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CONTENTS

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Estimating the Quality of Life Using Weighted Principal Components Method

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ABSTRACT

The paper proposes development of the approach to the construction of an integrated indicator of the population quality of life using the first principal component. We introduce the weighting coefficients into the principal component for the restoration quality of the initial features' variation in the integrated indicator (II). That is, a number of variables is assigned more valuable in the first principal component and the preservation of variations of which in II is preferable. For the case of the II, it was shown that the target functional with weights can be reduced to the well-known problem of finding the first principal component without weights. Moreover, the paper proposes objective approach for finding these weighting coefficients based on the migration statistics. In accordance with this methodology original countries' ranking based on the integrated indicator of Quality of Life (II QoL) was carried out.

INTRODUCTION

Correct and accurate measurement of the QoL is one of the most urgent tasks; a huge number of works is devoted to this topic, a very good overview of which is available in the work (Rakhmetova and Budeshov, 2020; Ulewicz and Blaskova, 2018). Usually, the process of constructing an integral indicator consists of two stages. At the first stage, an a priori set of initial variables is selected, then its unification and primary data processing is being done. The second stage is the construction of the "best representa-

tive" of this unified set. The choice of the initial set of indicators is determined by many factors, the requirements for it are described in detail, thoroughly and fully in the work (Aivazian, 2012). The choice of the "best representative" and correspondingly the final rating can be carried out in different ways. So, for example, in the work (Mironenkov, 2020), the final result is selected by sequentially applying the Pareto ratio; the work (Kobus, M, at. al, 2019; Aliyev, 2021; Aliyev et al., 2022) is based on stochastic dominance relations. Many papers use linear convolution with fixed weights as the main result (Blomquist et al, 1988; Moro et al, 2008; Belyaeva, 2009). In the works (Makarov et al., 2014; Leshchaikina, 2014; Aivazyan et al., 2016; Fantazzini et al., 2018; Shakleina and Midov, 2019; Afanasiev and Kudrov, 2019), the best representative of a unified set of variables is selected as the first principal component, modified principal component (Volkova, 2010) or generalized principal component (Volkova, 2019). Such a choice seems to be justified since the first principal component retains the maximum proportion of variation in the data set (Pearson, 1901). In other words, with the reverse restoration of the original data for the first principal component by the least square method, the sum of the squares of the deviations of the restored values from the original values is minimal. For more details look (Aivazyan and Mkhitaryan, 2001).

However, the use of the principal components in the quality of life analysis, with all the obvious advantages, has some problems (Jiang & Liu, 2021; Zheng & Jiang, 2021; Lapinskas et al., 2021). At the first stage, when compiling the initial (a priori) data set, the researcher has to take into account that each of the variables included in the set has the same value in the final rating. That is, despite the different values of the linear convolution weighting coefficients, the final integral indicator restores the original variables equally accurately. Or equally inaccurate. When a variable is included in an a priori data set, the researcher does not have the opportunity to set to each variable its own value (individual weight of reverse restoration). This in turn imposes restrictions on the choice of a set of variables. Thus, the introduction of weighting coefficients to improve the quality of restoration of some variables is seen as a natural direction for the development of the principal component method in the tasks of constructing an II QoL. At the same time, the quality of restoration of other variables may deteriorate.

1. WEIGHTED PRINCIPAL COMPONENT

At this stage we need to specify such a linear combination of the initial variables so that the OLS restoration of more important factors for this category is more accurate than the OLS restoration of less important factors. Thus, to build an integrated indicator based on the data $x_i^1, x_i^2, \dots, x_i^k$, where $i = 1, \dots, n$ the observation number, and k – is the number of variables, is suggested by predefined weights $w^1, w^2, \dots, w^k$, to build a linear combination $g = u^1x^1 + u^2x^2 + \cdots + u^kx^k$, so that after the OLS-restoration of the original variables by the variable g and obtaining the restored variables $\hat{x}_i^1, \hat{x}_i^2, \dots, \hat{x}_i^k$ the following condition is fulfilled

$$w^1(\hat{x}^1 - x^1)^2 + w^2(\hat{x}^2 - x^2)^2 + \cdots + w^k\left(\hat{x}^k - x^k\right)^2 \overset{u^1,\dots,u^k}{\rightarrow} \min, \qquad \text{(eq. 1)}$$

where x^1 is the first column vector of the source data, $\hat{x}^1$ is the column vector of the OLS restoration x^1 by column g.

So, let there be a matrix X of a posteriori set of unified variables of size $n \times k$, where n is the number of countries in the study (sample size), and k is the number of variables included in the posteriori set (number of features). It is assumed that $k < n$.

$X = \left(\begin{pmatrix} x_1^1 \\ \cdots \\ x_n^1 \end{pmatrix} \quad \dots \quad \begin{pmatrix} x_1^k \\ \cdots \\ x_n^k \end{pmatrix}\right)$ – a set of k variables, each of dimension n. For convenience, the lower index corresponds to the observation number, the upper index corresponds to the variable number.

Let G – $n \times m$ matrix of principal components, where m is the number of principal components used for analysis, i.e.

$G = \left(\begin{pmatrix} g_1^1 \\ \cdots \\ g_n^1 \end{pmatrix} \quad \ldots \quad \begin{pmatrix} g_1^m \\ \cdots \\ g_n^m \end{pmatrix} \right)$ – matrix of m principal components.

Let $U = \left(\begin{pmatrix} u^{1,1} \\ \ldots \\ u^{k,1} \end{pmatrix} \ldots \begin{pmatrix} u^{1,m} \\ \ldots \\ u^{k,m} \end{pmatrix} \right)$ – matrix of restoration coefficients.

Henceforth, constructing an integrated indicator, we assume $m = 1$, but the reasoning is valid for any $m \leq k$.

Due to the centering of a posteriori set, OLS-restoration of initial data using the principal components can be represented as $\hat{X} = G \cdot U^T$, where $\hat{X}$ is $n \times k$ matrix of recovered data, U^T is $m \times k$ matrix of data restoration coefficients (i.e., the matrix of coefficients for the principal components). Let there also be a diagonal $k \times k$ matrix $W = \begin{pmatrix} w^1 & & 0 \\ & \ddots & \\ 0 & & w^k \end{pmatrix}$, where $w^1, w^2, \ldots, w^k$ – strictly positive values[1] of restoring the original variables.

The objective functional can be represented in matrix form as

$$\Delta_w(G, U) = \|\hat{X} - \mathrm{X}\|_w = \|\mathrm{G} \cdot U^T - \mathrm{X}\|_w = \mathrm{tr}\big((G \cdot U^T - X)^T \cdot W \cdot (G \cdot U^T - X)\big)$$

and the optimization problem (eq. 1) takes the form

$$\mathrm{tr}\big((G \cdot U^T - X)^T \cdot W \cdot (G \cdot U^T - X)\big) \to \min_{G,U} \qquad \text{(eq. 2)}$$

There is a problem statement (without solution) in equation B.16 in the work (Abdi, Williams, 2010); in the paper (Gabriel and Zamir, 1979) the same optimization problem is posed and an algorithm for its numerical solution is given; in the work (Burnaev and Chernova, 2008) there are a numerical solution and an iterative algorithm for solving a similar problem in determining the optimal wing profile. An iterative algorithm called "Heteroskedastic Matrix Factorization" is proposed in the study of the astrophysical spectrum (Tsalmantza and Hogg, 2012); and the paper (Delchambre, 2015) presents examples of the application of weighted principal components in astrophysics problems.

Note that the solution of the problem without weights

$$\mathrm{tr}\big((G \cdot U^T - X)^T \cdot (G \cdot U^T - X)\big) \to \min_{G,U} \qquad \text{(eq. 3)}$$

is well known, see, for example, equation B.15 in (Abdi, Williams, 2010), the matrices G and U can be found from the system

$$\begin{cases} G = \mathrm{XU} \cdot (U^T \cdot U)^{-1}, \\ U = (X)^T G (G^T G)^{-1}. \end{cases} \qquad \text{(eq. 4)}$$

And the components of the vectors U are obtained as normalized eigenvectors of the covariance matrix Σ (Jackson, 2005; Jolliffe, 2002; Dunteman, 1989).

You can easily check that the problem (eq. 2) can be reduced to the problem (eq. 3) by the following change of variables:

$$X_W = X \cdot V^T,$$

$$U_W = V \cdot U,$$

where $V^T V = \mathrm{W}$. Due to the positive definiteness of W such a change exists.

[1] If the restoration weight w^j is 0, that is, the restoration value of some variable is unimportant; it should be removed from the dataset.

Indeed, let us substitute in (eq. 3):

$$\begin{aligned}
&\mathrm{tr}\left(\left(\mathrm{G}\cdot\mathrm{U}_{\mathrm{W}}^{\mathrm{T}}-\mathrm{X}_{\mathrm{W}}\right)^{\mathrm{T}}\cdot\left(\mathrm{G}\cdot\mathrm{U}_{\mathrm{W}}^{\mathrm{T}}-\mathrm{X}_{\mathrm{W}}\right)\right)=\\
&=\mathrm{tr}\left(\left(\mathrm{G}\cdot\mathrm{U}_{\mathrm{W}}^{\mathrm{T}}-\mathrm{X}_{\mathrm{W}}\right)\cdot\left(\mathrm{G}\cdot\mathrm{U}_{\mathrm{W}}^{\mathrm{T}}-\mathrm{X}_{\mathrm{W}}\right)^{\mathrm{T}}\right)=\\
&=\mathrm{tr}\left(\left(\mathrm{G}\cdot(\mathrm{V}\cdot\mathrm{U})^{\mathrm{T}}-\mathrm{X}\cdot\mathrm{V}^{\mathrm{T}}\right)\cdot\left(\mathrm{G}\cdot(\mathrm{V}\cdot\mathrm{U})^{\mathrm{T}}-\mathrm{X}\cdot\mathrm{V}^{\mathrm{T}}\right)^{\mathrm{T}}\right)=\\
&=\mathrm{tr}\left(\left(\mathrm{G}\cdot\mathrm{U}^{\mathrm{T}}\cdot\mathrm{V}^{\mathrm{T}}-\mathrm{X}\cdot\mathrm{V}^{\mathrm{T}}\right)\cdot\left(\mathrm{G}\cdot\mathrm{U}^{\mathrm{T}}\cdot\mathrm{V}^{\mathrm{T}}-\mathrm{X}\cdot\mathrm{V}^{\mathrm{T}}\right)^{\mathrm{T}}\right)=\\
&=\mathrm{tr}\left(\left(\mathrm{G}\cdot\mathrm{U}^{\mathrm{T}}-\mathrm{X}\right)\cdot\mathrm{V}^{\mathrm{T}}\cdot\mathrm{V}\cdot\left(\mathrm{G}\cdot\mathrm{U}^{\mathrm{T}}-\mathrm{X}\right)^{\mathrm{T}}\right)=\\
&=\mathrm{tr}\left(\left(\mathrm{G}\cdot\mathrm{U}^{\mathrm{T}}-\mathrm{X}\right)\cdot\mathrm{W}\cdot\left(\mathrm{G}\cdot\mathrm{U}^{\mathrm{T}}-\mathrm{X}\right)^{\mathrm{T}}\right).
\end{aligned}$$

In other words, the solution of the optimization problem with weights (eq. 2) with a data matrix X can be found as a solution to a standard problem without weights relative to the data matrix X_w. At the same time from (eq. 4) matrix G can be easily found.

2. METHODOLOGY

The above implies the possibility of generalization of considered method for a wide range of problems in which the integrated indicator is constructed as the first principal component and the weighted principal component can be constructed with pre-set weights. The question of obtaining weights w^j for the values of the variables remains open. The use of expert assessments does not correlate well with the "without a teacher" approach to obtain an integrated indicator. In the work (Fantazzini et al., 2021), it was noted that migration flows within the country are directed to the regions with a higher quality of life, usually to large cities. There are many sources that show the relationship between migration flows and human capital accumulation (Sardadvar, Vakulenko, 2021) or Happiness level (Porell, 1982; Michalos, 1996). Since, as shown in (Bartram, 2015), migration flows cannot directly serve as an indicator of the quality of life, migration statistics can be used as an objective teacher to determine the weighting coefficients for the values of variables in the principal component. In other words, it is supposed to pick up weight coefficients $w^1, w^2, \dots, w^k$ in such a way that the first principal component constructed with them most accurately corresponds to the real migration flows. The ratio of the number of migrants arriving to the number of those departing can be chosen as a measure of migration flows. It can be assumed that a higher value of the indicator will correspond to a higher level of quality of life. The correlation coefficient of the resulting integrated indicator with migration indicator is used as an objective function.

2.1 Data and Sources

In order to preserve continuity and the possibility of tracking dynamics, the a priori set of variables is identical to the one used in (Aivazian, 2012). There is also a very convincing list of conditions and data requirements for inclusion in the set. The list of variables is given in the Table 1.

Table 1. Selected predictors for II QoL.

№	Variable	Code WCY(2009)	Indicator
1	x^1	1.1.22	GDP per capita, PPP (USD).
2	x^2	3.1.04	Labor productivity, USD
3	x^3	1.1.23	Personal consumption expenditures per capita, USD
4	x^4	4.5.14	Literacy rate, %

5	x^5	2.5.07 / 2.5.06	20% coefficient of funds, times
6	x^6	1.5.01	Consumer Price Index, %
7	x^7	4.4.05	Life expectancy at birth, years
8	x^8	4.4.07	Infant mortality rate (per 1000 lives birth)
9	x^9	4.4.17	CO_2 emissions, metric tons
10	x^{10}	4.3.02	R&D expenditures, % of GDP

Unfortunately, the World Competitiveness Yearbook[2] (WCY 2009) database used in (Aivazian, 2012) is currently unavailable to us; the required indicators are obtained from the World Bank website[3] (WB 2019). At the time of the request (March 2020), variables x^2 and x^6 were available on the site for 2019 and variables x^1, x^3, x^4, x^8 for 2018, data on the other variables were presented for earlier periods. Herewith, countries containing a significant number of missing values were excluded from the sample. In case of a small number of omissions, the missing data was replaced by the available earlier ones. The latter took place in variables x^4, x^5, x^6, x^{10}. The World Bank also publishes statistics on migration (Bilateral Estimates of Migrant Stocks in 2017), at the moment of the access, data for 2017 are available. Since the initial data are presented in different units of measurement, to avoid the influence of dimensionality, we will carry out a standardization procedure $x^{new} = \frac{x - \bar{x}}{s(x)}$, where $\bar{x}$ is the mean value of the variable x, a $s(x)$ is the standard deviation.

2.2 Empirical findings

The resulting data matrix of dimension 103 by 10 is denoted by X. The correlation matrix of the original data set is shown in Table 2.

Table 2. The correlation matrix.

	x1	x2	x3	x4	x5	x6	x7	x8	x9	X10	MigrRate
x1	1,00										
x2	0,92	1,00									
x3	0,97	0,88	1,00								
x4	-0,66	-0,51	-0,66	1,00							
x5	-0,28	-0,30	-0,28	-0,12	1,00						
x6	-0,38	-0,39	-0,40	-0,28	0,09	1,00					
x7	0,64	0,71	0,68	-0,77	-0,35	-0,43	1,00				
x8	-0,51	-0,61	-0,54	-0,84	0,31	0,36	-0,93	1,00			
x9	-0,11	0,00	-0,10	0,31	0,08	0,02	0,10	-0,25	1,00		
X10	0,71	0,65	0,78	-0,39	-0,25	-0,34	0,59	-0,47	0,02	1,00	
Migr Rate	0,52	0,47	0,59	-0,17	0,00	-0,19	0,25	-0,17	0,04	0,49	1,00

[2] http://www.imd.org/research/books/world-competitiveness-yearbook-2019/

[3] https://data.worldbank.org/

We can see that migration flows are most strongly correlated with variables x^3 (Personal consumption) and x^1 (GDP per capita). First, let's build an integrated indicator as the first principal component without weights $g = u^1x^1 + u^2x^2 + \cdots + u^{10}x^{10}$, here $g = \min\limits_{u^1,u^2,\ldots,u^k} (gU^T - X)^2$. The resulting coefficients u^j are shown in Table 3, and the resulting integrated indicator g and country ranks are given in the appendix.

Table 3. The coefficients of the first principal component.

U	u^1	u^2	u^3	u^4	u^5	u^6	u^7	u^8	u^9	u^{10}
PC1	0.379	0.386	0.387	0.313	0.163	0.218	0.387	0.355	0.031	0.331

The integrated indicator g, constructed as the first principal component, contains more than half (0.538) of the total variation of the original set. And the correlation coefficient of the first principal component with the migration indicator is 0.441.

To find the weighting coefficients of the quality of preserving the variation of the initial features, the following problem is solved:

$$\begin{cases} w^1, w^2, \ldots, w^k = argmax\big(cor(g; MigrationRate)\big), \\ g = u^1x^1 + u^2x^2 + \cdots + u^{10}x^{10}, \\ w^1(gu^1 - x^1)^2 + w^2(gu^2 - x^2)^2 + \ \ldots + w^k\big(gu^k - x^k\big)^2 \ \xrightarrow{u^1,\ldots,u^k} min. \end{cases}$$

The coefficients for variables in the principal component are given in Table 4.

Table 4. The coefficients of the first weighted principal component.

U	u^1	u^2	u^3	u^4	u^5	u^6	u^7	u^8	u^9	u^{10}
wPC1	0.447	0.404	0.464	0.222	0.131	0.188	0.318	0.255	0.039	0.390

Normalized optimal values of weights w^j are shown in Table 5.

Table 5. The coefficients of the first weighted principal component.

w	w^1	w^2	w^3	w^4	w^5	w^6	w^7	w^8	w^9	w^{10}
wPC1	0.000	0.000	0.975	0.000	0.000	0.000	0.000	0.000	0.000	0.224

At these values, the correlation coefficient reaches its maximum of 0.591. Note that the variable x^3, personal consumption expenditures, has the greatest value of preserving variation; the value of the variable x^{10} is a quarter of x^3 and all other variables are useless to maximize the relationship of the integrated indicator with migration indicators. Relationship between the correlation coefficient and the weights' ratio of the variables x^3 и x^{10} is shown in Figure 1. We see that the maximum correlation is achieved when $w^{10} = 0.23w^3$.

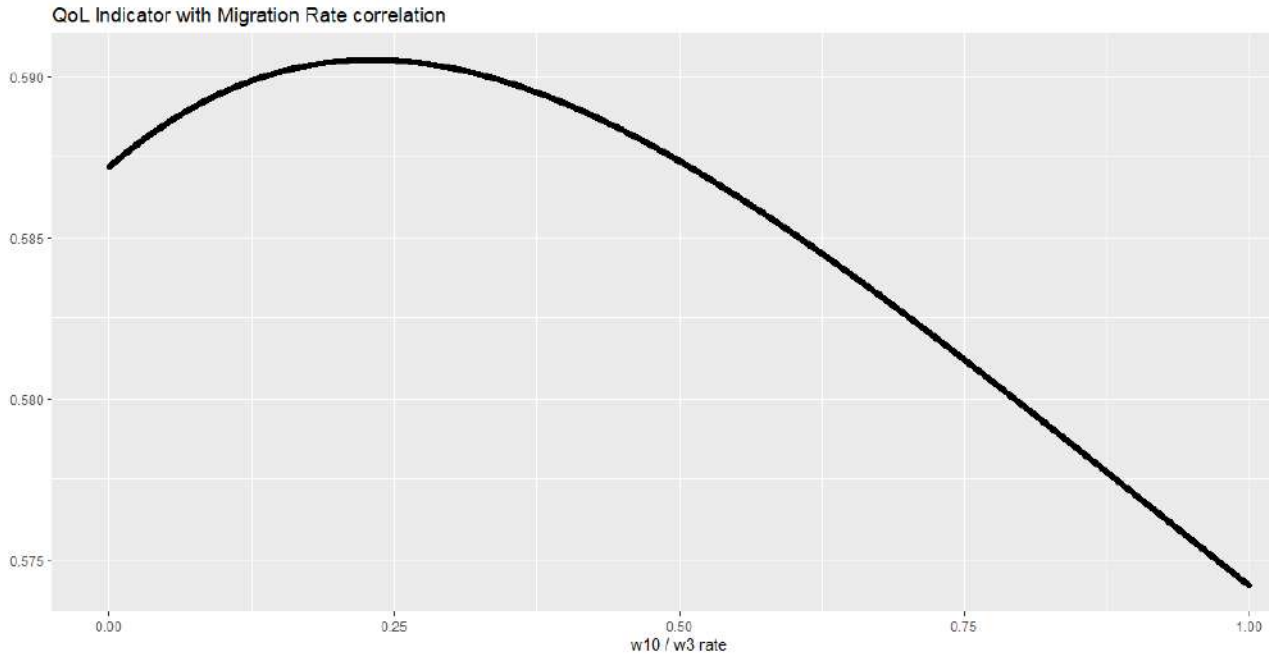

Figure 1. Dependence of the correlation coefficient on the ratio of weights.

The values of the integrated indicators obtained in this case, as well as the ranking, are given in the appendix.

DISCUSSION AND CONCLUSION

The paper has developed the principal component method in the applications for the QoL analysis, allowing the researcher to set the value with which the final integrated indicator should represent this variable when compiling an a priori data set. Comparing with the traditional principal component method, this approach has several advantages: the researcher has the opportunity to take into account the value of more important variables for his integrated indicator, while in the standard principal component method all the incoming factors are equally important. When constructing an integrated indicator, the researcher can consider (with an appropriately low weight) second-order factors that are incomparably less important than the main variables. Previously, the influence of such variables was ignored. This can make a significant contribution to the construction of II. It was possible to obtain a solution to the problem explicitly, without resorting to iterative evaluation procedures, thereby speeding up numerical calculations. As an application of the method, 103 countries were ranked in accordance with the generally accepted methodology.

As an interesting and relatively new approach we consider migration flows as an objective teacher for finding the corresponding weights. Of course, it is possible to introduce migration statistics in different ways and we use only one of them, anyway the final ranking results seem to be interesting and well consistent with the results of similar works known to the authors.

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APPENDIX.

Complete countries' ranking by the Migration Rate, Principal Component and weighted Principal Component.

Country	*Migr Rate*	*Rk*	*PC1*	*rk*	*wPC1*	*Rk*
Switzerland	3,950	12	4,755	2	5,970	1
Norway	4,111	11	4,534	3	5,612	2
Iceland	1,029	41	3,882	4	5,608	3
UnitedStates	15,652	1	3,756	7	5,492	4
Luxembourg	3,697	13	5,706	1	5,249	5
Denmark	2,150	24	3,836	5	4,593	6
Australia	11,856	2	3,312	12	4,114	7
Sweden	5,583	4	3,742	8	4,051	8
Finland	0,914	43	3,415	11	3,760	9
Austria	3,122	17	3,466	10	3,747	10
Israel	5,512	5	3,467	9	3,738	11
Germany	3,030	18	3,253	14	3,419	12
Belgium	3,335	15	3,310	13	3,414	13
Netherlands	2,004	26	3,170	15	3,293	14
Canada	6,328	3	2,773	19	3,180	15
UnitedKingdom	1,909	28	2,613	20	3,155	16
Japan	2,232	20	3,115	16	2,896	17
France	3,610	14	2,929	18	2,840	18
Ireland	1,085	39	3,835	6	2,652	19
Korea	0,510	55	3,020	17	2,223	20
Italy	1,825	29	2,374	21	1,962	21
Spain	4,306	9	2,039	22	1,411	22
Slovenia	2,221	21	2,006	23	1,031	23
Portugal	0,390	64	1,465	26	0,930	24
Greece	1,274	36	1,432	27	0,688	25
CzechRepublic	1,553	34	1,719	24	0,652	26
Estonia	0,668	48	1,393	28	0,554	27
Malta	0,427	59	1,699	25	0,520	28
Cyprus	1,158	38	1,288	29	0,370	29
Lithuania	0,342	68	0,834	34	0,260	30
SlovakRepublic	0,299	71	1,136	30	0,195	31
Uruguay	0,260	75	0,122	43	-0,026	32
Latvia	0,652	49	0,669	35	-0,035	33
Hungary	0,704	47	0,952	32	-0,064	34
Poland	0,155	84	0,989	31	-0,096	35
Croatia	0,602	53	0,879	33	-0,171	36
Chile	0,799	46	0,375	39	-0,263	37
Malaysia	1,717	31	0,524	36	-0,427	38
China	0,148	85	0,518	37	-0,513	39
Mauritius	0,340	69	-0,146	51	-0,520	40
Romania	0,107	86	0,308	40	-0,532	41
Brazil	0,431	58	-0,697	62	-0,537	42
CostaRica	3,171	16	0,034	45	-0,553	43
RussianFederation	1,063	40	0,080	44	-0,573	44
Turkey	1,676	33	-0,092	48	-0,744	45
Bulgaria	0,104	87	0,212	41	-0,753	46
Montenegro	0,345	67	0,383	38	-0,793	47
Serbia	0,822	45	-0,073	47	-0,815	48
Mexica	0,085	88	-0,378	53	-0,827	49
SouthAfrica	4,319	8	-2,149	85	-0,983	50
Botswana	2,007	25	-1,452	77	-1,027	51

Thailand	4,469	7	-0,010	46	-1,054	52
BosniaHerzegovina	0,023	102	0,177	42	-1,123	53
Jordan	4,278	10	-0,168	52	-1,132	54
Colombia	0,052	95	-0,724	63	-1,139	55
Kazakhstan	0,942	42	-0,139	50	-1,165	56
Ecuador	0,411	61	-0,580	58	-1,175	57
NorthMacedonia	0,232	77	-0,129	49	-1,191	58
Peru	0,072	92	-0,644	59	-1,213	59
Gabon	4,751	6	-1,097	72	-1,226	60
Tunisia	0,079	90	-0,660	60	-1,308	61
Paraguay	0,214	80	-1,114	73	-1,314	62
Iraq	0,192	81	-1,283	76	-1,330	63
Georgia	0,233	76	-0,518	55	-1,332	64
Morocco	0,036	99	-0,849	65	-1,351	65
Armenia	0,228	78	-0,411	54	-1,352	66
Guatemala	0,076	91	-1,503	78	-1,357	67
Eswatini	0,353	66	-2,624	87	-1,362	68
ElSalvador	0,027	101	-0,846	64	-1,366	69
Egypt	0,161	83	-1,812	81	-1,405	70
Moldova	0,395	62	-0,863	66	-1,410	71
Algeria	0,187	82	-0,529	56	-1,424	72
Ukraine	0,894	44	-1,026	69	-1,431	73
Kenya	2,501	19	-2,064	83	-1,437	74
SriLanka	0,030	100	-0,549	57	-1,478	75
Azerbaijan	0,424	60	-0,684	61	-1,481	76
Senegal	0,485	56	-2,178	86	-1,489	77
Vietnam	0,038	97	-0,907	67	-1,495	78
Indonesia	0,081	89	-1,082	71	-1,515	79
India	0,316	70	-1,824	82	-1,521	80
CaboVerde	0,065	94	-1,223	75	-1,536	81
Philippines	0,037	98	-1,153	74	-1,539	82
Mongolia	0,224	79	-1,005	68	-1,551	83
Ghana	0,609	52	-2,892	91	-1,562	84
BurkinaFaso	0,478	57	-3,087	93	-1,607	85
Honduras	0,049	96	-1,612	80	-1,624	86
Ethiopia	1,457	35	-3,211	96	-1,630	87
Nigeria	1,177	37	-4,506	102	-1,633	88
Pakistan	0,522	54	-2,851	90	-1,661	89
Nicaragua	0,067	93	-1,517	79	-1,662	90
Nepal	0,274	74	-2,067	84	-1,705	91
Lesotho	0,022	103	-4,085	101	-1,710	92
Mali	0,395	63	-3,695	100	-1,713	93
Coted'Ivoire	2,157	23	-3,599	98	-1,715	94
Sudan	0,367	65	-3,619	99	-1,716	95
Congo	1,683	32	-3,251	97	-1,719	96
KyrgyzRepublic	0,290	72	-1,034	70	-1,721	97
Chad	1,718	30	-4,615	103	-1,730	98
Togo	0,630	51	-2,984	92	-1,749	99
Gambia	1,925	27	-3,205	95	-1,779	100
Uganda	2,181	22	-2,675	88	-1,790	101
Burundi	0,642	50	-3,104	94	-1,840	102
Madagascar	0,284	73	-2,700	89	-1,857	103

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Dynamic Robustification of Trading Management Strategies for Unstable Immersion Environments

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ABSTRACT

The paper considers the problem of constructing channel management strategies for market chaos conditions. The nature of dynamic chaos violates the probabilistic-statistical paradigm's fundamental principle of experiment repeatability. Under these conditions, the traditional statistical methods of evaluation are not effective, and the generated management decisions are unstable. There is a need to create management strategies that produce effective decisions for a wide variety of dynamic characteristics of observation series generated by market chaos. In this article, we have considered two variants of such robustification using channel management strategies as an ex-ample. The first approach is based on the assumption that the optimal solution for the observation interval with the least favorable dynamics for this management strategy will produce solutions that are satisfactory at other observation sites as well. However, our numerical study does not confirm this assumption. Explanation is that optimization of parameters for highly dynamic segments with abrupt changes in the observed process produces degenerate decisions. The optimal control parameters corresponding to them are suitable only for a very narrow range of possible variations of the observed process. The second approach to the dynamic robustification of management strategies is based on searching for optimal parameters of the strategy on large observation intervals. It is assumed that at such observation intervals, chaos will demonstrate the most variants of local dynamics, and the found parameters will be adapted simultaneously to the most diverse variations in dynamic characteristics of observation series. In general, this approach gives an encouraging result, however, as expected, the decrease in performance in the non-matching data segment turned out to be significant.

