant impact on industry output although we may expect a different result if their lagged values are considered.

4.3. Sample Splits

The states in India differ widely in terms of size, the endowment of natural resources, population, and stage of development. This heterogeneity requires us to examine variations in the growth effect of credit among the developed and the less developed states. Since our study is based on output growth, we segregate the states based on their growth in output during the period of study. We classify the states as "developed" whose annual growth in output for the period has exceeded the annual growth rate of the combined sample states which is 7.46 percent. The balance states are classified as "less developed". The states in the two groups are 14 and 10 respectively. The results of the estimation on the two subsamples are reported in Table 7.

Table 7 Result estimates of one-step GMM (Sample Splits)

	"DEVELOPED" STATES			**"LESS DEVELOPED" STATES**		
	GVA	**GVAI**	**GVAS**	**GVAA**	**GVAI**	**GVAS**
$GVAA_{t-1}$	0.77*** (0.00)			0.55*** (0.00)		
$GVAI_{t-1}$		0.84*** (0.00)			0.5*** (0.00)	
$GVAS_{t-1}$			0.73*** (0.00)			0.9*** (0.00)
ACR	0.14 (0.14)			0.1*** (0.005)		
$LACR_{t-1}$	0.03 (0.74)			0.01 (0.62)		
ICR		0.16 (0.22)			0.03 (0.13)	
$LICR_{t-1}$		0.27*** (0.002)			0.04 (0.7)	
SCR			0.02** (0.076)			0.07*** (0.00)
SCR_{t-1}			0.17 (0.004)			0.04** (0.013)
TCR	0.034 (0.08) *	0.04*** (0.00)	0.07** (0.02)	0.02*** (0.00)	0.6** (0.05)	0.03*** (0.00)
SDP	0.07* (0.06)	0.24*** (0.001)	0.31*** (0.001)	0.1 (0.36)	0.19*** (0.00)	0.01** (0.07)
CE	0.06 (0.29)	0.21** (0.028)	0.39 (0.29)	0.1 (0.16)	0.1** (0.045)	0.02** (0.47)
CLAY	0.08 (0.34)	0.26** (0.03)	0.27 (0.54)	0.11 (0.3)	0.16** (0.07)	0.16** (0.04)

	"DEVELOPED" STATES			"LESS DEVELOPED" STATES		
	GVA	**GVAI**	**GVAS**	**GVAA**	**GVAI**	**GVAS**
WRKRS	3.44 (0.30)	0.87** (0.038)	2.6 (0.41)	0.2 (0.49)	0.5** (0.04)	0.84** (0.022)
Diagnostic tests						
AR (1)	-5.27 (0.00)	-3.1 (0.00)	-9.1 (0.00)	-6.9 (0.00)	-5.4 (0.00)	-5.2 (0.00)
AR (2)	-1.23 (0.21)	-2.7 (0.003)	-1.41 (0.14)	-2.08 (0.03)	-1.2 (0.21)	-0.07 (0.9)
Sargan test	34.25 (0.032)	37.33 (0.046)	43.66 (0.053)	21.67 (0.331)	29.12 (0.025)	39.11 (0.022)
No of observations	252	252	252	180	180	180

Note: Figures in parenthesis are the respective p values. ***, **, * denotes values significant at 1 percent, 5 percent, and 10 percent confidence levels respectively. GVAA, GVAI, and GVAS represent gross value added for sectors of Agriculture, Industry, and Services respectively.

For developed states, both the current and lagged values of credit have a positive and significant impact on industry and services output. While the growth effect of agriculture credit is insignificant for the developed states, this effect is positive and significant for the less developed states but only for current values of credit. Thus, the agricultural credit impact on the output of less developed states seems to be immediate. The growth effect of credit is positive and significant for the service sector for both the developed as well as the less developed states.

It is noticeable that across all sectors, the growth effect of total credit is positive and significant. This is an important finding which shows that despite other sources of credit available for the industry and service sectors over the years, bank credit continues to play a significant role in the growth of output across all sectors and states.

5. SUMMARY AND CONCLUSIONS

The study examines the growth of credit and output of sectors for the states of India from 2004-05 to 2021-22. It further empirically analyzes the relationship between bank credit and its effect on the output of the sectors for these states.

The findings reveal that the average growth rate of output of sectors has been significantly lower as compared to the growth of credit. Amongst the sectors, though Agriculture credit growth has been the highest, its output growth has been the lowest. Biradar (2013) in his study on the agriculture credit in India for the period 1971-2008 found banking credit to the sector had increased significantly

and especially in the post-liberalization period. We classify states based on sectoral output performance as compared with the national average and find four states namely Gujarat, Bihar, Rajasthan, and Tripura with all sectors' growth in output higher than the national average. Not surprisingly, the proportionate share of agriculture output has decreased by half with an increase witnessed in the output of the services sector.

On empirically examining the relationship between bank credit and the output of sectors we find the growth effect of agriculture credit to be positive but insignificant. The growth effect of industry credit is with a lag of one period while the growth effect of services credit is significant both at current and lagged values. The findings are broadly in line with the results on the positive impact of credit on the output of the Indian industry by Singh (2016). A regional-level study by Duican (Moisescu) and Pop (2015) covering Romania also had similar results on the positive impact of banking credit on the gross output of sectors. On segregating states into relatively more homogeneous groups we find that the growth effect of credit to the agriculture sector is significant only in the case of the developed states. Overall, the findings highlight the significance of bank credit in the growth of output of sectors, particularly industry, and services.

REFERENCES

1. Adusei, M. (2014). Does Economic Growth Promote Financial Development? *Research in Applied Economics*, *6*(2), 209. https://doi.org/10.5296/rae.v6i2.5106
2. Aghion, P., Howitt, P., & Mayer-Foulkes, D. (2005). The Effect of Financial Development on Convergence: Theory and Evidence*. *Quarterly Journal of Economics*, *120*(1), 173–222. https://doi.org/10.1162/qjec.2005.120.1.173
3. Aikaeli, J., & Mbellenge, C. R. (2015). The Causal Relationship between Financial Development and Economic Performance in Tanzania. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2706034
4. Ang, J. B. (2008a). A SURVEY OF RECENT DEVELOPMENTS IN THE LITERATURE OF FINANCE AND GROWTH. *Journal of Economic Surveys*, *22*(3), 536–576. https://doi.org/10.1111/j.1467-6419.2007.00542.x
5. Ang, J. B. (2008b). A SURVEY OF RECENT DEVELOPMENTS IN THE LITERATURE OF FINANCE AND GROWTH. *Journal of Economic Surveys*, *22*(3), 536–576. https://doi.org/10.1111/j.1467-6419.2007.00542.x
6. Arestis, P., Chortareas, G., & Magkonis, G. (2014). THE FINANCIAL DEVELOPMENT AND GROWTH NEXUS: A META-ANALYSIS. *Journal of Economic Surveys*, *29*(3), 549–565. https://doi.org/10.1111/joes.12086

7. Arora, R. U. (2009). Bank credit and economic development: an empirical analysis of Indian states. *Journal of Asian Public Policy*, *2*(1), 85–104. https://doi.org/10.1080/17516230902734502
8. Balago, G. S. (2014). Nexus between Bank Credit and Economic Growth in Nigeria: Evidence from VEC Model. *OALib*, *01*(08), 1–12. https://doi.org/10.4236/oalib.1100952
9. Balasubramanian, R. (2022). Role of Long-term Bank Credit in the Economic Growth of India. *Global Business Review*, 097215092110602. https://doi.org/10.1177/09721509211060218
10. Baltagi, B. H. (2013). *Econometric Analysis of Panel Data* (5th ed.). Wiley.
11. Bangake, C., & Eggoh, J. C. (2011). Further evidence on finance-growth causality: A panel data analysis. *Economic Systems*, *35*(2), 176–188. https://doi.org/10.1016/j.ecosys.2010.07.001
12. Bencivenga, V. R., & Smith, B. D. (1991). Financial Intermediation and Endogenous Growth. *The Review of Economic Studies*, *58*(2), 195. https://doi.org/10.2307/2297964
13. Biradar, R. (2013). Trends and patterns of institutional credit flow for agriculture in India. *Journal of Asia Business Studies*, *7*(1), 44–56. https://doi.org/10.1108/15587891311301016
14. Blackburn, K., & Hung, V. T. Y. (1998). A Theory of Growth, Financial Development and Trade. *Economica*, *65*(257), 107–124. https://doi.org/10.1111/1468-0335.00116
15. Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *87*(1), 115–143. https://doi.org/10.1016/s0304-4076(98)00009-8
16. Boyd, J. H., & Prescott, E. C. (1986). Financial intermediary-coalitions. *Journal of Economic Theory*, *38*(2), 211–232. https://doi.org/10.1016/0022-0531(86)90115-8
17. Calderón, C., & Liu, L. (2003). The direction of causality between financial development and economic growth. *Journal of Development Economics*, *72*(1), 321–334. https://doi.org/10.1016/s0304-3878(03)00079-8
18. Cameron, R. E. (1972). *Banking and Economic Development; Some Lessons of History*. Oxford Univ Pr.
19. Caporale, G. M., Rault, C., Sova, R., & Sova, A. (2014). Financial Development and Economic Growth: Evidence from Ten New EU Members. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2492404
20. Chakraborty, I. (2008). Does Financial Development Cause Economic Growth? The Case of India. *South Asia Economic Journal*, *9*(1), 109–139. https://doi.org/10.1177/139156140700900105
21. Christopoulos, D. K., & Tsionas, E. G. (2004). Financial development and economic growth: evidence from panel unit root and cointegration tests. *Journal of Development Economics*, *73*(1), 55–74. https://doi.org/10.1016/j.jdeveco.2003.03.002
22. de la Fuente, A., & Marín, J. (1996). Innovation, bank monitoring, and endogenous financial development. *Journal of Monetary Economics*, *38*(2), 269–301. https://doi.org/10.1016/s0304-3932(96)01277-9

23. Demetriades, P. O., & Hussein, K. A. (1996). Does financial development cause economic growth? Time-series evidence from 16 countries. *Journal of Development Economics*, *51*(2), 387–411. https://doi.org/10.1016/s0304-3878(96)00421-x
24. Duican (Moisescu), E. R., & Pop, A. (2015). The Implications of Credit Activity on Economic Growth in Romania. *Procedia Economics and Finance*, *30*, 195–201. https://doi.org/10.1016/s2212-5671(15)01286-1
25. Durafe, A., & Jha, A. (2018). Bank capital buffer, bank credit and economic growth: evidence from India. *Afro-Asian J. of Finance and Accounting*, *8*(3), 257. https://doi.org/10.1504/aajfa.2018.093464
26. Fry, M. J. (1978). Money and Capital or Financial Deepening in Economic Development? *Journal of Money, Credit and Banking*, *10*(4), 464. https://doi.org/10.2307/1991576
27. Goldsmith, R, 1969. *Financial structure and development*. New Haven, Yale University Press
28. Greenwood, J., & Jovanovic, B. (1990). Financial Development, Growth, and the Distribution of Income. *Journal of Political Economy*, *98*(5, Part 1), 1076–1107. https://doi.org/10.1086/261720
29. Greenwood, J., & Smith, B. D. (1997). Financial markets in development, and the development of financial markets. *Journal of Economic Dynamics and Control*, *21*(1), 145–181. https://doi.org/10.1016/0165-1889(95)00928-0
30. Harrison, P., Sussman, O., & Zeira, J. (1999). Finance and Growth: Theory and New Evidence. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.186142
31. Hassan, K. M., & Yu, J. S. (2007). Financial Development and Economic Growth: New Evidence from Panel Data. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.985889
32. Ho, S. H., & Saadaoui, J. (2021). Bank credit and economic growth: a dynamic threshold panel model for ASEAN countries. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3861675
33. Hwang, J., & Lee, J. H. (2013). Financial deepening and business cycle volatility in Korea. *Applied Financial Economics*, *23*(21), 1693–1700. https://doi.org/10.1080/09603107.2013.844324
34. Iyoboyi, M. (2013). Bank and Non-Bank Financial Deepening and Economic Growth: The Nigerian Experience (1981–2010). *Economic Notes*, *42*(3), 247–272. https://doi.org/10.1111/j.1468-0300.2013.12008.x
35. Jayaratne, J., & Strahan, P. E. (1996). The Finance-Growth Nexus: Evidence from Bank Branch Deregulation. *The Quarterly Journal of Economics*, *111*(3), 639–670. https://doi.org/10.2307/2946668
36. Kendall, J. (2012). Local financial development and growth. *Journal of Banking & Finance*, *36*(5), 1548–1562. https://doi.org/10.1016/j.jbankfin.2012.01.001
37. King, R. G., & Levine, R. (1993a). Finance and Growth: Schumpeter Might Be Right. *The Quarterly Journal of Economics*, *108*(3), 717–737. https://doi.org/10.2307/2118406

38. King, R. G., & Levine, R. (1993b). Finance and Growth: Schumpeter Might Be Right. *The Quarterly Journal of Economics*, *108*(3), 717–737. https://doi.org/10.2307/2118406
39. Macesich, G., & Goldsmith, R. W. (1970). Financial Structure and Development. *The Journal of Finance*, *25*(1), 204. https://doi.org/10.2307/2325833
40. Manoharan, N., & Varkey, R. S. (2021). Agricultural credit and agricultural productivity across Indian states: An analysis. *Journal of Public Affairs*. https://doi.org/10.1002/pa.2597
41. Marchionne, F., & Niccoli, A. (2011). Financial Deepening and Social Capital. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1915198
42. McCaig, B., & Stengos, T. (2005). Financial intermediation and growth: Some robustness results. *Economics Letters*, *88*(3), 306–312. https://doi.org/10.1016/j.econlet.2004.12.031
43. McKinnon, R., I. (1973). *Money and Capital in Economic Development*. Brookings Institution Press.
44. Miller, M. H. (1998). Financial Markets and Economic Growth. *Journal of Applied Corporate Finance*, *11*(3), 8–15. https://doi.org/10.1111/j.1745-6622.1998.tb00498.x
45. Nasir, H., Majeed, S., & Aleem, A. (2018). Does Financial Development Leads Economic Growth? Evidence from Emerging Asian Markets. *Asian Economic and Financial Review*, *8*(5), 599–617. https://doi.org/10.18488/journal.aefr.2018.85.599.617
46. Newlyn, W. T., & Shaw, E. S. (1975). Financial Deepening in Economic Development. *Economica*, *42*(167), 347. https://doi.org/10.2307/2553847
47. Nickell, S. (1981). Biases in Dynamic Models with Fixed Effects. *Econometrica*, *49*(6), 1417. https://doi.org/10.2307/1911408
48. Nikoloski, Z. (2012). FINANCIAL SECTOR DEVELOPMENT AND INEQUALITY: IS THERE A FINANCIAL KUZNETS CURVE? *Journal of International Development*, *25*(7), 897–911. https://doi.org/10.1002/jid.2843
49. Patrick, H. T. (1966). Financial Development and Economic Growth in Underdeveloped Countries. *Economic Development and Cultural Change*, *14*(2), 174–189. https://doi.org/10.1086/450153
50. Pradhan, R. P. (2010). Financial Deepening, Foreign Direct Investment and Economic Growth: Are They Cointegrated. *International Journal of Financial Research*, *1*(1). https://doi.org/10.5430/ijfr.v1n1p37
51. Rajan, R. G., & Zingales, L. (1998). Which Capitalism? Lessons from the East Asian Crisis. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.137550
52. Rioja, F. K., & Valev, N. T. (2003). Finance and the Sources of Growth at Various Stages of Economic Development. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.438261
53. Schumpeter, J.A, 1911. *The Theory of Economic Development*. Cambridge, MA: Harvard University Press

54. Seifallah, S., & Sami, B. A. M. (2014). The Credit-Growth Nexus: New Evidence from Developing and Developed Countries. *Economic Notes*, *43*(2), 115–135. https://doi.org/10.1111/ecno.12017
55. Shaw, E. S. (1973). *Financial Deepening in Economic Development*. Oxford University Press.
56. Singh, C. (2016). Economic Growth and Banking Credit in India. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2882398
57. Swamy, V., & Dharani, M. (2019). The dynamics of finance-growth nexus in advanced economies. *International Review of Economics & Finance*, *64*, 122–146. https://doi.org/10.1016/j.iref.2019.06.001
58. Tiwary, M. K., & Thampy, A. (2014). Bank Ownership, Credit and Local Economic Growth. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2481694
59. Valickova, P., Havranek, T., & Horvath, R. (2014). FINANCIAL DEVELOPMENT AND ECONOMIC GROWTH: A META-ANALYSIS. *Journal of Economic Surveys*, *29*(3), 506–526. https://doi.org/10.1111/joes.12068
60. Wooldridge, J. M. (2022). *By Jeffrey M. Wooldridge: Econometric Analysis of Cross Section and Panel Data, 2nd Edition Second (2nd) Edition* (Rev. ed.). MIT Press.
61. Yang, Y. Y., & Yi, M. H. (2008). Does financial development cause economic growth? Implication for policy in Korea. *Journal of Policy Modeling*, *30*(5), 827–840. https://doi.org/10.1016/j.jpolmod.2007.09.006
62. Yu, J. S., Hassan, M. K., & Sanchez, B. (2012). A re-examination of financial development, stock markets development, and economic growth. *Applied Economics*, *44*(27), 3479–3489. https://doi.org/10.1080/00036846.2011.577019

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PURCHASING POWER PARITY IN RUSSIA AND THE TRANSITIONING ECONOMY 1990-1995

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Abstract: *The role of purchasing power parity during the Russian transition period from 1990-1995 is studied. This paper describes the many changes during the transition period that provide a real world view of purchasing power parity in a reforming economy on a large scale that has not been seen in the world before or after this time. The authors' study looks at the real value of the Russian currency and its purchasing power parity valuation during the break-up of the Soviet Union and the transition of the newly created Russian Federation into a more market oriented economy. The undermining of purchasing power parity became a critical piece of the incredible profit achieved by the communist oligarchs. Specific factors and their influence on savings, income, and market structure are examined from the perspective of purchasing power parity. The analysis helps to understand the dramatic changes that took place during the transition period and how it impacted Russia.*

Keywords: *Transition Economies, Russia, Purchasing Power Parity, Former Communist Nations*

1. INTRODUCTION

The much debated concept of purchasing power parity (PPP) has a world from which to test the basic ideas and practices. In the early 1990's, the Russian economic changes put into place several dramatic shifts from the old centrally planned economy to a more market oriented economy. Some were unrealistically hopeful that these changes would establish a true market economy, as well as a more democratic system. The current authors examine the undermining of purchasing power parity in light of these changes. Even thirty years after the event, studies analyzing the undermining of PPP during this period in Russian history are virtually nonexistent, especially from authors who witnessed first-hand the events that unfolded. The authors'

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original research was conducted from 1991-2003 in Russia and the former Soviet Republics. Therefore, much of the paper relies on the authors' first-hand, experience while doing research and conducting seminars during the transition period in Russia and former Soviet republics.

The original research conducted by the authors involved the study of cultural values and entrepreneurship in former communist countries. The authors developed first-hand knowledge of savings, income, and the general living standards of the people in Russia and the former Soviet Republics. It was certainly a formidable undertaking to do the research half-way around the world from where the authors lived in Florida. Given the criminal elements that existed and the breakdown of the legal system, the inherent dangers faced were very real. One of the authors travelled back and forth between Florida and Russia and the former Soviet countries every year from 1991 to 2003, living in the different regions to collect data and study entrepreneurship and the transitioning economy.

The interaction in the Russian economy of virtually every aspect of economics, sociology, government, and politics established a perfect forum from which to study the effects of purchasing power parity on savings, incomes, and market structure. The authors chose to examine the PPP aspects in which fifteen separate factors influenced the ultimate ability of the controlling groups to subjugate the PPP theory to one of profit, corruption and theft. This paper seeks to describe the many changes during the transition period that provide a real world view of PPP in a reforming economy on a large scale that has not been seen in the world before or after this time. Because Russia was the largest economy to make a transition, it is very useful to understand these changes, how they impacted the people and overall economy, and how this caused a decline in PPP valuations during this time. The authors' study looks at the real value of the Russian currency and its purchasing power parity valuation during the break-up of the Soviet Union and the transition of the newly created Russian Federation into a more market oriented economy.

2. LITERATURE REVIEW

Sixteenth century Salamanca scholars in Spain described purchasing power parity in their writings (Officer, 2006). In 1601, British mercantilist Gerard de Malynes also put forth the idea of purchasing power parity and nineteenth century economist such as Marshal, Ricardo, Goschen, and Mill expanded on the idea of PPP (Officer, 1982; Taylor, 2006). The Purchasing Power Parity theory,

formulated by Gustov Cassel (1916), asserts that exchange rate between two currencies is the ratio of two corresponding national price levels.

Purchasing power parity is a fundamental concept in the study of exchange rates in international economics and finance. Simply stated, purchasing power parity occurs at that point where the exchange rates between two countries reaches equilibrium and the purchasing power is the same in each country. In its most simple and absolute form, a bundle of goods that cost 100 dollars in the United States and 7400 Russian Rubles in Russia, would have an exchange rate of 100USD = 7400RUB, or 1USD = 74RUB (Officer, 2006). In its relative form, purchasing power parity includes inflation over time in its calculation by setting the relative prices changes that occur to the relative exchange rates changes (the nominal exchange rate should equal the ratio of the aggregate price levels). Therefore, for a fixed basket of goods in the base year, the exchange rate between two currencies should, in the long-run, be equal to the relative price level for that basket of goods.

Purchasing power parity would likely hold in an open economy without trade barriers and adjusting for transportation cost. However, trade barriers, tariffs, non-tradeable goods, taxes, imperfect competition, and the existence of incomplete (or asymmetric) information would prevent purchasing power parity from occurring since market clearing prices would not occur. Keynes (1923) felt that PPP did not account for the movement of capital or the elasticity of reciprocal demand and therefore PPP was not a good measure or predictor of exchange rates.

Several problems with the concept of PPP have been identified. The first problem is the non-traded goods sector of the economy (Caves & Jones, 1981; Dornbusch, Fischer & Startz 2011; Grennes, 1984; Obstfeld & Stockman, 1985). The international markets exert considerable competition among national markets, while non-traded goods have no such pressure. If the goods which enter a country's economy have no price change, while the non-traded goods were to have a price increase, there would be no change in the exchange rate while the country experienced inflation. As inflation is regarded as a universal monetary event (Caves & Jones, 1981; Dornbusch, Fischer & Startz 2011; Barro, 1984; Grennes, 1984), then this inflationary non-traded goods pricing should result in a corresponding change in the exchange rate.

The second problem involves the impact of exogenous factors on the real value of variables compared to the effect this has on nominal values (Caves & Jones, 1981; Dornbusch, Fischer & Startz 2011; Grennes, 1984; Beach, Cottrell-

Kruse, & Uri, 1995). Beach, et al. (1995) cite an example of a technological change in Canadian agricultural production which is unique to Canadian applications. This would increase production, increase exports to the United States, which decreases the dollar exchange rate without any change in relative inflation. The reason is the size of the sector compared to the overall economy (Buiter & Eaton, 1987).

The last problem associated with PPP is the movement of capital and the resulting impact upon inflation. Several studies have shown that there is an impact on exchange rates, without any corresponding impact upon inflation (Caves & Jones, 1981; Grennes, 1984; Helliwell & Padmore, 1985; Levich, 1985). These three problems indicate that, both in the short run and the long run, there is no reason to expect PPP to be maintained (Beach, et al., 1995). While many studies have used a short run time frame, others have used a much longer time frame. PPP should allow for the exchange rates to reach some point of long term equilibrium, even when the short term is in disequilibrium (Flynn & Boucher, 1993).

An extensive number of studies have tested the PPP theory and many have concluded that, in the long-run, the PPP theory is supported, though it still remains a highly debated and unresolved topic, especially in former communist countries and transition economies (Froot & Rogoff, 1995; Frankel & Rose, 1996; Lothian & Taylor, 2000; Acaravci & Acaravci, 2007; Narayan, 2008; Kalyoncu & Kalyoncu, 2008).

Authors finding general evidence supporting purchasing power parity include, but not limited to, Diebold, Husted, & Rush (1991), Kugler & Lenz (1993), Mahdavi & Zhou (1994), Coakley & Fuertes (1997), Sarno (2000), Erlat (2003), Hoarau (2007), Kargbo (2009), Guloglu, Ispira, & Okat (2011), Yilanci & Eris (2013), Li, Lin, & Hsiao (2015), Canarellsal, Pollard, & Lai (1990), Enders (1988), Edison & Klovland (1987), Davutyan & Pippenger (1985), Hakkio (1984), and Taylor & McMahon (1988).

Bahmani-Oskooee, Chang, Chen, and Tzeng (2017) studied 23 OECD countries and found support for purchasing power parity in 16 countries. While, Bahmani-Oskooee & Wu (2018) analyzed 34 OECD countries and reported purchasing power parity supported in 18 countries. Mike & Kizilkaya (2019) studied twelve emerging market economies and found purchasing power parity supported in Columbia, India, Philippines, Poland, South Africa, and Turkey. Mike & Kizilkaya (2019) also found Brazil, Mexico, and Thailand consistent with purchasing power parity, but not necessarily supported. Doğanlar, Kizilkaya, &

Mike (2020) looked at Turkey's major trading partners and found evidence indicating purchasing power parity held for all countries involved. In a study of twenty-four OECD countries by Omay, Shahbaz, & Hasanov (2020), purchasing power parity was supported in the majority of the studied countries.

Authors whose studies did not find general evidence supporting purchasing power parity include, but not limited to Frenkel (1978), Darby (1980), Dornbusch (1980), Frenkel (1981), Adler & Lehman (1983), Junge (1985), Rush & Husted (1985), Edison (1985, 1987), Corbae & Ouliaris (1988), Taylor & McMahon (1988), McNown & Wallace (1989), Karfakis & Mosehos (1989), Layton & Stark (1990), Kim (1990), Copeland (1991), Ardeni & Lubian (1991), Cumby & Huizinga (1991), Bahmani-Oskooee & Rhee (1992), Bahmani-Oskooee (1993), Chowdhury & Sdogati (1993), Flynn and Boucher (1993), Pippenger (1993) Bahmani-Oskooee (1995, 1998), Telatar & Kazdagli (1998), Baum, Barkoulas, & Caglayan (1999), Cheng (1999), Bjørnland & Hungnes (2002), Zumaquero & Urrea (2002), Alba & Park (2005), Alberiko Gil-Alana, & Jiang (2013), and Tiwari & Shahbaz (2014). Nagayasu's (2021) analysis also failed to find support for purchasing power parity. According to Nagayasu's (2021), prices shocks, or price changes, are not simply transmitted through the exchange rate, and therefore purchasing power parity equilibrium does not occur.

Recent studies concerning Russia have been virtually non-existent as it pertains to the 1990-1995 period as most new literature refers to the 2008 financial crisis and later. The purpose of this paper is to examine the first changes from 1990-1995 and not the resulting reforms post 2008. The authors' current study fills that gap. The authors' study finds purchasing power parity during the transition period in Russia was not supported resulting in devastating adverse effects on incomes, savings, and market structure.

3. SOVIET RUSSIA AND THE RUSSIAN TRANSITION STATE 1990-1995

The election of Boris Yeltsin as president in June 1991 set the stage for the final dissolution of the Soviet Union in December 1991. Prior to the election of Yeltsin, Soviet Leader Mikhail Gorbachev's perestroika, or restructuring of the Soviet economic and political structure, as well as the implementation of glasnost, or openness, saw some reforms toward a freer and more open country. However, the economic system was in shambles, shortages worsened, and the economy, as well as the political situation, was on the verge of complete breakdown (Aron,

2002). In 1991, consumer goods shortages were extremely bad, such that most consumer goods were not routinely available (only around 20 of 1100 types of consumer goods were available on a routine basis); there were chronic shortages for everyday items such as toothpaste, soap, meat, potatoes, milk, bread, and butter, making them extremely hard to find (Moskoff, 1993).

President Yeltsin took drastic measures to reform the economy. In 1992, prices were allowed to adjust freely to reflect market prices of supply and demand. Once price controls were lifted in 1992, and prices were allowed to adjust freely, inflation accelerated and destroyed household savings (Stiglitz, 2002). However, natural resource prices were kept low leading to profiteers buying the low price natural resources in the domestic market and the reselling them in the international market for a huge profit (Stiglitz, 2002). Yeltsin took actions to privatize government run companies, transferring ownership of the companies to private individuals, creating the powerful oligarchs that still exist in Russia today (Ericson, 2000; Popov, 2004; Rutland, 2013; Gill & Young, 2013; Khafizullina, 2021). More than seventy-percent of the Russian economy was transferred to private ownership by the middle of 1994. In a desperate attempt to stay in power and improve his chances of winning the 1996 presidential election, Yeltsin transferred the ownership of valuable natural resources, telecommunications, metallurgical, and oil sectors to oligarchs in a loans-for-shares program (or theft of the state program) that further increased the power of the oligarchs, but led to their support (and reelection) of Yeltsin in the 1996 (Buiter, 2000; Ericson, 2000; Popov, 2004; Rutland, 2013; Gill & Young, 2013; Khafizullina, 2021).

When the Russian economy was opened to private enterprise the Yeltsin government had on its agenda much of what the West called, "the free market economic reforms". Some naively thought that the Yeltsin government would establish, a code of law, protect property rights, redesign the banking system along Western models, establish open and free competitive markets, decontrol prices, dispose, sell off, and/or close bankrupt enterprises, establish a free floating and convertible currency within two years, and control of government deficit in a timely manner (Ericson, 2000; Popov, 2004; Rutland, 2013; Gill & Young, 2013).

The problem with this agenda was that those who were to be most affected by the implementation, the people of Russia, had little if any voice in the decisions themselves. Thus, those who could benefit most from partial implementation were in fact those who had key positions of power from which huge profits could be generated. It is in this context that the currency markets,

the pricing mechanisms, and the control of distribution channels were turned over to these small tightly controlled groups. By fostering agreements, cooperation and corruption, the entire Russian economy was quickly controlled by the same people, who in the former communist days controlled the system. This process was a deliberate and calculated procedure of step by step actions resulting in the devaluation of the ruble at a time when inflation was running over 100% per month. The theory of PPP certainly was not evident during this time (see Table 1).

Once the Russian economy opened up, imports of cheap foreign goods began to flow into a chaotic economic environment, there were no laws to protect property rights or to honor contracts, leading to criminals controlling many markets, and the transfer of state assets to former Soviet officials and party elites (Stiglitz, 2002; Clarke, 2007; Kagarlitsky, 2008; Seyaz, 2020). The transition encouraged criminal activity, incentivized corruption, and rewarded failure, while penalizing the efforts of the honest, legitimate, and law-abiding business activity (Stiglitz, 2002; Clarke, 2007; Kagarlitsky, 2008; Seyaz, 2020). There was no legal environment to protect the legitimate business and the new system was viewed by most Russians as rigged, unjust, and unfair (Stiglitz, 2002; Clarke, 2007; Kagarlitsky, 2008). Former Soviet officials, party elites, and the criminal elements owned the banks, which they used to finance their importing and exporting operations (Kagarlitsky, 2008). In the former Soviet Union there was no capitalist (or bourgeoisie class described by Marx) class that owned the capital or other factors of production, such as land and raw materials. Since there was no ownership of capital under the communist system, when the Soviet Union collapsed it unleased the takeover by former Soviet officials, party elites, and the criminal elements and led to the oligarchs and monopoly capitalism (Holmstrom & Smith, 2000; Seyaz, 2020).

To study this period in Russia, and understand the transition processes, one must first examine the reasons underlying the actual events that subsequently transpired. The ability of the Russian bureaucrat to understand how Western economics worked was certainly limited by the teachings of the Marx communist philosophy. There is one important fact that is critical to understanding the changes that occurred. When the Russian citizen, educator, bureaucrat, or politician heard the words, free market or capitalism, what they understood and believed, at that time, was very different from the Western meaning.

In the context of Marx, the teachings inside the educational corridors were consistent with the beliefs of the Communist Party. Every Soviet citizen had to

take classes which taught about the evils of capitalism. This teaching proclaimed that capitalism was a system in which a few owned the means of production from which the masses were virtual slaves. They were taught that the capitalistic system included worker exploitation, monopoly pricing, and total control of the costs and profits. In addition, they were taught that capitalism was sanctioned by the government and big corporations, while the masses were unable to participate in the profits to any extent, and therefore, freedom of the workers in capitalism was virtually nonexistent.

One must remember that the Communist Party was in control of almost every facet of life by means of the trade union system. The trade unions were established across all of the Soviet Union. Each region had one union in which all workers were required to belong. Part of this organizational structure was the control by the Communist Party of each trade union. The Party had one of its own members as the head of the trade union in each location. These individuals were not from the region, but were employed from Moscow. The element which effects this analysis is the indoctrination for which the trade union was responsible. Each employee had to attend meetings, give free work days, and attend functions in which the theme of communism and socialism were repeated over and over. While it was not mandatory for workers to be a member of the Communist Party, they did have to attend functions, and were thus captive of the Communist Party (Little, 1989). A constant, never ending propaganda that was heard throughout the lifetime of each and every worker was the evils of capitalism, the concept of monopolies, control of the factories by a few, huge profit based pricing, government complicity in the scheme, and the inability of the workers to control their own fate.

From this concept of capitalism and government came the 1991 revolution in which for the first time, capitalism was suddenly to be adopted. It is natural that once the decision was made, the Marxian/communist concept of capitalism would be instituted; after-all, for over 70 years it had been discussed day after day. The understanding of what was to happen next was certainly simple in the minds of the former communist; gain monopoly control, establish monopoly pricing, make huge profits, and the workers are not important. This is consistent with what everyone, especially the Communist Party elite, believed was how capitalism performed.

There is one last aspect of this transition time period. Those who were in control of the factories, the distribution channels, the ministries, the raw material sources, local transportation networks, the trade unions, were all members of the old ruling party elite. While the centralization of the economy kept firm control of

the overall dimensions of the economy in the hands of the central government officials, the local leaders had virtual dictatorial control of their own regions. When the central authority disappeared, the ability to maintain stability was suddenly shifted into the hands of these local authorities. In the instant of the Yeltsin takeover in 1991, they became the local barons of their own kingdom. Decentralization meant, for them, the ability to gain the upper hand in controlling their own factory, transportation network, raw material source, food source, distribution channel and union group. Suddenly there was no counter-balance to their power coming from Moscow.

It is not surprising that in a very short period, these people took complete control of the country and all of its resources. At first, the control only meant the ability to steal money from sales, steal the production and sell it outside the normal channels, and control the reporting mechanisms. After a time, the privatization of companies put official control and ownership into their hands. This happened because those who were in control of the power wanted a piece of what was the old economy. The only way they could accomplish this was to establish a system in which this control resulted in ownership in the new capitalistic society. This meant monopoly control of markets, production, distribution, transportation, and labor.

Each region had different types of production as the old communist model set-up production facilities all over the Soviet Union in large factories. Thus, when the model collapsed in 1991, depending upon what that production output was, determined the level of crisis within that entire region. Olga Ignatova (1992), as the regional director for military output, said in a face-to-face, in-person interview with one of the authors, “the factories stopped producing and were unable to convert to another type of production as virtually all military production was eliminated while consumer goods production was non-existent.” While seeking to find alternative products to produce, Ignatova attempted to convert her factories to consumer products. But, with consumers having lost all of their savings in the devaluations, they had no money to buy anything. The result was that only importation of products ensued during the 1991-1994 era. Ignatova further indicated that her region would never regain economic viability as it had before when producing tanks and guns. Furthermore, one of the current authors conducted a series of seminars in the region to educate the out of work people that included scientists, managers, laborers and administrators as to what were the entrepreneurial opportunities available to them. Because importation of foreign parts, supplies, and products was needed to manufacture almost all consumer goods, and with PPP being disjointed during the short term, even with an understanding of new products

needed, it was impossible to buy the components to manufacture the products. This continued for a period of years as the centralized economy would slowly de-centralize while the PPP variable changed to permit new products being made. In a more recent interview, Ignatova (2015) indicated that this transition had caused massive poverty in her region that previously had been very prosperous during the Soviet times. Most people were forced to leave to seek work elsewhere.

Shortages and forced savings in Soviet Russia

Soviet authorities claimed very high savings by households. Reportedly, during Soviet times the average propensity to save was relatively high (Howard, 1976; Gregory, 1989; Mokhtari & Gregory, 1993; Mokhtari, 1996). However, some researchers, such as Ofer & Pickersgill (1980), found the Soviet savings rate lower than average, as compared to international averages, while Pickersgill (1976) found no difference in the savings rate of Soviet citizens compared to that of market countries. However, during Soviet times people were known to hide some of their savings at home, and this could have easily distorted the reported savings, as well as the studies done by various researchers.

A high average propensity to save in the Soviet Union has been described as a form of forced savings due to quantity constraints, chronic shortages, and the lack of consumer goods availability (Bronson & Severin, 1966, 1973; Barro & Grossman, 1971; Bush, 1973; Schroeder, 1975; Schroeder & Severin, 1976; Kornai, 1980, 1982, 1985; Grossman, 1990; Ickes, 1993; Kim, 1997). Shortages are ever-present in planned economies (such as socialism and/or communism) since market forces are not allowed to work properly, and prices and production are not set based on supply and demand. Waiting in lines and shortages was a way of life in the Soviet Union as households had limited choices to spend their income on consumer goods, and therefore were essentially forced to save (Bronson & Severin, 1966, 1973; Barro & Grossman, 1971; Bush, 1973; Schroeder, 1975; Schroeder & Severin, 1976; Kornai, 1980, 1982, 1985; Grossman, 1990; Ickes, 1993; Kim, 1997). In addition, a precautionary motive for savings took place as consumer items might randomly appear (or your long wait on the list finally arrived), and therefore households needed funds in their savings account to make those purchases that appeared randomly since there was no consumer financing (Bronson & Severin, 1966, 1973; Barro & Grossman, 1971; Bush, 1973; Schroeder, 1975; Schroeder & Severin, 1976; Kornai, 1980, 1982, 1985; Grossman, 1990; Ickes, 1993; Kim, 1997).

In the communist system, taxes and public savings were the mechanism by which funds were provided to finance economic activity. There was no effective mechanism in the Soviet Union to channel funds from private savings to public savings for investment purposes. Consequently, savings was viewed by the communist as disruptive, or at least unnecessary, for economic growth (Bronson & Severin, 1966, 1973; Barro & Grossman, 1971; Bush, 1973; Schroeder, 1975; Schroeder & Severin, 1976; Kornai, 1980, 1982, 1985; Grossman, 1990; Ickes, 1993; Kim, 1997).

In the Soviet Union, savings were protected by the Communist Party's control of the banking system and economy. According to Marxist philosophy, inflation in the capitalist society was caused by the implementation of monopolies, which resulted in high prices, combined with workers low wages (Little, 1989). These were the teachings that every Soviet citizen heard time and again.

Transition steps to a controlled economy: undermining PPP

There were 15 actions taken to accomplish the control necessary to undermine the PPP theory which enriched so many former communist officials, oligarchs, and criminal elements in Russia. It is necessary to examine these actions first before analyzing the PPP index for the 1990-1995 period. From these actions we can understand why the PPP index for Russia changed as it did. The authors will then analyze in this light the PPP for the 1990-1995 period. The undermining of PPP became a critical piece of the incredible profit achieved by the communist oligarchs.

15 Actions that took place to explain what happened:

1. Used the Western monopoly model as the capitalist model.
2. Established an inflationary pricing system based upon monopolies.
3. Allowed limited currency exchange.
4. Controlled the currency fluctuations.
5. Used inflation as a tool for currency and pricing control.
6. Created demand for dollars in inflationary marketplace below PPP.
7. Destroyed local production.
8. Destroyed the value of savings to fund monopoly control.
9. Established monopoly control of imports.
10. Placed high tariffs on imported goods.
11. Established monopoly control of the transportation network.
12. Used centralized control from prior times to manage the transformation.

13. Established wage levels to allow for import marketplace.
14. Established a non-legal framework for business.
15. Worked in conjunction with political elements.

The Western monopoly model as the capitalist model and establishment of inflationary pricing based on monopolies

When the Soviet economy began to collapse in the late 1980s, more and more production was being placed into the parallel (private) marketplace for profits outside the system. The resulting loss of taxes and income by the government was creating huge budget deficits. When the price of oil declined from historic highs and the Soviet oil production was declining, due to lack of reinvestment, the pressure on pricing was enormous (Gaidar, 2010). Low oil prices led to large balance of payments and budget deficits, in addition, government efforts to decrease alcohol consumption and control alcoholism resulted in even less government revenues, (Gaidar, 2010).

After a series of price increases in food and clothing by Gorbachev during the pre-1991 period, the pressure on the Soviet worker became even greater. The collapse of the central authority in 1991, when combined with a desire to move to a capitalist economy, established the mechanism by which the economy was to become a monopolistic economy run by oligarchs. Establishing private freedom and private capital would make this monopolistic market an even greater problem than any market preceding it, underlying this entire effort was the knowledge that there was a huge body of savings which was useless to the banks as they did not have a functional lending organization available in which to feed the economy (Vickers & Yarrow, 1988). However, in sharp contrast to this savings was a lack of capital to the degree necessary for privatization of the core industries (Shleifer & Vishny, 1986).

Limited currency exchange, control of currency fluctuations, and the use of inflation to control currency & prices

With a banking system full of trillions of rubles, which it was not able to lend for profit, and a government in which IMF and World Bank loans were the means to get rich, there was a convergence of goals. The banks needed to make profits for the new owners, while the government's deficit was quickly increasing from a collapsing economy. The only answer was to inflate away all the savings into the budget by raising prices, keeping wages low, and semi-freeing the currency to float at a controlled rate. By not actually floating the currency to real levels, the

government was able to keep the two tier exchange system, control repatriation of profits and establish taxes on all the profits. The program was implemented quickly with tax rates more than 100%.

Demand for dollars, inflationary marketplace, and destruction of local production

In one day the ruble went from 4 to the dollar to over 400 (see Table 1). In one month to over 600. In one year to over 800. The result was a complete loss of buying power for the population. This caused a total collapse of the production-sales economy inside Russia. This did, however, present an opportunity for the political figures to become involved in the profits of the economy. The idea was this, if no one could make profits from Russian production, then certainly profits could be made from imports, which were somewhat easy to control. There was one problem with this scenario, the population had wages of from $5-15 per month and could not afford to buy imports.

The answer fit the PPP scenario perfectly. The ruble had to be priced so as to allow the people to afford imports while still retaining the monopolist's ability to control output and/or price. The solution was to slowly raise the real wages in dollar terms over a period of one year by devaluing the ruble each day from 3-5 ruble/dollar while raising the prices more than the increase in the dollar value (see Table 1). One must offer one insight into this effort as to why the government would go along with this, as would the factory owners and the local monopoly controllers. The politicians failed to establish a legal code in which theft and the sale of public property was a crime. Enforcement was never even tried, except in publicity type arrests. Thus, the local mafia could steal state property and sell it for huge profits.

The local factory managers gained because of the huge subsidies from the government for their losses. The transportation bosses gained by virtue of total control of shipping. The banking industry gained because now the dollar could be traded legally. This meant the PPP index was in their favor by a huge factor (see Table 1). The only losers were the people of the society who lost literally hundreds of billions of ruble accumulated savings. This happened in a period of one month. One potent example of this effect was an interview in 1992, by one of the current authors, of a family which had been a very rich family by Soviet standards. They had saved the equivalent of 9000 U.S. dollars for over 20 years to buy an automobile. The only reason for them not owning an automobile was that they were on a waiting list for production. In a period of one month their

savings went from $9000 to $90. This was very typical of the average Russian family during this period.

The first step was to decontrol prices and allow them to seek market levels. However, in Russia, this meant in a monopoly market (not a competitive market), having monopoly prices and profits. Underlying this pricing structure was also a free cost basis due to factories not paying their bills, resulting in nearly 100% profit from the revenue received. Once this pricing was established at higher levels, the inflationary numbers became so large that it put pressure on the ruble. This pressure allowed the government, with IMF approval, to establish a market in the ruble that could be controlled. The rules were established so that two events were to occur simultaneous. First, overnight the ruble would seek the market level, and secondly only a limited number of firms could actually exchange rubles for dollars. This amounted to monopoly control of the currency by the government.

Destroyed savings value to fund monopoly control

In a period of 24 hours the savings of the average Russian was destroyed. An examination of the actual system to do this is in order at this time. At the time, dollars were in huge demand in Russia, but only the elite, former communist officials, or oligarchs could own them legally. They had access to them because the business groups which exported and imported needed them for business. This same group controlled the banks. When the devaluation occurred, they took dollars and exchanged them for rubles at the new rates. With all of the publicity and confusion, the people understood that the ruble was worthless, not understanding PPP theory, thus demanded dollars even in an inflationary marketplace. Thus, the monopolist was able to gain the ruble advantage for their dollars. The pricing differential between the buy/sell prices was often 20% or more. Officially it was about 15% which allowed huge profits just on a tradingvolume.

Suddenly, huge amounts of dollars came into the marketplace from mysterious places. In an economy in which it was not possible to own dollars, suddenly hundreds of millions of dollars were present. The reason is that this was a planned event in which much preparation must have taken place. The people were left with a worthless ruble, while they desired dollars, while the elite had dollars. This allowed the government to establish a controlled devaluation of the ruble, while still having control of prices. The news media was replete with government officials discussing the difficulty of controlling inflation, yet control of the economy was in the hands of a few people. The centralized system of the past was still in place and running most of the economy.

This scenario continued for a period of about six months. As the sale of goods inside the Russian production system was depleted and new production was not forthcoming, soon it became evident that the only way to supply goods, make profits, and establish control of the economy was to create a trade rather than a production economy. The sale of raw materials would generate enough revenue to allow the government to function without the huge tax revenues that the socialist system required.

Established monopoly control of imports and established high tariffs

The result of the actions taken created a new import marketplace. Soon, in virtually every region of Russia, products began appearing which had never been available before this time. However, the prices were far above the average Russian's wages. Real wages rebounded, increasing to $50-$75 a month in real terms. Even in the Russian economy, this was much too low to buy large amounts of goods. The pent up demand from the past years of product scarcity overcame the low wage levels. With incomes from three or four members of a family, enough was earned to establish an import goods demand.

The political fall-out from this series of events was the October 1992 confrontation between Yeltsin and the communists. While the fight was seemingly won by Yeltsin, immediately after the events ended, Viktor Chernomyrdin was appointed Prime Minister of Russia. Yeltsin put an enormous amount of control of the government in his hands, even though he was without experience, was a former communist, was not elected, and had preached a slowing of reforms. In fact everything he had preached was the line of the losing communist group.

Several facts emerged from this change of government. First, a new policy toward imports had to be established if this was to be the focus of the economy. The government made no money from allowing importers to reap huge profits. The result was that tariffs were placed upon the imported goods. Secondly, the lack of distribution channels had to be corrected so as to better control this network of foreign goods. A monopoly of inflow was easy to establish, while the ability to control the pricing and the availability of goods was in monopoly hands, the population needed, in dollar terms, a wage which allowed for the purchase of these imported goods. However, the average Russian did not earn a wage high enough to afford these imported goods.

Established monopoly control of the transportation network using centralized control to manage the transformation

The next action taken during this period was the control of the transportation network. This, as in past times, was controlled by the KGB for obvious reasons, thus when the privatization efforts took place, it was the KGB which established control of the rail and truck network. The centralization of this system made it relatively easy to control all elements of production and distribution. It was also easy to place taxes upon this movement, as well as control where and how it was to be distributed.

Once completed, this ability to control the economy was virtually accomplished. The PPP index of value for the ruble was now non-functional, except when it was convenient to do so. The political functions were controlled by those who had also established control of various segments of the economy. The banking system was in total control, the distribution network was established on a monopoly basis, the local production competition was put to rest by pricing mechanism and lack of capital except, through sales in the black market controlled by the monopolists, and the savings of the people had been used to fuel the entire effort. It was a remarkable effort that was successful beyond all expectations.

Established wage levels to allow for import marketplace

When it became convenient, the ruble was allowed to float freely. When this happened the ruble quickly depreciated and lost an enormous amount of value. It was obvious that the ruble was being controlled and not following purchasing power parity when this was allowed to happen, in addition, the ability to buy dollars was non-existent. In 1992, in one of the author's effort to buy dollars, prior to the changes, it was impossible, or the rates were equal to what would happen in a few days hence. The banking system always won this war with the people as the people were always on the wrong side of the transaction the elites had advanced knowledge of what was coming and could take advantage of this coming event.

From this change in the exchange rate the government was forced to institute a new wage level measured in dollars that more closely matched the market needs of importers. Because production of basic materials had ceased, except in the black market, the centralized system knew approximately what level was needed. The last part of this scenario was the ability to control imports to keep supply below demand, thus keeping upward pressure upon the pricing.

4. ANALYSIS OF THE PPP CHANGES IN THE 1990-1995 PERIOD

From Table 1, you can see the initial purchasing power which the ruble had in 1990. With a controlled economy under the communist regime, the ruble was not traded externally, the ability to own foreign currency in the Soviet Union was illegal and the ability to trade was tightly restricted. Under this criteria was an income level equivalent to $5,580 per year in salary. In addition to this was a controlled pricing structure in which the average rent paid was designed to be 1.5% of income. When the cost of food is added to this figure, the available money for consumption was designed to be over 75% of the average salary. This is much higher than the average industrial country.

Table 1 Index of Ruble Value, CPI, PPP, and Average Yearly Salary, 1990-1995

Year	Ruble/$	CPI	Annual CPI Increase	CPI/yr/ $Value	PPP Lost	Avg Salary Rubles	Avg Salary Dollars
1990	0.6					3,348	5,580
1991 Jan 1	100	1				3,348	33.48
1991 Dec 31	160	8.65	856%	865	805%	4,500	28.12
1992 Dec 31	400	34	3930%	340	3780%	16,000	40
1993 Dec 31	1396	245	720%	24,500	471%	111,680	80
1994 Apr 4	1742						
1994 June 27	1963						
1994 Dec 31	3854	306.5	125%	30,650	-51%	462,000	120
1995 Sept 1	4357	550	80%	55,000	67%	610,000	140

Source: International Financial Statistics, International Monetary Fund, and UN GDP International Comparisons Project, as reported in World Bank, World Development Indicators 2003).

The difficulty in this analysis is that the ability to purchase goods was also controlled, so demand always outstripped supply. When the black market pricing is considered, this reduced the average buying power available to the Soviet citizen in the context of purchasing power parity and the decisions that were made during the 1991 period.