INTRODUCTION

The main difficulty of asset management in the conditions of market chaos is the instability of the immersion environment (Gregory-Williams & Williams, 2004; Peters, 1996; Zhang & Cheng, 2003; de Wolff et al., 2020). The presence of dynamic chaos in the series of observations violates the fundamental premise of the probabilistic-statistical paradigm on the repeatability of experiments under identical conditions (Maknickienė et al., 2020). At the same time, in the process of asset management, geometrically similar observation segments correspond to completely different aftereffects (Zhang et al., 2020; Musaev et al., 2021). As a result, traditional forecasting and management techniques based on statistical data analysis approaches are ineffective (Abbasov & Karimov, 2020).

The practice of applying various management strategies in conditions of market chaos has shown that their implementation does not contradict the possibility of profitable decisions (Nie-derhoffer & Kenner, 2005; Colby & Meyers, 2012; Chordia et al, 2018; Kashif et al., 2020; Amoozad Mahdiraji et al. 2021). However, any optimized management is dynamically unstable. This means that even a small time shift of the observation area where management is carried out with fixed, previously optimized strategy parameters leads to unpredictable changes in the effectiveness of the management process.

Hence, the task arises to analyze the stability of management strategies in the conditions of market chaos and to discover ways of constructing their robust versions having increased resistance to variations in dynamic and statistical characteristics of the observed process.

1. MATERIALS AND METHODS

As a basis for modeling market asset quotes, we are to use Wald's additive model [Musaev et al., 2021]:

$$y_k = x_k + v_k,\ k = 1,\ldots,n, \qquad (1)$$

where x_k, k = 1,...,n is a system component estimated by sequentially smoothing the time series of initial observations y_k, k = 1,...,n and are to be used in the process of making management decisions, and v_k, k = 1,...,n is the noise component.

Traditional models of statistical data analysis made it possible to construct a wide class of control strategies based on various hypotheses on dynamic properties of observation series [Nie-derhoffer & Kenner, 2005; Chordia et al., 2018]. However, each management strategy of that sort is effective only in a narrow range of possible dynamic variations of quotations. The underlying reason for the low efficiency of the various management strategies stems from the fundamental discrepancy between the traditional statistical approach and the nature of real observations. The market asset observation series' significantly differ from traditional statistical models by following features:

- their system component x_k, k = 1,...,n is an oscillatory nonperiodic process with a large number of local trends. This description indicates the possibility of modelling this process as an implementation of some dynamic chaos models [Guanrong, 2021; Gardini et al., 2020; Davies, 2020; Jun, 2022].
- the noise v_k, k = 1,...,n is a nonstationary random process approximately described by the Gaussian model with fluctuating parameters. At the same time, noise variations contain local trends, and their correlation characteristics change significantly over time (Musaev et al., 2021; Musaev and Grigoriev, 2021).

In order to isolate the system component, any technique of sequential filtration can be applied. In the simplest case, an exponential filter is used for this purpose, defined as (Gardner, 1985):

$$x_k = \alpha y_k + (1-\alpha)y_{(k-1)} = x_{(k-1)} + \alpha(y_k - x_{(k-1)}),\quad k = 2,\ldots,n, \qquad (2)$$

with a smoothing coefficient α, whose value most often lies in the range $[0.01,\ 0.3]$.

These characteristics violate the conditions of applicability of traditional statistical methods for effective decision-making. Moreover, violation of repeatability under similar conditions prohibits any prior ana-

lytical assessments of forecasts and corresponding proactive management strategies. In essence, the main method of analyzing the quality of asset management in this case is numerical studies that assess the effectiveness of management algorithms over long observation intervals.

A management strategy is understood as a functional S: Y → U that maps a set of current and retrospective observations $Y_k = (y_1, \ldots, y_m)_k$, k = 1,...,m to the set of acceptable management decisions $U_j = (u_1,\ldots,u_M)$, j = 1,...,M, where M is the number of asset management operations.

The task of a trader or a trading robot is to choose a management strategy S and form a corresponding sequence of actions u_j, j = 1,...,M that provides maximum profit

$$R(S) = \sum_{j=1}^{M} \Delta y_j = \sum_{j=1}^{M} y_j\,(k_{close}) - y_j(k_{open}) = \max \qquad (3)$$

where $\Delta y_j = y_j(k_{close}) - y_j(k_{open})$, j = 1,...,M, is the effectiveness of the j-th operation, determined by the difference between the states of the asset at the interval of opening and closing the position. The difference in management strategies consists in the way to determine the time moments of time $(k_{open}, k_{close})_j$, j = 1,...,M, and, in some cases, the size of the lot. If the resulting amount at some k-th step turns out to be less than the trader's available deposit R_0, it means a complete loss.

As an example to illustrate the stable asset management technologies considered in the article, let us consider channel management strategies (Niederhoffer & Kenner, 2005; Chordia et al., 2018). The choice of this class of strategies is driven by their simplicity and clarity, which make it easy to visualize and interpret the obtained results and conclusions.

Let y_k, k = 1,...,n be a time series of observations on changes in the value of a financial asset used in trading or investment tasks. The term "channel" in the simplest case refers to the range of observations limited by a range $y_k = x_k \pm B$, k = 1,...,n, where x_k, k = 1,...,n is the system component of a observations segment. The segment is usually formed by a smoothing filter and used in the process of developing management decisions. Variations of observations in regard to the system component inside $|y_k - x_k| = |\delta y_k| \le B$, k = 1,...,n, are interpreted as fluctuations that do not contain a pronounced trend. The process itself is sometimes called a *sideways trend* or a *flat*. The choice of the channel width B can be driven by various considerations. It usually lies in the (1 – 3)s_y range, where s_y is the estimate of the *standard deviation* (SD) of the noise in model (1) $v_k = \delta y_k = y_k - x_k$, k = 1, ..., n.

In general, the channel width is an option that depends on the features of the selected management strategy. In some cases, it can be a variable value $B_k = B_k(y_k)$, k = 1, ..., n.

The current value of a quotation y_k, k = 1,...,n breaking out of the channel can be interpreted as the emergence of a trend. In this case, the well-known management strategy of "playing by the trend" (CSF, "channel strategy, play forward") is used. This means the recommendation to open a position in the direction corresponding to the sign of the channel boundary.

An alternative version of the channel strategy proceeds from the assumption that the process going beyond the channel is a random fluctuation that is to be damped by market mechanisms of asset price correction. This approach employs the channel strategy of playing against the trend (CSB, "*channel strategy, play back*"). This means a recommendation to open a position in the direction opposite to the sign of the channel boundary.

In both cases, the position can be closed when a given level of profit (TP, "*take profit*") or loss (SL, "stop loss") is reached, or in accordance with other, more flexible rules defined by the management strategy.

The given simplified channel strategy makes it possible to remove many minor details. It makes the problem clear for the terminal task of producing stable management for the selected class of management strategies.

2. RESULTS

2.1 Simplest dynamic robustification of the CSB strategy

Traditional methods of robustification the statistical estimation and management algorithms are based on finding the best solution for the least favorable conditions (Huber, 1981; Baltas et al., 2018; Maronna et al., 2019). After that, the solutions are used for other observation segments, with more favorable conditions for the chosen management strategy. The price for the stability of robustified solutions is a significant decrease in effectiveness compared to the optimal version. In this case, we compare the achieved gain (3) with the potentially achievable one.

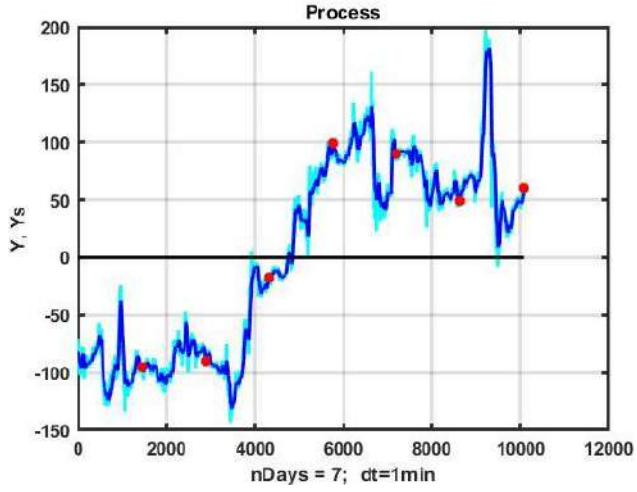


Figure 1. Change dynamics of quotations during seven observation days.

Source: Own

To investigate this issue, as an example of initial data, we consider a 7-day observation segment of the EURUSD quotation with one-minute counts. The corresponding plot is shown in Fig. 1, the separation between observation days is indicated by red circles.

Table 1 shows the performance R* of the best solutions and their corresponding parameters (α*, B_{Dn}*, B_{Up}*, TP*, SL*) of the CSB channel strategy. Optimization was carried out by bruteforcing their values with ranges and steps, respectively, being, α = 0.01:0.01:0.15, B_{Dn}, B_{Up}=5:1:15, TP, SL=7:1:15.

Table 1. Best solution performance

Day	R*, p.	α^*	B^*_{Dn}, p.	B^*_{Up}, p.	TP*, p.	SL*, p.
1	174	0.03	10	10	16	13
2	164	0.03	7	6	11	12
3	82	0.02	8	5	16	15
4	169	0.06	5	9	8	16
5	176	0.01	10	13	21	7
6	186	0.09	9	6	14	18
7	129	0.02	11	5	21	16

Source: Calculation by Author

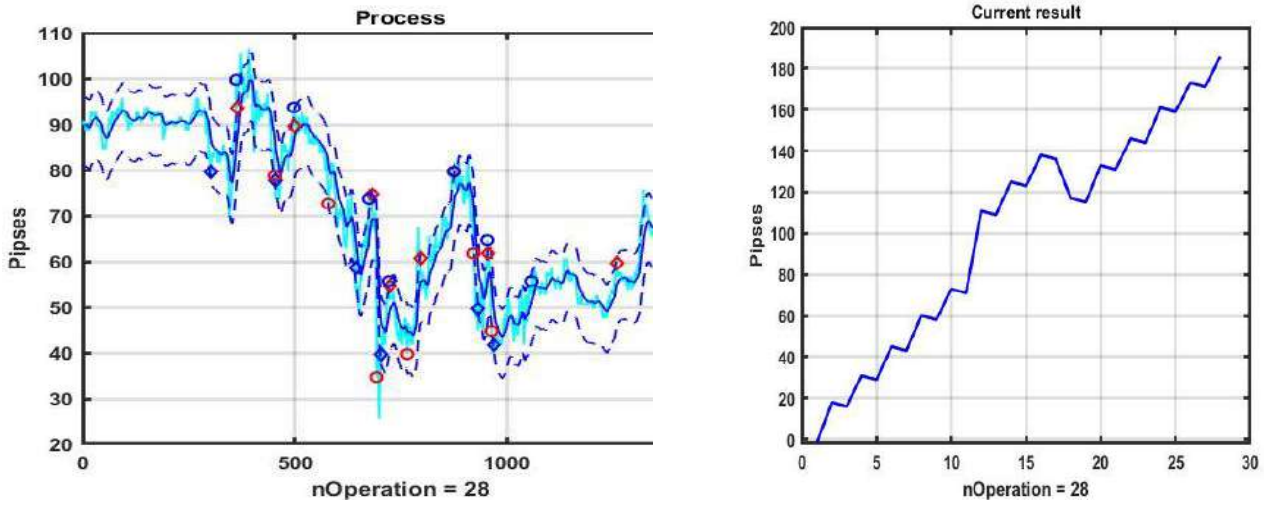
Comparing the values given in Table 1 with the plots in Figure 1, we can draw the expected conclusion that this strategy produces the best result in the observation segments tending to a sideways trend. However, even such a trivial conclusion has exceptions. For example, for the observation 5th day, which contains sufficiently strong fluctuations in the quotations, with correctly selected parameters, it is possible to obtain R = 176p. as a result. It seems that this is due to relatively large values of the channel boundaries B_{Dn}, B_{Up}, which made it possible to avoid incorrect openings with strong, abrupt trends.

As examples, Figure 2 (a) shows plots illustrating the management process with the best parameter values of the sixth day of observation. This observation segment is characterized by relatively weak local trends. In the figure, blue diamonds indicate opening a position up, red ones indicate opening a position down, and circles of corresponding colors are the closings. Figure 2 (on the left) shows a graph of changes in management performance. The total result of the management was R = 186p. Figure 3 shows similar plots for the third day of observation, characterized by a strong positive trend and having the least significant result of R = 82p.

Let us clarify what the most unfavorable conditions for the use of this management strategy are. As already noted, for the CSB channel strategy, unfavorable areas are characterized by strong trends with abrupt corrections (the areas in Fig.1 corresponding to the 3rd and 7th days of observation).

Let us consider the question of the effectiveness of using the best option parameters for a particular observation day for other observation days. For this purpose, we use the previous example with a 7-day observation area. In Table 2, the diagonal shows the effectiveness of the CSB control strategy with optimal parameters, and the lines show the result of applying the strategy with these parameters for all seven days of observation.

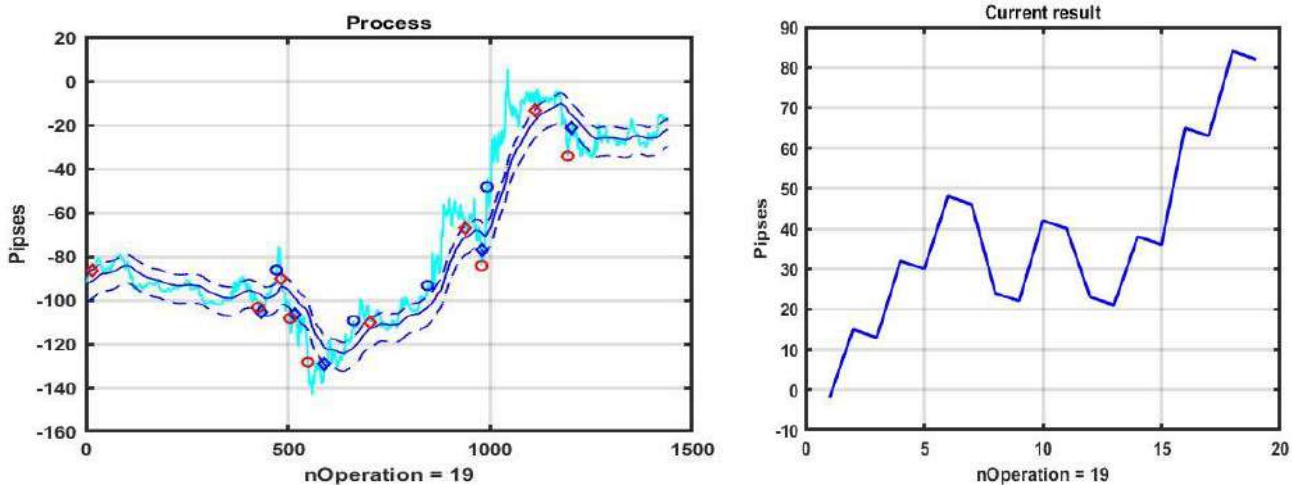
According to the general theory of robust estimation (Huber, 1981; Baltas et al., 2018; Maronna et al., 2019), the most stable result may be expected when using the optimal parameters obtained for the least favorable, 3rd day of observations. However, it is not difficult to see that both for the most unfavorable dynamics of observations (observation days 3 and 7) and for other days, the use of optimal parameters leads, in most cases, to losses. The exception is a set of optimal parameters for the 6th day of observation $P^* = (\alpha^*, B_{Dn}^*, B_{Up}^*, TP^*, SL^*) = (0.09, 9, 6, 14, 18)$, characterized by relatively moderate variability and some slight negative trend.



a) b)

Figure 2. CSB management (a) and its result (b) with parameters that are found to be optimal for the 6th day of observation

Source: Own



a) b)

Figure 3. CSB management (a) and its result (b) with parameters that are found to be optimal for the 3rd day of observation

Source: Own

Table 2. Performance with optimal parameters for the corresponding days

Day	*1*	*2*	*3*	*4*	*5*	*6*	*7*
1	**174**	21	–37	72	19	–5	44
2	17	**164**	96	0	–8	96	53
3	–56	–90	**82**	–96	–56	–40	–4
4	–36	–57	–121	**169**	–147	–57	–133
5	–35	–92	–64	–29	**176**	–52	–49
6	96	4	25	66	3	**186**	40
7	–12	–65	50	–87	–36	–228	**129**

Source: Calculation by Author

This set of parameters not only produced the best result among other vectors of optimal parameters for the corresponding days on which a posteriori optimization was carried out, but also ensured a gain, albeit small, on all seven days of observation. Its noticeable differences from other such vectors are the increased value of the exponential filter's transfer coefficient and an SL that slightly exceeds the other SLs (see Table 2). Of course, such an outcome may be random: it is not confirmed by the results of the 1st and 2nd observation days, which are also characterized by weak dynamics and have optimal parameters that produce gain over the entire 7–day observation interval.

In general, from the studies presented in this section, it can be concluded that the considered primitive robustification scheme is incapable to produce a stable positive result for the chosen management strategy. Moreover, the opposite result was obtained. Namely, the best set of options for the situations most favorable for the selected type of strategy, obtained the best result for the entire 7-day observation interval. Obviously, this conclusion cannot be accepted as reliable due to the limited size of the selected data polygon and requires confirmation with significantly large volumes of source data.

2.2 Dynamic robustification of the CSB based on optimal parametric solutions for large observation intervals

As an option of a channel management strategy with increased resistance to variations in the dynamic characteristics of observation series, consider a model with optimal parameters over a large observation interval. In the example, an observation interval of 15 days is considered (Figure 4). This area contains a multitude of quote variations: sideways trends with different levels of scope, areas of slow and abrupt growth and decline, impulse-like jumps, etc.

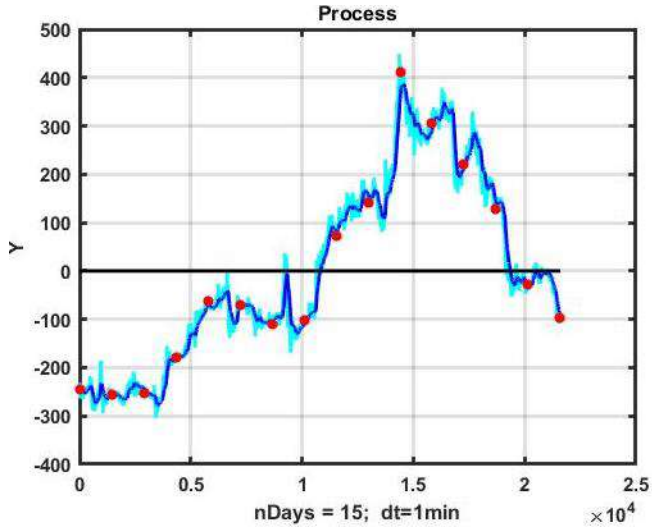


Figure 4. Change dynamics of quotations during 15 observation days.

Source: Own

We use bruteforce optimization on the values of optional parameters with ranges of variation α = 0.01:0.01:0.15, B_{Dn}, B_{Up}=5:1:15, TP, SL=7:1:15. In this case, the best result of using the CSB strategy was R=475p. with parameters P* = (α*, B_{Dn}*, B_{Up}*, TP*, SL*) = (0.02, 6, 8 , 17, 21). The performance of the management strategy with specified parameters at the selected observation interval is shown in Figure 5.

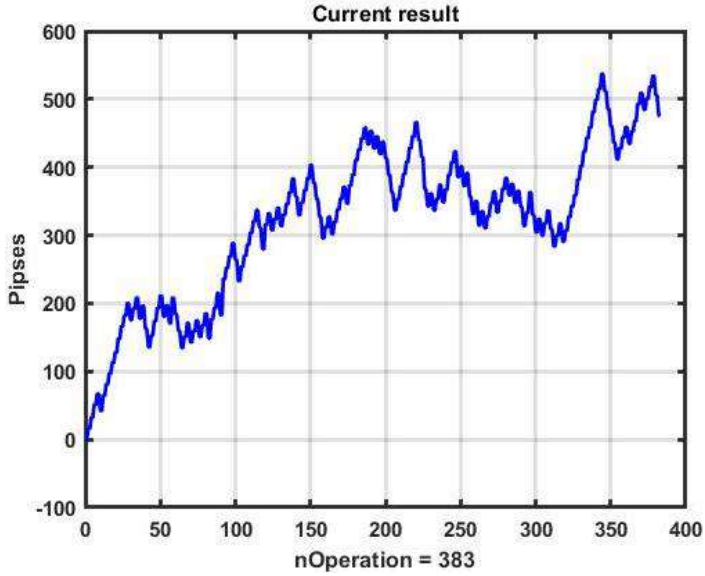


Figure 5. Performance change in the process of using the CSB strategy

Source: Own

Applying the found parameters of the management strategy separately to each of the observation days, we obtain a vector of results: R=(80, 101, 36, –59, 75, 49, –23, –4, 125, –102, 17, –7, 189, –2, –19). At the same time, the total result R_S = 456p is quite close to the previous result of optimizing for the entire 15–day observation area. Let us consider how effective the parameters P* are in the subsequent 10-day observation interval that does not intersect with the training data interval (Figure 6). The vector of one-day results in this case is R = (22, 49, 53, –7, –12, –20, 66, –51, 49, –98).

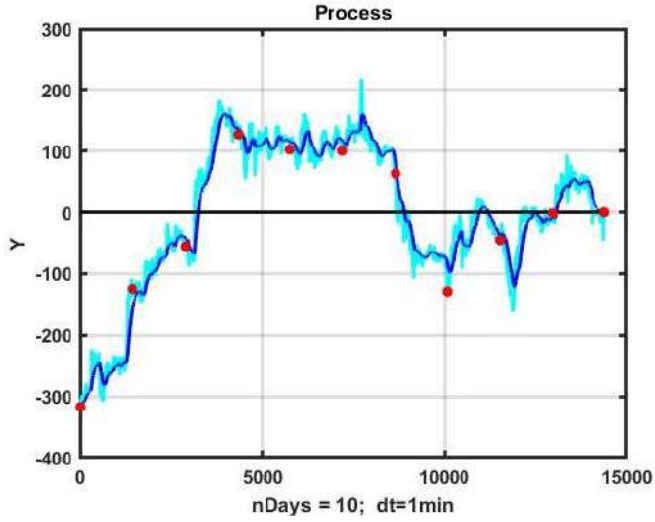


Figure 6. Quotation dynamics on a subsequent 10-day observation interval

Source: Own

Comparing obtained results with the dynamics of one-day processes (Figure 6), the following preliminary conclusions may be drawn:

- The application of the parameters of the CSB control strategy with optimal parameters estimated over a large training interval of observations significantly changes its initial properties. Namely, the best results were obtained in areas with highly linear dynamics (days 1, 2, 3, 7), and in areas with small linear trends (days 4, 5, 6), the strategy turns out to be losing.
- The effectiveness of the strategy is the most unpredictable for observation segments where the dynamics of the process move in the opposite direction (8-10 days).
- These examples, in general, confirm the a priori positive assumption about the applicability of the proposed scheme of dynamic robustification to the management strategy. At the same time, the negative assumption about the high cost of increasing the stability of management is also confirmed. This conclusion also needs further statistical studies on large datasets.
- In the process of parametric optimization of the control strategy, CSB acquired some properties that bring it closer to CSF. As a result, it is of interest to repeat the conducted studies for the CSF. The next section of the article is devoted to this issue.

2.3 Dynamic robustification of CSF

In accordance with the CSF management strategy, a position is opened up when the observed process y_k, k = 1,...,n crosses the level x_k + B, k = 1,...,n from the bottom up, or down when crossing y_k = x_k – B, k = 1,...,n from the top down. An example of its implementation on a one-day observation segment is shown in Figure 7. Here x_k, k = 1,...,n is the system component formed by an exponential filter (2) with α = 0.02. The remaining parameters were assumed to be equal to B_{Dn}, B_{Up} = 8, TP, SL = 17.