The average annual wage necessary to survive in the former Soviet Union was considered to be 25% of the average income or $1395, which was then 837 rubles. With the average family being over 3 members, this meant that an income per family of only 279 rubles was needed or $465. If prices of apartments were controlled, the price of food was reasonably controlled, and utilities prices were controlled; any change in the value of the currency when freeing prices could be based upon the value of $465 average purchasing power not the average income level of $5,580. This is a considerable difference when decisions are to be made.

The real value of the ruble was not known, yet it was assumed that it would be around 100 in a free market according to the governmental economists.

The average citizen had saved their rubles in the banking system. Because of the lack of supply for high priced items such as cars, refrigerators, televisions, and wash machines, it took years to save for these items with a waiting list for purchase. Any currency change would of course affect these savings accounts.

When the currency was allowed to change value in 1991, the initial impact was to destroy the savings accounts by virtue of the failure of the government to index the accounts. The resulting decline in value of the currency from 0.6 rubles to the dollar to 100 (see Table 1) resulted in the average Russian citizen losing virtually all of the value of their savings. At the same time the cost of living (measured by the consumer price index, CPI) increased dramatically (see Table 1). It was a double theft of the money which had been accumulated over 30 years of work in the socialist model of the Soviet Union.

This devaluation of the ruble had two consequences for the economy. The first was the loss of buying power by most members of society. The result was a decline in production over the next six months of over 50%. This caused the government to run huge deficits due to tax revenues declining dramatically. This also forced many workers into the open economy in which no taxes were collected, further expanding the problem.

The second difficulty this caused was the further decline in the value of the ruble, which destroyed what remained of the savings accounts of the population. The effects of this were felt for 3 years as the ability to establish a private capital market was destroyed. The lack of bank deposits eroded the ability to lend to private companies forcing the government to extend loans, which created a further budget deficit, and hence a further decline in the ruble's value. Combining all of these events established a basis for the hyper-inflation which made the government increase wages which made even more deficits.

When one combines the entire process that happened in this period, the shock therapy which was instituted virtually destroyed the economy of Russia in an effort to save it. The average annual salary went to a low of under $30, with the resulting loss of production approaching 65%. The effort to modernize industry became impossible as there was no base from which to build a consumer economy. In 1992, the loss of consumer buying power became so great that the government began a policy of the gradual increase in the value of the ruble from the 1991 low of $28.12 annual salary equivalent to over $140 in 1995.

The lack of a local consumer production base established Russia as in importer economy for consumer goods, while exporting raw materials for income. The economy continued under this plan, which established a class of rich owners and poor consumers. The job base of Russia was destroyed in terms of the industrial economy and replaced by a society of traders. What this meant was that the average person had to work a full time job, a part time sales job on the street, and/or give lessons to the rich for whatever talents they had to sell.

In examining the PPP index, one finds that the real value, in terms of inflation, for the ruble in 1995 should have been about 55,000 to the dollar (see Table 1), whereas it was 4357 to the dollar. It was, in fact, valued at approximately 1/10 what it should have been valued, while eroding the productive sector of the economy. The dramatic effect this analysis has upon the understanding of the changes that have happened in Russia only underscores the changes which took place. These changes are from a socialist/communist production economy to a monopolistic/oligarchic trading economy, with the resulting loss of an entire middle class, replaced by the rich and the poor. One must comment on the irony of this situation in light of the reasons, good or bad, for the 1917 revolution to equalize society and destroy the rich controlling class. It appears ironic that the very basis under which the revolution took place has been the greatest casualty of the 1991 changes while restoring the pre-revolution society. The loss of the productive sectors combined with the sale of raw materials has restored Russia to pre-1917 economic conditions complete with an underclass ruled by the rich.

5. CONCLUSION

The PPP index paints an all too pessimistic description of the past declines during the transition period for Russia. The PPP index shows a very negative view of this transition period from virtually every aspect. The use of the PPP index reveals the devastating effects on incomes and savings from the economic transformation that occurred during the break-up of the Soviet Union. The average worker fell further behind while a few became rich. The very concept of communism for 70 years created a very equal society, that while not at the living standards of the west, using PPP valuation, was above those of the developing world. The destruction of this equality for the benefit of the few caused a massive movement toward poverty for the majority of Russian people.

The implication for the world business community was the loss of a huge potential market in Russian and the former Soviet republics. It resulted in an inability to integrate their markets into the world economies and prevented the establishment of a potential trading economy far in excess of what is present today. If the economic model chosen had invoked the concept of PPP, the changes implemented would not only have been very different, but the timing of such changes would have resulted in a very substantial reduction in the movement toward poverty among the population. If the transition had followed a true market system, with well-defined property rights and institutions that promoted competition and the rule of law, instead of following a monopolistic/oligopoly economic system (creating the oligarchs in Russia), not only the short term transition results, but the long term results as well, would have been vastly different and purchasing power parity would have been closer to equilibrium. Perhaps in the current context, Russia today would be more open and with a free market oriented economy rather than an oligarch driven economy. The PPP model, while with many flaws as the literature indicates, can be a very useful tool for how to transition an economy toward one that is entrepreneurial rather than monopolistic.

Because this period of time has largely been forgotten by researchers post 2008, this study has again taken an examination of how a large economy makes a transition toward a modern quasi-free economy. The PPP index used in this paper, shows a much more complete view of this forgotten era. The optimistic view of 1991 has given way to the pessimistic viewpoint today as this transition destroyed jobs, incomes, and savings. For the first time in the world, the 1990-1995 period allowed the economic, social and political aspects of a formal transition to be studied. This paper has created a framework from which other research can flow in a more detailed manner.

6. LIMITATIONS AND FUTURE RESEARCH

There are many examples in the recent past of countries undergoing a transition from a closed economy to a more open economy. Examining the impact upon the population using PPP as a tool could be very useful to better understand both the strengths and limitations of the concept. The Russian and Eastern European transitions have provided real world examples of what does and does not work. The massive Chinese transition has provided yet another template that can be studied in this context. With the Chinese emergence as a global economic power, it also could

be the subject of study as to the many aspects of their transition to compare to the Russian example.

Additional studies could compare within Eastern Europe how each nation made their transition and perhaps create a template from which to examine the success or failure of each one and why it happened as it did. There are many examples of nations changing from the centrally planned model toward a more market oriented model, the PPP can show how during the transitions, various aspects of the economy influenced market structure, incomes, savings, and the average workers lifestyle.

REFERENCES

1. Acaravci, S. K., & Acaravci, A. (2007). Purchasing power parity under the current float. *Available at SSRN 1395924*.
2. Adler, M., & Lehmann, B. (1983). Deviations from purchasing power parity in the long run. *The Journal of Finance*, *38*(5), 1471-1487.
3. Alba, J. D., & Park, D. (2005). An empirical investigation of purchasing power parity (PPP) for Turkey. *Journal of Policy Modeling*, *27*(8), 989-1000.
4. Alberiko Gil-Alana, L., & Jiang, L. (2013). The Purchasing Power Parity Hypothesis in the Us–China Relationship: Fractional Integration, Time Variation and Data Frequency. *International Journal of Finance & Economics*, *18*(1), 82-92.
5. Ardeni, P. G., & Lubian, D. (1991). Is there trend reversion in purchasing power parity?. *European Economic Review*, *35*(5), 1035-1055.
6. Aron, L. (2002). Structure and context in the study of Post-Soviet Russia: several empirical generalizations in search of a theory. *Demokratizatsiya*, *10*(4), 429-461.
7. Bahmani-Oskooee, M. (1993). Purchasing power parity based on effective exchange rate and cointegration: 25 LDCs' experience with its absolute formulation. World Development, 21(6), 1023-1031.
8. Bahmani-Oskooee, M. (1995). Real effective exchange rates and the purchasing power parity: Experiences of 19 industrial countries. *Economic Notes-SIENA*, 239-250.
9. Bahmani-Oskooee, M. (1998). Do exchange rates follow a random walk process in Middle Eastern countries?. *Economics Letters*, *58*(3), 339-344.
10. Bahmani-Oskooee, M., Chang, T., Chen, T. H., & Tzeng, H. W. (2017). Quantile unit root test and the PPP in Africa. *Applied Economics*, *49*(19), 1913-1921.
11. Bahmani-Oskooee, M. & Rhee, H. J. (1992). Testing for long run purchasing power parity: an examination of Korean won. *International Economic Journal*, 6, Autumn pp. 93-103.
12. Bahmani-Oskooee, M., & Wu, T. P. (2018). PPP in the 34 OECD countries: evidence from quantile-based unit root tests with both smooth and sharp breaks. *Applied Economics*, *50*(23), 2622-2634.
13. Barro, R. (1984). Macroeconomics. New York, NY: John Wiley and Sons.

14. Barro, R. J., & Grossman, H. I. (1971). A general disequilibrium model of income and employment. *The American Economic Review*, *61*(1), 82-93.
15. Baum, C. F., Barkoulas, J. T., & Caglayan, M. (1999). Long memory or structural breaks: can either explain nonstationary real exchange rates under the current float?. *Journal of International Financial Markets, Institutions and Money*, *9*(4), 359-376.
16. Beach, E. D., Cottrell-Kruse, N. H., & Uri, N. D. (1995). Doctrine of relative purchasing power parity under fixed and flexible exchange rates reconsidered. *The International Trade Journal*, *9*(2), 273-302.
17. Bjørnland, H. C., & Hungnes, H. (2002). Fundamental determinants of the long run real exchange rate: The case of Norway (No. 2002, 23). Memorandum.
18. Bronson, D. W., & Severin, B. S. (1966, July). Recent trends in consumption and disposable money income in the USSR. In *US Congress, Joint Economic Committee, New Directions in the Soviet Economy, Part II-B. Washington, DC: US Government Printing Office* (pp. 495-530).
19. Bronson, D., & Severin, B. (1973). Soviet consumer welfare: The Brezhnev era. In *Soviet Economic Prospects for the Seventies. A Compendium of Papers Submitted to the Joint Economic Committee Congress of the United States* (pp. 376-403).
20. Buiter, W. H. (2000). From predation to accumulation?: The second transition decade in Russia. *Economics of Transition*, *8*(3), 603-622.
21. Buiter, W. H., & Eaton, J. (1987). Policy Decentralization and Exchange Rate Management in Interdependent Economies. *Exchange Rate Management Under Uncertainty*, 31.
22. Bush, K. (1973). Soviet Inflation in Yves Laulan, ed., *Banking, Money and Credit in Eastern Europe*, Brussels: NATO.
23. Canarellsal, G., Pollard, S. K., & Lai, K. S. (1990). Cointegration between exchange rates and relative prices: another view. *European Economic Review*, *34*(7), 1303-1322.
24. Cassel, G. (1916). The present situation of the foreign exchanges. *The Economic Journal*, *26*(101), 62-65.
25. Caves, R. & Jones, R. (1981). World Trade and Payments. Boston, Mass: Little, Brown and Company.
26. Cheng, B. S. (1999). Beyond the purchasing power parity: testing for cointegration and causality between exchange rates, prices, and interest rates. *Journal of International Money and Finance*, *18*(6), 911-924.
27. Chowdhury, A. R., & Sdogati, F. (1993). Purchasing power parity in the major EMS countries: the role of price and exchange rate adjustment. *Journal of Macroeconomics*, *15*(1), 25-45.
28. Clarke, S. (2007). The development of capitalism in Russia. Routledge. Coakley, J., & Fuertes, A. M. (1997). New panel unit root tests of PPP. *Economics Letters*, *57*(1), 17-22.
29. Coakley, J., & Fuertes, A. M. (1997). New panel unit root tests of PPP. *Economics Letters*, *57*(1), 17-22.

30. Copeland, L. S. (1991). Cointegration tests with daily exchange rate data. *Oxford Bulletin of Economics and Statistics*, *53*(2), 185-198.
31. Corbae, D., & Ouliaris, S. (1988). Cointegration and tests of purchasing power parity. *The Review of Economics and Statistics*, 508-511.
32. Cumby, R. E., & Huizinga, J. (1991). The predictability of real exchange rate changes in the short and long run. *Japan and the World Economy*, *3*(1), 17-38.
33. Darby, M. R. (1980). Does purchasing power parity work?. *NBER Working Paper*, (w0607).
34. Davutyan, N., & Pippenger, J. (1985). Purchasing power parity did not collapse during the 1970's. *The American Economic Review*, *75*(5), 1151-1158.
35. Diebold, F. X., Husted, S., & Rush, M. (1991). Real exchange rates under the gold standard. *Journal of Political Economy*, *99*(6), 1252-1271.
36. Doğanlar, M., Kizilkaya, O., & Mike, F. (2020). Testing the long-run PPP for Turkey: new evidence from the Fourier quantile unit root test. *Applied Economics Letters*, *27*(9), 729-735.
37. Dornbusch, R. (1980). Exchange rate risk and the macroeconomics of exchange rate determination.
38. Dornbusch, R., Fischer, S., & Startz, R. (2011). Macroeconomics. New York: McGraw-Hill.
39. Edison, H. J. (1985). Purchasing power parity: a quantitative reassessment of the 1920s experience. *Journal of International Money and Finance*, *4*(3), 361-372.
40. Edison, H. J. (1987). Purchasing power parity in the long run: A test of the dollar/pound exchange rate (1890-1978). *Journal of Money, Credit and Banking*, *19*(3), 376-387.
41. Edison, H. J., & Klovland, J. T. (1987). A quantitative reassessment of the purchasing power parity hypothesis: Evidence from Norway and the United Kingdom. *Journal of Applied Econometrics*, *2*(4), 309-333.
42. Enders, W. (1988). ARIMA and cointegration tests of PPP under fixed and flexible exchange rate regimes. *The Review of Economics and Statistics*, 504-508.
43. Ericson, R. E. (2000). The Post-Soviet Russian Economic System: An Industrial Feudalism?. In *Russian Crisis and Its Effects*, Komulanien, T., and I. Korhonen, eds., Kikamora Publications.
44. Erlat, H. (2003). The nature of persistence in Turkish real exchange rates. *Emerging Markets Finance and Trade*, *39*(2), 70-97.
45. Flynn, N. A., & Boucher, J. L. (1993). Tests of long-run purchasing power parity using alternative methodologies. *Journal of Macroeconomics*, *15*(1), 109-122.
46. Frankel, J. A., & Rose, A. K. (1996). A panel project on purchasing power parity: mean reversion within and between countries. *Journal of International Economics*, *40*(1-2), 209-224.
47. Frenkel, J. A. (1978). Purchasing power parity: doctrinal perspective and evidence from the 1920s. *Journal of International Economics*, *8*(2), 169-191.

48. Frenkel, J. A. (1981). The collapse of purchasing power parities during the 1970's. *European Economic Review*, *16*(1), 145-165.
49. Froot, K. A., & Rogoff, K. (1995). Perspectives on PPP and long-run real exchange rates. *Handbook of international economics*, *3*, 1647-1688.
50. Gaidar, Y. (2010). *Collapse of an empire: Lessons for modern Russia*. Brookings Institution Press.
51. Gill, G., & Young, J. (Eds.). (2013). *Routledge handbook of Russian politics and society*. Routledge.
52. Gregory, P. R. (1989). Soviet Household Saving Under Quantity Constraints: Evidence from the Soviet Interview Project. *Age*, *9*, 1.
53. Grennes, T. (1984). International Economics. Englewood Cliffs, NJ: Prentice-Hall.
54. Grossman, G. (1990). Command economy. In *Problems of the Planned Economy* (pp. 58-62). Palgrave Macmillan, London.
55. Guloglu, B., Ispira, S., & Okat, D. (2011). Testing the validity of quasi PPP hypothesis: evidence from a recent panel unit root test with structural breaks. *Applied economics letters*, *18*(18), 1817-1822.
56. Hakkio, C. S. (1984). A re-examination of purchasing power parity: A multi-country and multi-period study. *Journal of International Economics*, *17*(3-4), 265-277.
57. Helliwell, J. F., & Padmore, T. (1985). Empirical studies of macroeconomic interdependence. *Handbook of international economics*, *2*, 1107-1151.
58. Hoarau, J. F. (2007). Long run purchasing power parity in Eastern and Southern African countries: Evidence from panel data stationary test with multiple structural breaks.
59. Holmstrom, N., & Smith, R. (2000). The necessity of gangster capitalism: Primitive accumulation in Russia and China. *Monthly Review*, *51*(9), 1.
60. Howard, D. H. (1976). The disequilibrium model in a controlled economy: an empirical test of the Barro-Grossman model. *The American Economic Review*, *66*(5), 871-879.
61. Ickes, B. W. (1993). Saving in Eastern Europe and the Former Soviet Union. *World Savings: An International Survey, Basil Blackwell*.
62. Ignatova, Olga (1992 & 2015) Interview by authors.
63. Junge, G. (1985). Trends and random walks of real exchange rates. *Weltwirtschaftliches Archiv*, *121*(3), 427-437.
64. Kagarlitsky, B. (2008). *Empire of the Periphery: Russia and the World System*. London: Pluto Press.
65. Kalyoncu, H., & Kalyoncu, K. (2008). Purchasing power parity in OECD countries: Evidence from panel unit root. *Economic Modelling*, *25*(3), 440-445.
66. Karfakis, C., & Moschos, D. (1989). Testing for long run purchasing power parity: a time series analysis for the Greek drachma. *Economics Letters*, *30*(3), 245-248.
67. Kargbo, J. M. (2009). Financial globalization and purchasing power parity in the G7 countries. *Applied Economics Letters*, *16*(1), 69-74.
68. Keynes, J. M. (1923). *A tract on monetary reform*. London, Macmillan.

69. Khafizullina, E. (2021). Rich Russians: From Oligarchs to Bourgeoisie. *Insight Turkey*, *23*(1), 250-252.
70. Kim, Y. (1990). Purchasing power parity in the long run: A cointegration approach. *Journal of Money, Credit and Banking*, *22*(4), 491-503.
71. Kim, B. Y. (1997). Soviet household saving function. *Economics of Planning*, *30*(2), 181-203.
72. Kornai, J. (1980). *Economics of shortage.* Amsterdam: North-Holland.
73. Kornai, J. (1982). *Growth, shortage, and efficiency: a macrodynamic model of the socialist economy*. University of California Press.
74. Kornai, J. (1985). Comment. 11. In *Frontiers of Economics*, edited by K. J. Arrow ands. Honkapohja. Oxford: Basil Blackwell, 1985.
75. Kugler, P., & Lenz, C. (1993). Multivariate cointegration analysis and the long-run validity of PPP. *The Review of Economics and Statistics*, 180-184.
76. Layton, A. P., & Stark, J. P. (1990). Co-integration as an empirical test of purchasing power parity. *Journal of Macroeconomics*, *12*(1), 125-136.
77. Levich, R. M. (1985). Empirical studies of exchange rates: price behavior, rate determination and market efficiency. *Handbook of international economics*, *2*, 979-1040.
78. Li, H., Lin, Z., & Hsiao, C. (2015). Testing purchasing power parity hypothesis: A semiparametric varying coefficient approach. *Empirical Economics*, *48*(1), 427-438.
79. Little, D.R. (1989). Governing the Soviet Union. White Plains, NY: Longman, Inc.
80. Lothian, J. R., & Taylor, M. P. (2000). Purchasing power parity over two centuries: strengthening the case for real exchange rate stability: a reply to Cuddington and Liang. *Journal of International Money and Finance*, *19*(5), 759-764.
81. Mahdavi, S., & Zhou, S. (1994). Purchasing power parity in high-inflation countries: further evidence. *Journal of Macroeconomics*, *16*(3), 403-422.
82. McNown, R., & Wallace, M. S. (1989). National price levels, purchasing power parity, and cointegration: a test of four high inflation economies. *Journal of international money and finance*, *8*(4), 533-545.
83. Mike, F., & Kizilkaya, O. (2019). Testing the theory of PPP for emerging market economies that practice flexible exchange rate regimes. *Applied Economics Letters*, *26*(17), 1411-1417.
84. Mokhtari, M. (1996). Savings under quantity constraints: what can we learn from former Soviet families?. *Journal of Policy Modeling*, *18*(5), 561-582.
85. Mokhtari, M., & Gregory, P. R. (1993). Backward bends, quantity constraints, and Soviet labor supply: Evidence from the Soviet interview project. *International Economic Review*, 221-242.
86. Moskoff, W. (1993). *Hard times: impoverishment and protest in the Perestroika years: the Soviet Union 1985-1991*. ME Sharpe.
87. Nagayasu, J. (2021). Causal and frequency analyses of purchasing power parity. *Journal of International Financial Markets, Institutions and Money*, 71, 101287.

88. Narayan, P. K. (2008). The purchasing power parity revisited: New evidence for 16 OECD countries from panel unit root tests with structural breaks. *Journal of International Financial Markets, Institutions and Money*, *18*(2), 137-146.
89. Obstfeld, M., & Stockman, A. C. (1985). Exchange-rate dynamics. *Handbook of international economics*, *2*, 917-977.
90. Ofer, G., & Pickersgill, J. (1980). Soviet household saving: A cross-section study of Soviet emigrant families. *The Quarterly Journal of Economics*, *95*(1), 121-144.
91. Officer, L. H. (1982). The relationship between the absolute and the relative PPP theory of Cassel. *History of Political Economy*, *14*(2), 251-255.
92. Officer, L. H. (2006). Purchasing Power Parity: From Ancient Times to World War II. *Economic History Services, EH.*
93. Omay, T., Shahbaz, M., & Hasanov, M. (2020). Testing PPP hypothesis under temporary structural breaks and asymmetric dynamic adjustments. *Applied Economics*, *52*(32), 3479-3497.
94. Pickersgill, J. (1976). Soviet household saving behavior. *The Review of Economics and Statistics*, 139-147.
95. Pippenger, M. K. (1993). Cointegration tests of purchasing power parity: the case of Swiss exchange rates. *Journal of International Money and Finance*, *12*(1), 46-61.
96. Popov, V. (2004). The State in the New Russia (1992-2004): From Collapse to Gradual Revival?. *PONARS Policy Memos*, *324.*
97. Rush, M. & S. Husted. (1985). Purchasing power parity in the long run. *Canadian Journal of Economics*, 18., 125-145.
98. Rutland, P. (2013). The business sector in post-Soviet Russia. In *Routledge handbook of Russian politics and society* (pp. 297-313). Routledge.
99. Sarno, L. (2000). Real exchange rate behaviour in high inflation countries: empirical evidence from Turkey, 1980-1997. *Applied Economics Letters*, *7*(5), 285-291.
100. Schroeder, G. E. (1975). Consumer goods availability and repressed inflation in the Soviet Union. *North Atlantic Treaty Organization, F. economic Aspects of Life in the USSR*, 37-47.
101. Schroeder, G. E., & Severin, B. S. (1976). Soviet consumption and income policies in perspective. *Soviet Economy in a New Perspective*, 620-660.
102. Seyaz, A. (2020). The Effect of the Russian Presidential Power on the Political Regime: A Comparative Analysis of Yeltsin and Putin Periods. *Öneri Dergisi*, *15*(54), 305-324.
103. Shleifer, A., & Vishny, R. W. (1986). Large shareholders and corporate control. *Journal of political economy*, *94*(3, Part 1), 461-488.
104. Stiglitz, J. E. (2002). *Globalization and its Discontents* (Vol. 500). Norton: New York.
105. Taylor, M. P. (2006). Real exchange rates and purchasing power parity: mean-reversion in economic thought. *Applied Financial Economics*, *16*(1-2), 1-17.
106. Taylor, M. P., & McMahon, P. C. (1988). Long-run purchasing power parity in the 1920s. *European Economic Review*, *32*(1), 179-197.

107. Telatar, E., & Kazdagli, H. (1998). Re-examine the long-run purchasing power parity hypothesis for a high inflation country: the case of Turkey 1980–93. *Applied Economics Letters*, *5*(1), 51-53.

108. Tiwari, A. K., & Shahbaz, M. (2014). Revisiting purchasing power parity for India using threshold cointegration and nonlinear unit root test. *Economic Change and Restructuring*, *47*(2), 117-133.

109. Vickers, J., & Yarrow, G. K. (1988). *Privatization: An economic analysis* (Vol. 18). MIT press.

110. World Bank. (2003). World Development Indicators 2003. Washington, DC.

111. Yilanci, V., & Eris, Z. A. (2013). Purchasing power parity in African countries: Further evidence from fourier unit root tests based on linear and nonlinear models. *South African Journal of Economics*, *81*(1), 20-34.

112. Zumaquero, A. M., & Urrea, R. P. (2002). Purchasing power parity: error correction models and structural breaks. *Open economies review*, *13*(1), 5-26.

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INDUSTRIAL AGGLOMERATION AND FIRMS' PERFORMANCE: AN EXAMPLE OF TAIWANESE BIOTECHNOLOGY COMPANIES

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Abstract: *This paper investigates how industrial agglomeration affects clustered firms' strategies to receive better performance. We employed data from Taiwanese biotechnology firms for the years 2013–2020. Our data show that Taiwanese biotechnology firms located inside industrial parks had lower total costs, higher ratios of R&D cost shares to total costs, higher ratios of labor cost shares to total costs, and higher capital intensity than firms located outside of industrial parks. Our regression results confirmed the existence of the three benefits of agglomeration mentioned by Marshall (1920). Clustered firms should take advantage of such agglomeration by reducing the cost shares of R&D and labor and capital intensity to enable better performance.*

Keywords: *Geographic clusters; Knowledge spillover; Biotechnology; Firm performance; Agglomeration*

1. INTRODUCTION

Most previous studies have confirmed that industrial agglomeration has positive effects on performance and productivity, but how industrial clusters affect firms' strategies to receive better performance is still missing. Since Marshall (1920) proposed three main benefits to firms in industrial agglomerations—knowledge spillover, labor market pooling, and specialized suppliers—many studies have examined one or more of these effects in a certain industry or region, and their findings are mixed. This study reexamines Marshall's (1920) three benefits of industrial agglomeration using the Taiwanese biotechnology industry as an example.

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Among Marshall's (1920) three beneficial factors, knowledge spillover has been mentioned in previous studies the most[1]. Firms located in industrial areas or zones have much easier and cheaper access to their peers' and competitors' technology than others located outside of geographic clusters. Silicon Valley in California, industrial parks in Taiwan, and economic zones in China that have shown how firms, especially high-tech firms, can benefit from industrial clusters.

Firms concentrated in one location attract a pool of talented workers.[2] Overman and Puga (2010) empirically showed how firms can benefit from agglomeration through enhanced labor productivity. The mutual advantage can also be found on the labor supply side. De Blasio and Di Addario (2005) employed Italian data to investigate the impact of industrial clusters on workers. They found that workers in general have a higher chance of being employed and promoted, blue-collar workers have higher job mobility, and white-collar workers have better job matches (though no higher overall wage premiums). Freedman (2008) also found evidence that confirmed the theoretical prediction that industrial agglomeration improves job market conditions. Their results indicate that workers in clustered establishments in the software publishing industry had better job mobility and earnings dynamics.

Cost reduction due to industrial agglomeration can be observed in many aspects of a firm's selling operations and production procedures.[3] Marshall's third factor, specialized suppliers, can reduce firms' costs when they purchase inputs and produce intermediate and final products. In addition to specialized suppliers, the two advantages mentioned above are also part of the ways that clustered firms reduce their costs. By taking advantage of external knowledge from others in the same geographic cluster, firms can reduce their own R&D costs. Similarly, the thicker labor market in economic agglomeration allows clustered firms to find good matches and high-productivity workers without paying them excessive salaries. Some studies focus on how firms' choices of location were influenced by Marshall's three factors of industrial agglomeration,[4] but how well a clustered firm

[1] Detailed arguments and empirical evidence of knowledge spillovers in industrial clusters can be found in Jaffe, Trajtenberg, and Henderson (1993), Audretsch and Feldman (1996), Audretsch (1998), Baptista (2000, 2001), Tsai (2005), Iammarino and McCann (2006), Huber (2012), and Chyi, Lai, and Liu (2012).

[2] Also See Krugman (1991) for a detailed theoretical argument.

[3] Morrison Paul and Siegel (1999) present a detailed discussion for evaluating how much cost savings from both demand and supply side can be seen.

[4] For instance, Alcácer and Chung (2014) employed US firm–level data from 1985–1994 to see how firms' location choices were influenced by industrial agglomeration. They found all three of Marshall's factors significant and that they dominated all factors of US firms' choices of location.

turns its advantages into cost reductions and how those cost savings affect their performance are still unclear.

Biotechnology is playing an increasingly important role in our lives, especially after the COVID-19 pandemic, and the industry relies heavily on R&D activities. Locating in a cluster zone is a good strategy for a biotechnology firm. The two most mentioned cases of biotechnology clusters are San Diego and Boston in the United States. Walcott (2002) analyzed the innovative environment around the San Diego region and proposed that five key factors (outstanding research university, advocacy leadership, risk financing, entrepreneurial culture, and appropriate real estate) support regional agglomeration. Casper (2007) argued that regional agglomeration in San Diego region forged a social structure that favored job mobility and created many new companies in the region. Breznitz & Anderson (2005) conducted interviews with biotechnology firms in the Boston metropolitan area and found that local universities are the reason for the tight clustering there. These universities provide both skilled labor and producers of technological advances with commercial applications.

Based on those results in previous studies, we know that industrial agglomeration can provide many advantages to firms, especially the help in R&D activities and sources of skilled workers that the biotechnology industry needs the most. This paper empirically compares the performance between clustered and nonclustered biotechnology firms in Taiwan and investigates how industrial clusters affect firms' strategies to enhance their performance. This paper is organized as follows. Two-way fixed-effects regression models with interaction terms are set up in the next section. The data source of this study and summarized statistics of our sample are also introduced. Section III presents the results of the panel-data regression, and Section IV concludes the findings.

2. MODEL AND DATA

There are many ways to measure a firm's performance.[5] The nature of this study makes the marker-based measurement Tobin's q a better measurement than others. The biotechnology industry relies on massive R&D activities at the beginning, so a biotechnology company normally does not generate revenue during its early period. Therefore, from the investors' viewpoint in particular, no

[5] Most literature employed return on asset (ROA), return on equity (ROE), and Tobin's q to measure firms' performance. ROA and ROE are accounting-based measurements, and Tobin's q is a market-based measurement. See Alghifari, Triharjono, and Juhaeni (2013) for a comparison between ROE and Tobin's q.

accounting-based measurement can fully capture the true value and performance of a biotechnology firm.

Many factors have been considered as determinants of firms' performance or value in the previous literature. Connolly and Hirschey (2005) found R&D activities positively affect a firm's Tobin's q, and the effect is even stronger in small firms. Dalbor et al. (2007) found a positive relationship between long-term debt and firm value. Kapopoulos and Lazaretou (2007) employed Greek data to examine the relationship between ownership structure and firm performance, and their results suggest that a more concentrated ownership structure positively relates to higher firm profitability. Vu et al. (2019) found that capital intensity is negatively associated with firm performance in Vietnamese firms and the age of a firm and average wage per employee are negatively associated with firm performance.

This study would like to add the capital-labor ratio into regression models, because some studies consider the biotechnology industry to be a labor-intensive industry, but some have found the industry capital intensive.[6] It is interesting to see how Taiwanese biotechnology firms behave under the influence of industrial agglomeration. Based on the discussion in previous studies and our focus on the cost of R&D activities, labor cost, and capital per labor, the explanatory variables in our model are firms' R&D costs, labor costs, capital-labor ratios, profitability, debt financing, and shareholder structures. A two-way fixed-effects model is shown in Equation (1):

$$q_{it} = \beta_0 + \beta_1 RD_{it} + \beta_2 LC_{it} + \beta_3 KL_{it} + \beta_4 OP_{it} + \beta_5 DF_{it} + \beta_6 SS_{it} + \beta_7 RD_{it} \times D_i + \beta_8 LC_{it} \times D_i + \beta_9 KL_{it} \times D_i + \beta_{10} T + \alpha_i + \varepsilon_{it}, \quad (1)$$

where q_{it} is the Tobin's q for each firm i in year t, RD_{it} stands for R&D activities costs, LC_{it} is labor costs, KL_{it} indicates capital-labor ratios, OP_{it} stands for profitability, DF_{it} is debt financing, SS_{it} represents shareholder structures, T is time trends, and α_i is the unobserved time-invariant individual effects. We have three interaction terms that are related to the advantages of agglomeration and are mentioned by the past literature to check the influence of industrial clusters on Taiwanese biotechnology firms. They are R&D,

[6] For instance, Haaf, Hofmann, and Schüler (2021) reported that the biotechnology industry in Europe is capital intensive and highly productive. IBISWorld (2022) indicated that the biotechnology industry in the U.S. is labor intensive.

labor cost, and capital-labor interaction terms. D_i is a dummy variable for the industrial cluster of firm i. D_i equals 1 if firm i locates in an industrial agglomeration zone.

This study employs data on the biotechnology industry from the *Taiwan Economic Journal* (*TEJ*) database. According to the Taiwanese Ministry of Economic Affairs, the biotechnology industry in Taiwan includes four areas: pharmaceuticals, medical devices, applied biotechnology, and health and well-being. The total revenue of the Taiwanese biotechnology industry in 2020 was 21.5 billion USD, which was a 7.4% increase over the previous year. Taiwanese biotechnology continues to play an important role in Taiwanese technology industries, especially after the COVID-19 pandemic.

We compute or select close variables from the *TEJ* database to proxy those variables in Equation (1). First, *TEJ* provides the R&D expenditures of each biotechnology firm. We calculate the ratio of R&D cost share to total cost by dividing R&D cost by total cost. Similarly, we calculate the ratio of labor cost share to total cost by using total wage expenses and total cost. We use total assets to proxy capital. Total assets divided by the total number of employees becomes our capital-labor ratio (or capital per employee). This study employs the operating profit margin (OPM), which is the operating income divided by the sales revenue, to indicate a firm's profitability. Another benefit of using operating profit margin ratios is that they help us realize a firm's financial health. The debt ratio (DR) of each biotechnology firm is a good indicator of that company's debt financing. In the *TEJ* database, there are two variables: the shareholding ratio of independent directors (SSD) and the shareholding ratio of major shareholders (SSM), close to the stockholder structure mentioned in the previous studies. This study uses both variables to proxy variable SS_{it} in Equation (1). When the variables from the *TEJ* database are plugged into Equation (1), the result is

$$\begin{aligned} q_{it} = \beta_0 + \beta_1 RD\_sh_{it} + \beta_2 LC\_sh_{it} + \beta_3 KL_{it} + \beta_4 OPM_{it} + \beta_5 DR_{it} \\ + \beta_6 SSD_{it} + \beta_7 SSM_{it} + \beta_8 RD\_sh_{it} \times D_i + \beta_9 LC\_sh_{it} \times D_i \\ + \beta_{10} KL_{it} \times D_i + \beta_{11} T + \alpha_i + \varepsilon_{it}. \qquad (2) \end{aligned}$$

One aspect of Marshall's three factors not completely captured in Equation (2) is specialized suppliers. With the benefit of specialized suppliers, firms can reduce their costs. There are two types of costs in the *TEJ* database: operating expenses and cost of sales. Based on Marshall's theory, industrial agglomeration should reduce operating expenses, which include R&D expenditure, labor costs

that do not impact production directly, suppliers, and so forth. The impact of specialized suppliers on the cost of sales is undetermined. Industrial agglomeration lets buyers know where to find their suppliers, and that increases the sales of clustered firms. The decrease in the cost of inputs, therefore, could be overwhelmed by the increase in production. This study tests both types of costs and modifies Equation (2) as

$$q_{it} = \beta_0 + \beta_1 OER_{it} + \beta_2 CSR_{it} + \beta_3 KL_{it} + \beta_4 OPM_{it} + \beta_5 DR_{it} + \beta_6 SSD_{it} + \beta_7 SSM_{it} + \beta_8 OER_{it} \times D_i + \beta_9 CSR_{it} \times D_i + \beta_{10} KL_{it} \times D_i + \beta_{11} T + \alpha_i + \varepsilon_{it}, \quad (3)$$

where OER is operating expense ratio, which is operating expense divided by revenue; CSR is cost of sales divided by revenue.

Our sample period is from 2013 to 2020 for consistency. Since 2013, Taiwanese companies have been required to make changes in their financial reports to meet the International Financial Reporting Standards (IFRS). There were 131 biotechnology firms in 2020, 46 of which were located in industrial parks. Due to the incomplete data of some companies in our sample period, we had 980 observations in our panel data sample. Table 1 shows a summary of the descriptive statistics of our sample data.

In Table 1, we can see that Taiwanese biotechnology companies located in industrial parks have higher Tobin's q than those not located inside industrial parks. We also conducted a *t*-test to check the significance of the difference, and the result shows that the difference is statistically significant. Biotechnology firms located in industrial parks also have higher R&D and labor cost shares and more capital intensity but lower debt ratios than those not located in industrial parks. There is no significant difference between clustered firms and nonclustered firms in operating expense ratios, cost of sales ratios, shareholder structures, operating profit margin ratios, or total assets. Additionally, firms located outside industrial parks paid higher production costs than firms located in industrial parks.

The numbers in Table 1 show us that biotechnology firms in industrial clusters performed better and had lower cost than those outside. Which variables mattered as the industrial parks improved those firms' performance? As previous studies have suggested, stronger R&D activities and abundant labor markets make the difference. Did industrial parks in Taiwan provide an environment where firms can reduce their costs of R&D activities and labor so they performed better? Furthermore, which types of costs should clustered firms reduce to increase their Tobin's q? Did clustered Taiwanese biotechnology firms become more capital

intensive or labor intensive? The results from the panel data regression models should answer these questions.

3. REGRESSION RESULTS

We employed panel-data regression analysis to answer our research questions. Fixed-effects models were used in this study because Taiwanese biotechnology firms differ greatly in size and product, as can be seen in Table 1, where the standard deviation numbers for most variables are very large. We needed a fixed-effects model to capture their idiosyncratic factors. Table 2 shows the fixed-effects regression results.[7] First, we ran a regression test on all 131 Taiwanese biotechnology firms (980 observations). Then, we separated all 131 firms by their location inside or outside industrial parks. Finally, we added interaction terms, and the results of the last two columns in Table 2 are based on Equations (2) and (3), respectively, with all 131 firms.

The regression results for R&D cost shares show a significantly positive effect on Taiwanese biotechnology firms' performance. An interesting fact is that R&D expenditure is more important to firms not located in industrial parks. Our results show that Taiwanese biotechnology firms located in industrial parks enjoy knowledge and technology spillover and have less pressure on their own R&D activities. Labor cost shares do not affect overall Taiwanese biotechnology firms' performance, but high labor cost shares improve firms' performance for firms located outside industrial parks. As we expected, investing money in human capital is a great idea for biotechnology firms. The result of the capital-labor ratio shows that the more labor intensive a Taiwanese biotechnology clustered firm is, the higher its Tobin's q.

Similarly, the effect of the operation profit margin is negative only in clustered firms' performance. As mentioned previously, one special feature of firms in the biotechnology industry is that their R&D periods are long, so their profit normally is negative until the last part of their production cycle. If clustered Taiwanese biotechnology firms put more effort into R&D activities than other firms, it is not surprising that the difference between their production cycles and their profitability cycles is larger.[8] The sign of the coefficient of the debt ratio is

[7] We checked all independent variables' correlation coefficients and conducted panel data unit-root tests for all our variables to avoid unit-root issues in our regression equations. All results are available upon request.

[8] We tried to put a lagged operation profit margin into our regression analysis. When the lag is 5 years, the coefficient of OP is positive and significant in the clustered group. Because inserting

negative, which is also as expected. The results in Table 2 also show that shareholder structures do not affect Taiwanese biotechnology firms' performance.

There are three interaction terms in the column of results from Equation (2), and all their coefficients are negative and significant. As argued by Marshall (1920), external economies of scale bought by industrial agglomeration can help a biotechnology firm receive more resources for R&D and labor markets. Instead of conducting their own R&D activities, firms in an industrial cluster can take advantage of knowledge spillover from their peers or close cooperation with peer firms. Clustered Taiwanese biotechnology firms also need to take advantage of the thicker labor markets caused by industrial parks to obtain better Tobin's q. Finally, the negative coefficient of the capital-labor ratio means that firms located in industrial parks need to be more labor intensive to enhance their performance.

Our regression results from Equation (3) reveal that Taiwanese biotechnology firms located inside industrial parks should have a strategy for improving their performance different from those of firms located outside industrial parks. Nonclustered firms should reduce their cost of sales, but clustered firms should increase their cost of sales and decrease their operating expenses. With the advantage provided by industrial parks, clustered firms should take the savings from operating expenses to increase their cost of sales, which creates more products for sale. Nonclustered firms, by contrast, did not have the resources to reduce operating expenses, and to achieve better performance, they can only reduce their cost of sales and debt ratios.

4. CONCLUSION

Although the topic of industrial agglomeration has been addressed theoretically and tested empirically in many studies, how industrial agglomeration directly and indirectly affects a firm's strategy to get better performance is still missing. This paper employs Taiwanese biotechnology companies' data from the years 2013–2020 to investigate how industrial clusters affect firms' strategies to receive better performance, as measured by Tobin's q. Our sample indicates that biotechnology firms located in industrial parks in Taiwan had better firm performance, higher R&D cost shares to total cost, higher labor cost shares to total

lagged variables caused a loss of observations and a 5-year lag caused a loss of 80% of the observations, we have made the results with lagged variables available upon request.

cost, higher capital-labor ratios, lower debt ratios, and lower total costs than those not in industrial parks.

After employing two-way fixed effects regression models to capture each company's time effects and time-invariant individual unobserved characteristics, our results show that Taiwanese biotechnology firms located in industrial parks should take the benefit that goes with industrial agglomeration to reduce their operating expenses, especially R&D cost and labor cost, and use the savings to increase their cost of sales to receive better firm performance. Also, clustered firms should become more labor intensive to enhance their Tobin's q. Nonclustered Taiwanese biotechnology firms can decrease their cost of sales and debt ratios to enhance their performance.

There are several questions that cannot be answered in our study due to the limitations of our data. Although determining whether industrial parks in Taiwan improved biotechnology firms' performance is not this paper's focus, whether industrial parks in Taiwan actually increased firms' performance, the quality of R&D activities and the productivity of workers is still an interesting topic. These questions require that data be tracked for a longer period of time. We have left this for future study.

REFERENCES

1. Alcácer, J., & Chung, W. (2014). Location strategies for agglomeration economies. *Strategic Management Journal, 35*(12), 1749–1761.
2. Alghifari, E. S., Triharjono, S., & Juhaeni, Y. S. (2013). Effect of return on assets (ROA) against Tobin's q: Studies in food and beverage company in Indonesia stock exchange years 2007–2011. *International Journal of Science and Research (IJSR), 2*, 108–116.
3. Audretsch, D. B., & Feldman, M. P. (1996). Innovative clusters and the industry life cycle. *Review of Industrial Organization, 11*(2), 253–273.
4. Audretsch, B. (1998). Agglomeration and the location of innovative activity. *Oxford Review of Economic Policy*, *14*(2), 18–29.
5. Baptista, R. (2000). Do innovations diffuse faster within geographical clusters?. *International Journal of Industrial Organization*, *18*(3), 515–535.
6. Baptista, R. (2001). Geographical clusters and innovation diffusion. *Technological Forecasting and Social Change*, *66*(1), 31–46.
7. Breznitz, S. M., & Anderson, W. (2005). Boston metropolitan area biotechnology cluster. *Canadian Journal of Regional Science*, *28*(2), 249–264.
8. Casper, S. (2007). How do technology clusters emerge and become sustainable?: Social network formation and inter-firm mobility within the San Diego biotechnology cluster. *Research Policy*, *36*(4), 438–455.

9. Chyi, Y. L., Lai, Y. M., & Liu, W. H. (2012). Knowledge spillovers and firm performance in the high-technology industrial cluster. *Research Policy*, *41*(3), 556–564.
10. Connolly, R. A., & Hirschey, M. (2005). Firm size and the effect of R&D on Tobin's q. *R&D Management*, *35*(2), 217–223.
11. Dalbor, M. C., Lee, S., & Upneja, A. (2007). An investigation of long-term debt and firm value in the lodging industry. *Advances in Hospitality and Leisure*, 3, 195–204.
12. De Blasio, G., & Di Addario, S. (2005). Do workers benefit from industrial agglomeration?. *Journal of Regional Science*, *45*(4), 797–827.
13. Freedman, M. L. (2008). Job hopping, earnings dynamics, and industrial agglomeration in the software publishing industry. *Journal of Urban Economics*, *64*(3), 590–600.
14. Haaf, A., Hofmann, S., & Schüler, J. (2021). Measuring the economic footprint of the biotechnology industry in Europe. *Industrial Biotechnology*, *17*(3), 117–124.
15. Huber, F. (2012). Do clusters really matter for innovation practices in information technology? Questioning the significance of technological knowledge spillovers. *Journal of Economic Geography*, *12*(1), 107–126.
16. Iammarino, S., & McCann, P. (2006). The structure and evolution of industrial clusters: Transactions, technology and knowledge spillovers. *Research Policy*, *35*(7), 1018–1036.
17. "Industry Market Research, Reports, and Statistics." IBISWorld, Jan. 2022, https://www.ibisworld.com/united-states/market-research-reports/biotechnology-industry/.
18. Jaffe, A. B., Trajtenberg, M., & Henderson, R. (1993). Geographic localization of knowledge spillovers as evidenced by patent citations. *Quarterly Journal of Economics*, *108*(3), 577–598.
19. Kapopoulos, P., & Lazaretou, S. (2007). Corporate ownership structure and firm performance: Evidence from Greek firms. *Corporate Governance: An International Review*, *15*(2), 144–158.
20. Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy*, *99*(3), 483–499.
21. Marshall, A. (1920). *Principles of economics*. Macmillan
22. Morrison Paul, C. J., & Siegel, D. S. (1999). Scale economies and industry agglomeration externalities: A dynamic cost function approach. *American Economic Review*, *89*(1), 272–290.
23. Overman, H. G., & Puga, D. (2010). Labor pooling as a source of agglomeration: An empirical investigation., in *Agglomeration Economics* (pp. 133–150). University of Chicago Press.
24. Tsai, D. H. (2005). Knowledge spillovers and high-technology clustering: Evidence from Taiwan's Hsinchu Science-Based Industrial Park. *Contemporary Economic Policy*, *23*(1), 116–128.

25. Vu, T. H., Nguyen, V. D., Ho, M. T., & Vuong, Q. H. (2019). Determinants of Vietnamese listed firm performance: Competition, wage, CEO, firm size, age, and international trade. *Journal of Risk and Financial Management*, *12*(2), 62.
26. Walcott, S. M. (2002). Analyzing an innovative environment: San Diego as a bioscience beachhead. *Economic Development Quarterly*, *16*(2), 99–114.

Table 1 Summary of descriptive statistics

	Outside industrial parks			Inside industrial parks			Difference	
Variables	Mean	Std. Dev.		Mean	Std. Dev.		*t*-stat	*p*-value
q (Tobin's q)	2.178	3.112		2.938	3.671		-3.367	0.000
RD_sh	15.056	23.631		26.015	28.901		-6.275	0.000
LC_sh	21.749	9.952		24.411	7.902		-4.067	0.000
OER	2414.921	30112.93		1610.433	17223.03		0.4607	0.3225
CSR	60.547	22.688		61.105	81.677		-0.157	0.4378
KL	13.807	0.067		22.917	21.017		-1.776	0.038
OPM	44.759	331.562		77.092	674.485		-0.984	0.163
DR	32.743	21.054		25.349	16.215		5.593	0.000
SSM	24.171	15.615		24.259	17.506		-0.103	0.459
SSD	19.369	12.531		19.960	12.804		-0.717	0.237
Total Cost	1778	2978		1218	1484		2.345	0.010
Total Asset	3573	4557		3355	4377		0.742	0.229

Note: There are 85 firms located outside industrial parks (627 observations) and 46 firms inside industrial parks (353 observations). The unit *KL* is one million NTD per employee; the Taiwanese Wholesale Price Index (WPI) is employed to deflate asset values. Total costs and total assets are nominal variables, and their units are a million NTD. The units of the rest of the variables are percentage × 100.

Table 2. Regression results of fixed-effects models

	All firms	Outside industrial parks	Inside industrial parks	All firms with interaction terms	
RD	0.066***	0.048**	0.119***	0.115***	
	(0.01)	(0.02)	(0.02)	(0.02)	
LC	-0.003	-0.051	0.044*	0.046*	
	(0.02)	(0.03)	(0.02)	(0.03)	
OER					0.006***
					0.000
CSR					-2.627***
					-0.71
KL	-0.015**	-0.053***	-0.004	-0.003	0.006
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
OP	-0.325**	-0.470**	-0.006	-0.345**	-0.212*
	(0.16)	(0.23)	(0.26)	(0.16)	(0.13)
DF	-0.013*	-0.011	-0.012*	-0.012*	-0.008
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
SSM	-0.002	-0.013	0.012	0.000	0.006
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
SSD	0.012	0.026*	-0.002	0.012	0.005
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Time	-0.096***	-0.105	-0.108***	-0.114***	-0.125***
	(0.03)	(0.07)	(0.04)	(0.03)	(0.03)
$RD \times D$				-0.068**	
				(0.03)	
$LC \times D$				-0.102***	
				-0.04	

	All firms	Outside industrial parks	Inside industrial parks	All firms with interaction terms	
$OER \times D$					-0.007***
					(0.00)
$CSR \times D$					2.922***
					-0.72
$KL \times D$				-0.051***	-0.020*
				-0.01	-0.01
Constant	2.147***	4.411***	0.129	1.775**	3.770***
	-0.68	-1.31	-0.77	-0.69	-0.41
Obs.	980	353	627	980	939
R-squared	0.064	0.109	0.089	0.093	0.118

Note: Standard errors in parentheses. *, **, and *** indicate 10%, 5%, and 1% significance levels, respectively. For easy interpretation, the units of OER and CSR are percentages.

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THE IMPACT OF THE COVID-19 PANDEMIC ON THE BANKS' PROFITABILITY IN THE ROMANIAN BANKING SECTOR

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Abstract: *Covid-19 pandemic has a huge impact on all of the sectors, especially on the banking activity due to reduced demand for different types of loans. Therefore, we aim to investigate whether COVID-19 pandemic influences the banks' performance measured though two indicators, Return on Assets (ROA) and Return on Equity (ROE). We analyse Romanian banking sector, spanning from 2007-2022. The main findings show that the pandemic influences negatively the banks' profitability, but the economic environment plays also an important role in determining ROA and ROE. We bring new insights regarding the effects of macroeconomic indicators such as GDP Growth, Unemployment, Inflation and Volatility of RON/EUR on banks' performance. Further, we analyse the determinants of ROA's and ROE's volatility. Our results bring evidence that main driver of standard deviation of ROA and standard deviation of ROE are External Debt Growth and Domestic Liabilities Growth.*

Keywords: *banks' profitability; banking market; emerging markets; covid*

JEL Classification*: G21, G28*

1. INTRODUCTION

Every unexpected crisis has an impact on the stability of financial system which leads to a worser banks' performance. Covid-19 pandemic affects all of sectors' activity especially the traditional activity of banks due to the reduced demand for different types of loans. Although, noninterest revenues during Covid-19 pandemic can impact positively the banks' profitability (Li et al., 2021).