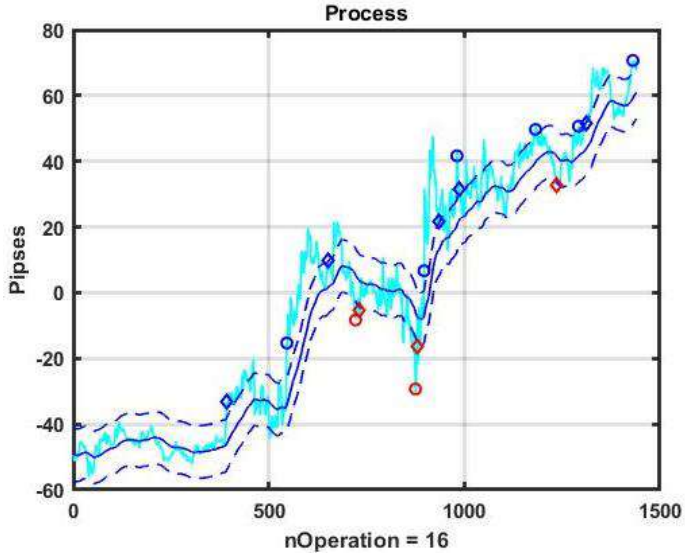


Figure 7. Example of CSF implementation on a one-day observation segment

Source: Own

We chose the same observation segment for the parametric optimization for a large interval of 15 days as for the CSB strategy (Figure 4), retaining the same set of ranges for optional parameters α = 0.01:0.01:0.15, B_{Dn}, B_{Up}=5:1:15, TP, SL=7:1:15. The best values of parameters P* = (α*, B_{Dn}*, B_{Up}*, TP*, SL*) = (0.1, 11, 14, 16, 13) are produced by bruteforce search.

The performance of the management strategy with the specified parameters at the selected observation interval is shown in Figure 8. The best result was *R=252* p., which is only 53% of the result of applying the CSB strategy with optimal parameters at the same observation interval.

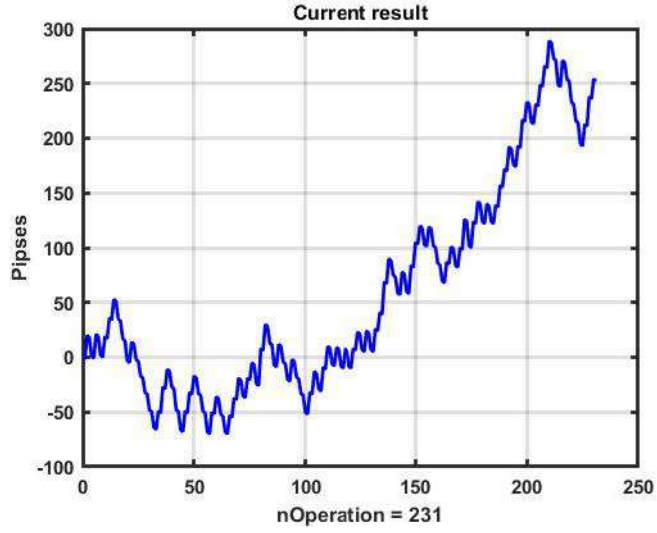


Figure 8. Performance for the CSF strategy with the best parameters

Source: Own

Following the proposed method of stability analysis of the obtained result, let us consider how effective the found optimal parameters are in the subsequent 10-day observation interval that does not intersect with the training interval (Fig. 6).

The vector of one-day results in this case is R = (–27, 64, –31, –71, –10, –107, –77, –75, –166, –34), which indicates low efficiency and pronounced dynamic instability of this management strategy.

DISCUSSION AND CONCLUSION

The problem of constructing management strategies that show stable performance in an unstable immersion environment with pronounced signs of dynamic chaos is essential in trading and investment.

This problem can be solved in several various ways. The obvious solution is the construction of a qualitative forecast regarding the dynamics of the observed process, but at present it is not effective due to the very nature of market chaos. The reason is the extremely high variability and lack of inertia of the observed processes, which obstructs the use of statistical extrapolation methods (Musaev and Grigoriev, 2022; Peng et al., 2018). Nevertheless, research in this direction continues, mainly focused on indirect analysis of multidimensional dynamic processes that takes into account correlation relationships and other features of large arrays of retrospective observations (Musaev et al, 2021; Musaev and Grigoriev, 2021).

Increasing the dynamic stability of management strategies may be provided by two primary approaches: adaptation and robustification, i.e. reducing their sensitivity to variations in the dynamic characteristics of the observed process.

The complexity of applying adaptive control methods in unstable immersion environments is associated with extremely rapid changes in the very structure of the observed processes. This fact is clearly visible in Fig. 1, 4, 6. As a result, the feedback loop in the process of adaptation does not keep up with the abrupt changes in quotations. Attempts to increase the speed of adaptation lead to a rapid response to dynamic fluctuations, which, in turn, causes an increase in statistical errors of type II ("false alarms"). Nevertheless, the question of the applicability of adaptive and self-organizing management strategies is worthy of independent research, which the continuation of this article will be dedicated to.

The problem of dynamic robustification (more precisely, robustification to variations of dynamic characteristics) is based on decrease in the sensitivity of control strategies to variations of the observed process. In this article, we have considered two variants of such robustification using channel management strategies as an example.

The first approach is based on the assumption that the optimal solution for the observation interval with the least favorable dynamics for this management strategy will produce solutions that are satisfactory at other observation sites as well. For the CSB strategy based on the hypothesis of trend absense, the most unfavorable are the observation areas with pronounced growth or decline. However, the experiment completely rejected this approach. The most stable result at seven observation segments was obtained by management with parameters optimal for the observation interval characterized by a slight negative trend. In other words, the best result for favorable conditions turned out to be quite satisfactory for other days of observation. This conclusion is also confirmed by the results of applying the optimal parameters of other observation days with dynamics close to a sideways trend.

This paradox can be explained by the statistical limitation of the number of experiments. Another, more convincing explanation is that optimization of parameters for highly dynamic segments with abrupt changes in the observed process produces degenerate decisions. The optimal control parameters corresponding to them are suitable only for a very narrow range of possible variations of the observed process. Any exit beyond this range quickly leads to a loss in management effectiveness.

The second approach to the dynamic robustification of management strategies is based on searching for optimal parameters of the strategy on large observation intervals. It is assumed that at such observation intervals, chaos will demonstrate most variants of local dynamics, and the found parameters will be adapted simultaneously to the most diverse variations in dynamic characteristics of observation series.

As an example, we consider a CSB management strategy with optimal parameters for a 15-day observation interval. The effectiveness of the found solution was validated at the subsequent 10-day ob-

servation interval. In general, this approach gives an encouraging result, however, as expected, the decrease in performance in the non-matching data segment turned out to be significant. This result is extremely important from a practical point of view and requires further research.

In conclusion, we note that the CSB channel strategy, which is based on the hypothesis that breaking through the channel boundaries is only a random fluctuation, has demonstrated a clear advantage over the alternative CSF strategy. Nevertheless, it should be remembered that both strategies were used to ensure the clarity of the drawn conclusions. For practical applications, it is advisable to use more complex modifications of these strategies, based, for example, on multi-channel, self-organizing, precedent and multi-expert computing schemes.

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Factors Affecting the Green Economy Based on the Attraction of Foreign Direct Investment in the Context of Climate Change, Vietnam

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ABSTRACT

The complicated developments of the Covid-19 pandemic have made enterprises' investment and business cooperation activities in general, and foreign direct investment (FDI) enterprises face many challenges and risks in particular. In Vietnam, foreign direct investment plays a vital role in socio-economic development. Realized FDI capital increased on average annually and accounted for over 25% of the total recognized investment capital of the whole society; the average GDP share of the foreign-invested sector accounts for more than 20% annually in the total GDP of the whole economy; attracting nearly 5 million workers. However, Vietnam has faced environmental and social consequences of developing the brown economy. Countries have gradually transitioned to a green economy - an economy that cares about happiness, social justice, and the environment in addition to other benefits and economic goals. Vietnam is no exception to this trend. Thus, the article's purpose is to analyze the key factors affecting the attraction of foreign direct investment (FDI) for the green economy of Vietnam and recommendations for green economic development in Vietnam. Besides, the authors applied quantitative methods processed by SPSS 20.0 and Amos software based on surveying 700 foreign investors with descriptive statistical tools, measuring scales with Cronbach's Alpha, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), structural equation modeling (SEM). The article's findings have three key factors affecting the attraction of foreign direct investment (FDI) for the green economy of Vietnam, with a significance of 1.0 percent. Three factors include investment policy (IP), Investment environment (IE), and quality of human resources (QHR). Finally, the study's value is to help policymakers and leaders of provinces and cities improve capital attraction efficiency and contribute to green economic growth in climate change and international integration.

INTRODUCTION

After more than three decades of opening up, the foreign-invested economic sector has become an essential component of Vietnam's economy. However, the context of trade conflicts in the world, the development trend of the Industrial Revolution 4.0, the outbreak of the global Covid-19 pandemic... along with the rise of conservatism protectionism and anti-liberalization of multilateral trade in the world have affected the adjustment of investment capital flows of countries (He & Choi, 2020). Therefore, it is necessary to identify the opportunities and challenges facing Vietnam, thereby proposing solutions for Vietnam to effectively attract foreign direct investment (FDI) inflows in the new context.

In Vietnam, the category of the green economy appeared in 2010 during the Conference of the United Nations Environment Program (UNEP) in Nairobi, Kenya, to prepare for the RiO+20 Summit in June/2012 in Rio de Janeiro, Brazil on sustainable development. During the implementation of this program, Vietnam has received help and support from many countries and the international community. As a result, the transition to a green economy in Vietnam has had initial results, such as Building and putting into operation many small hydroelectric projects, wind power, using solar energy, increasing strengthening afforestation and regeneration, controlling to limit deforestation, etc. Additionally, Vietnam has proposed temporarily closing natural forests to reduce greenhouse gas emissions.

Although Vietnam is considered an attractive investment destination in the world, to attract sustainable foreign investment flows, besides improving the business investment environment towards transparency, Vietnam needs to focus on developing the economy in a green direction with low greenhouse gas emissions. With the problems analyzed above, the authors researched various factors affecting the attraction of foreign direct investment for the green economy of Vietnam and recommendations for a green economy in Vietnam.

1. LITERATURE EMPIRICAL REVIEW

1.1 Green economy (GE)

The green economy is a new term that has emerged in recent years, such as green production, green consumption, green lifestyle, and green products with the implication of being environmentally friendly. There are many different definitions of a green economy. In the study, Williams & Horodnic (2015) said that a green economy is an economy with smart, sustainable, and fair growth. The Green Economy Alliance group defines a green economy as "an economy that creates a better quality of life for all within the Earth's ecological limits. The International Chamber of Commerce (ICC) is the world's largest, most representative business organization that has looked at the green economy from a business perspective: A green economy is an economy that grows. A green economy not only sets economic development goals but also pays much attention to human happiness, social justice, and environmental and ecological issues (Seetanah & Rojid, 2011; Silajdzic & Mehic, 2016; Hunady & Orviska, 2014). Economic growth and environmental responsibility go hand in hand and complement each other while supporting social development.

1.2 Foreign direct investment (FDI)

Foreign direct investment (FDI) is a form of long-term investment by an individual or organization from one country to another by setting up factories and business establishments. The aim is to achieve long-term interests and take control of this property (Egbo et al., 2011; Asiedu, 2006; Cheung & Lin, 2004). FDI is an activity that uses capital in the social production and reproduction process to create a larger capital capacity, which is a part of the production and business of enterprises business to obtain profits or socio-economic benefits (Ahmad et al., 2015; Demirhan & Masca, 2008). That investment capital is integral to the accumulations of industries, production and business establishments, social organizations, savings of individuals, and capital mobilized from other sources (Faeth, 2009; Iwai & Thompson, 2012; Kodongo & Ojah, 2016).

1.3 Investment policy (IP)

Policy to attract foreign investment. This policy is implemented by market-opening policies. Create incentives and an attractive business environment. The attraction is created based on the generated domestic potential. The expression of goodwill in cooperation and desire for foreign investment activities (Mohamed, 2019; Noorbakhsh et al., 2001). These policies are implemented when the country opens its market. Attracting investment brings all-around innovations to the country. These can be mentioned as implementing association, cooperation, and mutual development projects in the national market. Or let them conduct business activities, exploiting domestic conditions (Vogiatzoglou, 2007: Yu & Walsh, 2010; Alfaro et al., 2004). These factors help countries' governments deal with labor and employment conditions. People have access to many different markets, and diverse needs are met. Thus, the authors proposed the hypothesis below.

H1: Investment policy affecting foreign direct investment (FDI).

H2: Investment policy affecting the green economy.

1.4 Investment environment (IE)

The investment environment is a set of factors affecting the investment activities of enterprises. The investment environment includes economic, political, social, cultural, natural, and technological factors. Government policy, geographical factors, and market size are important (Xaypanya et al., 2015; Wang & Balasubramanyam, 2011). The investment environment combines national and local factors that affect investment activities and economic development. Besides, the investment environment in this concept only refers to the national and regional investment environment, not including external parties (Tintin, 2013; Mohiuddin & Salam, 2011). A good investment environment creates favorable conditions for investment activities and the production and business process until investors terminate investment activities. A good investment environment creates favorable investment activities conditions and promotes efficient production and business processes (Nantharath & Kang, 2019; Li & Liu, 2005). Thus, the authors proposed the hypothesis below.

H3: Investment environment affecting foreign direct investment (FDI).

H4: Investment environment affecting the green economy.

1.5 Quality of human resources (QHR)

The quality of human resources includes the moral, physical, ability, and aesthetic qualities of people, which have a decisive influence on the achievement of current and future goals of each organization (Pelinescu, 2014: Rogers, 2004; Jadhav, 2012; Kayode et al., 2013). the quality of human resources is about improving health, knowledge, and working skills to promote labor productivity, leading to increased income and improved quality of life in society. The quality of human resources in an enterprise is understood as the degree of responsiveness of employees' working ability to the work requirements of the organization and ensures the successful implementation of the objectives of the organization (Gharaibeh, 2015; Durham, 2004; Asiedu, 2002; Tsaurai, 2014). and satisfy the needs of employees. Thus, the authors proposed the hypothesis below.

H5: Quality of human resources affecting foreign direct investment (FDI).

H6: Quality of human resources affecting the green economy.

Based on these empirical findings, the authors expect that H7: FDI affects the green economy

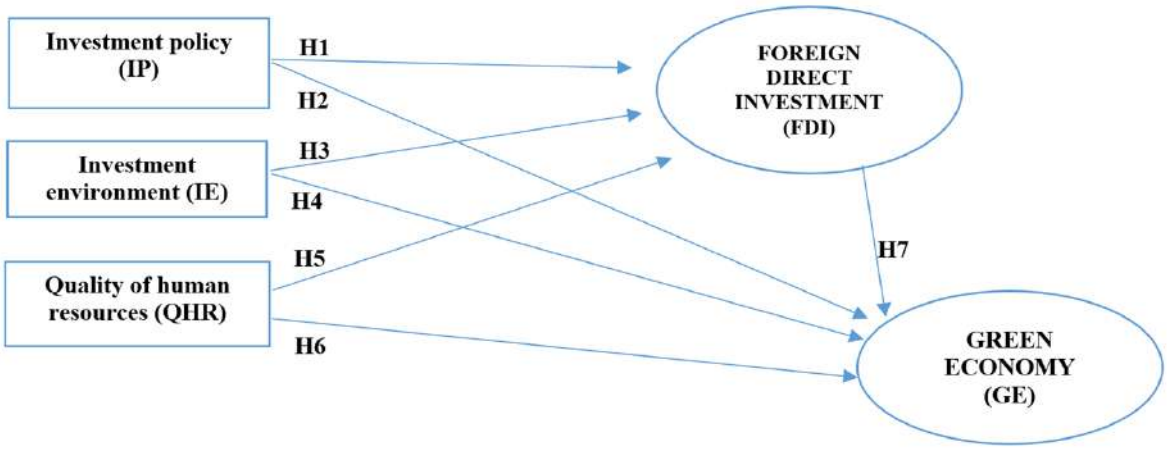


Figure 1. A research model for factors affecting foreign direct investment and the green economy

Source: Authors' proposed

Figure 1 shows factors affecting foreign direct investment and the green economy. Besides, three factors include investment policy (IP), investment environment (IE), and quality of human resources (QHR). Finally, foreign direct investment affects the green economy.

2. METHODOLOGY AND DATA

2.1 Qualitative research

In this study, the authors use some research questions and information collection methods prepared in qualitative research, but this method can be adjusted accordingly as new information appears during the collection process (Hair et al., 2021). That is one of the fundamental differences between qualitative and quantitative methods. The authors also use external data sources: The authors have taken from economic organizations and government agencies and researched information from different books, magazines, national magazines, and the internet (Hair et al., 2021).

Besides, the authors consulted with 11 experts in the field of investment in Vietnam. Based on these 11 experts' opinions, the authors have identified the information collected from the experts' responses and formed the questionnaire. The goal is to determine new lines of inquiry for the prepared questions. The steps are detailed: Literature review related to the dissertation, preliminary questionnaire design, interview enterprise leaders and experts, modify the initial questionnaire, and finally, there is nothing official about the questionnaire (Hair et al., 2021).

2.2 Quantitative research

This study collected data and solved relationships through numerical form and studies from interpretation using scientific models and quantitative research methods. Besides, the authors processed through SPSS 20.0 and Amos software with descriptive statistical tools, measuring scales with Cronbach's Alpha, exploratory factor analysis (EFA), and confirmatory factor analysis (CFA) (Hair et al., 2021). Structural equation modeling (SEM) based on data was collected through a questionnaire that surveyed about 700 foreign investors operating in Vietnam. With the following steps: Descriptive statistics, Cronbach alpha test of reliability, Exploratory factor analysis (EFA), Confirmatory factor analysis (CFA), and Testing of structural equation modeling (SEM).

The authors used the non-probability sampling method with random sampling. This means sample based on the subject's convenience or accessibility, where the investigator is more likely to encounter

the issue. The authors compiled the research questionnaire sent directly to each foreign investor in Vietnam, which was convenient for the authors' survey (Hair et al., 2021).

The authors surveyed Vietnam's 700 FDI enterprises (700 foreign investors) through direct interview questionnaires. The authors collected primary data after determining the study's sample size and sampling method. The authors have used official questionnaires to conduct direct interviews with each business owner in Vietnam. After completing the answer sheet, the authors instruct the answer, receive the answer sheet, check the accuracy, clean the data, and cast invalid votes.

Finally, the authors applied the Bootstrap method can provide more detailed information about the distribution of the mean, the confidence interval, and the probability of the standard based on a single sample (Hair et al., 2021).

3. EMPIRICAL RESULTS

3.1 Analysis of the situation of attracting foreign direct investment into Vietnam

Vietnam, with the competitive advantage of an open investment environment, a stable political environment, a stable macroeconomic environment, and abundant human resources at low costs, Vietnam is one of the most attractive countries in the world led by foreign investors. Thanks to these advantages, FDI inflows into Vietnam have increased recently, especially after Vietnam participated in bilateral and multilateral free trade agreements (FTAs).

From 2010 to 2014, registered FDI capital fluctuated continuously and increased slightly from 19.89 billion USD in 2010 to 21.92 billion USD in 2014. Since 2015 total registered FDI capital in Vietnam has had a substantial and continuous increase, with the total investment capital in Vietnam in 2015 being 22.7 billion USD. By 2019 this figure will increase to 38.95 billion USD. In 2020, due to the impact of the Covid-19 pandemic, the global economy was severely affected, so foreign investment capital registered in Vietnam decreased, reaching only 28.53 billion USD, down 25% compared to the previous year in 2019.

Not only increased in registered capital but realized FDI also increased in 2015-2019, from 14.5 billion USD to 20.38 billion USD; the number of newly registered investment projects increased from 1,843 projects in 2015 to 3,883 projects in 2019.

By 2020, due to the general influence of the Covid-19 pandemic, enterprises' production and business activities will be affected, so FDI projects in Vietnam will decrease in both registered capital and investment capital. Newly registered projects but implemented capital decreased slightly, reaching 98% compared to 2019.

In 2020, the processing and manufacturing industry was the field that attracted the most attention from foreign investors, with 800 new projects, 680 projects with adjusted investment capital, and 1268 times capital contribution and purchase. Shares with a total capital of 13,601 billion USD, accounting for 47.67% of total investment capital. The electricity, gas, and steam production and distribution fields ranked second with USD 5.1426 billion, accounting for 18.03% of total investment capital. The real estate business ranked third with 4.18495 billion USD, accounting for 14.67% of total investment capital. In general, processing technology, real estate business, electricity production, and distribution, accommodation and food services, etc., are the industries that attract the most FDI.

In 2021, Foreign direct investment (FDI) was a significant capital flow for growth and international economic integration, contributing to additional capital, technology, management capacity, business ability, organizational ability, and participation in the global supply chain. In 2021, despite the complicated development of the Covid-19 epidemic, FDI in Vietnam reached 31.15 billion USD, an increase of 9.2% compared to 2020. Newly registered and adjusted investment capital increased sharply compared to 2020, and adjusted capital increased sharply by 40.5%. This shows that foreign investors are placing an order with great confidence in Vietnam's investment environment.

3.2 Analysis of descriptive statistics and Cronbach's Alpha

Descriptive statistical analysis is critical for any scientific study on quantitative use; descriptive statistical analysis is regular for those familiar with statistics.

Table 1. Descriptive statistics and Cronbach's Alpha for critical factors affecting the green economy and foreign direct investment

Code	*Contents*	*Mean*	*Cronbach's Alpha if Item Deleted*	*Cronbach's Alpha*
FDI1	Priority projects that are high-tech and source technology projects	3.3821	0.943	0.952
FDI2	Use minimal land and resources but bring great benefits	3.3448	0.893	
FDI3	Connect global production and supply chains and are environmentally friendly	3.2731	0.952	
IP1	Reducing the retail price of electricity for production and business industries	3.0507	0.951	0.968
IP2	Land and capital support	3.0373	0.962	
IP3	Extension of tax payment and land rent	3.0582	0.967	
IP4	Exemption and reduction of interest and fees according to internal regulations of the credit institution	3.0537	0.949	
QHR1	Trained and young human resources	3.3537	0.803	0.858
QHR2	Human resources are skilled and have a high work ethic	3.5030	0.816	
QHR3	Ability to adapt in the fastest time to the working environment and progress. new science and technology	3.3045	0.852	
QHR4	Discipline and ethical behavior at work	3.3328	0.806	
GE1	Reducing environmental risks and sustainable living environment	2.3134	0.884	0.900
GE2	Considered an economy with low carbon emissions	2.3761	0.837	
GE3	Ecological resource scarcity	2.3537	0.900	
GE4	Efficient use of resources and social inclusion	2.3985	0.861	
IE1	Favorable legal conditions for investors	3.0746	0.969	0.976
IE2	Macroeconomic stability	3.0701	0.976	
IE3	Stable politics	3.1030	0.976	
IE4	Elements of complete infrastructure	3.1030	0.964	
IE5	Market capacity and also the advantages of a country	3.0910	0.965	

Source: Authors collected and processed from SPSS 20.0

Table 1 shows that 20 items have a value from 1.0 to 5.0, and the mean is around 3.0. All observed variables in the factor components use the 5-level Liker scale with the corresponding level: Level 1 is completely disagree, level 2 is disagree, level 3 is neutral, level 4 is agreed, and level 5 completely agrees. Besides, the Std. Deviation has a value of approximately 1.0. This data is perfect for the following research, and the authors have the Cronbach alpha test of the reliability of more than 0.6.

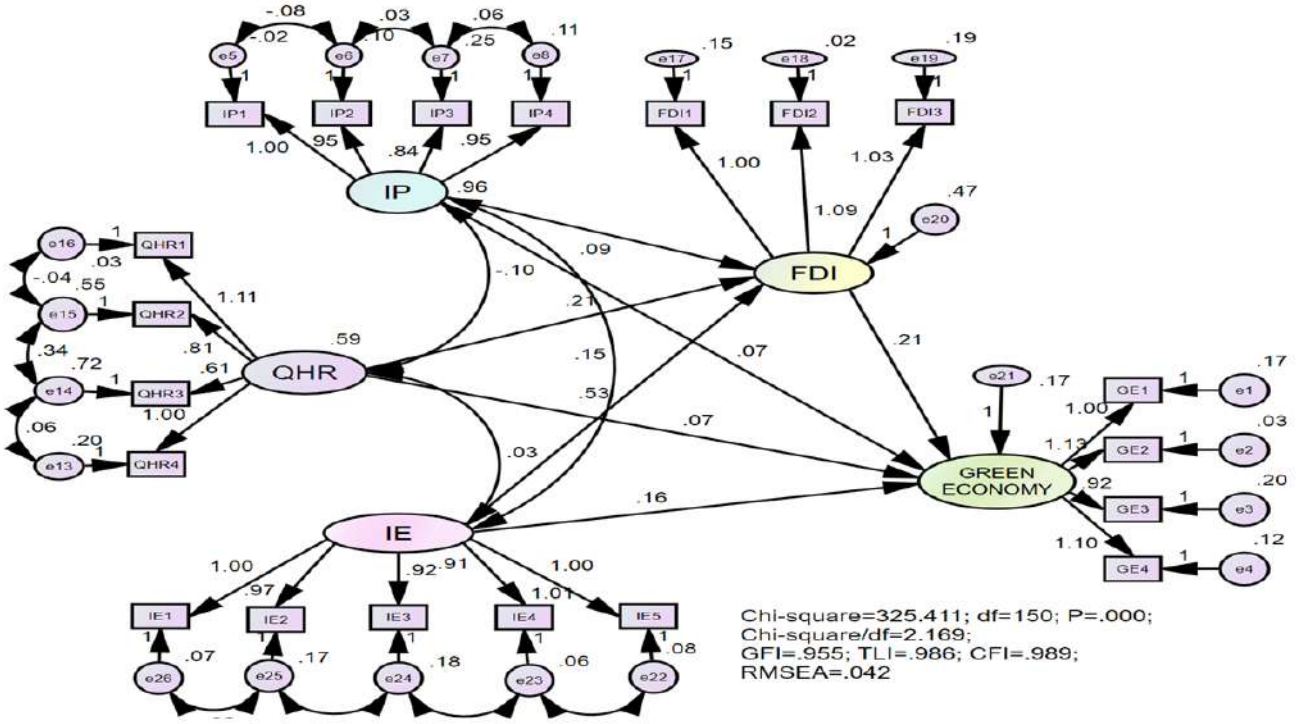
3.3 Analysis of critical factors affecting the green economy

Table 2. Testing factors affecting foreign direct investment and the green economy

Relationships			*Standardized Estimate*	*S.E*	*C.R*	*P*	*Result*
FDI	<---	IP	0.091	0 .028	3.277	0.001	Accepted
FDI	<---	QHR	0.208	0.036	5.713	***	Accepted
FDI	<---	IE	0.534	0.031	16.992	***	Accepted
Green economy	<---	FDI	0.209	0.026	7.981	***	Accepted
Green economy	<---	QHR	0.067	0.024	2.844	0.004	Accepted
Green economy	<---	IP	0.066	0.019	3.477	***	Accepted
Green economy	<---	IE	0.157	0.023	6.679	***	Accepted

Source: Authors collected and processed from SPSS 20.0, Amos

Table 2 shows three factors affecting the attraction of foreign direct investment (FDI) and the green economy of Vietnam, with a significance of 1.0 percent. Besides, foreign direct investment (FDI) affects Vietnam's green economy, with a value of 1.0 percent. These results are science evident for policy implications to enhance the attraction of foreign direct investment (FDI) and the green economy of Vietnam in Vietnam. Although the opportunity to receive FDI is enormous, the competition to attract FDI is increasingly fierce, especially in the context of limited capital supply and the heavy impact of the Covid-19 pandemic take advantage of attracting external resources to maintain and recover the economy. Therefore, competition to attract FDI among developing countries with similarities in the market, development level, technology, and labor is increasingly fierce.