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A profitable banking sector is needed in all of South Eastern European countries in order to sustain both private and public sectors (Athanasoglou, Delis, and Staikouras, 2006). Therefore, it is worthy to examine the possible determinants of banks' performance.

To better understand the implications of pandemic crisis on banks' performance, we employ empirical models to assess whether the Covid-19 pandemic influences the level of ROA and ROE by analysing the Romanian banking sector during the period 2007-2022. We investigate also, whether there are other macroeconomic determinants and banking characteristics of ROA and ROE. A further analysis was conducted by examining if the volatility of banks' performance is affected by the same determinants as in the case of ROA and ROE.

Our main results show that COVID-19 pandemic influences negatively the banks' performance measured through the indicators, ROA and ROE. We also bring new evidence regarding the association of Romanian economic environment and banking sector. Banks tend to be more profitable in the presence of a higher GDP growth and a higher inflation due to higher implemented fees. Then, we can notice a lower profitability when the unemployment and volatility of the change RON/EUR account for higher values. In respect to the banking characteristics, a higher ratio of leverage is negatively associated with ROA and ROE. Additional findings suggest that the volatility of ROA and ROE is determined by the level of external debt growth and domestic liabilities growth.

The main contribution of this study is the expansion of the literature regarding the determinants of banks' performance measured through the indicators, ROA and ROE. Firstly, we investigate whether Covid-19 pandemic is a significant determinant of banks' profitability. Then, we bring new evidence in respect to the association of ROA, respectively ROE, and the economic environment. The policy recommendation based on our main findings is to implement macroprudential policies as soon as possible when regulatory authorities declare a crisis. Further, the policy makers should take into account the effects of economic environment on banks' performance. Although, the regulators intervene in due time, the macroeconomic indicators influence significantly the efficiency of implemented macroprudential policies.

The paper is organized as follows. In Section 2 we present the literature review regarding the determinants of banks' performance. Section 3 illustrates data collection and describes the empirical approach. The results are discussed in the section 4. Section 5 concludes.

2. LITERATURE REVIEW

2.1.Determinants of banks' profitability

By analysing the banks' profitability in EU27 for the period 2004-2011, Petria, Capraru and Ihnatov (2015) show that the industries specifics such as the diversification of business, the market concentration/competition and the economic growth have a high impact on the banks' performance. They also obtain that competition influences positively the banks' performance by affirming that the one of the main objectives of EU is to increase the competition on markets. There are other studies in the literature which sustain these results. A negative association between market power and banks' performance is remarkable, bringing strong evidence that a higher competition results in more profitable banks (Le and Nigo, 2020).

One bank's specific characteristic which impacts the banks' performance is the liquidity risk measured by the ratio of net loans to customer and short time funding. It is noticed that the liquidity risk is positively associated with the domestic banks' profitability and negatively associated with the foreign banks' performance both measured with the help of return on average assets (Pasiouras and Kosmidou, 2007). Chen et al. (2009) also analyse the correlation between liquidity risk and the level of ROA, respectively ROE in Asia over the period 2006-2008. Their findings show that a higher liquidity risk lowers both indicators ROA and ROE. Demirgüç-Kunt and Huizinga (1999) bring similar evidence in respect to the correlation between liquidity risk and banks' performance, having a sample of 80 countries.

Other banks' characteristics which result in the decrease of banks' performance are loan loss provisions (Menicucci and Paolucci, 2016) and higher short-term interest rate, while higher long-term interest rates boost the profits of credit institutions (Kohlscheen, Pabón, and Contreras, 2018).

The healthy business environment is an important determinant of banks' activity. Therefore, the size and the capital ratios of companies influence significantly the banks' performance in Europe (Menicucci and Paolucci, 2016). Further, the expansion of banks can determine the banks' transactions. Due to this fact, a higher number of banks card issued, a higher number of automated teller machines and a higher number of points of sale are positively correlated with the performance of credit institutions (Le and Nigo, 2020).

The economic environment can also boost the level of ROA and ROE. Inflation impacts significantly the banks' performance (Athanasoglou, Delis, and

Staikouras, 2006). Similar results are obtained by Athanasoglou, Brissimis, and Delis (2008) who bring new insights not only in respect to the negative correlation of banks' performance and inflation, but also in regards to the association of business cycle and level of performance. Then, credit growth can influence more in normal times the banks' performance in comparison with the GDP growth (Kohlscheen, Pabón, and Contreras, 2018).

2.2.Impact of Covid-19 crisis on banks' profitability

Covid-19 crisis affected negatively the banks' performance due to the reduced demand for several types of loans and due to the tighter credit standards. Then, it was noticed that credit institutions which are involved in other activities besides the traditional ones tend to be more profitable, although these activities are riskier (Li et al., 2021).

By analysing the Romanian banking sector during the Covid-19 pandemic, Dinu and Bunea (2022), bring also evidence that the banks' performance was strong negatively influenced by the pandemic and the activity of credit institutions tended to be riskier. Some possible factors which lead to a worser banks' performance are lower levels of revenues and higher level of provisions for non-performing loans (Hlakika, 2021).

In order to mitigate the negative impact of this crisis, the financial institutions have to be more oriented to digital banking, to focus more on industries which remains rentable, to provide assistance to MSME actors and to promote the financial products and service with the help of digital marketing (Sihotang and Hasanah, 2021).

3. SAMPLE AND METHODOLOGY

3.1.Sample

To investigate the impact of COVID-19 pandemic on banks' profitability, we analyse the Romanian banking sector spanning from 2007-2022. In our models, we employ monthly and quarterly data in respect to the indicators of performance, ROA and ROE. Based on this data, we calculate further the standard deviation of ROA and ROE. We introduce also macroeconomic variables and banking sector's characteristics such as the level of Leverage and the ratio of Loans to Deposits.

The following tables depicts the definitions of variables employed in our empirical models.

Table 1 Definitions of variables

Variable	Frequency	Source	Description
ROA	quarterly	NBR	Return on assets (Annualized net profit / Total average assets)
ROE	quarterly	NBR	Return on equity (Annualized net profit / Average own capital)
Standard deviation of ROA	quarterly	OwnC based on NBR data	Volatility of ROA in a four-period rolling window
Standard deviation of ROE	quarterly	OwnC based on NBR data	Ratio of total deposits granted by credit institutions to financial corporations to total assets
Regressors			
Dummy Covid-19	monthly	OwnC	Dummy Covid-19 period which takes the value 1 after March 2020, 0 otherwise
Credit Facility Rate	quarterly	OwnC based on NBR data	Credit facility rate change
Leverage	quarterly	NBR	Leverage Ratio
GDP Growth	monthly	Eurostat	Gross domestic product per capita, percentage change compared to same period in previous year
Unemployment	monthly	Eurostat	Unemployment rate, percentage of population in the labour force, seasonally adjusted (%)
Policy rate	quarterly	NBR	Policy rate (%)
Inflation	monthly	INSSE	Monthly Consumer Price index CPI TOTALS (%)
Dummy Covid-19 x Volatility of RON/EUR	monthly	OwnC	The interaction of Covid-19 period and the RON/EUR change rate
Volatility of RON/EUR	monthly	OwnC based on NBR data	RON/EUR change rate (%)
Ext Debt Growth	monthly	OwnC based on NBR data	Long-term external debt service (growth rate)

Variable	Frequency	Source	Description
Dom Liabilities Growth	monthly	OwnC based on NBR data	Domestic liabilities; M3 (growth rate)
Loan to Deposits	quarterly	NBR	Loans granted to clients (gross value) / Deposits from clients

Table 2 represents the descriptive statistics of the variables. It is remarkable that ROA and ROE record a high level of volatility, while the standard deviation of ROA and the standard deviation of ROE encounter a lower volatility. Then, leverage values record values which are closer to the mean.

Table 2 Descriptive statistics

Variable	Obs	Mean	Median	Std.Dev.	Min	Max
ROA	170	0.925	1.125	0.543	0.010	1.770
ROE	170	8.985	10.450	5.271	0.130	19.410
Standard deviation of ROA	274	0.545	0.541	0.016	0.500	0.568
Standard deviation of ROE	274	5.285	5.245	0.192	4.750	5.552
Credit Facility Rate	238	10.322	9.250	8.649	1.750	45.000
Dummy Covid-19	274	0.117	0.000	0.322	0.000	1.000
Leverage	179	8.451	8.130	0.879	6.810	10.300
GDP Growth	252	4.464	4.600	4.778	-9.500	16.300
Unemployment	273	7.278	7.500	1.351	4.700	9.600
Policy rate	238	6.441	5.250	5.383	1.250	21.250
Inflation	271	187.015	146.360	89.652	100.560	562.960
Volatility of RON/EUR	213	0.029	0.021	0.030	0.000	0.230
Ext Debt Growth	174	25.426	18.625	57.464	-96.581	288.319
Dom Liabilities Growth	187	0.916	0.000	2.183	-5.882	9.091
Loan to Deposits	179	94.189	91.330	20.123	65.890	124.710

The correlation matrix suggests that the employed variables in our empirical models are less likely to be correlated with some exceptions. ROA tends to be high negative correlated with Credit Facility Rate and Unemployment, while Credit Facility Rate is negative correlated with Leverage ratio.

Table 3 Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
ROA	1.0														
ROE	1.0	1.0													
Standard deviation of ROA	0.0	0.0	1.0												

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Standard deviation of ROE	0.0	0.0	1.0	1.0											
Credit Facility Rate	-0.6	-0.5	0.0	0.0	1.0										
Dummy Covid-19	0.2	0.2	0.0	0.0	-0.4	1.0									
Leverage	0.4	0.4	0.0	0.0	-0.7	0.4	1.0								
GDP Growth	0.6	0.6	0.0	0.0	-0.2	-0.1	0.0	1.0							
Unemployment	-0.8	-0.8	0.0	0.0	0.5	-0.4	-0.7	-0.5	1.0						
Policy rate	-0.5	-0.4	0.0	0.0	1.0	-0.4	-0.6	-0.2	0.4	1.0					
Inflation	-0.4	-0.3	0.1	0.1	0.9	-0.6	-0.6	-0.1	0.4	0.9	1.0				
Volatility of RON/EUR	-0.2	-0.2	-0.1	-0.1	0.6	-0.2	-0.4	-0.1	0.2	0.6	0.5	1.0			
Ext Debt Growth	0.0	0.0	0.7	0.7	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.1	1.0		
Dom Liabilities Growth	0.1	0.1	0.0	0.0	-0.1	0.1	0.0	0.1	-0.1	0.0	0.0	0.0	0.0	1.0	
Loan to Deposits	-0.6	-0.6	0.0	0.0	0.9	-0.5	-0.8	-0.1	0.7	0.9	0.8	0.5	0.0	-0.1	1.0

3.2.Methodology

We assess the impact of Covid-19 pandemic on the banks' profitability by estimating the following models based on the OLS (Ordinary Least Squares) method with robust standard errors. Through the same models, we investigate whether there are other determinants of ROA and ROE such as banking sector characteristics and macroeconomic variables.

$$\mathrm{ROA} = \alpha + \beta * \text{Dummy Covid} - 19\ \mathrm{t} + \gamma * \text{Macroeconomic variables}t - 1 + \delta * \text{Banking sector variables}t - 1 + \varepsilon t \quad (1)$$

$$\mathrm{ROE} = \alpha + \beta * \text{Dummy Covid} - 19\ \mathrm{t} + \gamma * \text{Macroeconomic variables}t - 1 + \delta * \text{Banking sector variables}t - 1 + \varepsilon t \quad (2)$$

We consider in our empirical models the macroeconomic variables: GDP Growth, Unemployment, Policy Rate, Inflation, Volatility of RON/EUR, External Debt Growth, and Domestic Labilities Growth.

In respect to the banking sector' characteristics, we introduce in our models: Credit Facility Rate, level of leverage and the ratio of loans to total deposits.

To extend our analysis, we run the same models by employing as dependent variables the standard deviation of ROA, respectively the standard deviation of

ROE. Through these regressions, we can investigate whether banks' profitability vs. the volatility of banks' profitability are influenced by the same determinants.

4. MAIN RESULTS

The main findings depicted in Table 4 and Table 5 suggest the main determinants of banks' profitability. To measure the banks' profitability, we introduce two indicators as dependent variables, ROA and ROE. Overall, it can be noticed that Covid-19 pandemic has negative statistically significant impact on both indicators. Covid-19 pandemic affects all of the economic industries especially banks' activity. Therefore, the banks' profitability is negatively affected during pandemic due to the reduced demand for several types of loans (Li et al., 2021).

First, all four employed models illustrated in Table 4 and Table 5 bring evidence that Covid-19 crisis affects negatively both indicators, ROA and ROE, but a lower level of leverage can mitigate the influence of Covid-19 pandemic of banks' profitability as indicated by the interaction term Dummy Covid-19 x Leverage. Then, Credit Facility Rate and Leverage have a negative impact on ROA and ROE. A possible explanation is that higher level of debts will affect the banks' performance.

The economic environment influences significantly the performance of banks. GDP Growth has a positive effect on both indicators, while Unemployment rate and Volatility of RON/EUR change rate influence negatively banks' profitability. Further, we obtain that inflation impacts positively ROA and ROE. A higher inflation rate implies higher costs for both actors, banks and customers, but banks are more likely to introduce higher fees in order to increase their revenues.

Table 4 Determinants of banks' profitability (ROA)

	(1)	(2)	(3)	(4)
VARIABLES	ROA	ROA	ROA	ROA
Credit Facility Rate	-0.114***	-0.088**	-0.111***	-0.134***
	(0.012)	(0.045)	(0.011)	(0.022)
Dummy Covid-19	-4.216***	-5.543***	-4.270***	-4.366***
	(0.896)	(0.737)	(0.878)	(0.867)
Leverage	-0.286***	-0.363***	-0.287***	-0.301***
	(0.064)	(0.056)	(0.061)	(0.060)
Dummy Covid-19 x Leverage	0.442***	0.573***	0.448***	0.458***

	(0.093)	(0.078)	(0.092)	(0.091)
GDP Growth	0.029***	0.030***	0.029***	0.025***
	(0.005)	(0.006)	(0.005)	(0.006)
Unemployment	-0.203***	-0.240***	-0.204***	-0.232***
	(0.025)	(0.035)	(0.025)	(0.031)
Policy rate		0.007		
		(0.063)		
Volatility of RON/EUR	-1.857**	-1.801**	-2.031**	-2.168***
	(0.724)	(0.743)	(0.803)	(0.818)
Inflation	0.011***		0.010***	0.010***
	(0.003)		(0.003)	(0.003)
Ext Debt Growth			-0.000	-0.000
			(0.000)	(0.000)
Dom Liabilities Growth			-0.011	-0.011
			(0.011)	(0.011)
Loan to Deposits				0.005
				(0.005)
Constant	4.024***	6.262***	4.171***	4.144***
	(1.011)	(0.702)	(0.972)	(1.015)
Observations	170	170	166	166
R-squared	0.803	0.790	0.801	0.802

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5 Determinants of banks' profitability (ROE)

	(1)	(2)	(3)	(4)
VARIABLES	ROE	ROE	ROE	ROE
Credit Facility Rate	-1.123***	-0.855*	-1.086***	-1.359***
	(0.121)	(0.497)	(0.110)	(0.218)
Dummy Covid-19	-35.473***	-53.187***	-35.785***	-36.948***
	(9.520)	(8.380)	(9.352)	(9.145)
Leverage	-2.908***	-3.924***	-2.896***	-3.068***
	(0.610)	(0.557)	(0.574)	(0.576)
Dummy Covid-19 x Leverage	3.810***	5.556***	3.837***	3.968***
	(0.986)	(0.884)	(0.973)	(0.953)
GDP Growth	0.300***	0.320***	0.298***	0.251***
	(0.054)	(0.062)	(0.057)	(0.069)

Unemployment	-1.998***	-2.445***	-2.001***	-2.329***
	(0.250)	(0.379)	(0.250)	(0.321)
Policy rate		0.199		
		(0.702)		
Volatility of RON/EUR	-19.331***	-18.649**	-21.345***	-23.002***
	(7.058)	(7.493)	(7.878)	(8.055)
Inflation	0.145***		0.134***	0.135***
	(0.030)		(0.031)	(0.032)
Ext Debt Growth			-0.002	-0.003
			(0.004)	(0.004)
Dom Liabilities Growth			-0.110	-0.106
			(0.116)	(0.115)
Loan to Deposits				0.064
				(0.047)
Constant	34.696***	64.347***	36.202***	35.877***
	(9.576)	(7.149)	(9.223)	(9.690)
Observations	170	170	166	166
R-squared	0.792	0.768	0.785	0.787

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In the second phase, our objective is to assess whether the determinants of ROA's and ROE's volatility are the same as in the case of ROA, respectively ROE. We find that COVID-19 pandemic influences positively the standard deviation of ROA and ROE. This can be explained by the fact that economic situation during Covid-19 pandemic was uncertain which leads to instability in the banks' performance. Then, the impact of Covid-19 crisis can be mitigated in the presence of a lower volatility of change rate RON/EUR. As in the case of ROA and ROE, the economic environment can affect the volatility of banks' performance. The external debt growth and domestic liabilities growth influences statistically significant and positive the level of standard deviation of ROA, respectively ROE.

Table 6 Determinants of volatility of profitability (ROA)

	(1)	(2)	(3)	(4)
VARIABLES	Standard deviation of ROA	Standard deviation of ROA	Standard deviation of ROA	Standard deviation of ROA
Credit Facility Rate	-0.000	-0.002	-0.000	-0.002
	(0.001)	(0.001)	(0.001)	(0.002)

	(1)	(2)	(3)	(4)
	Standard deviation	Standard deviation	Standard deviation	Standard deviation
VARIABLES	of ROA	of ROA	of ROA	of ROA
Dummy Covid-19	0.010**	0.008	0.010**	0.010**
	(0.005)	(0.051)	(0.005)	(0.005)
Leverage	-0.000	0.000	0.001	-0.000
	(0.003)	(0.003)	(0.003)	(0.003)
GDP Growth	0.000	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Unemployment	0.001	0.002	0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)
Policy rate		0.002		
		(0.002)		
Volatility of RON/EUR	0.104**	0.097**	0.123***	0.112***
	(0.042)	(0.042)	(0.041)	(0.043)
Inflation	-0.000		-0.000	-0.000
	(0.000)		(0.000)	(0.000)
Ext Debt Growth			0.000***	0.000***
			(0.000)	(0.000)
Dom Liabilities Growth			0.001*	0.001*
			(0.001)	(0.001)
Loan to Deposits				0.000
				(0.000)
Dummy Covid-19 x Volatility RON/EUR	-0.809**	-0.807**	-0.801**	-0.772**
	(0.363)	(0.364)	(0.323)	(0.340)
Constant	0.551***	0.531***	0.526***	0.518***
	(0.044)	(0.038)	(0.044)	(0.043)
Observations	179	179	169	169
R-squared	0.052	0.053	0.136	0.147

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7 Determinants of volatility of profitability (ROE)

	(1)	(2)	(3)	(4)

VARIABLES	Standard deviation of ROE	Standard deviation of ROE	Standard deviation of ROE	Standard deviation of ROE
Credit Facility Rate	-0.001	-0.021	-0.004	-0.025
	(0.009)	(0.016)	(0.009)	(0.018)
Dummy Covid-19	0.119**	0.127**	0.112**	0.116**
	(0.054)	(0.051)	(0.054)	(0.053)
Leverage	0.001	0.004	0.011	0.002
	(0.033)	(0.033)	(0.032)	(0.035)
GDP Growth	0.002	0.003	0.003	-0.001
	(0.003)	(0.003)	(0.003)	(0.004)
Unemployment	0.010	0.019	0.016	-0.008
	(0.017)	(0.017)	(0.017)	(0.026)
Policy rate		0.024		
		(0.022)		
Volatility of RON/EUR	1.158**	1.091**	1.382***	1.258**
	(0.483)	(0.481)	(0.483)	(0.498)
Inflation	-0.001		-0.000	-0.000
	(0.002)		(0.002)	(0.002)
Ext Debt Growth			0.001***	0.001***
			(0.000)	(0.000)
Dom Liabilities Growth			0.016*	0.016*
			(0.008)	(0.008)
Loan to Deposits				0.005
				(0.004)
Dummy Covid-19 x Volatility RON/EUR	-9.557**	-9.531**	-9.492**	-9.190**
	(4.182)	(4.180)	(3.743)	(3.914)
Constant	5.331***	5.109***	5.062***	4.981***
	(0.509)	(0.400)	(0.508)	(0.502)
Observations	179	179	169	169
R-squared	0.050	0.051	0.131	0.139

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5. CONCLUSIONS

Covid-19 pandemic affects all of sectors especially the banks' activity due to the reduced demand for several types of loans. Therefore, the main findings in respect to the magnitude of Covid-19 pandemic' impact on banks' performance are relevant for policy makers and supervisors likewise. With this study, we enlarge the literature on the determinants of banks' performance by analysing Romanian banking sector, spanning from 2007 until 2022. We bring evidence that Covid-19 pandemic affects negatively banks' profitability measured with the help of the indicators, ROA and ROE. Other significant macroeconomic determinants of ROA and ROE are GDP Growth, Unemployment, Inflation and Volatility of RON/EUR change rate. Further, our extensive analysis shows that the volatility of ROA and ROE is influenced by other factors such as external debt growth and domestic liabilities growth.

BIBLIOGRAPHY

1. Athanasoglou, P. P., Delis, M., & Staikouras, C. (2006). Determinants of bank profitability in the South Eastern European region.
2. Athanasoglou, P. P., Brissimis, S. N., & Delis, M. D. (2008). Bank-specific, industry-specific and macroeconomic determinants of bank profitability. *Journal of international financial Markets, Institutions and Money*, *18*(2), 121-136
3. Chen, Y. K., Shen, C. H., Kao, L., & Yeh, C. Y. (2018). Bank liquidity risk and performance. *Review of pacific basin financial markets and policies*, *21*(01), 1850007.
4. Demirgüç-Kunt, A., & Huizinga, H. (1999). Determinants of commercial bank interest margins and profitability: some international evidence. *The World Bank Economic Review*, *13*(2), 379-408.
5. Dinu, V., & Bunea, M. (2022). The Impact of Competition and Risk Exposure on Profitability of the Romanian Banking System During the COVID-19 Pandemic. *Journal of Competitiveness*, *14*(2), 5-22.
6. Hladika, M. (2021). Impact of Covid-19 Pandemic on The Loans Quality, Provisions and Profitability of The Banking Sector. *Economic and Social Development: Book of Proceedings*, 138-149.
7. Le, T. D., & Ngo, T. (2020). The determinants of bank profitability: A cross-country analysis. *Central Bank Review*, *20*(2), 65-73.
8. Li, X., Feng, H., Zhao, S., & Carter, D. A. (2021). The effect of revenue diversification on bank profitability and risk during the COVID-19 pandemic. *Finance Research Letters*, *43*, 101957.
9. Kohlscheen, E., Murcia Pabón, A., & Contreras, J. (2018). Determinants of bank profitability in emerging markets.

10. Menicucci, E., & Paolucci, G. (2016). The determinants of bank profitability: empirical evidence from European banking sector. *Journal of financial reporting and Accounting*.
11. Pasiouras, F., & Kosmidou, K. (2007). Factors influencing the profitability of domestic and foreign commercial banks in the European Union. *Research in International Business and Finance*, *21*(2), 222-237.
12. Sihotang, M. K., & Hasanah, H. (2021, February). Islamic Banking Strategy In Facing The New Normal Era During The Covid 19. In *Proceeding International Seminar of Islamic Studies* (Vol. 2, No. 1, pp. 479-485).
13. Petria, N., Capraru, B., & Ihnatov, I. (2015). Determinants of banks' profitability: evidence from EU 27 banking systems. *Procedia economics and finance*, *20*, 518-524.

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SURVEY ARTICLE

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CONSIDERATIONS OF EFFICIENCY OF THE ROMANIAN PUBLIC HOSPITALS DURING THE COVID-19 PANDEMIC

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Abstract: *The COVID-19 pandemic has put the efficiency of the hospitals into the spotlight worldwide. In Romania, hospital services are the pillar of the healthcare system which has obtained low scores on efficiency and quality in the European comparative evaluations, for a long period. Hospital services are overutilized and among the most expensive in the European Union, while the medical needs of the population remain unsatisfied since Romania has registered in the pre-pandemic year 2019 the highest mortality rate although the diseases leading to the patients' deaths were treatable. The paper offers a documented perspective on the efficiency of Romanian public hospitals, emphasizing the effect of their low efficiency from the normal periods on the way they have coped with the sanitary crisis represented by the COVID-19 pandemic.*

Keywords: *Romanian public hospitals, hospital efficiency, healthcare system, COVID-19 pandemic*

JEL Classification*: I10, I18*

1. INTRODUCTION

Since they cover a wide and complex range of medical needs, hospital services are the most important agent of the healthcare system. Consequently, hospital services are the most expensive medical services. At the same time, they are prone to inefficiency on account of the large amount of resources they require. According to the World Health Organization (WHO), up to 40% of the global health expenditure is wasted (WHO, 2010, p. vi) and a significant proportion of this spending (50%-70%) is directed towards hospitals (WHO, 2003, p. 4). This

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implies that by improving hospital efficiency, the health systems could become more efficient, too.

Patient care is the core function of hospitals: they provide "constant nursing care for patients while they undergo medical therapy" to restore their health (Healey and McKee, 2002, p. 5). The problem of limited resources and the large amounts of consumption in hospitals are the main reasons for which the efficiency of the hospitals has become a highly investigated topic in the economic literature. Thus, hospitals are intended to respond and to manage sanitary crises like COVID-19 pandemic, a challenge for the medical facilities worldwide. Lockdown and physical distancing were the first measures that all governments imposed, and hospitals restricted their admissions, treating only the COVID patients and the emergencies, to avoid saturation of the wards. During the pandemic, healthcare utilization decreased, and all countries reported disruptions in up to 25 essential health services (WHO, 2020, p. 2). As for the hospital services, the percentage reduction in the number of admissions ranged from 20% to 87% (Moynihan et al., 2021).

The inefficiency of Romanian hospitals was highlighted in previous studies, conducted on data from normal periods. Nistor et al. (2017) and later Caunic (2020) obtained results showing that the public hospitals are inefficient in converting their resources in qualitative results. New sentence: Studies show that they do not operate on the optimal technological scale, being either too big or too small.

The aim of the paper is to analyze the efficiency of Romanian public hospitals as it is documented in the literature focusing on the health crisis, given the low efficiency of the Romanian health system from the period before the Covid-19 pandemic. The remainder of the paper is as follows: Section 2 contains a short description of the Romanian health system, Section 3 investigates the response of the Romanian hospital system to the pandemic outbreak, in the European context, and Section 4 offers a perspective on the impact of previous low hospital efficiency on the response to the pandemic. Conclusions are drawn in the final section of the paper.

2. ASPECTS OF THE ROMANIAN HEALTHCARE SYSTEM

The Romanian healthcare system is in a process of reform even from before the country's accession to the EU, in 2007. The reform of the healthcare system has focused on increasing the efficiency of public hospitals by reducing the number of beds and by controlling the costs, based on the implementation of

the Diagnosis Related Groups (DRG) reimbursement system, used at the international level. The DRG system reimburses hospitals according to the complexity of the cases, classified in Groups of Diagnosis, and according to the costs associated with these groups.

Radu (2006) argues that the DRG system can be applied to standardize hospital activity, so they could be financed according to the medical needs of the population, identified based on the dominant DRGs and not according to the number of approved beds. In this way, money would follow the patient and not the number of approved hospital beds. Antohi (2017) notes the positive effects of the implementation of the DRG reimbursement system in Romanian hospitals: reduction of costs per patient, reduction of hospitalization days and of waiting times and also reduction of the number of admissions and discharges, allowing a better management of admitted cases.

Also, monitoring and control systems were created, including annual evaluations of hospital management, based on performance indicators, and the accreditation of public and private hospitals, based on the standards of the National Authority of Quality Management. However, the major problem, which is the financing of the healthcare sector, remained unsolved: the budget of the healthcare system is ensured only by 5.7% of the Gross Domestic Product (GDP), which is much lower than the EU average of 9.9%. Most of it is allotted to hospitals, while preventive and primary care are underfunded and underdeveloped. Although the main financing is directed to hospitals, the efficiency and quality of hospital services are questionable, since in 2016 Romania occupied the first position in the EU with the rate of treatable mortality, and this situation has not changed over the past years. Also, in the pre-pandemic year 2019, Romanian hospitals spent 44% of the total health expenditure (OECD, 2021, p. 11). Moreover, according to Eurostat[iii], the money spent per patient was of only 299.10 Euros, compared to the average of EU countries, which was 1,032.97 Euros per patient. These disparities have left their mark on the health of the population, on the hospital system and on its resilience during the sanitary crisis.

3. HOSPITAL EFFICIENCY IN THE PANDEMIC PERIOD

The coronavirus took by surprise healthcare systems all over the world, since the medical infrastructure was not prepared to receive and to handle so

[iii] Eurostat Database: Health care expenditure by provider – Hospitals -Euro per inhabitant, time 2019 https://ec.europa.eu/eurostat/databrowser/view/HLTH_SHA11_HP/default/table?lang=en [Accessed 28.06.2023]

many infected patients and, at the same time, to contain the spread of the virus within the community.

In Europe, the first and most affected countries were Italy and Spain, followed by France and Germany. The response of these countries to the pandemic outbreak depended on the structural features of their hospital system and on the performances of their facilities in the previous periods, as shown by Pecoraro et al (2021). Italy and Spain were identified as low efficient countries in managing the sanitary crisis at the pandemic outbreak, while France was highly efficient during the first 5 weeks of the pandemic, and Germany had an oscillating efficiency in managing the crisis (Ordu et al., 2020). The study of Pecoraro et al. (2021) indicates that France and Germany had a good management of complex cases in the normal periods and a well-organized structure of the hospital system, and consequently they were less affected by the pandemic in terms of number of deaths and registered cases until the midst of 2020. Before the outbreak of the pandemic, the hospital system in these countries was characterized by high availability of beds, low occupancy rate and high turnover interval. During the pandemic, these structural features of healthcare units proved to be helpful in managing COVID patients, without the saturation of wards. By contrast, Italy and Spain showed low performance in managing even low complex cases in the normal periods, although hospital beds used to be efficiently managed. The average age of the population in these two countries and the reduced number of hospital beds increased the risk of saturation of the hospital wards at the outbreak of the pandemic.

During the Covid-19 pandemic, the Romanian Ministry of Health has restricted hospitals admissions up to 80% to free up hospital beds and medical personnel. Although Romania has an average number of 7 hospital beds per 1000 inhabitants, higher than the EU average of 5 beds per 1000 inhabitants, the medical personnel in hospitals is less than the EU average, due to the migration of these professionals in the European countries after 2007, when the country was accepted in the EU. According to Eurostat data[iv], in 2019 Romania had about 40% less doctors in hospitals per 100 000 inhabitants, compared to European countries with the same number of 7 hospital beds per 1000 inhabitants. At the same time, the poor financing led to neglection of preventive and primary care, which remained underdeveloped, and the focus of healthcare is still on hospitals, that are short in medical personnel and do not manage efficiently the limited resources they have.

[iv] Eurostat Database: Hospital employment – Physicians – Full – time equivalent per hundred thousand inhabitants, time 2019, https://ec.europa.eu/eurostat/databrowser/view/HLTH_RS_PRSHP2/default/table?lang=en [Accessed 28.06.2023]

In Romania, at the outbreak of the pandemic, the Suceava County was the most affected by the coronavirus. The county hospital, that had neither protective equipment nor training to manage highly infectious diseases, turned into a hotspot, after registering 1529 cases of COVID-19, representing 30% of the entire cases registered in Romania at the pandemic outbreak (Dumitrescu, 2021). Although previously, the County Hospital from Suceava ranged first in the Webometrics Ranking of Hospitals, conducted by Beșciu (2016), at the outbreak of the pandemic the civil management had to be replaced by a military management, to take control over the crisis. As it is shown by Dumitrescu (2021), the low-capacity state of the country led to a weak response of the Romanian healthcare sector to the coronavirus pandemic, although "pockets of efficiency" could be identified in some counties, such as Timișoara and Arad, where the experience and the discipline of the medical staff had a great contribution to limit the infections among medical personnel and within the community. Lupu and Țigănașu (2020) obtained results showing that Romania had a low efficiency in using the resources of the healthcare sector, especially in the second wave of the COVID-19 pandemic, while other Eastern European countries, such as Czech Republic and Slovakia, had a better response and a level of efficiency comparable to that of well-funded health systems in Norway, Denmark, and Switzerland.

The low development of primary care, which had a significant role during the sanitary crisis, contributed to the inefficient behavior of the Romanian healthcare system during the pandemic. Due to the pressure exerted on hospitals, the monitoring of asymptomatic COVID patients or of patients with mild symptoms, as well as the vaccination action, were transferred to primary care physicians. The underdevelopment of the prevention sector left its mark on the vaccination campaign which, although it was correctly planned, did not achieve the expected results among the population, poorly informed and not aware of the importance of vaccination and responsible behavior for the promotion of public health.

4. ROMANIAN HOSPITALS EFFICIENCY DURING THE PANDEMIC PERIOD

The response of the Romanian healthcare system to the coronavirus pandemic was much determined by the low resilience capacity of the system. The low resilience was caused firstly by the chronic underfunding and secondly by the inefficient management of the existing resources.

Analyzing causes of inefficiency in Romanian healthcare facilities with arrears, Duran et al. (2017) point out three main causes: underfunding, structural imbalance, and poor management. These authors note that the indicators for hospital infrastructure (number of beds and number of discharges) are higher than the EU average. Therefore, they strongly recommend strongly recommend the rightsizing of hospitals, according to international demands, the rationalization of hospital services and a reevaluation of the costs applied in the DRG system, so that they correspond to the real costs from the Romanian hospitals. The results of Talaghir et al. (2018) support the idea of achieving efficiency by treating more complex cases, but in a number corresponding to the hospital's admission capacity.

However, during the pandemic period medium hospitals proved their efficiency. By ministerial order, in March 2020, the municipal hospitals, that have an average number of beds of about 300 beds, were put in the second line, as support-hospitals for the facilities in the first line against the coronavirus. The support-hospitals were meant to take over COVID patients if the first-line hospitals became overloaded, while treating, at the same time, non-COVID patients. Caunic et al. (2021) have obtained results that prove the efficiency of municipal hospitals during the sanitary crisis, with an average efficiency score reaching 90%, suggesting a good management of beds and human resources during the pandemic, in the investigated hospitals.

As it could be expected, the expenses of the Romanian hospitals during the pandemic registered an important growth, accounted for mainly by the number of deaths in hospitals as a result of COVID-19 infection. Using an econometric model, György and Simionescu showed that the expenses with sanitary materials, drugs and the special allowance granted to the medical personnel that managed the COVID cases were significantly explained by the number of deceased patients due to COVID-19 (György and Simionescu, 2021, p. 34).

This is not the case just for the Romania: American Hospital Association estimated that the financial impact of the pandemic on low and middle-income countries, such as Romania, would be of 52 billion US dollars per month (meaning 8.60 US dollars per person) to provide an effective healthcare response (Kaye et al., 2020). As it is noted by Abor and Abor (2020) the pandemic combined the health crisis with the economic crisis, affecting the national health systems and imposing also new economic interventions and measures.

5. CONCLUSION

The aim of the paper was to describe the efficiency of Romanian public hospitals, focusing on the response of the hospital system to the COVID-19 pandemic, in the context of its previous inefficiency, emphasized on this topic. The coronavirus pandemic was a huge challenge for all healthcare systems. The crisis caused by it was global. In this context, it was expected that the poorly managed and poorly financed healthcare systems, such as the one in Romania, would have a poor response to this challenge.

The Romanian healthcare system is underfunded and lacking specialized personnel and, as it was shown, these weaknesses left their mark on the response of Romanian hospitals to the coronavirus pandemic: at the outbreak of the pandemic, one county hospital became a hotspot and imposed military management, and in the second wave Romania had a low efficiency in managing the healthcare system resources. Still "pockets of efficiency" could be identified, due to the clinical experience and discipline of the medical staff in some hospitals. Medium hospitals, designated as support-hospitals for COVID patients in case of saturation of the hospitals in the front line, used their main resources (beds and medical staff) with an average efficiency of 90%, revealing a good management of the crisis.

In the pre-pandemic years, the literature that focused on the efficiency of Romanian public hospitals points out towards efforts in increasing the efficiency by adapting the international reimbursement system of the hospitals based on the diagnosis groups (DRGs) to Romanian hospitals and by adjusting this system to the real financial needs of the Romanian facilities. Also, performance indicators such as number of treated cases and hospitalization days are investigated in relation to the DRG reimbursement system, having a positive effect upon these indicators.

The current paper contributes to this research field in Romania, providing a basis for future investigations on the efficiency of the Romanian hospitals and healthcare system. The challenge for healthcare facilities in the upcoming period is to reconfigure themselves in order to be able to respond effectively to a new reality and so more measures are expected to be applied.

REFERENCES

1. Antohi, V.M. (2017). Romanian Healthcare Financing Based On Diagnosis - Related Group Payment System (DRG). *Multidimensional Education and Professional Development: Ethical Values*, *European Proceedings of Social and Behavioural Sciences*, 27, pp. 19-28.

2. Abor, P.A. & Abor, J.Y. (2020) Implications of COVID-19 Pandemic for Health Financing System in Ghana. *Journal of Health Management*, 22, pp. 559–569.
3. Beșciu, C. D. (2016). Efficiency of the Management Practiced in Twenty Emergency Hospitals in Romania Reflected by the Web Performance and the Indicators Used, *Management Research and Practice*, Vol. 8, No. 2, pp. 67-86
4. Caunic, R.E., (2020). Technical and scale efficiency in Romanian public hospitals: Estimating with Data Envelopment Analysis. *Proceedings of the International Conference on Applied Statistics*, vol.2, no.1, pp.66-76.
5. Caunic, R.E., Asandului, L. and Bedrule-Grigoruță, M. V. (2021). "A Data Envelopment Analysis of the Response of Healthcare Facilities to Coronavirus Pandemic: Evidence from Romania. *Eurint Conference Proceedings, Centre for European Studies*, Vol. 8, pp. 23-40.
6. Dumitrescu, L. (2021). Pockets of efficiency in a low-capacity state: dealing with the COVID-19 pandemic in Romania. *Southeast European and Black Sea Studies*, Vol. 21, No. 3, pp. 373-391
7. Duran, A., Chanturidze, T., Gheorghe, A. & Moreno, A. (2019). Assessment of Public Hospital Governance in Romania: Lessons From 10 Case Studies. *International Journal of Health Policy and Management*, Vol. 8, No. 4, pp. 199-210
8. György, A. & Simionescu, I. (2021). The Impact of COVID-19 on the Romanian Hospitals' Expenses. A Case Study Toward the Financial Resilience after the Pandemic, *Transylvanian Review of Administrative Sciences*, Special Issue 2021, pp. 22-36
9. Kaye, A.D., Okeagu, C.N., Pham, A.D., Sylva, R.A., Hurley, J.J., Arron, B.L., Sarfraz, N., Lee, H.N., Ghali, G.E., Gamble, J.W., Liu, H., Urman, R.D. and Cornett, E.M. (2020), Economic impact of COVID-19 pandemic on healthcare facilities and systems: International perspectives. *Best Practice and Research: Clinical Anaesthesiology*. https://doi.org/10.1016/j.bpa.2020.11.009
10. Lupu, D. & Țigănașu, R. (2022). COVID-19 and the efficiency of health systems in Europe. *Health Economics Review*, 12, article number: 14. https://healtheconomicsreview.biomedcentral.com/articles/10.1186/s13561-022-00358-y
11. Moynihan, R., Sanders, S., Michaleff, Z. A., Scott, A. M., Clark, J., To, E. J., Jones, M., Kitchener, E., Fox, M., Johansson, M., Lang, E., Duggan, A., Scott, I., and Albarqouni, L. (2021). Impact of COVID-19 pandemic on utilization of healthcare services: a systematic review. *BMJ Open*, Vol. 11, No. 3, e045343. doi:10.1136/bmjopen-2020-045343
12. OECD/European Observatory on Health Systems and Policies (2021), *Romania: Country Health Profile 2021, State of Health in the EU*, OECD Publishing, Paris/European Observatory on Health Systems and Policies, Brussels. https://doi.org/10.1787/74ad9999-en [Accessed 27.06.2023]
13. Ordu, M., Akin, H. K. & Demir, E. (2021). Healthcare systems and Covid19: Lessons to be learnt from efficient countries. *The International Journal of Health Planning and Management*, Vol. 36, No. 5, pp. 1476-1485

14. Radu, C.P. (2006), Introducere în sistemul grupelor de diagnostic (DRG), (in Badea, E., Bărbuță, D., Chiriac, N., Gheorghe, I., Haraga, S., Ionescu, A. et al., *Managementul Spitalului*), Public H Press, pp. 91-95.
15. Radu, C.P., Chiriac, D. N. & Vlădescu, C. (2010), Changing Patient Classification System for Hospital Reimbursement in Romania, *Croatian Medical Journal*, Vol. 51, No. 3, pp. 250-258.
16. Talaghir, L.G, Gheonea, V., Rus, C. M., Crețu, C.M. & Iconomescu, T.M. (2018), Statistical Analysis of Hospitalized Indicators Based on DRG in Romanian Public Hospitals, *Revista de Cercetare și Intervenție Socială*, Vol. 61, pp. 163-186.
17. World Health Organization (2003), *Measuring Hospital Performance to Improve the Quality of Care in Europe: a Need for Clarifying the Concepts and Defining the Main Dimensions.* Report on a WHO Workshop, Barcelona. https://www.wido.de/fileadmin/Dateien/Dokumente/Publikationsdatenbank/wido_kra_who_1204.pdf [Accessed 27.06.2023]
18. World Health Organization (2010), *The world health report: health system financing: the path to universal coverage*. Geneva: World Health Organization. https://apps.who.int/iris/handle/10665/44371 [Accessed 27.06.2023]
19. World Health Organization (2020), *Pulse survey on continuity of essential health services during the COVID-19 pandemic interim report. WHO reference number: WHO/2019-nCoV/EHS_continuity/survey/.1.* Geneva: World Health Organization. https://www.who.int/publications/i/item/WHO-2019-nCoV-EHS_continuity-survey-2020.1 [Accessed 27.06.2023]

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FINANCIAL RISK OPTIMISATION METHODS: A SURVEY

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Abstract: *An important part of the management activity is related to the management of financial risk management. It involves the assessment of financial risks in relation to a particular financial institution, situation or decision and the consistent development of management strategies and internal policies. The basic work of risk management is to measure risk. This paper examines the existing literature on financial risk measurement, pointing out the limitations in existing risk measurement indicators and what was done in terms of optimization of risk measures, good performance, easy calculation, and testing. In addition, the paper wants to explore future research ideas.*

Keywords: *Financial risk management, Risk measures, Value-at-risk, Expected Shortfall, Risk measurement*

1. INTRODUCTION

Financial stability is a concept that plays an essential role in the well-being of individuals, businesses, and society. It forms the foundations for economic growth, personal security, and overall stability of the financial system. Taking care of three main components – financial institutions, financial markets, and financial infrastructure, financial stability is not only an essential condition for central bank policy objectives of price stability but also a necessary condition for the development of the economy. In that sense, the responsibility of maintaining the financial stability climate has become desirable. Besides the numerous advantages such as economic growth, prosperity, and financial development, a financially stable system is one that is preoccupied with risk mitigation and crisis prevention.

The focus on financial risk has grown considerably in recent years, but risk management and risk are not contemporary issues. The rapid growth of global

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markets has also led to a diversity of sources of risk. Therefore, it is important to ensure that financial risks are properly identified and managed.

Over time and out of a desire to increase income, exposure to risk has increased precisely because risk is the foundation for opportunity. There are fine economic differences between the terms risk and exposure. Risk is the probability of loss, and exposure is the possibility of loss. Risk results from exposure. Because it is not always possible or desirable to eliminate risk, it is important to understand it in order to determine how to manage it. Interest in risk measurement has grown with exposure to potentially risky situations, with investors concerned about the anticipation of losses and adverse situations. The identification of exposures and risks provides the basis for the proper identification of the risk management strategy. Probability is the central principle of risk; measuring risk involves estimating the likelihood of loss to a particular financial institution or portfolio. In a general framework, financial risk can be defined as the "probability of losing some or all of the investment", but it is not limited to the perspective of investors, but claims can also be made for other actors of the financial system.

(Danielsson, 2011) points out that the objective of risk measures is to help make decisions. As a result, the best way to evaluate these measures is to consider their ability to meet the target. Therefore, if different measures offer the same results, the choice to use one of them will be based on the level of difficulty of implementation. On the other hand, if the measurements give different results, a deeper analysis is necessary for the choice of the right measurement.

The process of estimating risk is twofold. The first part refers to the process of estimating the probable gain, or even more importantly in risk management, of the probable loss, resulting from the market or price changes, if we refer to market risk, or other factors if we refer to other types of financial risks. To calculate the potential loss, one needs to estimate the sensitivity of the instrument or its exposure to market changes. The second part of the process involves estimating the probability of the above-mentioned market changes, given the change in market conditions and the size of the position of the underlying assets, but also the likelihood of their occurrence and the estimation of potential loss or gain.

In what concerns this paper, the purpose is to shed light on systemic risk and the systemic risk measures, due to the importance of financial stability and the significant impact that it has on the financial system.

The remainder of this paper is divided into five sections: Section 2 describes the literature, Section 3 presents the most used measures for risk quantification and presents and discusses the relevant aspects of the Value-at-

Risk methodology and compares it with other relevant measures of financial risk, Section 4 presents the results of the literature analysis related to systemic risk measures, and Section 5 concludes.

2. LITERATURE REVIEW

(BIS, 2002) gives a definition of financial risk management as a process that implies four steps: *identification* of the risky situations and potential risk producers; the *assessment* of the risk by using data and risk models; *monitoring* risk by implementing policies, procedures, and processes in order to mitigate risk; and *control* these risks at the managerial level.

Due to the adverse situation, the authorities and all persons involved in the financial market have adopted a risk-management-oriented approach. In this case, our research aims to focus on the second stage of financial risk management, especially the risk model used to evaluate market risks, and more specifically systemic risks.

The literature has devoted an important interest to systemic risk, especially after the negative events that affected the financial system. In the last years, studies that approach systemic risk have increased significantly. Systemic risk was first brought to the public's attention globally in 2008 when the Global Financial Crisis (GFC) was beginning to emerge. There was not much research up until that point that explored this idea. One of the first studies to address systemic risk from the perspective of revising the literature is that of (deBandt & Hartmann, 2000). They provide a definition of systemic risk, noting that the key component is the systemic event, which includes two elements, shocks and propagation mechanisms. A general and widely accepted definition of systemic risk was given by the Bank of International Settlements in 2001: "*Systemic financial risk is the risk that an event will trigger a loss of economic value or confidence in, and attendant increases in uncertainly about, a substantial portion of the financial system that is serious enough to quite probably have significant adverse effects on the real economy."* (BIS, 2001)

After the GFC, the interest in the study of systemic risk has grown significantly. The studies followed both the study of the factors that contribute to the occurrence of the systemic risk and the way of its propagation. In this sense, following both the contribution and the participation, the literature was concerned with identifying the institutions exposed to risk, the so-called systemically important institutions, and the ways of classifying them, as well as identifying a

model to describe and measure systemic risk. Several models have been proposed, in this sense the review studies of the literature analyze and identify a significant number of measures and methods: (Bisias, Flood, Lo, & Valavanis, 2012) that identified 31 measures of systemic risk, providing definitions for them and Matlab implementation; (Benoit, Colletaz, Hurlin, & Pérignon, 2013) which tries to provide a common framework for several popular systemic risk measures; (Giglio, Kelly, & Pruitt, 2016) analyses empirically 19 measures, and the more recent, the study of (Ellis, Sharma, & Brzeszczynski, 2021) which provides 60 measures divided into 5 categories. The need for comprehensive and comparative studies for the systemic risk measures and the alignment of regulatory standards and requirements preoccupied the researchers, the papers of (Silva, Kimura, & Sobreiro, 2017) and (Benoit, Colliard, Hurlin, & Perignon, 2017) being relevant for the topic.

3. FINANCIAL RISK MANAGEMENT MEASURES

The literature on this topic identifies three main methods for modeling systemic risks: volatility, value-at-risk, and expected shortfall.

Volatility is the primary measure of risk employed in financial analysis. The market risk measurement was first introduced in Markowitz's portfolio selection theory, later studied and developed by many studies (Poon & Granger, 2003), proving that volatility models include historical volatility models, GARCH series models, or stochastic models. It is in fact the standard deviation of profitability and is used, in particular, where financial returns follow a normal distribution. If the distribution of the data is not normal, the results may be erroneous, which complicates the use of this measure.

One of the most popular risk measures after volatility is Value-at-Risk (VaR). A definition of this measure for risk quantification may be given by the maximum probable loss that a portfolio of positions can obtain over a given trading period, h, and for a certain level of confidence $(1-\alpha)$. This statistical measure depends on the distribution of the data and measures the losses resulting from the evolution of the market. VaR provides the best balance between existing risk measures and underlies the most common risk quantification models used in practice. The actual calculation of the Value-at-Risk involves establishing two parameters: the period for which the risk is estimated, h, and the confidence level (p or α) or the risk tolerance level ($1-p$ or $1-\alpha$). The Basel Committee proposes

to use a 10-day time horizon and a value of 1%[1] (i.e., a 99% confidence probability) in the calculation of VaR. The RiskMetrics department within (J.P.Morgan, 1996) proposed a 1-day horizon and a 5% risk tolerance percentage (i.e., 95% likelihood of confidence). Therefore, VaR can be calculated as the difference between the current value of the portfolio and its lowest value (quartile) obtained in the chosen time horizon and with the established probability *p* or as the difference between the expected value of the portfolio and the lowest obtained value of this one (Armeanu & Balu, 2007).