Source: Authors collected and processed from SPSS 20.0, Amos

Figure 2. Testing SEM for factors affecting the attraction of foreign direct investment (FDI) and the green economy of Vietnam

Figure 2 showed that the assessment the attraction of foreign direct investment (FDI) and the green economy of Vietnam: CMIN/DF = 2.169 (<5.0), GFI = 0.955 (>0.800), TLI = 0.986 (>0.900), CFI = 0.989 (> 0.900) and RMSEA = 0.042 (<0.08). The article's main goal is to explore critical factors that can affect the attraction of foreign direct investment (FDI) and the green economy of Vietnam. Therefore, in the coming time, Vietnam needs to focus on finding measures that can develop service industries in-depth, creating a good impetus for increasing the productivity of the service sector, the production and business sector, and many other sectors of the economy. In addition, Vietnam needs to prepare necessary conditions to attract investment, such as reviewing and supplementing the clean land fund, reviewing the electricity planning, and training high-quality human resources.

Supplementing policies to develop supporting industries; evolving regulations and standards as a new filter to select FDI investors with advanced technology, able to withstand external pressure for sustainable development and national security.

Table 3. Testing Bootstrap for critical factors affecting the green economy and foreign direct investment

Parameter			*SE*	*SE-SE*	*Mean*	*Bias*	*SE-Bias*
FDI	<---	IP	0.027	0.000	0.089	-0.002	0.001
FDI	<---	QHR	0.038	0.001	0.206	-0.002	0.001
FDI	<---	IE	0.044	0.001	0.531	-0.003	0.001
Green economy	<---	FDI	0.028	0.000	0.211	0.002	0.001
Green economy	<---	QHR	0.024	0.000	0.065	-0.002	0.001
Green economy	<---	IP	0.022	0.000	0.065	-0.001	0.000
Green economy	<---	IE	0.024	0.000	0.155	-0.002	0.001

Source: Authors collected and processed from SPSS 20.0, Amos

Table 3 shows that testing results are consistent with the survey data and is also reliable scientific evidence to suggest the main implication.

3.4 Result discussion

The new context with many opportunities and challenges today requires Vietnam to make changes in its strategic orientation to attract FDI in the coming time, specifically as follows:

First of all, the Ministry of Planning and Investment shall coordinate with the Ministry of Foreign Affairs and other ministries and branches to develop strategies to attract investment capital from large technology corporations and submit them to the Prime Minister for approval (local areas, priority technology industries, competitive policies to encourage and support investment, etc.). Besides, Vietnam reviews and timely adjusts foreign investment policies to suit and keep up with fluctuations and uncertainties of the global economy and changes in FDI attraction strategies of countries around the world.

Secondly, Vietnam continues to focus on preventing and controlling the Covid-19 epidemic, in parallel with recovering the economy after the pandemic so that investors can safely access and learn about the Vietnamese market. Maintaining the stability of the macro environment and improving the economy's resilience to external shocks. At the same time, always ensure the consistency, strength, and suitability of mechanisms and policies on taxes, land, and labor... so that foreign investors can feel secure in building long-term investment plans in Vietnam.

Thirdly, Vietnam reviews, update and adjust appropriately in decentralizing investment approval, streamlining the process and procedures, publishing regulations, and transparent public processes. Accelerating investment, upgrading infrastructure synchronous infrastructure (industrial park, electricity, water, transport infrastructure, information, logistics, services associated with the industrial park.

Building long-term strategies to drastically improve the business environment, ensuring publicity and transparency, administrative procedures need to be simplified, convenient, and practical...

Fourthly, it is necessary to prepare a long-term strategy to attract FDI, shift the focus of foreign investment attraction and cooperation policies from quantity to quality, prioritize projects with high added value and models, and modern management. Actively selectively attract FDI projects; If you take the initiative in FDI projects, especially those with significant capital sources and business lines that focus on critical national goals, you should have separate policies to attract them effectively.

Finally, it is necessary to encourage and create conditions for FDI projects to invest and produce in Vietnam in the form of joint ventures with domestic enterprises so that Vietnamese enterprises have requirements to access technology and skills, modern management of FDI enterprises, and at the same time help FDI enterprises focus on critical stages to create products. In recent years, FDI inflows into Vietnam focus more on sustainable development projects. Technology, processing, manufacturing, and green energy are becoming the primary investment areas of FDI. Most recent FDI inflows have gone into high-quality, green, or renewable projects. With the current trend, the future of FDI inflows into sustainable development in Vietnam is positive.

CONCLUSIONS

Despite many challenges caused by Covid-19 in 2021, Vietnam continues to be considered a beautiful investment market. The attractiveness of the Vietnamese market comes from its stable political background, which is expected to be a desirable investment market. With large foreign exchange reserves, a cost-effective operating environment, and a persistent and hard-working workforce, Vietnam has 15 signed Free Trade Agreements, high vaccination rates, prospects for rehabilitation, and substantial economic recovery.

Based on applying quantitative research processed by SPSS 20.0 and Amos software based on surveying 700 foreign investors with descriptive statistical tools, measuring scales with Cronbach's Alpha, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), structural equation modeling (SEM). The article's findings have three key factors affecting the attraction of foreign direct investment (FDI) for the green economy of Vietnam, with a significance of 1.0 percent. This is also reliable scientific evidence to suggest the main implication.

However, there are also challenges to be faced, such as the legal framework and regulations related to sustainable development need to be further improved in terms of consistency, especially environmental tax and preferential conditions. to encourage investment in sustainable development. The Government needs to continue actions and policies for a long time to continue to attract FDI in the fields of high technology and renewable energy; diversify FDI flows; closely monitor and manage FDI inflows into provinces/cities to ensure local governments comply with national environmental targets.

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Asymmetric Effect of Investors Sentiments on Herding Behavior and Stock Returns: Pre and Post Covid-19 Analysis

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ABSTRACT

The study investigates the asymmetric effect of investors sentiments on herding behavior and stock returns of S&P 500 markets during pre and post covid 19. We analyze daily data from May 15, 2000 (Pre Covid) to 20 Feb 2020 and form 20 Feb to –13 May, 2022 (Post Covid). We conduct Modified multiple regression Analysis by introducing investors sentiments proxy i.e., trading volume into the Chang et al., (2000) herding model named as cross-sectional absolute deviation along with Vector Autoregressive Regression and Granger Causality tests. We establish that trading volume increases herding asymmetric. Post COVID-19 has significant negative effects on herding behaviour. The findings illustrate that COVID-19 increased herding behavior in S&P 500 markets and became more intensified during COVID-19, which contributes to accentuate and elongate it. The study also documents significant positive effect of investor sentiment on stock returns, whereas COVID-19 has negative effect on S&P 500 stock returns. We propose that investor sentiments may present extrapolative or predictive feature of herding behaviour. The study will be beneficial to shape an understanding of different dynamics associated with portfolio and market in-efficiency, trading strategies as well as risk management perspective.

INTRODUCTION

Over the years, the modeling of decision-making process and how investors behaviour patterns impact stock prices have turned out to be a challenge among stock markets players, academia and financial researchers. While efficient market hypothesis (EMH) stats that investors are fully rational, their decision

making is grounded on all available information and markets are informationally efficient. The behavioral finance theory challenged and argue that in real world market participants are not rational fully. A growing of empirical evidence that demonstrates agents are not fully rational, because they don't have the same faculty or programming in the mind to process all information in the same way, con-sequently commit systemic error, and manifested in the form of inefficient prices (Jlassi and Bensaida, 2014; and Choi and Yoon, 2020). Besides, the decisions are significantly complicated in markets with the asymmetry of the information caused by many reasons, first of all, illegal activity of economic actors (Mishchuk et al., 2018; Shkolnyk et al., 2020). The investment behaviour of markets participants' is associated with many factors such as volatile economic environment, trading behaviour of other markets players and changes in corporate values. Some authors explain changes in investment behaviour by shifts in business culture (Gao et al., 2022), including changes in stakeholders values that should be met by companies (Samoliuk et al., 2022). In the similar strain, there are various flaws and cognitive (How People think) biases, such as human errors in financial markets trading process. In this situation, sometime invertors fail to act their own information or ignore their beliefs and tend to follow market sentiments or rely profoundly on others investments actions and act to buy or sell. This is what we call herding behaviour meaning people are imitating each other.

This phenomenon was seen in financial markets for example the 2007-2008 global financial crunch and 2000-2021 IT bubble (Alexakis, 2011; Ergun and Durukan, 2017 and Zouaoui and Nouyrigat, 2011). In addition, Investors' Herding can be of two types i.e., rational or irrational herding (Alexakis, 2011). Where participants in the financial markets utilizes information about the behaviour of others participants rather than taking cues from the financial markets themselves is called rational herding (Zouaoui and Nouyrigat, 2011; Choi and Yoon, 2020). Whereas, sometime people follow the flow of market without assessing the fundamental values is termed as irrational herding (Ergun and Durukan, 2017). Numerous authors assert that based on emotions and psychological biases only the behavioral finance may perhaps put forword an adequate apprehension of one of the complex puzzles of as far as human's decision-making is concerned. In behavioral finance herding is regarded as one of the key features in eludcidating the market fantasy or bubbles because it is mostely viewed as a motivating force of bubble and price's variation or heterogeneity from its fundamental value. Moreover, in existence of (SC) social connectivity erroneous thought ,Concepets as well as beliefs can be carried particularly from one individual and generate an adding bubble as well as prime to market disruption (Jlassi and Bensaida, 2014; Grullon et al., 2005) and Dawkins, 1976). A lot of violations of EMH proposition has been reported over the past couple of years. In the paper "The end of Behavioral Finance", Thaler (1990) concludes: "*I predict that in the not-too-distant future, the term "behavioral finance" will be correctly viewed as a redundant phrase. What other kind of finance is there? In their enlightenment, economists will routinely incorporate as much "behavior" into their models as they observe in the real world. After all, to do otherwise would be irrational*". Contends that the (FM) "*financial markets are efficient and security prices fully reflect all available information at any time; and investors are rational in these efficient markets. But reality is somewhat different and investor's decisions are governed by their emotions and individual behaves irrationally because their decisions are caused by their emotions*".

Considering the aforementioned trajectory of background of the problem there is growing scholarly empirical evidence that demonstrates agents are not fully rational, because they don't have the same faculty or programming in the mind to process all information in the same way, consequently, commit systematic error, and manifested in the form of inefficient prices (Jlassi and Bensaida, 2014; Grullon et al., 2005). The volatile economic environment and fluctuations in the stock returns and cognitive basis such as herding, overconfidence, prospect theory, mental accounting, framing, investors sentiments and disposition effect the investors decision are get affected (Zouaoui and Nouyrigat, 2011; Choi and Yoon, 2020). There is sheer knowledge gap therefore We take a different approach.We link psychological research and a traditional modified basic model by conducting robust survey of herding behaviour. We introduce investors sentiments as an explanatory behavioral bias to investigate whether investors sentiments are preponderating force or factor specifically fueling herding behaviour during tranquil as well as turmoil period. As one of the utmost contagious viruses in history named as Corona Virus (Covid-19) spread with astound pace around the globe blighting millions of people in the year 2020. Above and

beyond, killing massive number of persons, the catastrophe not only exploded severe panic and chaos among them, it even affected vast businesses and stock markets around the globe.

Therefore, this study is undertaken to investigate asymmetric impact of investors sentiments on extent of herding behaviour and stock market in S&P 500 markets during spread of covid-19. This study uses daily data from May 15, 2000 –13 (Pre-Covid) and MAY, 2022 Post-Covid. We purpose that investor sentiments may present extrapolative explanatory or predictive feature of herding behaviour. We conduct Modified multiple regression Analysis (MMRA) by introducing investors sentiments proxy i.e., Trading Volume (TV) to herding model named as CSAD- cross sectional absolute deviation. We establish that Trading volume contributes in increasing herding asymmetric. Post Covid 19 pandemic has negative and statistically significant effects on herding behaviour. The current research fallouts also illustrate robust indication that Covid 19 pandemic increased herding behavior in S&P 500 markets. We find that investors herding behaviour is more intensified during Covid out-break, whichin tern contributes to accentuate as well as elongate it. The study also documents those investors sentiments has significant positive effect before covid 19 whereas covid 19 has negative effect on S& P 500 stock returns.

The first contribution of this paper is the inclusion of the asymmetric effect of Covid-19 pandemic and investors sentiment proxy (Trade Volume) on herding behavior by conducting Modified multiple regression Analysis (MMRA) to herding model named as CSAD- cross sectional absolute deviation. This paper analyzed daily time series data with covering good Spain of time data which is the second contribution.The reminder of the study is as follows: - the section 1 presents the literature reviw and formulation of hypotheses, section 2 consort with research methodology and data description, the section 3 offers the empirical results and discussion and section 4 contains the conclusion summary, policy implication, research limitations and directions for future researchers.

1. LITERATURE REVIEW

A strand of literature is replete with more empirical studies than the scholarly theoretical studies on herding behaviour because the measurement of the extent of herding behaviour in real market is difficult. So, several herding behavior measurements have been utilized in carrying out empirical studies, such as (CSAD) Cross-sectional Standard deviation, (LSV) Lakonishok Shleifer and Vishay model, (PCM) Portfolio change measure as well as (CSSA) Cross-Sectional Absolute Deviation (Ergun and Durukan, 2017; Zouaoui and Nouyrigat, 2011; and Chang et al. 2000). However, after gone over recent literature till present day, the most popular approach has been the CSAD, since other herding behaviour measurement methods based on low frequency data as well as need investor's holding information (Choi and Yoon, 2020; Chang et al. 2000; Chiang and Zheng, 2010). In context of US stock markets Christie and Huang CSSD model was used by major empirical studies to examine the investors herding behavior during market stress. The fallouts of these studies reported that there were no investors herding behavior in time of high price volatility. To that respect, Chang et al. (2000) applied the CSAD in place of the CSSD and reported that there was no herding behaviour in perspective of US, Japan and Hong Kong.

However, their research documents herding behaviour in cases of Taiwan and Koeria. Lao and Singh (2011) documented herding presence in cases of Chinese A share companies in their studies. These researchers also documented stronger herding behaviour evidences during high trading volume than down-market trading volume. To that respect Lam and Qiao (2015) established evidence of herding behaviour in case of Hong Kong's stock market. Another important study carried by Economou et al. (2015) established that herding behavior in context of Portuguese market. Moreover, in context of frontier economy like (Bangladesh, Egypt) emerging (Indonesia, Malaysia, Pakistan) and developed economies like (Morocco and Turkey) To this addition, Pochea et al. (2017) also established the herding behavior among seven countries in their analysis including, Croatia, Hungary, the Czech Republic as well as Bulgaria. On the other extreme of the strand of literature, several recent empirical studies reported the reverse he herding behaviour for instance. an important study conducted by Jlassi, and Bensaida, (2014) in order to investigate reverse herding and found that reverse herding accentuates and elongate return dispersion return dispersion above the national prices level. This infers that the investors accommodate their investment portfolios to shelter risk-less assets within high uncertainty. The IS means investors the

optimism/pessimism about the activity of future stock market (Jlassi, and Bensaida, 2014). Investors sentiments (IS) as the way investors form beliefs (Ibid.). The measurement of investors has always been thought-provoking. Baker et al. (2012) argued that investor sentiment is an important type of overconfidence bias and acting as an imperative behavioral factor in explaining investors herding behaviour (Jlassi, and Bensaida, 2014) reported that Spanish stock market to probe whether the behaviour of investors can be described by emotional factors or not by employing a popular Granger causal test, and established that herding behavior was described by past returns as well as investor sentiment. They also argued that the investor sentiment is one of the imperative factors that explaining herding behaviour. In the similar stern PH and Rishad, (2020) and Economou et al. (2018) also argued that the market sentiment is a most important factor in elucidating herding behavior.Choi and Yoon (2020) studied the linkage between herding behaviour and investors sentiments in context of Korean stock market by employing the CSAD herding technique. Through quantile regression found herding evidence and conclude that the IS are one of the imperative features that can cause herding behavior. Baker et al. (2012) developed sentiment index by considering United Kingdom, Germany, France, United States, Japan by gathering pooled data covering period from 1981 to 2006 and argued that investors can help to predict returns. Fernandes et al. (2013) used CCI to investigate the impact of IS on markets returns of Portuguese share and negative impact IS on returns.

Lemmon and Portniaguina (2006) employed CCI and indicated that individual investors incline to be uncovered to mispricing owing to sentiment. Cheema et al. (2018) conduct research in perspective of China and found positive linkage between sentiments during bubble and insignificant after bubble period. Literature is replete with many proxy measures for IS . For instance CCI (Oprea and Brad, 2014), Fear and greed index Baker and Stein (2012) and trading volume by (Jlassi, and Bensaida, 2014; Anusakumar, and Wooi, (2017).There are different proxies to be used if different proxies give fallouts (Güler, 2021). Lemmon and Portniaguina (2006) stated that in spite of its widespread appliciation in theoretical research, T.V. trading volume was only new-flanged unified measure in the APM named as asset pricing models. In addition, trading volume has complex non-linear linkage with stock prices and herding behavior is an important psychological force.

1.2 Formulation of Hypothesis

The RT-Rational theory assumes that there is linear association between dispersion of Stock & returns. But, if investors imitate (herd) each other, then (SR) stock returns would not diverge in a significant manner from (MR) market return. So, we should in turn observe a decline as far as the dispersion level in the period of economic turmoil is concerned (Jlassi, and Bensaida, 2014). Under CAPM theorem, the relationship between return dispersion of equity and market returns in considered to be linear. If herding behavior exists it would in turn imply violation of return model. The behavioral proponents argue that investors tend to follow aggregate behavior of the market behavior, by forgetting their investment strategies. Consequently, the linkage between returns of equity and market return will become non-linear (Choi et al., 2020). We proposed that IS may present extrapolative or predictive feature of herding behaviour as doumented by (Jlassi and Bensaida, 2014 and Grullon et al., 2005). A lot of violations of EMH proposition has been reported over the past couple of years Baker et al. (2012) argued that investor sentiment is an important type of overconfidence bias and acting as an imperative behavioral factor in explaining investors herding behaviour. Jlassi, and Bensaida, (2014) documented whether the behaviour of investors can be described by emotional factors or not by employing a popular Granger causal test, and established that herding behavior was described by past returns as well as investor sentiment. They also argued that the investor sentiment is one of the imperative factors that explaining herding behaviour. In the similar stern et al. (2018) also argued that the market sentiment is a most important factor.

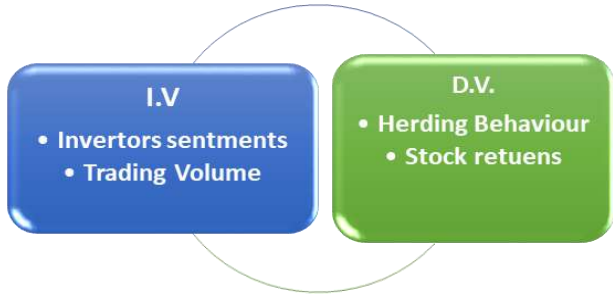

Figure 1. Conceptual Framework _investors sentiments herding behavior and stock returns

Source: authors conceptualization

Hypotheis of the study are outlined below:

H1: *There is significant asymmetric association between investor sentiments and herding behaviour during tranquil period* (before Covid 19 Pandemic).

H2: *There is significant asymmetric association between investor sentiments and herding behaviour during turmoil period* (after Covid 19 Pandemic).

H3: *There is significant asymmetric association between investor sentiments and stock returns during tranquil period* (before Covid 19 Pandemic).

H4: *There is significant asymmetric association between Stock returns and herding behaviour during turmoil period* (after Covid 19 Pandemic).

2. METHODOLOGICAL APPROACH

The study investigated the asymmetric effect of investors sentiments on herding behavior and stock returns of S&P 500 markets during pre and post covid 19 pandemics.

2.1 Study Population, Sample and data collection

The population of the study was companies listed on US stock exchange. We analyzed daily data from May 15, 2000 (Pre Covid) to 20 Feb 2020 and form 20 Feb to –13 May, 2022 (Post Covid). The Table 1 presents the Sources of Data collection.

Table 1. Data Streams and Sources of Data collection

S.No.	*Data streams and Sources*
1	https://www.investing.com/
2	https://tradingeconomics.com/
3	https://www.spglobal.com/spdji/en/indices/equity/sp-500/#overview).
4	https://finance.yahoo.com/
5	https://finance.yahhttps//finance.yahoo.com/,https://www.thomsonreuters.com/en.html,
6	https://www.investopedia.com/terms/s/sp500.asp

2.2 Variable Description Measurement and Econometrics Modeling

We used equation 1 to calculate stock returns as used (Jlassi and Bensaida, 2014; Anusakumar, and Wooi, 2017).

Equation 1. Rm, t=100*(log (Pt)-(log (Pt-1)

Where Rm, t= returns, t=at time, Pt =Closing individual stock daily price prices, P t-1= Price of individual stocks at the end of the previous month. In order to maintain a consistent proxy measure of investor sentiment across markets a proxy measure of IS' we took into consideration was the trading volume throughout as a measure of investors sentiments as used by (Jlassi and Bensaida, 2014; Anusakumar, and Wooi, 2017). Based on logarithmic this study utilized following formula as used by (Jlassi, and Bensaida, 2014; PH and Rishad, 2020 and Güler, 2021).

Equation 2. IS_TVm, t=log (IS_TVm, t)-log (IS_TVm, t-1)

Where, IS_VO represents investors sentiments measured through Trading volume, t is the daily IS_TV scaled by market capitalization. Formal CSADt (Chang et al., 2000) equation as under:

Equation 3. $CSADt=\alpha+\Upsilon_1 |Rm, t|+\Upsilon_2 R^2 m, t+\varepsilon_t$

In equation 3, Rm, t = is the average market return of a cross section of all firms' stocks at time t, |Rm, t|= absolute term (of a cross section of all firms' stocks at time t), R2m, t= is the non-linear term (to capture investors herding behavior), ϒ=coefficient, εt= error term. If the ϒ2 (coefficient) is negative and statistically significant, this suggests that herding behavior exists in stock market. If ϒ2 (coefficient) is positive and statically significant, this suggests that there is a reverse herding exists in the stock market. The term absolute return (Equaion 4) means the absolute gain or loss (in terms of %) an investment generates over a specific period of time (Chang et al., 2000).

Equation 4. $\mathrm{CSADt} = 1/N \sum_{I=1}^{N} |\mathrm{Ri,t} - \mathrm{Rm,t}|$

Equation 5. $\mathrm{CSADt} = \alpha + \Upsilon_1 |Rm,t| + \Upsilon_2 R^2 m,t + \Upsilon_3 |\mathrm{IS-TVm,t}| + \Upsilon_4\ S\_TV^2 m,t + \varepsilon t$

In equation 5, Rm, t = is the average market return of a cross section of all firms' stocks at time t, |Rm, t|= absolute term (of a cross section of all firms' stocks at time t), R2m, t= is the non-linear term (to capture investors herding behavior),|ϒ3IS_TVm, t| = absolute Term cross section trading volume of all firms at time t), IS_ TV 2m, t= is the non-linear term (to capture investors sentiment i.e., trading volume effect), ϒ=coefficient , εt= error term , If the ϒ2 (coefficient) is negative and statistically significant, this suggests that herding behavior exists in stock market. If ϒ2 (coefficient) is positive and statically significant, this suggests that there is a reverse herding exists in the stock market, the term absolute return means the absolute gain or loss (in terms of percentage) an investment generates over a specific period of time.

Equation 6. $\mathrm{CSADt} = \alpha + \Upsilon_1 |\mathrm{Rm,t}| + \Upsilon_2 \mathrm{R^2 m,t} + \Upsilon_3 |\mathrm{IS-TVm,t}| + \Upsilon_4\ \mathrm{S\_TV^2 m,t} + \delta_1 \mathrm{DCt} + \varepsilon t$

In equation 6, by addeding Covid 19 (DCt) as dummy variable that takes value 1 in equation 3 to capture the impact of post Covid 19 effects on herding.

2.3 Asymmetric Effect of Investor sentiment on herding behavior

Additionally, to offer robustness surveys we inspect the asymmetric effect between the variables. Ceremoniously, we determine or asses investors herding behavior across periods of (HTV) i.e., high trading volume as well as low trading volume (LTV) by considering dummy variables as used in litrature. We used top 10th percentile for abnormal (HTV) whereas for abnormal (LTV) bottom 10th percentile in line with (Jlassi, and Bensaida, 2014; Anusakumar, and Wooi, 2017). The staticically significant negative value of Υ_1 and Υ_2 parameters encapsulate the presence of investors herding and vice versa i.e,.positive & significant sign encapsulate inexistance. DCt= DCt represents Covid 19 as dummy variable that takes value 1 to capture the impact of post Covid 19 effects on herding. To do so, equation 7 and 8 have been foluulated stated as under;

Pre- Covid

Equation 7. $\mathrm{CSADt} = \alpha + \Upsilon_1 |\mathrm{Rm,t}| + \Upsilon_2 \mathrm{R^2 m,t} + \theta_1\ \mathrm{IS-TV_{high} R^2 m,t} + \theta_2 \mathrm{IS-TV_{low} R^2 m,t} + \varepsilon t$

Post Covid

Eqution 8. $\mathrm{CSADt} = \boldsymbol{\alpha} + \Upsilon_1 |\mathrm{Rm,t}| + \Upsilon_2 \mathrm{R^2 m,t} + \boldsymbol{\theta}_1 \mathrm{IS-TV_{high} R^2 m,t} + \boldsymbol{\theta}_2 \mathrm{IS-TV_{low} R^2 m,t} + \delta_1 \mathrm{DCt} + \varepsilon t$

2.4 Vector Autoregressive Regression (VAR) and Granger Causality tests

We used Vector Autoregressive Regression (VAR) and Granger Causality tests between trading Volume (TV) a measure of investors sentiments and herding. It is extensively acknowledged that the divergent in TV often precedes the change in the price of stocks. For example,HIP termed as high index prices are cause by (HTV). Yet, the extent of delay as well as the nature of linkage between the (PV) price-volume leftover. Exclusively, less is explored with regard to dual influencing linkage relaying on TV and herding as it is deducted based on return of stock (SR) dispersion (Jlassi, and Bensaida, 2014; Anusakumar, and Wooi, 2017).