The decision to consider the Value-at-Risk of a particular portfolio as a relevant tool for measuring the risk of short-term financial difficulties depends on the liquidity of the positions held in the portfolio and the risk of extreme cash outflows. Unfavourable liquidity situations can lead to high transaction costs, which VaR cannot capture. The main advantages of this measure are to summarize, in a single value, the risks that a portfolio may have, including interest rate risk and currency exchange rate risk, and to facilitate comparisons between different asset classes.

Several methods are used to estimate VaR values, such as a variance-covariance approach, a hybrid approach, and Monte Carlo simulations. Of course, these methods have been criticized by researchers, but the merits attributed to each technique have been pointed out and appreciated. (Resti & Sironi, 2007) describe these methods, underlining the fact that none of them offers a "best solution" in absolute terms, each being, more or less adequate, depending on the purpose for which it is used. Therefore, if the objective is to measure the risk-adjusted return of the individual trading units of the bank (ex-ante – based on estimated earnings and ex-post – based on earnings), the variance-covariance model is best suited. Furthermore, the model limitations are relatively unimportant if the objective is to estimate the daily individual risks of trading units, impose restrictions on autonomy, and calculate the risk-adjusted return. If, on the other hand, assumptions about the normal distribution of data can lead to “extreme” events related to the occurrence of a flat-tailings in the distribution of returns, such as a potential underestimation of the required capital of the bank, the variance-covariance model can be simple, fast to implement and sensitive to possible increases in risk factor volatility. Similarly, if the financial institution holds a significant amount of non-linear payoffs in its portfolio, such as options, models that provide a full valuation, such as numerical simulations or Monte Carlo, are more suitable for use.

[1] See (BIS, 2009).

As mentioned, it is impossible to maintain one "more accurate" model than another. The main reason is that they are characterized by models which are more or less in line with current market conditions or the particular circumstances of the bank. However, they are predictive models, none of which is defined as the most precise *a priori*. Since VaR models suffer from several limitations, alternative risk measures have been developed.

One of the limits of the model has to do with the confidence interval used. As mentioned above, VaR is a risk measure that aims to get an answer to the question of "*What is the maximum loss that could be borne within a given time frame, except for a small percentage, for example, 1%, of the worst case?".*

A portfolio position is therefore a probability measure that takes different values at different levels of confidence. If the confidence interval is α and the loss is denoted by L, then we will have:

$$Pr(L > VaR) = 1 - \alpha. \quad (1)$$

What truly matters is the likelihood that the actual loss is higher than VaR. In this case, the model will not provide any information on the magnitude of this surplus loss.

Another significant limitation of VaR is related to one of the essential properties of a uniform risk measure, i.e., subadditive. This refers to the fact that the risk of a portfolio consisting of multiple positions must not exceed the sum of the risks of individual positions.

Mathematically, for a portfolio composed of two positions, X and Y, a measure of risk, $F(\cdot)$ is regarded as subadditive, if this relationship is satisfied:

$$F(X + Y) \leq F(X) + F(Y). \quad (2)$$

This property depends on the fact that any portfolio benefits, to a lesser or greater extent, from a diversification effect based on the fact that there is an imperfect correlation between different market factors. As a result, there are studies ((Danielsson, Jorgensen, Samorodnitsky, Sarma, & de Vries, 2005); (Rau-Bredow, 2019)) that identified several examples in the estimation of VaR values that violate the principle of sub-additive, i.e.

$$VaR(X + Y) > VaR(X) + VaR(Y). \quad (3)$$

This result is mainly explained by the fact that the VaR values for individual positions underestimate their risk by completely ignoring the excess loss level.

This is mainly due to the fact that the VaR value of individual positions underestimates their risk by completely ignoring excess loss levels. The non-

compliance of subadditive conditions can be avoided by using a parametric approach to obtain the VaR value and assuming that the data are distributed normally in relation to the change in the portfolio value. However, when the experimental distribution of data changes, it is difficult to process parametric modifications to guarantee these properties.

One alternative method of solving the problem of sub-additivity is Expected Shortfall (ES), also known as Marginal Value at Risk. (Artzner, Delbaen, Eber, & Heath, 1999) shows its sub-additive property and thus meets the VaR's shortcomings. Assuming the selected portfolio follows a continuous distribution, the expected shortfall represents the expected value of the portfolio, conditioned on the value of the risk level below the *p*-level.

$$ES = -[Q \mid Q \leq -VaR(p)]. \tag{4}$$

Expected Shortfall and Value-at-Risk have multiple advantages, including universality and applicability to almost any instrument and virtually any source of risk.

Despite this theoretical advantage, in practice, most financial institutions use Value-at-Risk instead of the Expected Shortfall. In essence, there are two reasons why this happens: The Expected Shortfall is measured with a higher degree of uncertainty than Value-at-Risk. The first stage of the Expected Shortfall estimate is the finding of the VaR values, the second is the obtaining of the expected values of the marginal observations and then the actual obtaining of the values of ES, hence the result has at least three sources of errors. Also, Expected Shortfall is more difficult to test than VaR because a prediction of it is required. ES can be compared to the model results, whereas the VaR can be compared to present observations.

The main objective of the article published by (Danielsson & Zhou, 2015) is to provide a practical comparison between Value-at-Risk and Expected Shortfall, the authors point out that VaR is inferior to ES, given that the first measure is not consistently compared to the second one. This argument was also presented by (Artzner, Delbaen, Eber, & Heath, 1999). Second, as a quartile, the VaR cannot obtain marginal risk values beyond the associated probability threshold, while the ES achieves them. Value-at-risk values may also be easily handled by financial institutions.

To conclude, volatility is the appropriate risk measure, as long as returns are distributed normally, which is rarely the case in practice. Assuming normal yield distribution and using volatility as a risk measure can be justified in many cases; however, in most applications, it is likely to lead to a sub-representation of risk. Volatility is most used as a measure of risk in practice. The second most

common risk measure is Value-at-Risk, which often provides the best balance between theoretical information and the feasibility of implementation. Its biggest weakness, however, is the absence of sub-additiveness in certain asset classes (the assets for which a first-moment order cannot be defined, such as the assets that follow a Cauchy distribution, as stated by (Danielsson, Jorgensen, Samorodnitsky, Sarma, & de Vries, 2005)). However, (Malevergne & Sornette, Value-at-Risk-Efficient Portfolios for a Class of Super- and Sub-exponentially Decaying Asstes Return Distributions, 2004) shows that if the data follows a Weibull distribution, the coherence problem of VaR is solved and these two measures become (asymptotically) equivalent. Finally, the Expected Shortfall is the most well-known risk measure that meets the principle of subadditive and is preferred both theoretically and intuitively. However, the difficulty of practical implementation leads to limited use of the latter. An important finding is that the VaR is most relevant for short periods of time, particularly a day. As the time period increases, it becomes difficult to implement and identify the appropriate risk quantification method.

If on a theoretical level, the advantages of using the Expected Shortfall are obvious, on a practical level, both instruments are poorly understood and can even provide distorted information, the reason being the introduction of additional considerations, some of them even in opposite directions. As mentioned before, estimating ES values requires more steps and assumptions than estimating VaR, resulting in more uncertainty in the interpretation of the results obtained.

In terms of optimizing methods for quantifying financial risk, the need to develop and identify more efficient methods is also caused by the continuous development of the financial system and its connections.

4. SYSTEMIC RISK MEASURES

As the purpose of this paper is to review the literature on financial systemic risk, our focus will be the analyze the most used measures in practice. (Benoit, Colletaz, Hurlin, & Pérignon, 2013) mentioned in their paper that the most popular measures used by researchers are Marginal Expected Shortfall (Acharya, Pedersen, Philippon, & Richardson, Measuring Systemic Risk, 2016), SRISK (Brownlees & Engle, SRISK: A Conditional Capital Shortfall Measure of Systemic Risk, 2016), and Conditional Value-at-Risk of (Adrian & Brunnermeier, 2016). As they stated, all three measures want to identify the systemically important institutions, but they give different classifications for the same dataset used.

The most important result achieved in the direction of the financial systemic risk optimization method is undoubtedly the conditional value at risk (CoVaR). The measure was proposed by (Adrian & Brunnermeier, 2016) and is one of the most cited articles related to systemic risk.

(Sarykalin, Serraino, & Uryasev, 2008) analyses Value-at-Risk and Conditional Value-at-Risk from the perspective of optimizing them. They mention that there is a close correspondence between the two measures, VaR represents the lower limit of CoVaR, and (Rockafeller & Uryasev, 2000) and (Rockafeller & Uryasev, 2002) show that the second measure is superior to the first in terms of application optimization. The choice of one measure or another is a problem of the difference between the mathematical properties of the two, the stability of statistical estimates, the simplification, and optimization of applications, or the acceptance by the regulatory institution.

Among the arguments presented by the authors to identify the strong and weak points of the two measures are: the higher mathematical properties of CoVaR versus the VaR – CoVaR is a "coherent measure", i.e. the CoVaR function associated with a portfolio is continuous and convex in relation to the positions held by the portfolio, while the VaR may have discontinuities; Optimization difficulty – CoVaR can be optimized using linear and convex programming methods, while for VaR it is more difficult to achieve an optimization; stability of statistical estimates – VaR provides more stable statistical estimates than CoVaR, automatically ignoring large losses and extreme values. Numerical optimization of risk measurement is a challenging task when losses are not normally distributed. As a tool in optimization models, CoVaR has superior properties in many respects. The CoVaR optimization is consistent with the VaR optimization and provides the same results for normally distributed or elliptical distribution data.

As mentioned above, although Value-at-Risk faces difficulties in use in certain scenarios, this measure remains popular due to government regulations requiring financial institutions to use it. The mitigation of CoVaR is carried out effectively, as outlined (Sarykalin, Serraino, & Uryasev, 2008), and (Larsen, Mausser, & Uryasev, 2002) propose two other heuristic algorithms for obtaining results: the first algorithm refers to building upper limits for VaR and then minimizing them, and the second algorithm is based on the idea that low values of VaR can be obtained by minimizing the values of CoVaR, by defining new α confidence intervals, chosen so that the two risk measures can coincide sufficiently. Other studies aimed at optimizing the value-to-risk measure are that of (Goh, Lim, Sim, & Shang, 2012), implementing a measure to separate the

distributions of profits of a portfolio of assets in positive and negative semi-spaces, also that of (Rockafellar & Uryasev, 2013) which develops a tool called “risk dial”, which proposes to build relationships between risk and deviation, as well as between their consequences, regret, and error.

As for the optimization of SRISK, the measure proposed by (Brownlees & Engle, SRISK: A Conditional Capital Shortfall Measure of Systemic Risk, 2016), the papers that states this subject are not so many. There is one of (Migueis & Jiron, 2021) that proposes an update of the measure, by defining the capital shortfall using a maximum function – if a firm cannot meet the required capital level, the capital shortfall is positive and zero otherwise. Since SRISK is a measurement based on an initial hypothesis and a capital shortage estimate for a specific scenario, the accuracy of the measurement is dependent on the appearance of the hypothetical scenario.

An appropriate measure for SRISK is Systemic Expected Shortfall (SES), proposed by (Acharya, Pedersen, Philippon, & Richardson, 2011) and detailed in (Acharya, Pedersen, Philippon, & Richardson, 2016). The paper of (Engle, 2018) surveys the research related to SRISK, also providing a comparison between metrics. His results show that this measure is inexpensive to compute and suggests a complementarity between methods (SRISK is computed weekly, by V-LAB[2], on more than 1000 firms).

As for MES, there are not so many papers that focus on the optimization of this measure, (Kleinow, Moreira, Strobl, & Vachamaa, 2017) documenting that MES produces the most accurate measurement of systemic risk over time and across different industry sectors.

There is an increasing number of papers that aims to compare different systemic risk measures: for VaR and ES - (Malevergne & Sornette, 2004), (Borowska, Hoogerheide, Koopman, & van Dijk, 2020), (Song & Li, 2023), (Dhaene, Laeven, & Zhang, 2022), (Muller & Righi, 2022); for CoVaR, MES and SRISK - (Brownlees, Cavaliere, & Monti, 2018), (Foglia & Angelini, 2020), (Pagano & Sedunov, 2016), (Yun, Jeong, & Park, 2019), (Brownlees, Chabot, Ghysels, & Kurz, 2020), (Sedunov, 2016).

Also, there is an increasing number of studies that wants to explore the extreme value theory and his applications on systemic risk measurement ((Di Clemente, 2017)) or elements of artificial intelligence and machine learning ((Kellbar & Wang, 2022)).

[2] See https://vlab.stern.nyu.edu/.

5. CONCLUSIONS

As the financial market is in continuous change and development, financial risk management has increased in importance, with the need for developing better tools for risk quantification being a necessary part of the risk management process.

This study wants to provide an overview of the main risk measures developed and the general aspects that concern the optimization process that followed after their implementation. This field still needs to be developed, and the focus of further research can be done on better performance, easy calculation and implementation, and better results on exogenous events such as the COVID-19 pandemic or the war.

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REFERENCES

1. Acharya, V. V., Pedersen, L. H., Philippon, T., & Richardson, M. (2011). Measuring Systemic Risk. *AFA 2011 Denver Meetings Paper, Available at SSRN: https://ssrn.com/abstract=1573171 or http://dx.doi.or*.
2. Acharya, V. V., Pedersen, L. H., Philippon, T., & Richardson, M. (2016). Measuring Systemic Risk. *Oxford Unversity Press*.
3. Adrian, T., & Brunnermeier, M. K. (2016). CoVaR. *American Economic Review 106(7)*, 1705-1741.
4. Armeanu, D., & Balu, F.-O. (2007). Aplicarea Metodologiei VaR Portofoliilor Valutare Detinute de Banci. *Economie Teoretica si Aplicata*, 83-92. Retrieved from http://store.ectap.ro/articole/197.pdf
5. Artzner, P., Delbaen, F., Eber, J.-M., & Heath, D. (1999). Coherent Measures of Risk. *Mathematical Finance*, 203-228.
6. Benoit, S., Colletaz, G., Hurlin, C., & Pérignon, C. (2013). A Theoretical and Empirical Comparison of Systemic Risk Measures. *HEC Paris Research Paper No. FIN-2014-1030*.
7. Benoit, S., Colliard, J.-E., Hurlin, C., & Perignon, C. (2017). Where the Risks Lie: A Survey on Systemic Risk. *Review of Finance*, 109-152.
8. BIS. (2001). *Group of Ten: Report on Consolidation in the Financial Sector*. Bank of International Settlements.
9. BIS. (2002, July). Sound Practices for the Management and Supervision of Operational Risk. *Basel Committee on Banking Supervision*.

10. BIS. (2009). *Revisions to the Basel II Market Risk Framework.* Bank of International Settlements.
11. Bisias, D., Flood, M., Lo, A. W., & Valavanis, S. (2012). A Survey of Systemic Risk Analytics. *The Office of Financial Research, US Department of Treasury*.
12. Borowska, A., Hoogerheide, L., Koopman, S. J., & van Dijk, H. K. (2020). Partially Censored Posterior for Robust and Efficient Risk Evaluation. *Journal of Econometrics, 217*(2), 335-355. doi:https://doi.org/10.1016/j.jeconom.2019.12.007
13. Brownlees, C., & Engle, R. F. (2016). SRISK: A Conditional Capital Shortfall Measure of Systemic Risk. *Oxford University Press*.
14. Brownlees, C., Cavaliere, G., & Monti, A. (2018). Evaluating the Accuracy of Tail Risk Forecasts for Systemic Risk Measurement. *Annals of Financial Economics, 13*(2). doi:https://doi.org/10.1142/S2010495218500094
15. Brownlees, C., Chabot, B., Ghysels, E., & Kurz, C. (2020). Back to the Future: Backtesting Systemic Risk Measures during Historical Bank Runs and The Great Depression. *Journal of Banking and Finance*.
16. Danielsson, J. (2011). *Financial Risk Forecasting.* London: John Wiley & Sons Ltd.
17. Danielsson, J. (2011). *Financial Risk Forecasting: The Theory and Practice of Forecasting Market Risk, with Implementation in R and Matlab*. Chichester: John Wiley & Sons Ltd.
18. Danielsson, J., & Zhou, C. (2015). Why Risk is so Hard to Measure. *SRC Discussion Paper No 36*.
19. Danielsson, J., Jorgensen, B. N., Samorodnitsky, G., Sarma, M., & de Vries, C. (2005, October). *Subadditivity Re-Examined: the Case for Value-at-Risk.* Retrieved from Risk Research: https://www.riskresearch.org/
20. deBandt, O., & Hartmann, P. (2000, November). Systemic Risk: A Survey. *European Central Bank Working Papers Series 35*.
21. Dhaene, J., Laeven, R. J., & Zhang, Y. (2022). Systemic Risk: Conditional Distortion Risk Measures. *Insurance: Mathematics and Economics, 102*, 126-145.
22. Di Clemente, A. (2017). *Estimating the Marginal Constribution to Systemic Risk by A CoVaR-model Based on Copula Functions and Extreme Value Theory*. Economic Notes by Banca Monte dei Paschi di Siena.
23. Ellis, S., Sharma, S., & Brzeszczynski, J. (2021). Systemic Risk Measures and Regulatory Challenges. *Journal of Financial Stability*.
24. Engle, R. (2018). Systemic Risk 10 Years Later. *Annual Review of Financial Economics, 10*(13), 1-28.
25. Foglia, M., & Angelini, E. (2020). The Triple (T3) Dimension of Systemic Risk: Identifying Systemically Important Banks. *International Journal of Finance & Economics, 26*(1), 7-26. doi:https://doi.org/10.1002/ijfe.2386
26. Giglio, S., Kelly, B., & Pruitt, S. (2016). Systemic Risk and the Macroeconomy: An Empirical Evaluation. *Journal of Financial Economics 119*, 457-471.
27. Goh, J. W., Lim, K. G., Sim, M., & Shang, W. (2012). Portfolio Value-at-Risk Optimization for Asymmetrically Distributed Asset Returns. *European Journal of Operational Research 221*, 397-406.

28. J.P.Morgan. (1996). *Risk Metrics - Technical Document.* New York: Reuters.
29. Kellbar, G., & Wang, W. (2022). Modelling Systemic Risk using Neural Network Quantile Regression. *Empirical Economics, 62*, 93-118.
30. Kleinow, J., Moreira, F., Strobl, S., & Vachamaa, S. (2017). Measuring Systemic Risk: A Comparison of Alternative Market-Based Approaches. *Finance Research Letters*. doi: https://doi.org/10.1016/j.frl.2017.01.003
31. Larsen, N., Mausser, H., & Uryasev, S. (2002). Algorithms for Optimization of Value-at-Risk. In P. Pardalos, & V. Tsitsiringos, *Financial Engineering, E-Commerce and Supply Chain* (pp. 19-46). Kluwer Academic Publishers.
32. Malevergne, Y., & Sornette, D. (2004). Value-at-Risk-efficient Portfolios for a Class of Super- and Sub-exponentially Decaying Assets Return Distributions. *Quantitative Finance, 4*, 17-36.
33. Malevergne, Y., & Sornette, D. (2004). Value-at-Risk-Efficient Portfolios for a Class of Super- and Sub-exponentially Decaying Asstes Return Distributions. *Quantitative Finance 4*, 17-36.
34. Migueis, M., & Jiron, A. (2021). SRISKv2 - A Note. *Economics Letters 21*. doi:https://doi.org/10.1016/j.econlet.2021.109797
35. Muller, F. M., & Righi, M. B. (2022). Comparison of Value at Risk (VaR) Multivariate Forecast Models. *Computational Economics*.
36. Pagano, M. S., & Sedunov, J. (2016). A Comprehensive Approach to Measuring the Relation Between Systemic Risk Exposure and Sovereign Debt. *Journal of Financial Stability, 23*(C), 62-78. doi:10.1016/j.jfs.2016.02.001
37. Poon, S.-H., & Granger, C. W. (2003). Forecasting Volatility in Financial Markets: A Review. *Journal of Economic Literature 41*, 478-539.
38. Rau-Bredow, H. (2019). Bigger is Not Alrways Safer: A Critical Analysis of the Subadditivity Assumption for Coherent Risk Measures. *Risks*.
39. Resti, A., & Sironi, A. (2007). *Risk Management and Shareholders' Value in Banking.* Chichester, West Sussex: John Willey & Sons.
40. Rockafellar, R. T. (2007). Coherent Approaches to Risk in Optimization under Uncertainty. *INFORMS Tutorials in Operations Research. Institute for Operations Research and the Management Sciences*, 38-61.
41. Rockafellar, R. T., & Uryasev, S. (2013). The Fundamental Risk Quadrangle in Risk Management, Optimization and Statistical Estimation. *Surveys in Operational Research and Management Science 18*, 33-53.
42. Rockafeller, R. T., & Uryasev, S. (2000). Optimization of Conditional Value-at-Risc. *Journal of Risk*.
43. Rockafeller, R. T., & Uryasev, S. (2002). Conditional Value-at-Risk for General Loss Distribution. *Journal of Banking & Finance 26*, 1443-1471.
44. Sarykalin, S., Serraino, G., & Uryasev, S. (2008). Value-at-Risk vs. Conditional Value-at-Risk in Risk Management and Optimization. *Institute for Operations Research and the Management Sciences (INFORMS)*.
45. Sedunov, J. (2016). What is the Systemic Risk Exposure of Financial Institutions? *Journal of Financial Stability, 24*, 71-87.

46. Silva, W., Kimura, H., & Sobreiro, V. A. (2017). An Analysis of the Literature on Systemic Financial Risk: A Survey. *Journal of Financial Stability 28*, 91-114.
47. Song, S., & Li, H. (2023). A New Model for Forecasting VaR and ES using Intraday Returns Aggregation. *Journal of Forecasting, 42*(5), 1039-1054. doi:https://doi.org/10.1002/for.2932
48. Yun, T.-S., Jeong, D., & Park, S. (2019, June). "Too Central to Fail" Systemic Risk Measure using PageRank Algorithm. *Journal of Economic Behavior & Organization, 162*, 251-272. doi:https://doi.org/10.1016/j.jebo.2018.12.021

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QUALITY ANALYSIS OF LEARNING IMPROVES THE QUALITY OF LEARNING

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Abstract: *The title of this article may seem easy to invalidate given its nuance of truism. However, as life experience has taught us, small details can often provide great transformations, so that would be the purpose of this analysis. There are many years since information technologies have been part of the normal life of learners, much of the information needed in the learning activity being provided also due to information technologies. Learning analysis can have favorable economic implications, both for education and for the business environment. Web tracking tools have developed more and more, which has provided educational institutions with the opportunity to collect useful data about the learning experiences of students.*

Keyword: *learning analytics, LMS, Education Data Mining, MOOC*

JEL Classification: *I21, C55, L86*

1. INTRODUCTION

It is understood that to be able to increase the quality of learning, a necessary condition is the possibility of evaluating how learning is achieved.

"Given that, increasingly, information technologies are used for the purpose of learning, measuring, collecting, analyzing, and reporting data on learners and their contexts, evaluation can be easily obtained." (Stofor, 2021). The new generation - called "Generation Z" (zoomers) - is as dynamic as the technological evolution on which it seems to be quasi-dependent.

Learning management systems (LMSs) offer the possibility to obtain the necessary data for learning analytics in a non-invasive way for the student, through clicks and browsing like collecting data from social networks.

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The development of web tracking tools has greatly supported learning analytics, helping to collect data about the learning experiences of students (Czerkawski, 2015).

"Although many educational institutions have access to a lot of data about students (grades, attendance records, home and online addresses, various fees), there are several challenges in using this data to improve the experience of pupils/students" (Stofor, 2021).

2. LEARNING ANALYSIS AND ECONOMIC IMPLICATIONS

For quality learning analysis, it is necessary that data collection in online learning environments be combined with contextual tools, theories, and frameworks to shape theory and guide learning analysis.

An article from 2014 (Chatti, et al.) proposed a reference model based on four dimensions, each with a question mark: "What?" "Who?" "Why?" "How?" (Figure 1).

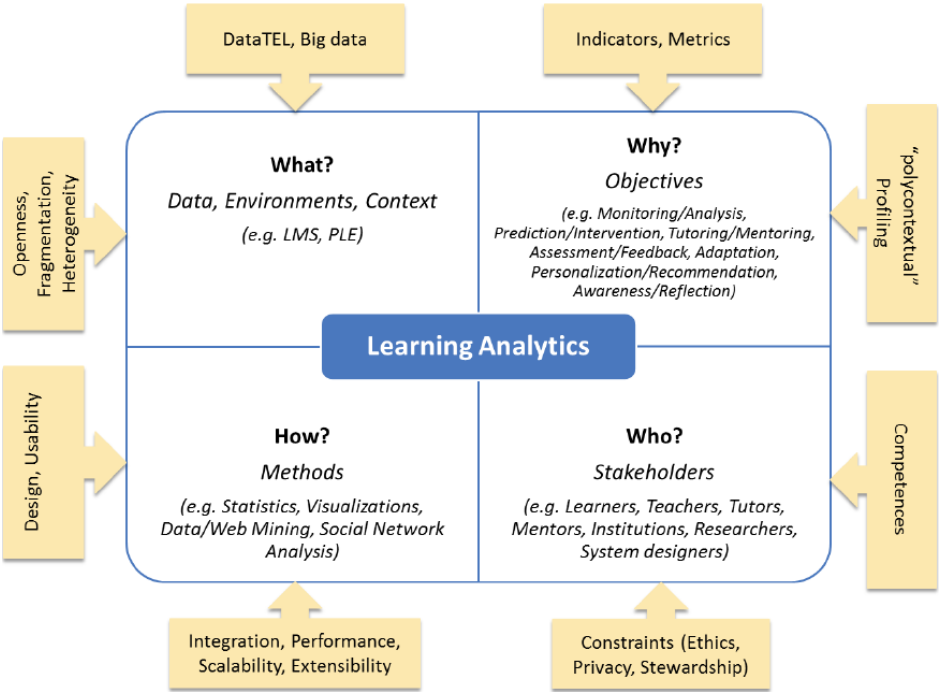

Figure 1 Learning Analytics Reference Model
(Chatti, et al., 2014, p. 3)

As you can see in the previous figure it is necessary to clarify **what** type of data is collected, managed, and used by the system in learning analytics, **who** is the

subject of the analysis, **why** the collected data are analyzed by the system, and **how** does the system analyze the collected data?

In a large sense, learning analytics "analyzes a large amount of data in education and presents the results to stakeholders (learners, teachers, faculty, etc.) for evidence-based decision-making" (Chen, 2019, p. 1957).

According to Drachsler & Greller (2011), in a succinct form, the aspects that have a role in learning analytics mean:

- *Competences*: "user requirements to exploit the benefits". Thus, it is about critical thinking and interpretation.
- *Constraints*: "potential restrictions or limitations on anticipated benefits", such as privacy and ethical issues.
- *Method*: "technologies, algorithms, and theories that carry the analysis". The methods are reflected in Educational Data Mining, machine learning, statistical analysis.
- *Data*: "the educational datasets and their environment in which they occur and are shared". They can be opened data or protected data.
- *Objectives*: settings the "goals that one wants to achieve", generating reflection or prediction.
- *Stakeholders*: contributors and beneficiaries of the learning analysis, which are the institutions, teachers, learners, parents.

According to Khalil's modeling (2017), the learning analysis framework in Figure considers four main parts:

1) **Learning environment** – "stakeholders produce data";
2) **Big Data** – "massive amounts of datasets and large repositories of information";
3) **Analytics** – "different analytical techniques";
4) **Act** - objectives "are achieved to optimize the learning environment".

Taken together, learning analytics uses four types of technological resources to complete the continuous model of three-phase cycles (Elias, 2011) aimed at the continuous improvement of teaching and learning, as shown in Figure .

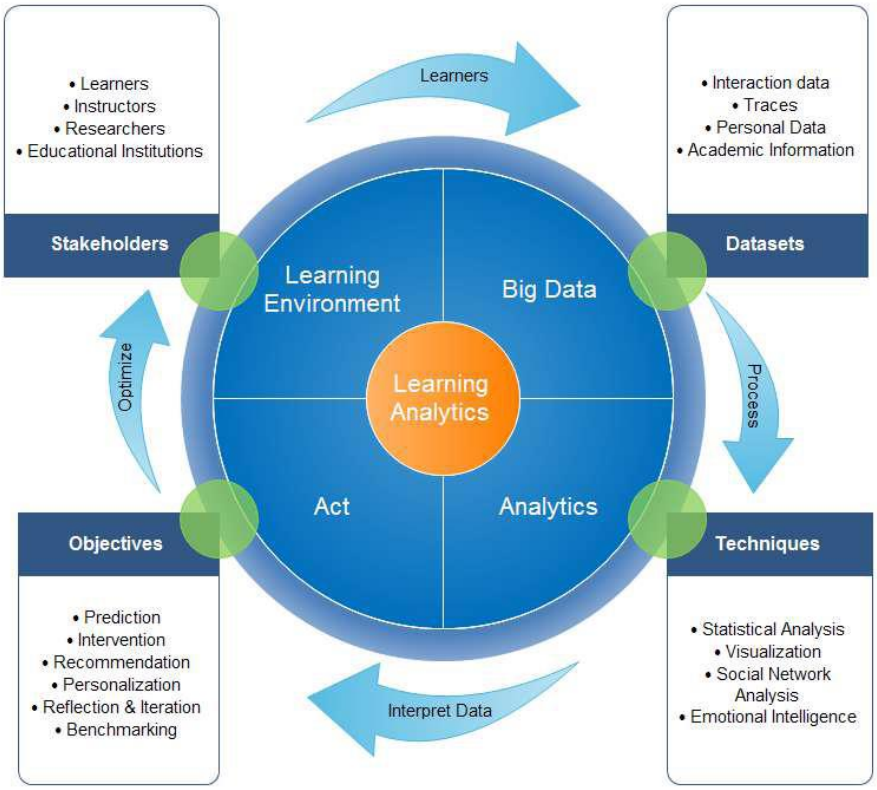

Figure 2 Learning analytics framework and lifecycle (Khalil, 2017)

As in the model exemplified in Figure , the cycle generates continuous improvement of learning analytics, which can be represented as an evolutionary spiral, without reaching the same place at a given time.

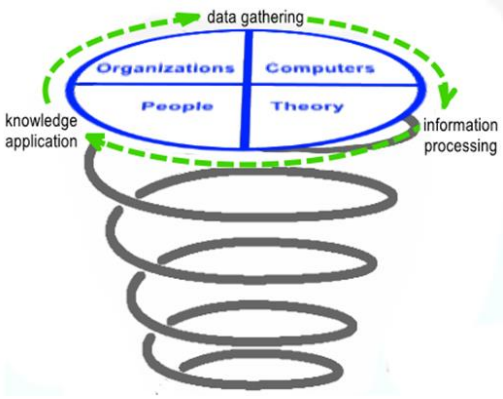

Figure 3 Learning analytics continuous improvement cycle

It is useful to mention that "digital knowledge content plays a pivotal role in learning design and learner interactions occurring in smart learning", which is "defined as learning in interactive, intelligent, and tailored environments, supported by advanced digital technologies and services" (Chen, 2019, pg. 1958-1959).

An important aid in evaluating how teaching and learning is achieved "through online media comes from massive open online courses" (Stofor, 2021). MOOC objectives can be varied (Khalil, 2017, p. 21):

- "saving costs and increasing revenues",
- "improving educational outcomes",
- "extending reachability" "of learning material" for all
- "providing support for open educational resources"

"Learning analytics offers the possibility to make decisions based on data about education by using quantitative methods, with the help of computer science, statistics, but also psychology" (Stofor, 2021). The obtained results, combined with the involvement of decision-makers, can increase the quality of education.

2.1.Economic implications of learning analysis

Learning analysis can have numerous economic implications in both the educational and business sectors. While it is convenient to frame "learning analytics" in abstract terms, in reality, this is becoming an industry that involves a complex range of technologies and actors – from data storage centers in Idaho to salespeople in Singapore (Selwyn, 2019). Here are some ways this can influence the economy:

- **Education efficiency.** Educational institutions can use learning analytics to improve efficiency of education. Costs can be reduced and a better return on investment in education can be ensured by identifying effective teaching methods and factors that influence student performance. So, empirical studies indicated that learning analytics can be useful for improving education (Avella, Kebritchi, Nunn, & Kanai, 2016). Therefore, by leading to a more skilled and educated workforce, it can increase economic productivity.
- **Personalized learning.** Learning analytics can provide personalized learning experiences for students. When content and support are personalized, students have a better chance of succeeding, without great expense.
- **Dropout rate reduction**. Learning analytics can help identify students at risk of dropping out and provide timely intervention to help them continue their

education. For example, according to a study (Sclater, Peasgood, & Mullan, 2016), in The University of New England, New South Wales, Australia, 20% of the students have a low socio-economic status, which could put them in a situation to give up their studies. Reducing dropout rates can save institutions the cost of recruiting and replacing lost students. This can lead to an increase in the graduation rate, which can have significant economic benefits for society.

- **Educational product development**. In the private sector, companies that develop and deliver educational products and services can use learning analytics to improve the quality and relevance of their offerings. This can increase income and improve competitiveness.
- **Resource allocation.** Educational institutions can allocate their resources more effectively by analyzing data on student performance and engagement. Cost savings can be realized by focusing investments on areas that have the most significant impact on student success.
- **Business efficiency in training and development**. In the business environment, learning analytics can be used to evaluate the effectiveness of training and staff development programs, so they can optimize them. Companies can save money by identifying more effective training methods and adapting training programs to the individual needs of employees. This can lead to faster onboarding, improved employee performance, and reduced training costs.
- **Labor market and qualifications.** Learning analytics can provide data on the skills and competencies that students develop during their education. This can help align labor supply with market demands and facilitate the matching process between employers and candidates. As we mentioned before, thanks to the learning analysis, companies optimize training and development programs, which can lead to faster integration of new employees and a reduction in training costs, as well as improving the performance of existing employees.
- **Innovation in technology and online education.** The continuous development of learning analytics technology can generate economic opportunities for technological companies that develop online learning tools and platforms. These companies can take advantage of the increased demand for digital education solutions, especially due to the Covid pandemic crisis.
- **Research and innovation.** Learning analytics generates valuable data that can be used for research purposes. This can stimulate innovation in education and training methodologies, leading to long-term economic benefits.

- **Competitive advantage**. Organizations that effectively use learning analytics to improve their educational or training offerings can gain a competitive advantage. This can increase market share and revenue.
- **Cost savings.** Learning analytics can help identify inefficiencies in educational processes and instructional materials. Institutions can realize cost savings by eliminating redundant or inefficient practices.
- **Data-driven decision-making.** Educational institutions, as well as businesses, can make more informed decisions based on the data and insights provided by learning analytics. This can lead to better strategic planning and resource allocation. Visualizing complex, multi-layered data for students in accessible ways that allow them to understand their performance against other students and other variables can improve variously their awareness, reflexivity, participation, involvement and motivation, and through therefore, their ability to deliver actionable attitude and behavior changes (Francis, Broughan, Foster, & Wilson, 2020).
- **Global Education Market**. Companies that develop learning analytics solutions can tap into the global education technology market, which has been growing significantly in recent years.

Overall, learning analytics can contribute to increasing the efficiency and quality of education and training, thus having the potential to have a positive impact on the economy by increasing labor market competitiveness, increasing skills and reducing costs. Although learning analytics is able to make pragmatic and theoretical contributions to optimize and support learning, obstacles remain hindering its growth toward effective, scalable, ethical, and measurable impacts (Khalil, Slade, & Prinsloo, 2023). These improvements can have both short- and long-term economic impacts, contributing to a more educated and skilled workforce and increasing the competitiveness of educational institutions and businesses in a global marketplace.

2.2.Calculation Methods in Learning Analytics

Without listing all the possible methods, we will list a few that can help to evaluate various aspects of student performance and progress, formulas and calculation methods can be used, which can vary according to:

- specific objectives of the analysis,
- available data and
- types of questions asked.

a) **Retention rate** is a metric that measures the percentage of learners who stay and continue to engage with the learning materials or programs for a certain

period (Malmstrom, 2023). It can help to evaluate the efficiency of an educational institution in keeping students in their study program by calculating according to the following formula:

$$Rr = \frac{SNS - SDO}{SNS} \times 100 \quad (1)$$

where:

Rr – retention rate,

SNS – number of students at the beginning of the period

SDO – number of students who left or dropped out of classes

Of course, the retention rate can also be influenced by other factors; for example, especially in science, technology, engineering and mathematics education (STEM), demographic factors seem to influence the retention rate, especially in the first half of the academic year (Li, Herbert, Yeom, & Montgomery, 2022). At first sight, the explanation might seem simple, on the one hand, it is about the necessity of physical presence at such courses, and on the other hand, the first semester is the one that implies some instability regarding the accommodation. Of course, deepening the study, it will be obvious that a significant determining factor of the retention rate is, most of the time, age (Harrison, Villano, Lynch, & Chen, 2021).

b) **Average grade** can provide a picture of the overall performance of a group of students in a particular course by analyzing the sum of grades for all students in relation to the total number of students, according to the formula:

$$AG = \frac{SAG}{TS} \quad (2)$$

where:

AG – average grade,

SAG – sum of all student grades

TS – total number of students

c) **Graduation rate** can help to evaluate the success of a study program or an educational institution in retaining and graduating students, it is calculated by relating the number of students who successfully graduated to the total number of students and is simply expressed by the formula:

$$GR = \frac{SG}{TS} \times 100 \quad (3)$$

where:

GR – graduation rate,

SG – number of students who successfully graduated

TS – total number of students

d) **Predictive modeling** can be used to predict student performance or identify students at risk of dropping out using logistic regression, decision trees, etc.

3. USEFUL TOOLS FOR LEARNING ANALYTICS

Learning analytics can be done with tools developed internally by universities; according to Czerkawski (2015), these projects could be considered as "academic analytics" - a slightly different concept of learning analytics, the beneficiaries being political decision-makers and governmental organizations. An alternative to locally developed tools could be represented by some free platforms that can be used by teachers interested in such analyzes and can be integrated into a learning management system:

- Google Analytics (http://www.google.com/analytics)
- SNAPP (http://www.snappvis.org)
- Netlytic (https://netlytic.org/home)
- R Project (http://www.r-project.org/)
- Weka (http://www.cs.waikato.ac.nz/ml/weka)

And while we still referred above to free tools, Siemens (2013, p. 1385) found that learning analytics tools can be grouped into two categories: commercial (SPSS, Stata, Nvivo, etc.) and research (listed above). An important technological tool to help manage and improve student retention are Early alert systems (EAS) (Harrison, Villano, Lynch, & Chen, 2021).

Other platforms that can perform analyzes (Taylor, 2021):

- Clicky (https://clicky.com/), truncating, and anonymizing visitors' IPs is friendly to GDPR.
- Matomo (https://matomo.org/) like Clicky, truncates and anonymize IPs; is a declared opponent of Google Analytics, as it appears right on their site (Matomo, 2021).
- Fathom Analytics (https://usefathom.com/), a competitor to Google Analytics, emphasizes speed and privacy. Their availability in terms of free is maximum, the source code can also be found downloadable on the popular download and testing platform GitHub.
- Get Insights (https://getinsights.io/) like the previous platform, it can be downloaded from GitHub, the strong point being privacy. It also has premium versions with certain advantages.
- AT Internet (https://www.atinternet.com/) is self-proclaims an ultra strong and flexible analytical suite, giving more precision in data analysis.

4. EDUCATIONAL DATA MINING

The concept of Data Mining refers to a process of extracting new information from existing data collections, information that can answer not

only the question "what is happening?", but also "why is it happening?" (Tofan, 2005, p. 30).

In the field of informatics is a clear distinction between data and information: the processed data becomes information. This remark is interesting: the world is data rich but information poor (Han, Kamber, & Pei, 2012, p. 5). It is eloquent the scheme presented by the above-mentioned authors, regarding data mining as a step in the process of knowledge discovery, depicted in Figure .

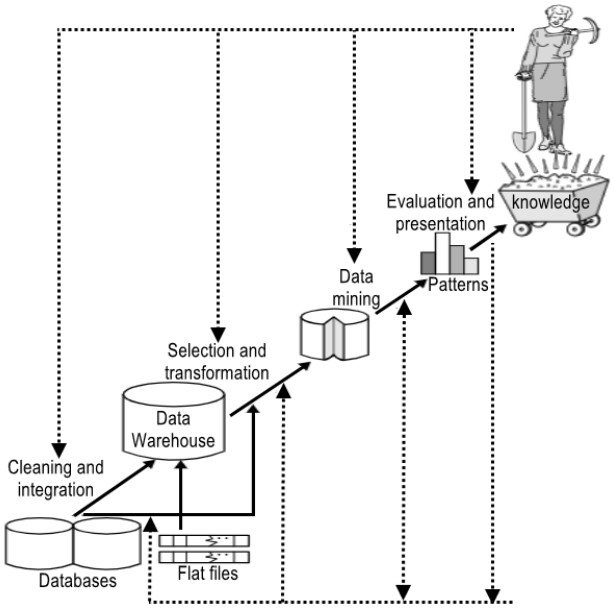

Figure 4 Data mining as a step in the process of knowledge discovery (Han, Kamber, & Pei, 2012, p. 7)

Thus, summarizing it as set out in a paper from California State University (2019), the knowledge discovery process is shown as an iterative sequence of the following steps: data cleaning, data integration, data selection, data transformation, data mining, pattern evaluation, knowledge presentation.

Speaking of education, the methods and techniques necessary for large-scale data management are called Educational Data Mining, with the role of helping to better understand the problems that arise in educational environments (Coelho & Silveira, 2017, p. 143).

As mentioned by Şahin and Yurdugül (2020, p. 123), educational data mining refers to the development of various methods to reveal the significant and implicit patterns from the data that are present in educational environments in

structured and/or unstructured way and the use of the methods developed accordingly (Baker & Siemens, 2014).

Comparing Learning Analytics and Educational Data Mining, Table 1 shows the definition of each field and describes their objectives, stakeholders, methods and initial trigger behind section of analysis (Ranjeeth, Latchoumi, & Victer Paul, 2020, p. 39).

Table 1 Features of learning and EDM analysis

Field	Learning Analytics	Education Data Mining
Stake Holders	Learners, Teachers, Institutions	Teachers, Students
Objectives	Recommendation, prediction, admissions, marketing, adaption, personalization	Improving the learning process by converting data into relevant information
Methods	Quantitative methods and classification clustering, association	Data mining techniques (Clustering, Association, Classification)
Data	Quantitative methods and classification clustering, association	Education environments data

Processing after (Ranjeeth, Latchoumi, & Victer Paul, 2020)

5. RIGORS OF ETHICS AND PRIVACY

An important concern in learning analytics is ensuring student data privacy. Personal data must be protected and used only for legitimate educational purposes.

The scope, volume, and speed of data collection for learning analytics have raised concerns about intruding on the learner's privacy and various ethical implications (Tsai, et al., 2020). However, referring to the GDPR, learning analytics may seem to have an obstacle, although it is natural that the ownership of data and their privacy should be increasingly important for participants in such projects. On the other hand, if it complies with this rule much data can be collected and analyzed which can be subsequently used to give an improved direction for learning. It is sufficient to illustrate what happens to our phone and its applications to which we sometimes grant too easily our right to collect data; so sometimes it is enough to talk to someone and find, for example, that the Google feed is full of articles from that discussion area. Even Netflix reacts to my viewing preferences recommending me some movies based on my "taste".

Therefore, it can certainly find a middle ground on the confidentiality of data collected from students given that it is easy to see how transparent the above-mentioned generation Z is, providing more sensitive information about it than

necessary for the analysis of learning, if we refer to the ease with which they "open" on social networks.

6. CONCLUSIONS

Because information comes from many media sources, the generation of students in these times is forced to realize the difference between popular information and/or qualitative information. If “learning tools have modernized, and online platforms have become vital”, especially in pandemic times, how learning analytics to “be qualitative has also evolved” (Stofor, 2021).

A wider adoption of learning analytics systems is needed, as well as work towards standardized measures, visualizations, and interventions, which can be integrated into any digital learning environment to reliably predict at-risk students and to provide personalized prevention, and intervention strategies (Ifenthaler & Yin-Kim Yau, 2020).

Learning analysis can favorably influence not only educational institutions, but also the business environment, providing long-term efficiency.

In these circumstances, “Learning analytics, as a field of research, has evolved rapidly as a necessity of supervising the quality of education, taking into account the ethical and privacy aspects” (Stofor, 2021).

REFERENCES

1. Avella, J., Kebritchi, M., Nunn, S., & Kanai, T. (2016, 06). Learning Analytics Methods, Benefits, and Challenges in Higher Education: A Systematic Literature Review. *Online Learning, 20*(2), 13-29. Retrieved 04 10, 2023, from https://files.eric.ed.gov/fulltext/EJ1105911.pdf
2. Baker, R., & Siemens, G. (2014). Educational data mining and learning analytics. In K. Sawyer, *Cambridge Handbook of the Learning Sciences* (2nd ed., pp. 253-274).
3. California State University. (2019, July 10). A Data Mining Courseware. Sacramento, California, SUA. Retrieved from https://athena.ecs.csus.edu/~mei/datamini/
4. Chatti, M. A., Lukarov, V., Thüs, H., Muslim, A., Fahmy Yousef, A. M., Wahid, U., . . . Schroeder, U. (2014). Learning Analytics: Challenges and Future Research Directions. *ResearchGate*.
5. Chen, W. (2019). Knowledge-Aware Learning Analytics for Smart Learning. *Procedia Computer Science, 159*, pp. 1957-1965. doi:10.1016/j.procs.2019.09.368
6. Coelho, O. B., & Silveira, I. F. (2017). Deep Learning applied to Learning Analytics and Educational Data Mining: A Systematic Literature Review. *VI Congresso Brasileiro de Informática na Educação (CBIE 2017).* doi: 10.5753/cbie.sbie.2017.143

7. Czerkawski, B. (2015). When Learning Analytics Meets E-Learning. *Online Journal of Distance Learning Administration, XVIII*(2). Retrieved from https://www.westga.edu/~distance/ojdla/summer182/czerkawski182.html
8. Drachsler, H., & Greller, W. (2011). The Pulse of Learning Analytics Understandings and Expectations from the Stakeholders. *International Conference Proceeding Series (ICPS).* doi:10.1145/2330601.2330634
9. Elias, T. (2011). *Learning Analytics: Definitions, Processes and Potential.* Retrieved from shorturl.at/iwP04
10. Francis, P., Broughan, C., Foster, C., & Wilson, C. (2020, 08 17). Thinking critically about learning analytics, student outcomes, and equity of attainment. *Assessment & Evaluation in Higher Education, 45*(6), 811-821. doi:https://doi.org/10.1080/02602938.2019.1691975
11. Green, K. (2017). *Provosts, Pedagogy and Digital Learning.* Association of Chief Academic Officers. Retrieved from https://bit.ly/3eO72EB
12. Han, J., Kamber, M., & Pei, J. (2012). *Data Mining. Concepts and Techniques* (3rd ed.). Elsevier Inc.
13. Harrison, S., Villano, R., Lynch, G., & Chen, G. (2021). Microeconometric Approaches in Exploring the Relationships Between Early Alert Systems and Student Retention: A Case Study of a Regionally Based University in Australia. *Journal of Learning Analytics, 8*(3), 170-186. doi:https://doi.org/10.18608/jla.2021.7087
14. Howells, E. (2021, April 30). *Using Data to Better Support Students.* Retrieved from Educause Review: shorturl.at/ceqy3
15. Ifenthaler, D., & Yin-Kim Yau, J. (2020, 08 01). Utilising learning analytics to support study success in higher education: a systematic review. *Educational Technology Research and Development, 68*(4), 1961–1990. doi:10.1007/s11423-020-09788-z
16. Khalil, M. (2017). *Learning Analytics in Massive Open Online Courses.* Graz University of Technology. Retrieved from https://arxiv.org/ftp/arxiv/papers/1802/1802.09344.pdf
17. Khalil, M., Slade, S., & Prinsloo, P. (2023, 03 14). Learning analytics in support of inclusiveness and disabled students: a systematic review. *Journal of Computing in Higher Education*, 1-18. doi:https://doi.org/10.1007/s12528-023-09363-4
18. Li, C., Herbert, N., Yeom, S., & Montgomery, J. (2022, 11 03). Retention Factors in STEM Education Identified Using Learning Analytics: A Systematic Review. *Education Sciences, 12*. doi:https://doi.org/10.3390/educsci12110781
19. Malmstrom, H. (2023, 05 31). *10 Learning analytics metrics*. Retrieved 06 10, 2023, from EdApp.com: https://www.edapp.com/blog/learning-analytics/
20. Matomo. (2021). *Google Analytics alternative that protects your data and your customers' privacy*. Retrieved January 30, 2021, from https://matomo.org/
21. Ranjeeth, S., Latchoumi, T., & Victer Paul, P. (2020). A Survey on Predictive Models of Learning Analytics. *International Conference on Computational Intelligence and Data Science*, (pp. 37-46). doi:10.1016/j.procs.2020.03.180
22. Roll, I., & Winne, P. (2015). Understanding, evaluating, and supporting self-regulated learning. *Journal of Learning Analytics*, 7-12.

23. Sclater, N., Peasgood, A., & Mullan, J. (2016). *Learning Analytics in Higher Education. A review of UK and international practice.* Bristol. Retrieved 04 10, 2023, from https://www.jisc.ac.uk/sites/default/files/learning-analytics-in-he-v2_0.pdf
24. Selwyn, N. (2019). What's the Problem with Learning Analytics? *Journal of Learning Analytics, 6*(3), 11-19. doi:http://dx.doi.org/10.18608/jla.2019.63.3
25. Siemens, G. (2013). Learning Analytics: The Emergence of a Discipline. *American Behavioral Scientist, 57*(10), 1380-1400. doi:10.1177/0002764213498851
26. Stofor, O. (2021, 10 21). Learning Analytics in the Current University Context. *Journal of Public Administration, Finance and Law*(21), 89-98. doi:https://doi.org/10.47743/jopafl-2021-21-10
27. Şahin, M., & Yurdugül, H. (2020). Educational Data Mining and Learning Analytics: Past, Present and Future. *Bartın University Journal of Faculty of Education, 9*(1), 121-131. doi:10.14686/buefad.606077
28. Taylor, S. (2021, January 27). *The complete list of alternatives to all Google products.* Retrieved February 10, 2021, from shorturl.at/msDI1
29. Tofan, C. A. (2005). Conceptul «Data Mining». *Tribuna Economică*(32)
30. Tsai, Y.-S., Rates, D., Moreno-Marcos, P. M., Muñoz-Merino, P., Jivet, I., Scheffel, M., . . . Gašević, D. (2020, October). Learning analytics in European higher education—Trends and barriers. *Computers & Education, 155*. doi:10.1016/j.compedu.2020.103933