Equation 9. $I: Prob\ (\ X_{t+1}\acute{O}\ l\ \Omega_t)\ \#Prob\ (\ \Omega_t - X_{t+1}\acute{O}\ l\ \ \Omega_{t+1}t - \ Y_1)$

In the equation 9, Omega (Ω), t(time), Ωt variable is the information set comprising of all the available information bot up to as well as at time t. Hence, Yt can cause Xt+1 when it keeps some of the exclusive information with regard to Xt+1. Certainly, (dummy) disiginates with symbol (X) can support to outline (Y). Moreover, if the β of the lagged difference (LD) of (X) are statistically meaningful as well as significant statistically. This study employed (GC) Granger causality equations formally as used by (Jlassi, and Bensaida, 2014; Anusakumar, and Wooi, 2017) as under.

Equation 10. $\mathrm{CSADt} = \Upsilon_1 + \sum_{\mathrm{I=1}}^{\mathrm{p}} \boldsymbol{\alpha}_{\mathrm{i}}\ \mathrm{CSAD}_{\mathrm{t-i}} + \sum_{\mathrm{J=1}}^{\mathrm{p}} ß_1\ \ \mathrm{IS\_TV}_{\mathrm{m-i=J}} + \varepsilon\mathrm{t}$

Equation 11. $\mathrm{IS\_TV\ t} = \Upsilon_1 + \sum_{\mathrm{I=1}}^{\mathrm{p}} \boldsymbol{\alpha}_{\mathrm{i}}\ \mathrm{IS\_TV}_{\mathrm{t-i}} + \sum_{\mathrm{J=1}}^{\mathrm{p}} ß_1\ \mathrm{CSSD}_{\mathrm{t=J}}\ + \varepsilon\mathrm{t}$

The restoring forces into the market equilibrium are stating in equation (10 and 11), where γ1 and 1 p is number of lags. IS_TV m-i=J as well as CSSDt=J both are corresponding lagged herding Variable (LHV) and (LTV) lagged Trading Volume. The null hypothesis is;

Equation 12. $\mathbf{H}_0: \alpha_{\mathrm{J}} = 0$

The IS_TV does not Granger-cause investors herding behaviour (P<5 %) indicate that market return may enhance herd behavior. In addition to this, "it should be emphasized that granger causality (GC) assumption i.e., 2 time series of TV and investors herding variable should be cointegrated, i.e., both variables variation's wavelengths have to be of the same order"(Jlassi, and Bensaida, 2014)

2.5 Effect of Investors Sentiments on S&P Stock Return

To analyze c effect Investors sentiments, on stock return post and pre Covid 19 pandemic, the study built following MMR model.

Equation 13. $\mathrm{Rm,t}\ = \alpha + \beta_1 \mathrm{IS\_TV}^2\mathrm{m,t} + \delta_1 \mathrm{DCt} + \varepsilon\mathrm{t}$

Equation 14. $\mathrm{Rm,t} = \alpha + \beta_1 \mathrm{IS\_TV}^2\mathrm{m,t} + + \varepsilon\mathrm{t}$

3. CONDUCTING RESEARCH AND RESULTS

3.1 Summary Statistics

The Table 2 reports the summary statistics by providing the statistical feature for returns Rm, t, (TV) and CSAD for S&P 500 markets over sample period (05/15/2000-05/13/2022). The mean return for S& P 500 companies over a period of (05/15/2000-05/13/2022) is very small (-0.482) whereas the TV have a (+) mean value (0.043) which are indicating that excessively trading by investors which further provide insights on irrational behavior. The standard deviation is larger than mean and maximum values which indicate there is a high volatility of S&P 500 market index.

Table 2. Descriptive Statistics of Investor Sentiments (Trading Volume) and CSAD

Variable	*Obs*	*Mean*	*Std. Dev.*	*Min*	*Max*
CSAD	5536	0.729	0.414	0.230	0.418
$R_{m,t}$	5536	-0.002	0.208	-0.782	0.213
IS-$TV_{m,t}$	5536	0.043	0.216	0.033	0.329

3.2 Normality and Stationary Test

Before proceeding further as ideally the normality test should be done as prerequisite means before undertaking a time series regression estimation. We used time series data because for this study the data collection has been done at number of specific points in time i.e., S and P 500 stocks prices. Moreover, time series can have different frequencies (Daily, weekly as well as monthly). The ADF is one of the most common statistical techniques specially when it comes to dealing with stationary time series data. The estimated statistics from ADF test whether a given time series is stationary or not are reported in table 3. It is to note that the data points are often considered as non-stationary or when they have covariance, means as well as variances that change over time and it cannot be forecasted or modeled further supposed to be unpredictable. ADF in case of -S&P 500 market Index, time series does not have a unit root because the value of p is significant at 5% confidence interval. It means data is stationary do not change overtime. Jarque-Bera test values are always positive or close to zero if not means data does not have normally distributed. The table 3 reports Jarque-Bera test statists are indicating the sample data is normally distributed and there is no issue in the data set.

Table 3. Jarque-Bera and Augmented Dickey Fuller)-S&P 500 Market Index

Variables	Jarque Bera	ADF
CSAD-Cross-sectional Absolute deviation	7804.21 ***	33.721***
$R_{m,t}$ is the average market return of a cross section of all firms' stocks at time t,	6696.123***	34.316***
IS_$TV_{m,t}$ Investors sentiments (Trading Volume)	4300.11***	30.209***

Note: *** indicates level of significance at 1%.

3.3 Modified Multiple Regression Estimation Results

Table 4. Modified Multiple Regression Estimation Results

Model 1			*Model 2*		
Effect of trading volume on herding behavior (Per-covid)			*Effect of trading volume on herding behavior (Post covid)*		
CSAD	Coef.	t-value	CSAD	Coef.	t-value
Abs_$R_{m,t}$	0.541 (0.019)	9.021	Abs_$R_{m,t}$	0.531 (0.053)	10.018
$R^2_{m,t}$	-0.431 (0.024)	-2.041	$R^2_{m,t}$	-0.046 (0.003)	-15.333
abs_IS_$TV_{m,t}$	0.052 (0.018)	2.888	abs_IS_$TV_{m,t}$	0.593 (0.016)	9.938
IS_$TV^2_{m,t}$	-0.059 (0.018)	-4.916	IS_$TV^2_{m,t}$	-0.093 (0.042)	-2.214
Cons_	0.021 (0.008)	2.625	DCt	-0.975 (0.311)	-3.136
Parametric Statistics (Normal distribution)			Constant	0.031 (0.008)	3.875

Number of obs	4952	Number of obs	816
R^2	0.141 (14.1%)	R^2	0.151 (15.1%)
Prob > F	10.103	Prob > F	12.003

Table 4 reports the equation 4 and 6 estimation results. The β (ϒ1=0.541), is positive and statistically significant at (** p<.05 and * p<.1) is singling that there is lack of compliance with or the violation of (LNC) linear regression condition and suggesting the presence of herding behavior on S&P 500 Markets. Besides, the β i.e., R^2m, t=is the non-linear term to capture investors herding behavior, (γ_2=-0.431) is also negative significant at threshold (** p<.05 and * p<.1) which significs herding on S&P markets during pre-Covid pandemic. The finding of this study confirms that the investors imitative behavior is not only present in S&P 500 markets. Hence, herding is a daily and long-lived market Participants phenomenon. The study results are in agreement with (Chang et al., 200). If the γ_2 β is negative and significant, this suggests that herding behavior exists in stock market. If γ_2 is positive and statically significant, this suggests that there is a reverse herding exists in the stock market (Chang et al., (200).The value of F-test is significant signifying precise specification of model employed with extrapolative/predictive power 14.1%. The coefficient term of (γ_3=0.052) absolute TV has positive that suggests market return (MR) dispersion upsurge with TV. Nevertheless, the β value (γ_4=-0.059) indicates this increase at a decreasing degree. The results or in consistent with (Chiang & Zheng, 2010).

Table 4 reports the results of Equation 5, over the period of 20 January 2020 to 13, May 2022 , post covid. The coefficient value (γ_5=-0.975) is negative and statistically which indicates Covid 19 effects on S&P stock herding behavior. The results also illustrate robust evidence that Covid 19 outbreak increased herding behavior in S&P 500 markets. The results are in line with (Espinosa-Méndez et al., 2021). The study outcomes of CSAD (daily cross-sectional absolute standard deviation) Eq-6 after Covid. The coefficient term of (γ_1=0.531), is positive and significant is the violation of (LNC) and signifying the evidence of herding on S&P 500 Markets. Besides, the β the non-linear term to capture investors herding behavior, (γ_2=-0.046) is also negative significant statistically at threshold (** p<.05 and * p<.1) which significs herding on S&P markets (pre-Covid pandemic). The finding of this study confirms that the investors imitative behavior is not only present in S&P 500 markets. In addition, the study results are in agreement with (Chang et al., 200). If the γ_2 (coefficient) is negative and statistically significant, this suggests that herding behavior exists in stock market. If γ_2 (coefficient) is positive and statically significant, this suggests that there is a reverse herding exists in the stock market (Chang et al., (200). The value of F-test is significant signifying precise specification of model employed with extrapolative/predictive power 14.1%. The coefficient term of (γ_3=0.593) absolute TV has positive that suggests market return (MR) dispersion upsurge with TV. Yet, the coefficient term of (γ_4=-0.093) directs this increase at a decreasing degree. The results or in consistent with (Chiang & Zheng, 2010).

3.4 Asymmetric Effect of Investor Sentiment on Herding Behavior

The table 5 reports the Equation 7 and 8 results. The empirical findings of our study corroborate modified regression results as stated in table 5 suggesting that in spite of controlling for highest as well as lowest trading days the herding in S& P 500 markets is still exits. The estimated values θ_1 and θ_2 reflects the effect of change in S&P 500 (High and low trading volume) on herding behavior. If the value of θ1 is negative and significant this infers the prevailing of herding during high market liquidity (HTV) and the same for θ_2 (LTV). Equation 8 estimated values θ_1 and θ_2 reflects the effect of change in S&P 500 (High and low trading volume) on herding behavior. If the value of θ_1 is negative and statistically significant this infers the prevailing of investors herding during (HTV) and the same as for as θ_2 (LTV) is concerned. The results of asymmetric effect of TV (investors sentiments are in agreement with volume-return equilibrium model (VREM), deposition, overconfidence models as well as information asymmetric (IA) models (Ngene and Mungai, 2022).

Table 5. Asymmetric effect of trading volume on herding behavior

Model 3			*Model 4*		
Asymmetric effect of trading volume on (Pre-Covid)			*Asymmetric effect of trading volume on (Post-Covid)*		
CSAD	Coef.	t-value	CSAD	Coef.	t-value
$Abs\_R_{m,t}$	0.5747 (0.092)	6.247	Abs_rm, t	0.673 (0.092)	7.3152
$R^2_{m,t}$	-0.523 (0.048)	-10.896	RM2m, t	-0.423 (0.051)	-8.2941
θ_1_Abs_IS_$TV_{m,t}$	-0.639 (0.125)	-5.112	θ_1_Abs_TVm, t	-0.643 (0.125)	-5.1440
θ_2_IS_$TV^2_{m,t}$	-0.317 (0.032)	3.648	θ_2_TV2m, t	-0.432 (0.091)	-4.7473
Cons_	0.225 (0.032)	-7.031	DC_t	-0.067 (0.032)	-2.0938
Parametric Statistics (Normal distribution)			Cons_	0.131 (0.032)	4.0938
Number of obs	4952		Number of obs	816	
$\theta_1 - \theta_2$	-0.322		$\theta_1 - \theta_2$	-0.211	
Adjusted R^2	0.167 (16.7%)		Adjusted R^2	0.187(18.7%)	
X^2(p-value)	23.509		X^2(p-value)	24.501	
F-test	12.191		F-test	14.101	

4.5 Vector Autoregressive Regression (VAR) and Granger Causality tests

The table 6 reports the estimated results (Eq. 10 and 11) .The empirical results (VAR) are in line with (Chuang and lee 2006*;* Jlassi, and Bensaida, 2014*)*. Here, we used the Akaike (AIC) and Schwarz (SIC) information criterions. Resultantly, we capture the effect of past one-two days log-TV on current investors herding and vice versa. We consider trading volume-investors herding linkage, 1st investors herding effect on investors sentiments proxy TV and IS proxy trading volume on investor herding. the study estimated results are meaningfull i.e., significant to one-day as well as one, two day lagged investors herding and signaling that investors herding is only influenced in S&P 500 markets by the past herding movements respectively. These empirical findings are in line with (Jlassi, and Bensaida, 2014) . Besides, these results provide insights that while the trading volumes could put forward a potential cause and it is not the prime driven factor of herding. The herding behavior is enhanced in morewhere markets are liquid, the reason behind HTV have more readily accessible financial infomation. Therefore, the investors can fetch return quicker as far as high liquid markets are concerned (Ibid.) .

In addition, Granger Causality test indicates that the IS i.e., TV Causality is driven in on sense/ direction. The estimated value of Wald_test statistics for Sand P 500 markets reject the null hypothesis means that market return (MR) dispersion (CSAD) does not granger cause TV of S&P 500 Markets since the estimated P statistics (0.031) is less than 5% threshold with significant F-Statistics value (4.883). Moreover, in accordance with VA regression test and GCT, we conclude that TV for S&P 500 markets cannot generate herding behaviour expect for the liquid markets.

Table 6. Vector Autoregressive Regression (VAC) Granger Causality tests_(GCT)

	$CSAD_t$	$IS\_TV_{,t}$
$CSAD_{t-1}$	0.732*** (-34.139)	0.421 (1.571)
$CSAD_{t-2}$	0.063 (-1.259)	-0.579** (-2.543)
$IS\_TV_{,t-1}$	0.007 (0.0431)	-0.339*** (-21.01)
$IS\_TV_{,t-2}$	(-0.005) (-0.164)	-0.212*** (-11.223)
Adjusted R^2	0.347	0.201
Statistics	71.613	65.51
Granger Causality Tests, for S&P 500 markets		
Null Hypothesis	F-Statistic	P-Value	Sig.
CSADt does not Granger Cause IS_TV m, t	4.563	0.031	***
IS_TVm, t does not Granger Cause CSADt	0.631	0.511	

Note: *** p<.01, ** p<.05, * p<.1

The study findings also suggests that investors one period herding relies on the past herding periods. The results also indicates that TV for previous two days is significant and negative. The empirical estimated values a decreasing signifying that the investor sentiments' proxy is widely explained by actual as well as past days tendency of investors herding. In addition, significant (+) and (-) linkage between investors herding d S&P 500 markets TV is highly significant indicating that investors herding can have the potential to generate (HTV). Further, (+) and significant β implying that more contemporaneous investors herding i.e., smaller CSAD will produce the HTV in S&P 500 markets in next period. The β negative value implies that 1% decrease in CSAD will cause an upsurge (accentuate) of more than 1% in the degree of TV. According to Grullon et al., (2005) under the turmoil environment, particularly during market disorder the traders have to make decision in a short time frame, resultantly they frequently fail or inapt to determine the correct fundamental value; therefore, traders elucidate the signals wrongly (RTS) relative to stock prices and they are called "Nice Traders". They are incline to go for or make irrational strategies which will further lead them towards herding and fuel the market with an abnormal accentuate TV which in turn contributes to the upsurge of increase stocks volatility.

4.6 Effect of trading volume on S&P 500 Markets returns

Table 7. Effect of trading volume on S&P 500 Markets returns

Model 5			*Model 6*		
Effect of trading volume on herding (Per-covid)			*Effect of trading volume on herding (post covid)*		
Stock return	Coef.	t-value	CSAD	Coef.	t-value
$IS\_TV^2_{m,t}$	0.174 (0.042)	2.2381	$IS\_TV^2_{m,t}$	0.094 (0.042)	2.2381
Cons_	0.031 (0.008)	3.8751	DCt	-1.065 (0.332)	-3.2078
Parametric Statistics (Normal distribution)			Constant	0.031 (1.185)	3.81029
Number of obs	4952		Number of obs	816	
R^2	0.119 (11.9%)		R^2	0.151	
Prob > F	58.003***		Prob > F	61.003***	

Note: *** p<.01, ** p<.05, * p<.1

The Table 7 reports the results of Equation 13 and 14. The term coefficient (β1 =0.094) implies that average TV has significant and positive impact on S&P 500 markets. The β_1=-1.065) is negative and significant suggests that covid 19 has significant negative impacts on S&P 500. The F-test value implies that model is correctly specified. The R^2 is explained 15.1% variability in variable stock return is due to TV and covid 19 pandemic. The Equation estimated coefficient value indicates that there is positive and significant the term coefficient (β1 =0.094) implies that average TV has significant and positive impact on average return S&P 500 markets.

CONCLUSION

This study analyzed the asymmetric effect of investors sentiments on herding behavior and stock returns of S&P 500 markets during pre and post covid 19 pandemics. We proposed that IS may present extrapolative explanatory or predictive feature of herding behaviour and tested time series daily data from May 15, 2000 (Pre Covid) –13 May, 2022 (Post Covid). We conducted (MMRA) along with Vector Autoregressive Regression and Granger Causalityby introducing investors sentiments proxy i.e., Trading Volume (T.V) into the Chang et al., (2000) herding model i.e., CSAD-.We established that TV. contributes in increasing herding asymmetric. Post Covid 19 has negative and significant effects on herding behaviour. We also found robust indication that Covid 19 increased herding behavior in S&P 500 markets. We found that herding in S&P markets is more intensified in Covid 19 period, which in turn contributes to accentuate as well as elongate it. The study also documented those IS has significant positive effect before covid 19 whereas covid 19 has negative effect on S&P 500 stock returns. This study concluded that in the period of extreme market conditions herd behavior exists. The Investors herd behavior built on market conditions and other investors decisions somewhat using their information because of heighted anxiety and fear. This study also demonstrated that sentiments of investors one of the imperative factors that could lead to investors herding behavior. So, based on study results we recommends that, the investors should be more careful to make investments decision rationally, especially where extreme market conditions and returns drop.

This paper contributes through inclusion inclusion of the asymmetric effect of Covid-19 pandemic and investors sentiment proxy (Trade Volume) on herding behavior by conducting (MMRA) to herding model. Future researchers can use alternative measures for investors sentiments, like consumer confidence index. Secondly, they can investigate the impact of macroeconomics-fundaments because herding behaviour occurs in extreme market conditions. They can also use overconfidence model and other behavioral finance basis like disposition effect, prospect theory and stock returns with updated methodology. Moreover, Future researchers may investigate the impact of investors overconfidence and loss aversion behavioral biases on economic and market performance by conducting firms level analysis (sector-wise).

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Technical Efficiency and Total Factor Productivity Changes in Manufacturing Industries: Recent Advancements in Stochastic Frontier Model Approach

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ABSTRACT

This paper aims to evaluate total factor productivity growth (TFPG) of Vietnamese manufacturing industries over the period 2000 – 2019. The stochastic frontier models were applied to decompose the sources of TFPG into technical efficiency changes, technological changes, allocative efficiency, and scale effects. We find that technological changes and the rate of scale component effect have been the major driving force of productivity growth in the 2-digit manufacturing industries as well as total manufacturing industry. In contrast, technical efficiency changes and allocative efficiency had negative effects on TFPG. Furthermore, TFP in the manufacturing sector has declined at an annual rate of -0.062 during the period of 2010 – 2015, then it grows continuously during the period of 2015 - 2019, with a rate of 5.4%. This study suggests that specific guidelines are required to promote productivity in each industrial sectors. For example, Industries with slow technological progress (textile and electrical products) require the introduction of new frontier technology. Government policy should encourage investments that can introduce newly developed production technology. In addition, considering allocative inefficiency, a policy to enhance TFP by improving resource allocation should be pursued, which be done by promoting free markets and lessening government intervention.

INTRODUCTION

Total factor productivity growth (TFPG) has been recognized as one of main sources for economic growth, and particularly important for developing countries that depend on commodity exports (Krugman, 1997). The reason for this is that technological advancements and operational efficiency are core competences for competitiveness in the international market (Mattsson et al., 2020). Therefore, a great deal of effort has been expanded in measuring and identifying sources of productivity change (Solow, 1957; Kumbhakar et al., 2000; Murillo-Zamorano, 2004).

Since the economic reform in 1986, Vietnam's real gross domestic product (GDP) has experienced dynamic performance in response to the global economic fluctuations in the past decades, however, it is still considered as one of the fastest growing economies over the period. In addition, the country has been highly successful as attracting foreign direct investment (FDI), particularly into the fast-growing electronics and garments sectors. For example, in 2020, Vietnam was recognized among the world's top 20 host economies for FDI with an inflow of USD 16 billion (UNCTAD, 2021). The manufacturing sector is of specific importance for export and potential spillover effects on other sectors (Mattsson et al., 2020). Therefore, it is important to investigate TFPG within manufacturing sector in Vietnam in searching of an explanation for the successful economic transformation model.

Previous studies on TFP in Vietnam include either non-parametric approach using data envelopment analysis (DEA) (Coelli and Rao, 2005; Ho, 2014; Nguyen et al., 2019) or parametric using the production function such as Cobb-Douglas production in logarithm form or translog function (Ngo and Tran, 2020; Le et al., 2021). To overcome the problem of endogeneity problem may arise in Cobb-Douglas production function, some studies applied semiparametric methods proposed by Olley and Pakes (1996) and Levinsohn and Petrin (2003) or GMM estimator proposed by Arellano and Bond (1991), and Blundell and Bond (1998), (Nguyen, 2017; Huynh et al., 2021).[1] However, there is a lack of studies on TFP in Vietnam using stochastic frontier analysis (SFA) approach which decomposes the growth of TFP into technical efficiency change (TEC), technological change (TC), scale effects, and allocative efficiency (Tsionas and Kumbhakar, 2014; Mattsson et al., 2020).

The aim of this paper is: (i) using stochastic frontier model (SFM) to analyses the level of technical efficiency in manufacturing industry, and in particular for 2-digit industrial sectors in Vietnam for the period of 2010 – 2019; (ii) Based on results of SFM, examine TFPG and its decomposed factors. By using firm-level data from 2010 to 2019, this paper is significant different previous studies in several aspects. First, this study contributes to literature on TFP in Vietnam by using a large-unbalanced panel data set with over 330,000 observations. Second, by decomposing TFP into a four-component SFM, this study provides additional insights into TFP performance and help us better understand why some sectors improve efficiency levels at higher rates than do others. Consequently, results also help explain differences in TFPG over time.

1. THEORETICAL MODELS

1.1 Technical efficiency

The SFM is motivated by the theoretical assumption that all firms operate as a maximize output given their quantities of inputs, however, no one can exceed the ideal "frontier" and deviations from this extreme represent firms' inefficiencies (Murillo-Zamorano, 2004; Belotti et al., 2013). To capture this, Aigner et al. (1977), Meeusen and van Den Broeck (1977), and Battese and Corra (1977) simultaneously developed a SFM that can capture not only efficiency term but also the effects of exogenous shocks beyond the control of the analyzed units. Here, we briefly describe the SFM for panel data since we are using firm-level data spanning for the period of 2010 – 2019.

Based on proposed models of Pitt and Lee (1981) and Schmidt and Sickles (1984), the standard model can be written as:

$$y_{it} = \beta_0 + \beta_i X_{it} + \varepsilon_{it}, i = 1, \dots., N, t = 1, \dots, T_i \quad (1)$$

$$\varepsilon_{it} = v_{it} - u_i$$

$$v_{it} \sim \mathcal{N}(0, \sigma_v^2)$$

$$u_i \sim \mathcal{N}^+(0, \sigma_u^2)$$

[1] The econometric issues within Cobb-Douglas function include possible simultaneity, measurement errors and the specification of the functional form.

Where y_{it} is the output of each firm i at time t, the vector X_{it} comprises factor inputs quantities, and β_i are corresponding coefficients to be estimated. Finally, ε_{it} is the composed stochastic error term contains technical inefficiency (u_i) and regular disturbance (v_{it}). Equation (1) can be rewritten as

$$y_{it} = \alpha_i + X_{it}\beta_i + v_{it} \; with \; \alpha_i = \beta_0 - u_i \quad (2)$$

Equation (2) can be estimated by fixed effects (FE) model (Schmidt and Sickles, 1984) or random effects (RE) model (Pitt and Lee, 1981) using the maximum likelihood (ML) method. It worth to note that the Equation (2) has considered technical inefficiency effects to be time-invariant. However, this assumption seems unrealistic as the time dimension becomes larger. Therefore, Cornwell et al. (1990) suggested to account for time-varying inefficiency effects by specifying a quadratic function form of time trend t so that

$$y_{it} = \beta_{it} + X_{it}\beta_i + \vartheta_{it} \; with \; \beta_{it} = \beta_{0t} - u_{it} \quad (3)$$

$$u_{it} = \theta_{1i} + \theta_{2i}t + \theta_{3i}t^2 \quad (4)$$

Where β_{0t} indicates the common intercept, θ_s represent cross-section producer specific parameters. Similarly, researchers extend model of Pitt and Lee (1981) by allowing the mean of inefficiency to vary over time, however, the temporal patterns of inefficiency only depend on one or two parameters (see e.g., Lee and Schmidt, 1993)

Recently, due to the methodological development, there has been modern SFM proposed simultaneously by Kumbhakar et al. (2014) and Colombi et al. (2014). These models overcome some limitations of the previous models by splitting the error term into four components including firms' latent heterogeneity (Greene, 2005), short-run (time-varying) inefficiency, persistent (time-invariant) inefficiency, and the random shocks (Kumbhakar et al., 2015). The model is specified as

$$y_{it} = \alpha_0 + X_{it}\beta_i + \mu_i + \vartheta_{it} - \eta_i - u_{it} \quad (5)$$

$$v_{it} \sim_{iid} \mathcal{N}(0, \sigma_v^2)$$
$$u_{it} \sim_{iid} \mathcal{N}^+(0, \sigma_u^2)$$
$$\mu_i \sim_{iid} \mathcal{N}(0, \sigma_\mu^2)$$
$$\eta_i \sim_{iid} \mathcal{N}^+(0, \sigma_\eta^2)$$

The model (5) has four components two of which, η_i and u_{it} are inefficiency and the other two are firm effects and noise, μ_i and v_{it}, respectively. In this study, we apply the model (5) to estimate the technical efficiency of manufacturing firms in Vietnam from 2010 to 2019. [2]

1.2 Total factor productivity decomposition

The measurement of TFP is based on a production function which is identical to the SFM without an inefficiency component, written as

$$Y_{it} = \gamma_0 + X_{it}\beta_i + t_t + u_{it} \quad (6)$$

where Y_{it} denotes total output of the ith firm, X_{it} is vector of j inputs. The γ_0 measures the mean efficiency level across firms and over time, T_t the time-specific effects and u_{it} the stochastic error term. The TFPG is defined as output growth unexplained by input growth, such that

$$T\dot{F}P = \dot{Y} - \sum_j S_j X_j \quad (7)$$

[2] For more details of estimating model (5), please see Kumbhakar et al. (2015).

Where S_j is input J's share in production costs. [3] Following Kumbhakar et al. (2015), we differentiate (6) and substitute (7), thus

$$T\dot{F}P = TC + TEC + (RTS - 1)\sum_j \lambda_j \dot{X}_j + \sum_j (\lambda_j - S_j)\dot{X}_j \quad (8)$$

Where $RTS = \sum_j \frac{\partial lnY}{\partial lnX_j} \equiv \sum_j e_j$ is measure of return to scale, and e_j are input elasticities defined at the production frontier, $\lambda_j = {}^{e_j}/_{RTS}$ is marginal product of input X_j.

The equation (8) decomposes TFP change into:

Scale components (SC), $(RTS - 1)\sum_j \lambda_j \dot{X}_j$,
Technological change (TC),
Technical efficiency change (TEC),

And allocative component (AC), $\sum_j (\lambda_j - S_j)\dot{X}_j$

2. METHODOLOGY AND DATA

2.1 The model

Since the four-component SFM is perform better than previous model, we adopt it in this paper to analyze TFP change for manufacturing firms in Vietnam (Mattsson et al., 2020). We apply the multistep procedure proposed by Kumbhakar et al. (2014) because it is straightforward to implement and possible verification for each step. Although some may argue that Kumbhakar et al. (2014)'s procedure is not efficient as other single-stage procedures, however, this argument is not crucial as the number of observations is large in this paper (Mattsson et al., 2020). To apply the multistep procedure, equation (5) is rewritten as

$$\begin{aligned} &y_{it} = \alpha_0^* + X_{it}\beta_i + \alpha_i + \varepsilon_{it} \\ &where\, \alpha_0^* = \alpha_0 - E(\eta_i) - E(u_{it}) \\ &\alpha_i = \mu_i - \eta_i + E(\eta_i) \\ &and\, \varepsilon_{it} = v_{it} - u_{it} + E(u_{it}) \end{aligned} \quad (9)$$

The most common functional forms of the model in equation (9) are Cobb-Douglas production function and translog function (Murillo-Zamorano, 2004). While the former is preferred because of its simple linear regression, the latter provides for some generality and encompasses all commonly used specifications (Sharma et al., 2007). In addition, the translog model also allows for non-constant return to scales as well as varying of elasticities among inputs. Therefore, following Sharma et al. (2007), this study applies the translog specification of model (9), so that

$$\begin{aligned} lnY_{it} = {} & \beta_0 + \beta_1 lnK_{it} + \beta_2 lnL_{it} + \beta_3 lnK_{it}^2 + \beta_4 lnL_{it}^2 + \beta_5 (lnK_{it} * lnL_{it}) + \beta_6 t + \beta_7 t^2 + \beta_8 (t * lnK_{it}) \\ & + \beta_9 (t * lnL_{it}) + \varepsilon_{it} \end{aligned} \quad (10)$$

Where K, L are capital and labor inputs, respectively. Technological change is captured by the time trend, t, and the production function in equation (10) is allowed to vary over time. The model in equation (10) turns out to be a standard panel data model and can be estimated by panel data estimation methods. [4] The estimated results of model (10) will be used to estimate TFP change basing on equation (8).

[3] Subscripts *i* and *t* are omitted to avoid notational clutter.
[4] The multistep procedure is implemented in Stata using the commands which is written by Kumbhakar et al. (2015).

2.2 Data

An unbalanced firm-level panel data set that covers all firms within manufacturing industry in Vietnam during the period 2010 – 2019 is obtained from the General Statistics Office (GSO) of Vietnam. The manufacturing sector consists of the two-digit VSIC2018 from 10 to 35. The data set includes capital assets (K), number of full-time employees (L), and value-added (Y). All nominal variables were converted into 2010 constant price using annual GDP deflator.

Table 1 reports the descriptive statistics after elimination of outliers. Although there are no universally accepted method for outlier detection, we follow the method proposed by recent literature on TFP and exclude observations that have the value added in present year changes more than 80% in comparison with previous year (Mattsson et al., 2020). In addition, variables in SFM are in logarithm form, hence, we also exclude missing and zero observations after performing log transformation. After these exclusions, the data consists of 363,807 observations. We also report the summary statistics of variables in three-groups of firm ownerships including state-owned enterprises (SOEs), foreign invested enterprises (FIEs), and private enterprises (PRIVs).

Table 1. Descriptive statistics of the used variables

	Total	*SOEs*	*FIEs*	*PRIVs*
Observations	363,807	7,400	45,393	311,014
Value added (*Y*)	886.61	4,812.00	3,823.35	326.64
	(19,474.87)	(29,703.28)	(51,525.82)	(2,205.98)
Capital (*K*)	6,924.62	2,488.91	55,075.63	139.39
	(3,993,629.00)	(12,369.48)	(11,400,000.00)	(20,529.59)
Labour (*L*)	114.79	459.56	508.41	50.91
	(726.72)	(738.45)	(1,892.73)	(250.55)
Time variable	2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019			
Industrial dummies	5-digit from 10101 to 33200			

Notes: the value without parentheses is mean of variables, standard deviations are in parentheses.

3. RESULTS

First, we present results of technical efficiency and its relative specifications. Second, TC, SC and AC are presented before we use them to calculate TFPG.

3.1 Technological efficiency

Column (1) of Table 2 presents baseline estimates of the equation (10). All coefficients in the production function are individually statistically significant at conventional level of confidence. In order to check for the robustness of our results, we include the industry dummy variables which are constructed on 5-digit industry level (VSIC 5-digit classes) to control for industry specific effects. [5] The results are presented in column (2) of Table 2. It can be seen from Table 2 that the inclusion of industry dummy variables does not alter the baseline results of this study.

[5] In order to save space, we have not listed the estimation results of industry dummies in column (2) of Table 2. However, it is worth noting that the inclusion of these dummies increased the fit of the estimated model, since dummies are significant at conventional levels.

Table 2. Coefficient estimates of translog production function, 2010 -2019

	(1) Y	(2) Y
β_1	0.193***	0.153***
	(0.003)	(0.003)
β_2	0.894***	0.878***
	(0.004)	(0.004)
β_3	0.101***	0.088***
	(0.001)	(0.001)
β_4	0.108***	0.124***
	(0.001)	(0.001)
β_5	-0.095***	-0.089***
	(0.001)	(0.001)
β_6	-0.125***	-0.111***
	(0.004)	(0.004)
β_7	0.027***	0.025***
	(0.001)	(0.001)
β_8	0.012***	0.013***
	(0.001)	(0.000)
β_9	-0.031***	-0.031***
	(0.001)	(0.001)
β_0	2.711***	2.972***
	(0.012)	(0.076)
Industry dummy	No	Yes
usigmas		
t	-0.044***	-0.035***
	(0.002)	(0.002)
_cons	1.119***	1.100***
	(0.011)	(0.010)
vsigmas		
_cons	0.089***	-0.104***
	(0.005)	(0.005)
Observations	336201	336201
chi2	835471.302	951400.356
p	0.000	0.000

Notes: Standard errors are in parentheses; *, ** and *** denote 10%, 5% and 1% levels of significance, respectively; for brevity, the coefficients of industrial dummies are not reported here. The estimation is based on ML method.

Source: Authors' estimation.

The TE measures are presented in Table 3. The results indicate that the TE on average is to be around 42 percent. Comparing the level of efficiency by sector, the Table 3 showed that for the whole period 2010 – 2019, the TE differs from 0.394 for FBT to 0.411 within ONMP. The other industries have estimates that range from 0.387 to 0.410. The average TE for all industries fluctuates throughout the sample period, 2010 – 2019, and reaches peaks in 2011 and 2016.

Table 3. Technical efficiency (TE) by year and by sub-sector

Year	Mean	Std. Dev.	Max
2010	0.370	0.169	0.887
2011	0.434	0.150	0.843
2012	0.406	0.170	0.894
2013	0.400	0.167	0.890
2014	0.426	0.175	0.884
2015	0.398	0.173	0.857
2016	0.432	0.145	0.865
2017	0.424	0.157	0.860
2018	0.427	0.161	0.879
2019	0.415	0.150	0.862
By Industry sector for 2010 - 2019			
All manufacturing	0.418	0.155	0.894
Food products, beverages, and tobacco (FBT)	0.394	0.182	0.881
Textile and leather products	0.403	0.157	0.880
Wood and products of wood	0.397	0.174	0.858
Pulp, paper, paper products, publishing, and printing	0.406	0.159	0.890
Coke, refined petroleum products, chemicals, rubber and plastic products	0.406	0.164	0.870
Other non-metallic mineral products (*n.e.c*) (ONMP)	0.411	0.146	0.850
Basic metals products	0.400	0.174	0.862
Machinery and equipment	0.403	0.165	0.894
Electrical and optical products	0.406	0.163	0.884
Other manufacturing products (OMP)	0.410	0.152	0.842
Transport equipment	0.407	0.155	0.843
Repair of manufacturing equipment, personal and household goods	0.403	0.165	0.882

Notes: n.e.c is not elsewhere classified.

Source: Authors' estimation.

3.2 Technological changes, scale change and TFP

Table 4 presents the averages of the rates of technological change (TC), the scale components (SC), the changes in allocative efficiency (AC), technical efficiency change (TEC) and the total factor productivity growth (TFP) for selected time periods. [6] Performances of manufacturing firms could be separated into two sub-periods, 2010 – 2015 and 2015 – 2019. The average rate of TC was declined continuously at -0.037 for the first sub-period, then increased significantly at an average rate of 0.067 in the total sample during the second sub-period. The rate of the scale components increased continuously over two sub-periods ranging from 0.3% to 0.6%. The results of SC, which measure the effects of input changes on output growth, indicate that RTS is increasing over the period (Kim and Han, 2001). However, technical efficiency change (TEC) and the allocation efficiency effects in most of the manufacturing firms in Vietnam are found to be negative during the entire period of our study as well as during both the two sub-periods. In fact, allocative inefficiency results when factor prices are not equal to their marginal product. Almost every estimate of AC has a negative value, implying the existence of allocative inefficiency. For the total sample, the average rate of AC was -0.051, implying the existence of inefficient allocation of inputs in production with a resulting decline of TFP.

[6] The decomposition results by year are omitted here to save space but are available from the authors on request.

Table 4 also shows that technological change exceeds efficiency change and has played a greater role in contributing to TFPG during the period, 2010 – 2019. Therefore, TFPG (TFPG) of manufacturing firms in Vietnam is due more to outward shifts of the production frontier than by movement towards it. The TFPG rates and all its components, except the economic scale effect component (SC), of almost all the manufacturing firms in Vietnam have declined during the first sub-period. However, the decline in TFPG rates of most of the manufacturing industries in the first sub-period is mostly responsible for the decline in TC of the same during that period as it has become the major contributor to TFPG during the entire period of our study. In contrast, while the rate of growth of TC of the manufacturing industries became higher during the second sub-period, the rate of growth of TFPG became higher too. Our findings correspond most closely to those in Sharma et al. (2007) and Roy et al. (2017), who showed that the technological progress was the most important factor of the TFPG of manufacturing industries in United States and India.

Table 4. Technological change (TC), scale component (SC), technical efficiency change (TEC), allocative component (AC), and TFPG period 2010 – 2019

	TC	*TEC*	*SC*	*AC*	*TFPG*
2010-2015	-0.037	-0.028	0.006	-0.060	-0.062
2015-2019	0.067	-0.026	0.003	-0.041	0.054
2010-2015					
Food products, beverages, and tobacco (FBT)	-0.020	-0.028	0.005	-0.058	-0.045
Textile and leather products	-0.054	-0.028	0.007	-0.053	-0.072
Wood and products of wood	-0.017	-0.028	0.005	-0.074	-0.058
Pulp, paper, paper products, publishing, and printing	-0.017	-0.028	0.006	-0.058	-0.041
Coke, refined petroleum products, chemicals, rubber and plastic products	-0.029	-0.028	0.007	-0.058	-0.052
Other non-metallic mineral products (*n.e.c*) (ONMP)	-0.033	-0.028	0.004	-0.076	-0.076
Basic metals products	-0.032	-0.028	0.006	-0.070	-0.067
Machinery and equipment	-0.020	-0.028	0.006	-0.070	-0.056
Electrical and optical products	-0.046	-0.028	0.010	-0.044	-0.052
Other manufacturing products (OMP)	-0.033	-0.028	0.005	-0.061	-0.060
Transport equipment	-0.049	-0.028	0.007	-0.052	-0.066
Repair of manufacturing equipment, personal and household goods	-0.033	-0.028	0.006	-0.066	-0.065
2015-2019					
Food products, beverages, and tobacco (FBT)	0.073	-0.026	0.002	-0.036	0.065
Textile and leather products	0.034	-0.026	0.003	-0.047	0.016
Wood and products of wood	0.076	-0.026	0.003	-0.055	0.050
Pulp, paper, paper products, publishing, and printing	0.072	-0.026	0.002	-0.031	0.069
Coke, refined petroleum products, chemicals, rubber and plastic products	0.060	-0.026	0.002	-0.029	0.058
Other non-metallic mineral products (*n.e.c*) (ONMP)	0.067	-0.026	0.003	-0.055	0.042
Basic metals products	0.064	-0.026	0.004	-0.048	0.046
Machinery and equipment	0.069	-0.026	0.002	-0.049	0.049

Electrical and optical products	0.037	-0.026	0.004	-0.024	0.043
Other manufacturing products (OMP)	0.059	-0.026	0.002	-0.040	0.048
Transport equipment	0.044	-0.026	0.004	-0.030	0.044
Repair of manufacturing equipment, personal and household goods	0.057	-0.026	0.003	-0.048	0.038

Source: Authors' estimation.

For industry-level estimation, TC was highest in the wood and products of wood industries with estimates greater than 7.6% for the second sub-period, and it was lowest in the textile and leather industries with estimates of about 0.034 in the same sub-period. The rate of TC increased continuously over time across all manufacturing industries. This increase was most apparent in the non-metal industries, where initially the TC in this sector was declined at -3.3% in the first sub-period, then increased significantly at average rate of 6.7% from 2015 to 2019.

The Vietnamese government pursued an industrial policy to promote manufacturing sectors from begin of 1990s to now. This policy tried to direct limited national resources into strategically chosen industries (mostly in car manufacturing, machinery and equipment, chemical and plastic products). One of the policy objectives was to enable firms to grow large enough to utilize scale economies and to compete in foreign markets, especially in state-owned enterprises (SOEs). However, estimated scale component in TFPG for the heavy industries (chemical, machinery and equipment, and other manufacturing products) are very small, implying that firms in these industries had already reached a certain size where scale economies no longer existed. Therefore, this study suggests that the prior industrial policy of exploiting economies of scale is no longer effective in promoting productivity in such industrial sectors.

TFPG is calculated as the sum of technological changes, technical efficiency changes, changes in allocative efficiency, and changes in scale components. In Vietnamese manufacturing industries, TC has been a key contributor to TFPG, and improvements in scale components made a considerable contribution to TFPG, especially in the food, paper products, and chemical industries. AC exerted a negative effect on TFPG, although its magnitude was smaller than that of TC. Total TFP in the manufacturing sector has declined at an annual rate of -0.062 during the period of 2010 – 2015, then the TFPG grows continuously during the second sub-period, with a rate of 5.4%. For industry estimates during the sample period, TFP grew fastest in the paper industry, with an annual average growth rate of 6.9%, followed by the food products, beverages, and tobacco industry with a rate of 6.5%, and the chemical industry with a rate of 5.8%. The remaining industries have grown by about 2-5% per annum. During the early 2010s (from 2010 to 2015), a large downturn in TFP was observed in every industry. This downturn coincided with an economic slowdown in the Vietnamese economy during the same period, supporting the presumption that lagging productivity was a major reason for the depression of the Vietnamese economy during the early 2010s.

Compared to previous studies on TFP in Vietnam, this study suggests the following. First, previous studies aggregate data and measured TFP as a residual of the growth accounting method proposed by Solow (1957) they cannot examine changes in technological efficiency, which this study estimates to had considerable effects on TFPG. Second, this study implies that part of the increase is due to an improvement in TC. Thus, attributing all changes in TFP to technological progress, as in previous growth accounting studies, is misleading, and overestimates actual technological progress.

CONCLUSION

Using recent advancements in stochastic production frontier approach, this study examines the sources of TFPG of the 2-digit manufacturing industries as well as total manufacturing industry in Vietnam during the period of 2010 – 2019. The methodology involves decomposition of the sources of TFPG into four components, including technological change, technical efficiency change, economic scale effect and allocation efficiency effect.

The main findings of the study is that, from 2010 to 2019, technological changes and the rate of scale component effect have been the major driving force of productivity growth in the 2-digit manufacturing industries as well as total manufacturing industry in Vietnam. Further, the growth rates of TFP of almost all the 2-digit manufacturing industries in Vietnam have declined during the first sub-period, 2010 – 2015. The rate of technical efficiency effect has also declined in the period of study and in almost all the afore-mentioned industries. With respect to scale effect, its contribution to TFPG in Vietnamese manufacturing industries has been decreased over the period. Overall, it can be said that the manufacturing industries of different 2-digit manufacturing industries in Vietnam have benefitted from economies of scale. Although its estimates are still far below the estimates of technological changes in our study. However, from the results of our study it can be inferred that factor accumulation has led to the TFPG through increasing returns to scale, but the technological progress happens to be the most important factor of the TFPG of organized manufacturing industries in Vietnam. The change in allocation efficiency component shows that resource allocation in almost all the industries in our study has decreased during the period.

Policy implications derivable from this study suggest that specific guidelines are required to promote productivity in each industry. Industries with slow TC (textile and electrical products) require the introduction of new frontier technology. Government policy should encourage investments that can introduce newly developed production technology. In addition, considering allocative inefficiency, a policy to enhance TFP by improving resource allocation should be pursued, which be done by promoting free markets and lessening government intervention. Meanwhile, industries where TE is small (food, wood, and basic metal), a policy to enhance the efficient use of existing technology is recommended to catch up to frontier technology. Finally, this study shows that the recent advancements in stochastic frontier production function model could be a complementary and alternative model to growth accounting methods for measuring and explaining productivity growth.

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Influence of Human Development Index to the State Economy in V4 Region*

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ABSTRACT

Along with economic development, it is the human development index that is needed for the final assessment of the country's position. Chronologically, not only personal statements of people about their satisfaction, but also information of an objective type was assigned to quality of life indicators. Due to the mentioned the contribution is orientated to the indicator of the UN Development program, dealing with problems of human development, consisting of Human Development Index (HDI). The contribution analysis mentioned indicator according to three areas, orientated to the development of the indicator in the frame of chosen countries. The goal of the contribution is achieved through the evaluation of the development of life quality in V4 countries, in the context of HDI using. The research also includes an overview of the key factors that affect the calculation of the index, the approximation of individual components of the index and their importance, development, influence. In the analytical part, a thorough analysis of secondary information sources is performed using higher statistics. The results of the contribution show specifications in individual time periods, offering possible influences to the analyzed indicator. Together with economic development it is necessary for final evaluation of the country position. Due to its relevance it present also proper tool for qualitative and high informative value of monitoring. To maintain prosperity and competitiveness is extraordinary important the country could know its position.

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INTRODUCTION

In last decades, but also in developing countries, the quality of life has come to the forefront in recent decades, among other indicators. Interest in this issue has been aroused primarily by significant political, social, economic changes and, last but not least, technological progress. In general, there are a relatively large number of quality of life models. Many of them are therefore very different in structure and concept. According to Johnston et al. (1994) quality of life is a state of well-being of an individual or group that can be perceived or identified by "observable" indicators. Since 1990, the United Nations Development Program (UNDP) has published human development reports containing the Human Development Index (HDI). It was created to emphasize the fact that people and their abilities should be the ultimate criterion for assessing a country and therefore not just economic development itself. We rank the human development index among the aggregated indicators measuring the progress of society in three dimensions related to the health, education and living standards of the population.

The aim of the paper is to analyze the quality of life in selected EU countries using the human development index. In addition to the above, the Human Development Index also meets the three basic characteristics of indicators, which are relevance, credibility, legitimacy and is therefore one of the examples of the possible use of aggregated indicators. Along with economic development, it is the human development index that is needed for the final assessment of the country's position.

To understand the concept, we can look into history and follow its development from a given perspective. In the literature, we often find inconsistencies between when and how the term first appeared. According to Spilker, the beginning dates back to the 1930s, when the term was still associated with the medical environment. From an economic point of view, the concept of quality of life was mentioned by Ordwayo and Osboron in 1953-1954 (Kacmarova, 2013). Social indicators have been used since the 1960s and describe objective living conditions in society (Ferriss, 2006). The concept of behavioral economics is currently one of the fascinating fields of integration of psychological phenomena into economic models, so that they predict more accurately and reliably human behavior and decision-making (Heckova et al., 2019).

Chronologically, not only personal statements of people about their satisfaction, but also information of an objective type was assigned to quality of life indicators. They included material indicators such as money, sufficient food and quality of accommodation and intangible indicators such as social relations, health and the quality of the environment in which they live (Bacova, 2008). In the 1980s, we can say that the issue is stagnating, but the approach to quality of life indicators is gradually changing, the greatest influence can be attributed to the growing relativism and individualism in the social sciences. It has been shown that a deeper theoretical and philosophical foundation is lacking, and that an empirical approach to capturing quality of life is not enough (Gullone, 2002). Since the 1990s, the study of quality of life has been further developed, where we see an effort to unify and thoroughly define the theoretical foundations as well as to create appropriate ways of measuring quality of life (Veenhoven, 2000). Above all, such development is intended to create opportunities that will make it possible to increase people's abilities so that they have the opportunity to live a life that they value themselves. Therefore, the primary preconditions are a long and healthy life, access to education, access to the means to actually live a dignified life, but also the opportunity to actively participate in the life of the community.

Presently diagnosis of the life quality in the country, as well as prediction of its failure, becomes much discussed theme. To maintain prosperity and competitiveness is extraordinary important the country could know its position. Adequate managerial decisions could not be done without detail analysis of the country. The important assumption for effective decision, leading the representatives of the country means qualitative, complex and timely diagnosis, supported by detail analysis of negative factors, threatening the country existence (Horvathova and Mokrisova 2019).

1. LITERATURE REVIEW

The area of the HDI and life quality is studied in literature by number of authors. The well-known Human Development Index (HDI) encompasses only three rather basic aspects of human welfare. Ranis et

al. (2011) aims to go beyond this, by identifying 11 categories of human development, according to which the HDI are shown to be worse indicators of the extended categories of human development for OECD countries than for developing countries. Chakravarty (2003) characterizes a general measure of human development index achievement, which contains the UNDP human development index as a special case, regarded as a generalized human development index. The general index allows calculation of the percentage contributions of individual attributes to overall achievement and hence to identify the attributes that are more/less susceptible to achievement. The factors that affect individuals' concepts of QOL are physical health, psychological status, and level of independence, social relationships, personal beliefs and environmental characteristics. QOL somewhat describes the status of the people living in a country or region, and is nowadays considered an acceptable theoretical framework for examining the living conditions of different societies. In addition to economic issues, QOL affects the statuses of a society's individuals, taking into account exogenous factors such as infrastructures, social organizations, social relationships, environment etc. (Koohi et al., 2017)

McGillivray (1991) used simple statistical analysis, questioning the composition of the HDI and its usefulness as a new index of development, concluding HDI fails to provide insights into inter country development level comparisons which preexisting indicators, including GNP per capita, alone cannot. Noorbakhsh (1998) discusses a modified index for measuring human development testing the robustness of the suggested index. The new index is then used to delineate, with some justification, different groups of countries at various levels of human development. Also McGillivray and White (1993) confirmed HDI contribution to the assessment of development levels differs markedly among country groups. Hagerty et al. (2001) testified availability and utility of the index in various countries, found their using is limited but possible for determination of public policies. Neumayer (2001) proposes to qualify a country's human development as potentially unsustainable if the net depreciation of its manufactured and natural capital stock is bigger than its investment, linking the human development index with sustainability. There is connections between economic growth (EG) and human development (HD) (Ranis et al., 2000), when countries initially favoring economic growth lapse into the vicious category, while those with good HD and poor EG sometimes move into the virtuous category. Where choice is necessary human development should be given sequencing priority. Hagerty (2000) studied evidence for social comparison effects of income on subjective well-being (SWB), showing that the range and skew of the income distribution in a community affects a person's happiness, and that decreasing the skew (inequality) of the income distribution in a country increases average national SWB. Both studies strongly support social comparison effects of income within a community.

2. METHODOLOGY AND RESEARCH METHODS

The aim of the paper is to analyze the quality of life in selected EU countries using the human development index. The research also includes an overview of the key factors that affect the calculation of the index, the approximation of individual components of the index and their importance, development, influence. In the analytical part, a thorough analysis of secondary information sources is performed using higher statistics. We chose the V4 countries as selected EU countries. Contribution also contains an analysis of the influence of individual components of the index, possible variants of development as well as final proposals. We based our research on the definition of the UN Development Program (2018), which defines human development as a process of expanding human possibilities. We also used the construction of the human development index in such a way that the human development index is formulated as a measure of a country's shortage or deficit in each of three separate areas - life expectancy (x_1), education (x_2) and adjusted income (x_3). It further defines the following as a deficit indicator for country j with respect to the variable x_i as

$$I_{ij} = \frac{\max_k\{x_{ik}\} - x_{ij}}{\max_k\{x_{ik}\} - \min_k\{x_{ik}\}}$$

The index is compiled so that each single deficit indicator for country j, i = 1,2,3, lies between 0 and 1. The average deficit index for country j from the three areas is defined as a simple unweight average of z i_{ij}:

$$I_j = \frac{1}{3}\sum_{i=1}^{3} I_{ij}$$

The deficit in the human development index for country j is subsequently defined as the average deficit. Thus, if H_j is the human development index for a country is j, we have by definition $1-H_j = I_j$ or $H_j = 1-I_j$.

The V4 region is the name of a grouping of four countries in the Central European region, between which there is a relationship of common interest. This community includes the Czech Republic, Poland, the Slovak Republic and also Hungary. As these countries draw on the same cultural, social, historical aspects but also on many other values, their common goal of cooperation is to preserve and strengthen the countries. V4 cooperation has become the most clearly profiled initiative in the Central European region. The group has also gained a good reputation as a catalyst for integration processes, as one pragmatically functioning form of multilateral cooperation in the region and as a symbol of stability in the region. The data had been obtained from worldwide database Eurostat (2018) and Euroekonom (2010).

Table 1. Classification of the countries according to the HDI development

Scale	*Level of human development*
0,000 - 0,499	Low
0,500 - 0,799	Medium
0,800 - 0,899	High
0,900 - 1,000	Very high

Source: own processing according to UN Human Development Report, 2018

In assessing the V4 countries, we relied on the 2009 UN Human Development Report, which divides countries into four groups: countries with low, medium, high and very high levels of human development (Hopkins, 1991). The values given in Table 1 are the basis.

3. RESULTS

3.1 Czech Republic

The values of the indicator of gross national income per capita in purchasing power parity range from 100 to 75,000. From the collected data we can observe that the Czech Republic from 1990 to 2015 at gross national income per capita in purchasing power parity increased from 19 965 up to 28,144 units this shift is up to 8,179 units. As we observe with this partial indicator from 1991 to 1994, the values range from 17638 to 17971, which are the lowest values that the Czech Republic has achieved with this indicator. After 1994, the values increased and increased by almost 10,000 over the course of twenty years.

The expected number of years of education was at the beginning of the observed period, i. j. in 1990 only 11.9 and gradually over the next three years the values decreased by 0.1. The scale of this indicator ranges from 0 to 18. As the value at the beginning of recording was 11.9, we can say that the Czech Republic, despite a not very high number, has not been one of the worst countries in terms of the V4 countries since 1990. During the years 1990 to 1993, the value does not exceed 12. The values from

1990 to 1997 have an increasing tendency. In 1998, a decrease compared to the previous year from 13.3 to 1.9 is a difference of 0.4 units. However, an increase of 0.5 units is recorded in the following year. We can evaluate this positively, as the average year-on-year shift is 0.2.

The average number of years of schooling ranges from 0 to 15. As with the previous two indicators, the value at the beginning of the observed period is the lowest, with a value of 10.9. However, it should be noted that this value is high enough, taking into account that the maximum value in this indicator is 15. The following year, a value was recorded with an increase of 0.2 and the Czech Republic maintained this trend in growth until 1994, where it reached the value of 11.8. After the mentioned year 1994 the value exceeded 12 and in most of the following years from 1995 to 2001 it remained approximately at the value 12. After 2001 there was an increase to 13.0 but not permanent, this increase lasted 4 years and after 2005 again the value reached the number 12. The Czech Republic has maintained such a value for a long time until the end of the period monitored by us.

With the partial indicator of the average life expectancy at birth, we range from 20 to 85. In the development of this indicator in the Czech Republic, we observe an increase of 7 years. In 1990, at the beginning of our collected data, the country reached a value of 71.8. Among the V4 countries, this number was the highest. Among the data, we only observe an increase in this indicator without interruption and without any irregularities. We can evaluate the development of this indicator positively in all monitored periods.

In the table Kendall Tau - Czech Republic, we evaluated the dependencies of individual sub-indicators and how they affect the overall human development index. It is clear that as these sub-indicators contribute to the calculation of the total HDI, there is a relationship between these indicators. In the Gretl program, we used the Kendall-Tau calculation to find out how strong the dependence is between the individual indicators in the case of the Czech Republic. This finding was necessary for the targeted direction of our proposals. In the presented table we see that the closest to the value of 1, which is significant for us in the method we use, is the indicator Expected number of years of education with the value of 0.986000963. Another indicator with the second highest weight is the average life expectancy at birth and only in third place is the economic indicator, Gross National Income per capita in purchasing power parity. With the lowest value, i.e. the indicator that least affects the overall HDI, we present the average number of years of schooling.

Table 2. Kendall Tau Correlations – Czech Republic

AVERAGE	Kendal Tau Correlation HDI - Health, average life, average years of education, HDI V4 Marked correlations are significant at p≤0,01				
	average life at birth	*average years of schooling*	*assumed years of schooling*	*gross national pension per inhabitant in purchasing power parity*	**HDI**
average life at birth	1	0,53098332	0,99283225	0,953528713	**0,985374**
average years of schooling	0,53098332	1	0,53685171	0,430384203	**0,648833**
assumed years of schooling	0,99283225	0,53685171	1	0,949678253	**0,98601**
gross national pension per inhabitant in purchasing power parity	0,953528173	0,430384203	0,949678253	1	**0,944913**
HDI	**0,985373813**	**0,648833224**	**0,986000963**	**0,944913461**	1

Source: own processing according to program Gretl

3.2 Poland

In the range of values from 100 to 75,000 for the partial indicator of the value of gross national income per capita in purchasing power parity, Poland reached the value of 9,614 in 1990, i.e. at the beginning of the observed period, which is due to economic strength, state size and position in the V4 group low value. However, the increase from 1990 to 2015 is significant, and even more so. We are talking about a total increase plus 14,503 units. Interestingly, the Czech Republic started with a value of 19,965, but Poland did not approach this value until 2008, when it reached 19,734. Although it is clear from the data collected that these are positive and progressively evolving values, as in the case of the Czech Republic. Republic as well as in the case of Poland, it must be stated that these are lower values in the case of Poland. The best values developed after 2004, where the positive development is the most seeming and visible.

Another partial indicator analyzed by us is the expected number of years of education; it ranges from 0 to 18. In the case of Poland, the value starting in 1990 is 12.3 and during the next two years this value is unchanged. In 1994, there was a change of an incremental nature by 0.6. At first glance, the gradual development trend is seemingly stable, as the changes took place on average at three-year intervals. After 2004, the situation stabilized slightly at around 15.0 - 15.4. The growing development trend was violated only in 2004, when a decrease in value was recorded from 15.5 in 2003 to 14.8 in 2004. Fortunately, this trend did not continue in the following period, and since 2005 we have only observed an increase in values. The total increase of the given indicator from 1990 to 2015 is 4.1.

The average number of years of schooling is expressed on a scale from 0 to 15. Compared to other V4 countries, Poland, with an initial value of 9.8 in 1990, is in the penultimate place. Only Hungary was worse off. From 1992 to 1999, we can observe a stabilization of the value in the range from 10.1 to 10.9. During these eight years, the increase is gradual every year by 0.1, which represents a 10% increase. Since 2000, growth has been slower but still positive. Since 1990, we have only seen an increase in values without any interruption. Regarding the values achieved in measuring the average number of years of schooling, we state that the development was either positive or stable from year to year, i.e. we observed an increase or the same value compared to the previous year.

For the indicator of average life expectancy at birth, the values range from 20 to 85 years. In the case of Poland, we start at 70.9 in 1990. During the period under review, we can state an increase of more than 7 years, which is similar to the case of the Czech Republic. The overall development of this indicator was similar, and in the end, from the analyzed data, we can say that it was only an increase. From 1991 to 1995, the value reached from 71.0 to 71.8. Subsequently, from 1996 to 1997, we observe a gradual increase of 0.4. The development after 1997 reached the value of 73.0. On average, by the end of the period under review, the values had increased by 0.4 until 2015, when Poland reached 77.6.

The Kendall Tau - Poland table presents the dependencies closest to the value of 1, with the average life expectancy at birth being up to the value of 0.993837121. Another indicator that represents a very strong dependence is the average number of years of schooling. The following are values that have lower values, namely gross national income per capita in purchasing power parity, which reaches the value of 0.979950865. Indicator The expected number of years of education according to our calculation in the Gretl program reaches the value of 0.973124054, which is the weakest dependence.

Table 3. Kendall Tau correlations – Poland

AVERAGE	Kendal Tau Correlation HDI - Health, average life, average years of education, HDI V4 Marked correlations are significant at p≤0,01				
	average life at birth	*average years of schooling*	*assumed years of schooling*	*gross national pension per inhabitant in purchasing power parity*	**HDI**
average life at birth	1	0,98375768	0,949745166	0,992065188	**0,993837121**

average years of schooling	0,983757678	1	0,954899931	0,970254281	**0,991052325**
assumed years of schooling	0,949745166	0,954899931	1	0,916997326	**0,973124054**
gross national pension per inhabitant in purchasing power parity	0,992065188	0,970254281	0,916997326	1	**0,979950866**
HDI	**0,993837121**	**0,991052325**	**0,973124054**	**0,979950865**	**1**

Source: own processing according to program Gretl

3.3 Slovakia

When analyzing the values of gross national income per capita in purchasing power parity, we also range from 100 to 75,000 in the values of the Slovak Republic. Gross national income per capita in purchasing power parity was recorded at the beginning of the period under review with a value of 14,319, which is compared to the V4 countries as the third best result. In 1990 the value is 14,319, but in 1991 the value has a declining tendency, namely 12 143. An interesting finding is that while in countries such as the Czech Republic and Poland the values increased over time in the Slovak Republic, we do not see such a trend in the first years. However, the increase occurred during the years from 2000 to 2015. However, we cannot talk about a continuous increase. In 2009, the value was 23,115, at which we observe a decrease compared to 2008, in which the value was 2, 4191 by 1,076 units. The decrease in values is also recorded in 2011 compared to 2010. Overall, we can evaluate the development as positive, because during the years from 1990 to 2015 there was an increase of 12,445 units, which is comparable to the increase in gross national income per capita in purchasing power parity e.g. with Poland (Slovakian statistics and demography, 2007).

The following partial indicator, which we analyzed in the V4 countries and in the Slovak Republic, was the expected number of years of education. This indicator ranges from 0 to 18. At the beginning of the period we monitored, the Slovak Republic led appropriately to its position among other countries. The initial value was 11.6 in 1990, but also in 1991. Until 1999, we observe a gradual increase to 13.3. This value was the same for two consecutive years in 2000 and 2001. The recurring increase is interrupted by 15.0 in 2009, which was stable for the next four years. In 2013, we can record a low increase of 0.1, but this trend was not maintained and the years 2014 and 2015 had a value reduced to 15.0. Although in later years the values were without significant progress, we can still rate the development period as positive, because even in the case of the Slovak Republic there is an obvious improvement of 3.4. However, this value of improvement is the lowest among the V4 countries.

The partial indicator, the average number of years of schooling, is expressed in values from 0 to 15. Among the analyzed countries, Slovakia ranked behind the Czech Republic with final values. At the beginning in 1990, Slovakia reached a value of 10.8, which is only 0.1 less than in the case of the Czech Republic. In contrast to Poland with a value of 9.8 and Hungary with a value of 8.7, in 1990 we were among the stronger countries in this respect. In terms of time, the values increased until 1995, where they fell from 11.4 by 0.2 to the value in 1996 to 11.2. In the same proportion, the year 1997 had a decreasing tendency, where the value decreased to 11.0. The declining trend lasted until 2001 to 10.1. In 2002, it rose to 10.3 and rose to 12.1 until 2011. After the years 2011 to 2014, when it remained in the same values of 12.1, in 2015 it increased by another 0.1 to 12.2.

As in the assessment of other countries, in the case of the Slovak Republic, we ranged in the range of indicators of average life expectancy at birth between values from 20 to 85 years. In 1990, with a value of 71.2, the Slovak Republic was, as with the indicator of the average number of years of schooling, closely

behind the Czech Republic. During the years from 1990 to 2015, we observe an increase of 5.2. The increase in values was significant over time without any fluctuation. The largest shift was in 1997 from 72.6 to 72.9 in 1998. Subsequently, 10 years later, a positive development of 0.3 was recorded again between 2007 and 2008.

Table 4. Kendall Tau correlation – Slovakia

Slovakia					
AVERAGE	Kendal Tau Correlation HDI - Health, average life, average years of education, HDI V4 Marked correlations are significant at p≤0,01				
	average life at birth	*average years of schooling*	*assumed years of schooling*	*gross national pension per inhabitant in purchasing power parity*	**HDI**
average life at birth	1	0,573754441	0,974140989	0,964422983	**0,982759399**
average years of schooling	0,573754441	1	0,459915001	0,656271119	**0,666787795**
assumed years of schooling	0,974140989	0,459915001	1	0,949783655	**0,96424251**
gross national pension per inhabitant in purchasing power parity	0,964422983	0,656271119	0,949783655	1	**0,992435378**
HDI	**0,982759359**	**0,666787795**	**0,96424251**	**0,992125378**	**1**

Source: own processing according to program Gretl

The strength of the dependence of individual indicators in the table Kendall Tau - Slovak Republic can be assessed as follows. We show the strongest dependence in the case of gross national income, which reaches a value of up to 0.992135378. Another strong indicator is the average life expectancy at birth. The third strongest indicator appears to be the expected number of years of education, which has a value of 0.96424251, which is still a value with a very strong impact. The lowest value achieved in this calculation was the value of the average number of years of schooling.

3.4 Hungary

The last country we analyzed is Hungary. When evaluating the achieved values of national income per capita in purchasing power parity, our values should range from 100 to 75,000. This indicator was achieved in the values of 15 986 in 1990 from the beginning of the period value declining character. From 1993 we can state a gradual increase until 1995. In 1996, according to the data collected, we found a slight decrease of 46. From the following year, which means in 1997, the indicator has retained its gradually increasing character. In 2015, the value of gross national income per capita in purchasing power parity was 23,394, which is an increase of 7,408 compared to the first observed year 1990. However, the resulting value is the lowest achieved value compared to the Czech Republic, the Slovak Republic and Poland.

Another indicator analyzed in the assessment of Hungary's position is the expected number of years of education. This indicator measured on a scale from 0 to 18 is at the level of 11.1 in the first observed year, i.e. in 1990. In terms of the countries we compare and analyze, this number is at its lowest value compared to other V4 countries. With a gradual increase in 1996, this value reached the level of 13.2. The following year the value decreased by 0.1. However, since 1998, this value has started to develop in a positive direction again. In 2003, the value reached the level of 15.3. After a slight decrease in 2004 to

2005, the value returned to 15.3 until 2012. In 2013, it increased to 15.8, but during the following year and 2015 it was only in the values of 15.6. In general, however, we can state an increase of 4.5 over the entire period analyzed by us.

The average number of years of schooling ranges from 0 to 15. Hungary is in last place when comparing the 1990 data, as the value for the year is only 8.7. Gradually, however, these values developed, as in other countries, and as early as 1995, Hungary reached a value of 10.0. From 1990 to 1998, this value had an increasing tendency to 10.3. In the given period it increased by 1.6. This was followed by three years of a slight decline, when the value remained at the level of 10.2. The year 2011 with a value of 11.7 held the value from 2010, but the year 2012 reduced this indicator by 0.1 and ended at a value of 11.6. Since 2002, we can state another increase, this increase ended in 2015 at 12.0. The overall increase was by 6.3.

The average life expectancy at birth, which ranges from 20 to 85, was at the beginning of the observed period 1990 in Hungary at the lowest level among the analyzed countries. The difference between the Czech Republic, i.e. the country with the highest value of 72, and Hungary with a value of 69.4 is 2.6. The overall development of this indicator has developed relatively slowly. Until 2015, the values did not equalize. The difference between the best rated country, the Czech Republic and the worst rated country, Hungary, is up to 3.3. Although the values were still growing in no year, they did not match another V4 country. In the last year of our analysis, Hungary reached a value of 75.3. However, the progression between the initial value is noticeable at 5.9.

Table 5. Kendall Tau correlations – Hungary

Hungary					
AVERAGE	Kendal Tau Correlation HDI - Health, average life, average years of education, HDI V4 Marked correlations are significant at p≤0,01				
	average life at birth	*average years of schooling*	*assumed years of schooling*	*gross national pension per inhabitant in purchasing power parity*	**HDI**
average life at birth	1	0,927093063	0,915222063	0,833066957	**0,932933251**
average years of schooling	0,927093063	1	0,893438218	0,872253816	**0,95385491**
assumed years of schooling	0,915222063	0,893438218	1	0,903333198	**0,97507085**
gross national pension per inhabitant in purchasing power parity	0,833066957	0,872253816	0,903333198	1	**0,955066295**
HDI	**0,932933251**	**0,95385491**	**0,97507085**	**0,955066295**	**1**

Source: own processing according to program Gretl

In the table Kendall Tau - Hungary we can see that all values are very strong. However, the value of the indicator, the expected number of years of education, is the strongest indicator. The second high-strength indicator is gross national income per capita in purchasing power parity, which in the case of Hungary is 0.955066295. As the third indicator with a lower value, we analyzed the indicator of the average number of years of schooling. The lowest value in our table is the average life expectancy at birth.

In the following section, we performed an analysis of the main indicator, i.e. the human development index, as well as the other four indicators, which in our opinion are significant for determining the quality of human life. In addition to evaluating the development of the human development index, it was necessary

to analyze other sub-indicators, which we believe are needed to further clarify the understanding of quality of life. The dimensions in which it is necessary to consider when assessing the quality of life are:

- health - we analyzed this indicator in terms of average life expectancy at birth;
- education - we described the importance of education in the dimension of the average number of years of schooling, but also in the expected number of years of education;
- economic variables The economic aspect chosen by us, which we analyzed in the following section, was gross national income in purchasing power parity.

3.5 Human Development Index

The development of the human development index indicator is on the rise. As we can see in the graph (Figure 1), the Czech Republic appears with the highest values. The HDI in Czech Republic increased by 3.31%, from 1995 to 1999. This presents a significant increase and the highest 5-year cycle. In the next five years, we observe an increase of 2.31%, which is 0.84. In 2009, the increase is only 1.42%, but in 2014 we see a higher increase, namely 1.63%. By 2015, the index reached 0.878, which is the highest value index of all countries and the overall percentage increase was 11.85%.

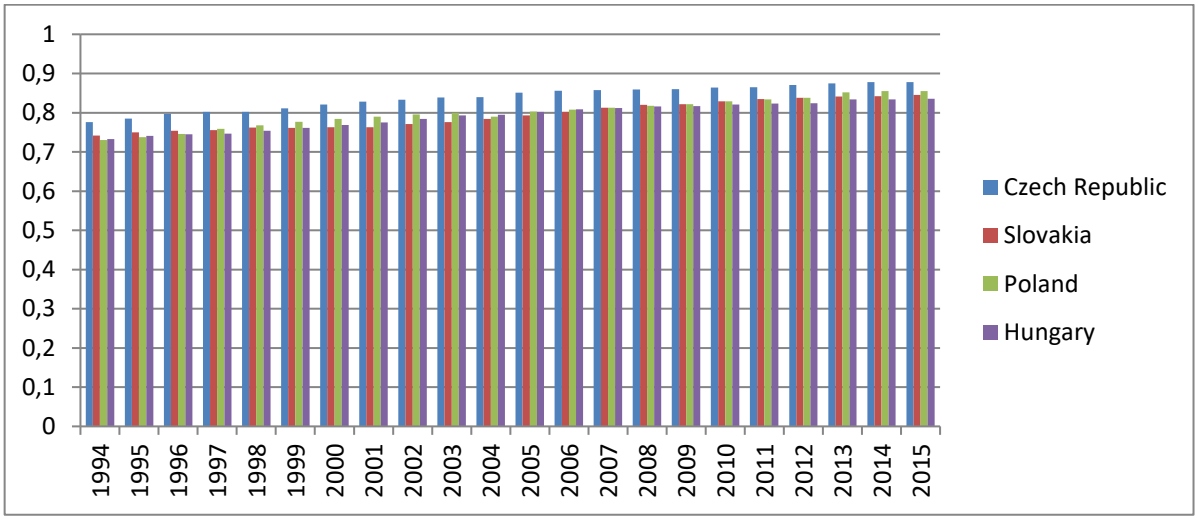

Figure 1. Trend of HDI development in V4

Source: own research.

Another country is the Slovak Republic, which at the beginning of the period analyzed by us reached a human development index of 0.75. After five years, we see a significant progress of 1.47%. In the next five years, the increase is higher by 2.75, which is a higher increase compared to the Czech Republic in 2004. In 2009, we observe a significant increase, namely 3.66%, which is the highest increase of all V4 countries for the period 2005-2009. By 2004, the index had moved another 1.57% and in 2015 it reached 0.845. The overall shift of the human development index in the Slovak Republic was by 12.67%, which we consider to be a better value than achieved by the Czech Republic.

Poland, as the third country in the Visegrad Group, reached an index value of 0.738 in 1995, which, however, was the lowest value among the countries. In the next five years, however, the index gradually grew and the increase was up to 5.28%, which is the highest number that was achieved in this period. Until 2004, the increase was in the normal value, namely 1.66, which was the lowest increase, but in 2009 Poland strengthened again, namely by 2.37% to 0.822. Another increase in 2014 was 2.77%. Poland reached a value of 0.855 in 2015, which represented an increase of 15.85% from the value in 1995, namely 0.738.

The last country analyzed was Hungary, which at the beginning of 1995 reached an index value of 0.741 and by 1999 had risen by 2.7% to 0.761. Another increase, the highest among the four countries, was in 2004 at 3.38%. In 2009, a shift of 1.87% to 0.817 was recorded, but it was still the lowest value in the V4 area. Hungary strengthened its human development index by 1.58% by 2014, but still reached its lowest level. By 2015, the index had reached a value of 0.836, which we evaluate an increase of 12.85% compared to 1995. This increase is the second highest among the Visegrad Group countries.

4. DISCUSSIONS

From the point of view of the statistical evaluation of the first country, i.e. the Czech Republic, it is important to be aware of the need to increase the value of the expected number of years of education. Equally important is the increase in the indicator of the average life expectancy at birth. Only the third important indicator is the economic factor, namely gross national income per capita in purchasing power parity. The average number of years of schooling appears in our statistical survey as the element with the lowest priority of increase in the case of this country.

With regard to the informative value of the statistics used in our work, we evaluate the situation in Poland as similar to that in the case of Hungary. Poland has the highest dependency on variables - average life expectancy at birth and also the average number of years of schooling. Once again, we can recall the absence of an economic indicator, which is only in third place with its weight. As the last indicator on which Poland should focus from the indicators analyzed by us, we state the expected number of years of education, which fell to the lowest value.

In the case of the Slovak Republic, we interpret the obtained results as the most surprising. The statistics we carry out show the strongest dependence between gross national income per capita in purchasing power parity. This indicator is the most important for the Slovak Republic in its efforts to increase HDI. As is well known, the EU community evaluates the state of the economic situation and development forecasts annually for each country, so our recommendation is for the Slovak Republic to focus on these reports, predictions and recommendations that could be helpful in the future direction of the country. This ongoing economic policy cycle also provides various recommendations. The second equally important indicator is the average life expectancy at birth. The other two indicators relate to education. The third most important value turned out to be us in the case of the expected number of years of education. We see the lowest weight in the case of the average number of years of schooling.

The last country we analyzed from the V4 group is Hungary. In this case, we see the strongest relationship in the indicator of the expected number of years of education. The second indicator with the strongest interconnection is the economic factor gross national income per capita in purchasing power parity. We evaluate the area of education as the third strongest indicator in the case of the average number of years of schooling. We see the weakest dependence in the case of life expectancy at birth.

Among the identified positive influences that affect the value of the human development index in individual countries, we recommend a combination of an increase in average life expectancy at birth, average number of years of schooling, expected number of years of education, gross national income per capita in purchasing power parity.

In analyzing the definition of possible tools and measures that have a positive effect on the quality of life, we relied on available information on how individual states can legitimately proceed with this influence.

From the available sources, we evaluate that in the case of the Czech Republic, influencing the factor of the expected number of years of education can take place at several levels. Education as such can be understood as preschool, which usually takes place within five years. After completing the sixth year of life, a person in the Czech Republic enrolls in basic education, and it is in that period that it is necessary to influence the development of educational needs. It is important to prolong education as it does not end with compulsory schooling. The indicator of life expectancy at birth reflects the functioning of health care in a given country and the level of health of the citizens of a given country. As in the case of the Czech Republic this indicator had the second highest value in statistical monitoring, it is necessary to focus on the provision, access to health services and the provision of more professional care. The indicator of gross

national income per capita in purchasing power parity represents the monetary value of goods and services at a certain time, which were created through residents of the Czech Republic. Influencing this indicator can be applied through economic factors, but also a tool can be a change in legislation, which will ultimately have economic benefits. The average number of years of schooling in the case of the Czech Republic needs the least intervention and adjustment, as our statistics show that it has the least impact of the indicators. However, if we want to provide a recommendation in this area as well, the Czech Republic should focus on managing school attendance as in 2002-2005, when this country could be an example for all V4 countries.

Poland should focus on the average life expectancy at birth of its inhabitants when drawing up strategies to influence the human development index. In particular, healthcare could best contribute to the health of citizens and thus to a better quality of life. Not only is the provision of quality health care important for health, but access to this care should also be an object of concern. Another factor that needs to be addressed in our recommendations is the average number of years of schooling, as this factor is largely determined by EU standards. It is necessary to look at this indicator differently. With regard to school attendance in a country such as Poland, given the size of the country and the population, it is necessary to focus on making school facilities accessible to the population. Gross national income per capita in purchasing power parity is an economic factor that can be influenced most by legislation and legal regulations. The expected number of years of education in the case of Poland is not the most important for influencing the overall human development index, but even in this case there are possible recommendations that could strengthen its values. One of the key factors is to make available and support additional education of the population.

The evaluation of a country such as the Slovak Republic is the most accessible in our work in terms of obtaining additional information, on which we build recommendations and suggestions. Gross national income per capita in purchasing power parity should be an indicator for a country that needs to be given the highest priority. Influencing that indicator could bring about a positive course in terms of quality of life. Another important factor that needs to be adjusted is life expectancy at birth. Not just a healthy birth. But also the healthy development of citizens should be important for the Slovak Republic. When increasing the indicators, the expected number of years of education should not be forgotten. The value is the third lowest, when influencing the HDI. The last indicator is the average number of years of schooling, although with the lowest statistical value, this indicator is still significant for the overall value.

Hungary, as the last country we evaluated, should focus on the expected number of years of education in its further direction. As we have had the opportunity to find out when collecting data, Hungary has gradually understood the power of education and is currently strengthening the education of citizens. The second important factor that Hungary should pay attention to is the gross national income per capita in purchasing power parity. As with the recommendations in other countries, we consider the use of legislative and legal options to be the best tool here. We evaluate the average number of years of schooling as the third important indicator in the statistical phase implemented by us. This indicator needs to be increased, and the possible means to achieve this is to make school facilities available. As the last indicator with regard to the achieved values, we advise the average life expectancy at birth, which in our opinion could be targeted directly through health care.

CONCLUSION

Based on our goal to analyze the quality of life using the human development index on the example of the V4 countries in a given time, we can assess that the development of this index took place in a positive spirit. Since we think that the index of human life reflects the quality of life, it is necessary to increase this index.

The aim of the paper was a gradual analysis of the data obtained not only from several perspectives with regard to different specifics, but also to examine the various dimensions at what stage the countries we selected are. Today, with the volatile situation in many spheres of life, it is difficult to predict how the various factors influencing the quality of life will develop in the following, future periods in individual countries. A more appropriate and effective solution is not only long-term country strategies and visions in the long term, but also operational and action plans to achieve early results. Another finding is that just as a

country's economy is as important to the well-being of its citizens, there are many non-economic factors that are increasingly taken into account over time when assessing the overall situation of countries.

In spite of the countries we select have many characteristics in common, and in many spheres the direction of countries is influenced by EU directives and regulations, it is necessary to realize that each country must maintain its integrity in its direction. Based on the implemented statistical part, we can state that it is more important for each country to focus on other sectors to improve the overall index of human development, and thus the quality of life of people. An appropriate solution for improving individual indicators is to adopt the strategy of countries with better values. As the V4 countries have common features, it can be deduced from this assumption that the application of already established strategies of one country could contribute to the improvement of the situation in another country.

Although the quality of life is influenced by many factors, we have chosen the ones that act for us as the most influencing quality of people and human life. Understanding the importance and following developments is the initial stage. We will only achieve improvement when we take steps to make changes.

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Development of an Integrated Strategic Cost Management Model

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ABSTRACT

The individual application of strategic cost management techniques has shown significant shortcomings in calculating total costs and assessing product profitability. Therefore, there is a need for a comprehensive decision-making system that would integrate modern cost management techniques to calculate product life cycle costs, which is increasingly being affirmed. The possibility of integrating different cost management methods in this paper is conducted to develop a model for integrated cost management and a systematic presentation of techniques for practical application of modern cost management methods at all stages of the product life cycle. This paper aims to provide guidelines for developing, implementing, and applying an integrated cost management system, emphasising its application in the new product development process and proving that this model contributes more to business results than individual methods. The subject of research is the possibility of integrating modern cost management methods. The aim of this paper is to propose a unified model of strategic cost management aimed at the integrated application of modern cost management methods. In this context, the research hypothesis is as follows: a cost management model that integrates modern cost management methods reduces costs of the product and increases product profitability. This hypothesis has been proven by several scientific methods, the most important of which are analysis, comparison, mathematical and statistical methods, modelling and simulation. After conducting research using the above scientific methods, it was proven that integrated cost management systems more objectively assess the total cost of products. They also reduce total costs and thus increase product profitability.

INTRODUCTION

Due to changes in the business environment and more dynamic business conditions, there is a growing need for comprehensive decision-making systems whose requirements the traditional cost management model cannot meet due to the short-term nature of the information it provides (Augustyniak, 2020).

Traditional cost management systems were developed when direct labour cost had a large share in the total cost of products. Changes in production technologies, such as "just in time" philosophy, robotics, development of flexible production systems, etc., have reduced direct labour costs and increased overhead costs (Rymarczyk, 2020, Krenkova et al., 2021). Therefore, modern costing methods, which allocate overheads to products based on process activities, have a higher degree of objectivity in allocating overheads to products compared to traditional methods. However, the problem is that modern cost management methods are mainly applied individually, and the information on the amount of costs, obtained by a particular method is not used to calculate the amount of costs by the method that occurs chronologically after it. For example, target costs are calculated based on standard costs and do not consider information on the amount of costs obtained by the ABC method, although it provides more realistic data on the number of overheads. Furthermore, value analysis, Kaizen costs and lifecycle cost analysis are also based on standard cost data, although information on the amount of costs obtained by modern calculation methods is available. Following all the above, the aim of the paper is to develop and *propose an integrated cost management model that would represent a comprehensive conceptual framework for strategic cost management.*

1. METHODOLOGY OF RESEARCH AND RESEARCH HYPOTHESES

1.1 Research hypotheses

Integrated cost management systems can more accurately estimate actual costs, identify cost drivers and find ways to reduce overhead through product redesign or changes in product development, production and sales. This research aims to examine the impact of the application of integrated cost management systems on the business results of a particular business entity. According to the stated goal of the research, the following hypothesis is set:

H1: A cost management model that integrates modern cost management methods reduces product costs and increases product profitability.

The impact of the application of an integrated cost management model on business results will be examined by model simulation. Namely, the costs of one product from a metal processing company will be compared with the costs obtained by simulating the application of an integrated cost management system and based on the obtained results, and the set hypothesis will be accepted or rejected. The inductive approach using analysis and synthesis methods, statistical and mathematical methods, modelling and simulation methods, comparative methods, generalization and specialization methods and compilation methods will be used to examine the impact of integrated cost management systems on total costs and product profitability.

1.2 Methodological Framework of Research

The main goal of this paper is to determine the impact of the application of an integrated cost management system on the business results of the company. The main research method in this paper is simulation modelling through several phases described below.

The development of an integrated cost management system refers to the development of system components or subsystems related to strategic cost management instruments and the identification of possible interactions between them.

The collection of input data includes identifying individual details of the model and collecting the necessary documentation from the company, which provides the necessary information for the calculation of costs according to the methodology of the integrated cost management system. Specifically, data on target costs, activity costs and standard costs of product components were obtained by interviews and questionnaires with competent persons from the analyzed company and by reviewing business

books. Based on market research results, the target price of the product is defined, and individual product characteristics are ranked according to market requirements. Using the information on the amount of target costs, costs of business process activities and parameters required for value analysis, it was possible to analyze the impact of these methods on business results.

Development of a simulation model and simulation program within the Ms Excel program included the development of a model that corresponds to the system and allows the hypothesis to be tested. This phase of systematic simulation referred to the modular structure of the model (determining the structure of the system, technology and work organization, cost management system, etc.) and determining the performance of the system (resource utilization, costs of individual product components, costs of individual activities, quality costs, etc.)

The analysis of the simulation results enables the acceptance or rejection of the set hypothesis. If the simulation results' analysis shows that the integrated model's application achieves lower unit product costs, the hypothesis will be accepted.

1.3 Expected scientific contribution

The scientific contribution of this paper is contained in the development and systematic presentation of integrated cost management models. It is important to note that the model presented in this paper is unique and developed by the article's authors. Some authors and researchers (Cooper and Kaplan, 1998; Cooper and Slagmulder, 1997; Sakurai, 1996; Hill and Jones, 2001; Cookins, 2002; Terdpaopong et al., 2019; Stanczyk-Hugiet et al., 2021; Wang et al., 2021) have developed partial models of an integrated cost management system that include a combined application of ABC methods and target cost methods or target cost methods and value analysis. The model, which includes a combination of all methods involved in strategic cost management, cannot be found in any available bibliographic item. Therefore, the scientific contribution of this paper is of great importance for the development of economic and financial science. This model can be applied in industrial enterprises and should make the most significant contribution to determining the cost of the product lifecycle, providing more realistic information of total costs than existing models.

2. OVERVIEW OF PREVIOUS RESEARCH

Integrated cost management systems can be viewed from several aspects, and authors have a different approaches in defining these systems. Thus, for example, Cooper and Kaplan (1998) talk about integrated cost management systems, which imply the integration of the ABC method with the ERP – system (enterprise resource planning). These authors are based on two basic questions in their paper:

- Does the ERP system provide accurate data on the costs of activities, processes and products? and
- Can the ERP system automatically provide relevant, timely information necessary for managers and employees to make strategic decisions?

Namely, the work of these authors is based on the possibilities of applying the information obtained by the ABC method in all business segments.

Furthermore, R. Cooper and R. Slagmulder (1997) researched the cost management system at Olympus Optical and concluded that the integration of individual cost management methods provides greater cost savings compared to the application of individual cost management methods. These authors based their research on the impact of the integration of the target cost method and the product life cycle cost method on cost reduction.

J. Kreuze and G. Newel (1994) integrated the ABC method and product lifecycle cost method and concluded that this integration provides many advantages in cost management and affects the reduction of overall costs.

G. Cookins (2002) researched the possibilities of integrating the ABC method and target cost method and concluded that at each stage of the calculation of the target costs, the information obtained by the ABC method can be used and that the integration of these two methods provides more realistic information about the amount of costs and profitability of the product.

From the previous research and analysis of the available literature in the field of integrated cost management systems, it can be concluded that to date a complete model of integrated cost management has not been developed, covering all the most important methods of strategic cost management, namely the ABC method, target cost method, value analysis, Kaizen method and method of calculating product lifespan costs. In fact, unlike previous research based on partial integrations of strategic cost management methods, this article will present a comprehensive model of an integrated cost management system.

From the review of previous research and analysis of available literature in the field of integrated cost management systems, it can be concluded that no comprehensive model of integrated cost management, including all modern methods for cost calculation, has been developed. Namely, previous research has been based on partial integrations of strategic cost management methods (Tamulevicienė et al., 2020; Hu et al., 2019). This article will present a comprehensive model of an integrated cost management system.

3. INTEGRATED COST MANAGEMENT SYSTEM

The concept of strategic cost management has a broad focus. It is not limited to continuous cost reduction and cost control but is more focused on using cost information by management that is relevant to decision making. Strategic cost management is not limited to the application of cost management techniques but also other actions and tools that reduce costs and at the same time improve the strategic position of the company.

Authors define modern methods of cost management differently. H. Johnson and R. Kaplan (1991) define them as "a complex and integral part of management accounting practice, representing an efficient control and planning tool that provides quality information to create successful management decisions that affect the overall business."

The research problem is based on the fact that the individual application of specific strategic cost management techniques does not allow a realistic estimation of the total costs that a particular product incurs during its lifetime. This statement primarily refers to the calculation of target costs, which uses data on direct standard costs while ignoring indirect costs. Given that there are fewer and fewer costs in the modern production system that can be directly related to the product, and the share of overhead costs is growing, the calculation of target costs based on direct standard costs becomes insufficient. The integration of the target cost method, ABC method, value analysis method, Kaizen cost, quality cost and product lifecycle cost analysis eliminate these shortcomings by allowing simpler and more accurate estimation of actual product costs, determining cost drivers and finding ways to reduce total costs through product redesign or changes in the process of product development, production and sales.

3.1 Overview of the integrated strategic cost management model

The simplified methodology for calculating total costs under the integrated model is based on estimating costs at certain stages of the product's life cycle using modern cost management methods. All individual cost management methods, except the Kaizen method, are applied from the very beginning of the product idea before the product research and development phase. The Kaizen method can be applied only in the production phase because this method is based on a comparison of actual data on the company's business with the desired and planned. By the production phase, the target cost method and value analysis identify the components of the product and cost optimization activities, and then the Kaizen method determines how or how much it is necessary to reduce or increase costs. The ABC method, in this context, is used to allocate overhead on products as a starting point for calculating target costs.

Throughout implementing an integrated cost management system, the optimization of the amount of quality costs is implied. Based on the data prepared in this way, the lifetime costs of the product are calculated.

The following figure 1 shows the chronology of the inclusion of particular strategic cost management methods under an integrated cost management system.

From the previous figure, it can be concluded that the costing of the proposed integrated model begins with the calculation of activity-based costs (ABC method), which allocates indirect costs to products. Based on the cost data obtained by the ABC method, the target costs are calculated to determine the maximum allowable costs. According to market research results, these costs are determined by the target price and the desired level of profit. This model needs to include value analysis, whether the calculated target costs exceed the allowable ones. Value analysis will answer which product components and activities can reduce costs by respecting the functional characteristic of the product and market requirements.

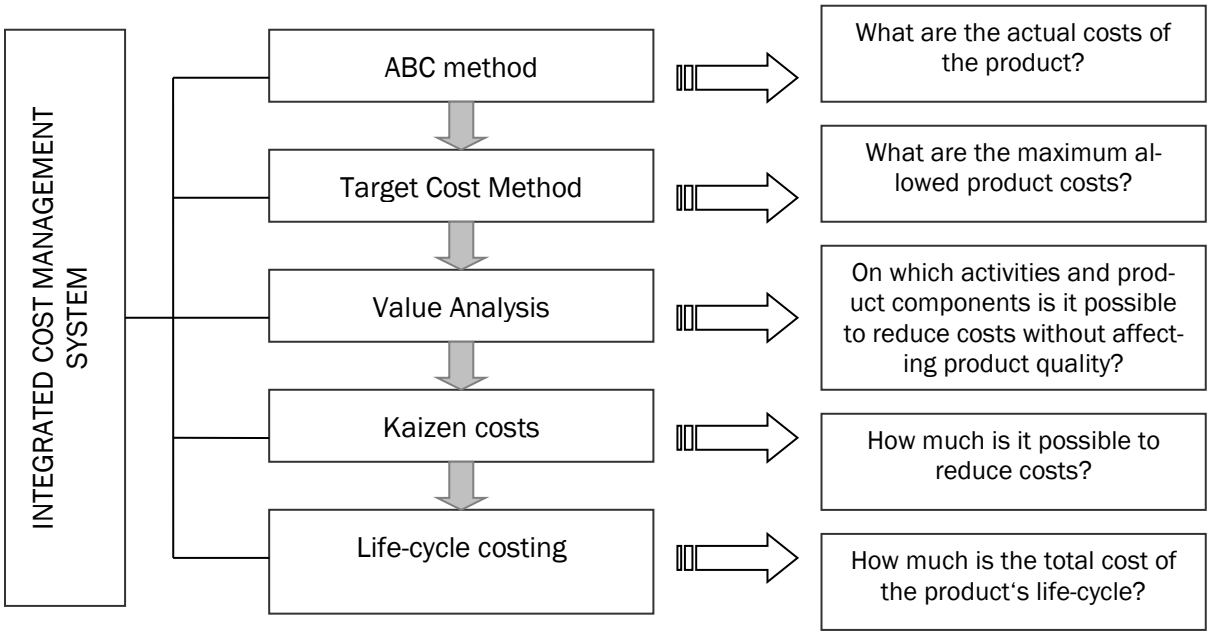

Figure 1. Overview of individual cost management methods within an integrated system

Source: Potnik Galic, 2015.

Once the value analysis determines which components and activities savings can be achieved, the Kaizen method will answer the question "by how much" it is possible to reduce costs on the specified components and activities. After that, it is possible to analyze the cost of the product lifecycle, which will provide an answer to the question of how much costs a product incurs during its life cycle, both from the perspective of producers and users of the product, respecting the time value of money by applying the discounting method and reducing all future product costs to present value. It is important to note that at all stages of the implementation of the integrated model of cost management implies the application of the concept of "quality management".

3.2 Analysis of the impact of integrated cost management system application on the business result

The product that is the subject of the analysis within the integrated model refers to the product of medium value and long lifecycle of the metalworking enterprise. The test method was used to collect

data necessary for research of the impact of integrated systems on business results. The interview method was conducted to provide the information necessary to develop an integrated cost management system model. According to the pre-prepared interview plan, an interview was conducted with competent persons in the company. The modelling method included a research procedure by which a practical integrated model was generated, which enabled a simulation study of the impact of the model application on the company business result. After completing the modelling process, the simulation was performed with the computer support of Ms Excel. This method enabled quantitative analysis of business processes and provided an answer to the question "what if" the company starts applying integrated cost management systems? In this context, this method made it possible to test the hypothesis.

3.2.1 Research the impact of the application of integrated cost management model on business results

The investigation of the impact of the application of the integrated cost management model on business results begins with the calculation of the target costs, as shown in the following table.

Table 1. Calculation of Product Target Costs

Calculation of target costs	*Amounts in HRK*
Net sales price (excluding VAT)	2.741,20
Target gain (30% of the sale price)	822,36
TARGET AND COSTS	1.918,84
STANDARD COSTS	1.858,89
DIFFERENCE	59,95

Source: Authors Calculation.

The target costs in the previous table were calculated based on the collected data on the amount of standard direct and indirect costs. The data in the table indicates that the company achieves the target costs because its standard costs are less than the allowable costs. The next step is to apply a value analysis model based on an attempt to identify the components that have the strongest impact on the product characteristics that customers rated as the most important when making a purchasing decision. The next step in the analysis is to research customer preferences regarding product characteristics.

Table 2. Customer Preferences by Product Characteristic

Product characteristic	*Average market rating*	*% in the overall rating*
C_1	4,50	17,86%
C_2	3,10	12,30%
C_3	4,10	16,27%
C_4	2,90	11,51%
C_5	1,10	4,37%
C_6	3,80	15,08%
C_7	2,30	9,13%
C_8	3,40	13,49%
ALTOGETHER		100,00%

Source: Business Records of Company "X".

Table 2, which lists customer preferences according to product characteristics, shows that the most important characteristics for potential customers when deciding to purchase this product are C-1 and C-3, and the least important characteristics are C-7 and C-5.

The integrated model method includes the calculation of target costs using data from the ABC method (integration of the TC and ABC methods), value analysis based on data from the integrated TC model and ABC method (VA, TC and ABC method integration). As a product of value analysis, the value index will identify the activities that are "candidates" for reducing costs. The Kaizen method will determine the amounts of possible decrease per individual activity (integration of the TC[1], ABC[2], VA[3] and Kaizen methods).

Table 3. Correlation matrix between costs of business process activities, required market properties and product functionality

	PRODUCT CHARACTERISTICS									
ACTIVITY	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	TOTAL	RANK
	% / %	% / %	% / %	% / %	% / %	% / %	% / %	% / %	%	
A_1	45 / 8,04	20 / 2,46	15 / 2,44	5 / 0,58	10 / 0,44	25 / 3,77	30 / 2,74	35 / 4,72	**25,18%**	**1**
A_2	25 / 4,46	20 / 2,46	25 / 4,07	10 / 1,15	30 / 1,31	10 / 1,51		50 / 6,75	**21,71%**	**2**
A_3		35 / 4,31	30 / 4,88		5 / 0,22	25 / 3,77	15 / 1,37		**14,54%**	**3**
A_4	5 / 0,89	5 / 0,62		15 / 1,73	15 / 0,65				**3,89%**	**7**
A_5			10 / 1,63	20 / 2,30	5 / 0,22	20 / 3,02	5 / 0,46		**7,62%**	**4**
A_6				30 / 3,45	10 / 0,44				**3,89%**	**7**
A_7				5 / 0,58	15 / 0,65				**1,23%**	**14**
A_8	5 / 0,89	20 / 2,46		/ 0,00			15 / 1,37		**4,72%**	**6**
A_9				10 / 1,15	10 / 0,44		/ 0,00		**1,59%**	**12**
A_{10}			15 / 2,44				30 / 2,74	15 / 2,02	**7,20%**	**5**
A_{11}	5 / 0,89			5 / 0,58	0 /	10 / 1,51	5 / 0,46		**3,43%**	**9**
A_{12}	10 / 1,79								**1,79%**	**10**
A_{13}	5 / 0,89					5 / 0,75			**1,65%**	**11**
A_{14}			5 / 0,81			5 / 0,75			**1,57%**	**13**
TOTAL %	100 / 13,39	100 / 9,84	100 / 13,02	100 / 5,75	100 / 4,37	100 / 15,08	100 / 9,13	100 / 13,49	100,00%	

Source: Authors Calculation by Company Business Records

The research continues by analyzing the influence of individual activities on product characteristics and functional analysis based on activities. This analysis was performed using the correlation matrix and the calculation of the value index of each activity.

[1] TC – Target costing
[2] ABC – Activity based costing
[3] VA – Value analysis

The left columns in the previous table represent the percentage impact of individual activities on product characteristics required from the market, while the right columns show the results obtained by multiplying the share of costs of individual activities in total costs with the percentage impact of individual activities on product characteristics in meeting market demands. The results of this matrix show which activities contribute the most to product quality from the customer's perspective and which activities are unnecessary, ie which activities could reduce costs without affecting product characteristics that are important to customers when making a purchase decision.

It resulted in the conclusion that the activities A-1, A-4, A-5, A-6, A-8, A-9, A-10, A-13 and A-14 have an index value of more than 1, which means that these activities should be given more attention because they are most affect the characteristics of the products that customers rated as the most important when deciding to purchase the product. If there is a possibility to increase the quality of product characteristics through these activities, the costs of these activities should not be reduced but find the optimal level of costs that will provide a better quality final product. The following table shows the determination of costs after business process reengineering.

Table 4. Determination of costs after product redesign

Activities	*Costs before redesign (in HRK)*	*Value Index*	*Costs determined by value index*	*Maximum quality costs*	*Minimum quality costs*	*Costs after redesign (in HRK)*	*Savings on activity costs*
1.	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*	*8.*
			*2.*3.*				*(7. - 2.)*
A_1	178,00	1,00	178,00	186,00	163,00	178,00	0,00
A_2	224,00	0,69	154,56	232,50	211,00	211,00	13,00
A_3	112,00	0,92	103,04	115,00	109,00	109,00	3,00
A_4	15,00	1,83	27,45	16,50	15,00	16,50	-1,50
A_5	45,00	1,20	54,00	46,20	42,30	46,20	-1,20
A_6	11,00	2,50	27,50	12,30	11,00	12,30	-1,30
A_7	9,00	0,97	8,73	8,40	7,20	8,40	0,60
A_8	11,50	2,91	33,47	12,40	10,30	12,40	-0,90
A_9	8,50	1,32	11,22	8,50	8,50	8,50	0,00
A_{10}	17,60	2,90	51,04	18,50	17,00	18,50	-0,90
A_{11}	36,00	0,67	24,12	38,20	31,50	31,50	4,50
A_{12}	18,00	0,70	12,60	21,35	16,50	16,50	1,50
A_{13}	11,50	1,01	11,62	11,50	9,25	11,50	0,00
A_{14}	10,50	1,06	11,13	10,50	10,50	10,50	0,00
TOTAL	707,60		708,47	737,85	662,05	690,80	16,80

Source: Authors Calculation by Company Business Records Data

The previous table shows the result of a value analysis that, in addition to identifying activities where costs can be reduced, also allows you to determine the level of optimal costs for individual activities. The costs determined by the value index, shown in column 4, are calculated by multiplying the standard costs by the value index. If the amount of costs thus obtained exceeds the costs necessary to achieve maximum quality, the costs are determined at the level that ensures the maximum quality of the product. Conversely, if the costs determined by the value index are at a level that does not ensure the minimum quality of the product, they increase to the amount of minimum quality costs. From the last column of the previous table, it can be concluded that the application of the integrated cost management model achieves savings on the total cost of products of HRK 16.80 per product unit.

3.2.2 Hypothesis verification results

Based on previous calculations, it is possible to conclude the impact of the application of integrated cost management systems on the business result.

Table 5. Results of the analysis of the impact of the integrated cost management system application on the amount of profit achieved

In HRK	*Savings achieved using an integrated cost management model*	*Production Quantity*	*Increase realized profits from product x using an integrated system*
1.	*2.*	*3.*	*4.*
ENTERPRISE X	16.80	15.545	261.156

Source: Authors Calculation by Company Business Records

By applying the integrated model in the calculation of each method, the results obtained by the previous integration of the methods are used. By allocating overheads to products based on process activities and including the results obtained in the value analysis, which have previously passed the verification of maximum allowable costs by calculating target costs, it is possible to achieve greater savings in product costs. It is necessary to consider that this research covers the calculation of costs by an integrated model and focuses on a much broader aspect of research into the possibility of reducing costs through the cost management process. Namely, cost management is a much broader concept than accounting cost coverage (cost calculation) and includes budgets based on the consideration of the possibility of optimal determination of product costs. Therefore, in addition to data from the accounting records of the analyzed company, this study also used data collected from the entire team of experts involved in the business process at all stages of the product life cycle. In this context, marketing experts provided the information necessary for the calculation of target costs and value analysis, based on the results of market research, and obtained information on the required characteristics of products from the market. The joint work of authors and engineers, experts in the technical-technological process field, has enabled the reduction of costs on product components and business process activities. The involvement of product quality assurance staff in the research provided information on the costs of minimum and maximum quality of individual components and product activities. This way, all costs after product redesign and business process reengineering are determined. Competent persons from accounting provided data on the purchase value of individual product components and the costs of business process activities. Also, information was obtained on the share of costs of individual components and product activities in the structure of total costs based on accounting data. The simulation method is used to calculate costs by individual methods and an integrated model, and the simulation results show that the application of an integrated cost management system can significantly impact product profitability.

According to the results from Table 5, the hypothesis that the integrated cost management system has the effect of reducing total costs and increasing product profitability has been proven.

CONCLUSION

This paper presents a critical analysis of literature and previous scientific contributions in the field of modern cost management and presents practical models for the application of an integrated cost management system. The scientific contribution of this paper is in the development and systematic presentation of a comprehensive model of integrated cost management. It is important to note that the model presented in this paper is unique and developed by the article's author.

The objectives of this research related to the research of the possibility of applying integrated cost management systems have been met. The presented model of integrated cost management allows for very simple implementation and application within the enterprise with the necessary minimal modifications. Modifications refer to adjusting the model to the number of components and properties of the product and business process activities.

In accordance with the defined problems and goals of the research, a research hypothesis was set up. The hypothesis that the application of an integrated cost management system reduces costs and increases product profitability has been proven by modelling and simulation methods.

Further research should focus on studying the possibilities of applying integrated cost management systems in service companies, which would require further modifications of the model. It would also be desirable to examine the cost-effectiveness of implementing an integrated cost management model by including the investment costs that the implementation of the model causes. Namely, in this paper, it is assumed that the company applies modern cost management methods, and the costs of their implementation are not included in the calculations. If this system were to be implemented in an enterprise where the modern cost management system had not previously been implemented, investment costs should be included in the feasibility assessment.

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Estimating the Threshold Level of Public Expenditure and Fiscal Deficit in the United Arab Emirates (UAE): Evidence from Kuznets Curve Hypothesis

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ABSTRACT

This study estimates the threshold level of the relationship between fiscal deficit and public expenditure in the United Arab Emirates (UAE) based on the public expenditure Kuznets curve (PEKC) hypothesis during the 1975-2020 period. Employing the autoregressive distributed lag (ARDL) bound testing approach, the results indicate the existence of an inverted U-shaped PECK. In other words, public expenditure-fiscal deficit relationship exhibits an inverted U-shaped in the long-run, feature with public expenditure expanding in the early phases of rising fiscal deficit, and falling in the latter phases. Using the quadratic specification, the threshold of 22.45 percent is obtained for fiscal deficit (as a share of the GDP), and Dh. 6.583 billion for public expenditure. Moreover, the results illustrate that oil price, outflow of money, FDI outflow and interest rate are other important determinants of public expenditure in the country. Based on this evidence, policies aimed at reducing fiscal deficit through rationalisation of spending and prioritising of investment in human capital development are encouraged.

INTRODUCTION

In the conduct of fiscal and monetary policies, fiscal deficit and public expenditure are crucial. Perhaps, John Maynard Keynes was the first economist to advocate for deficit-financed expenditure during economic downturn to raise aggregate demand, savings, investment and production (Orji, Onyeze & Edeh, 2014). However, the linkage of fiscal deficit to public expenditure growth is credited to Buchanan and Wagner (1977). They argued that beyond just raising output and its components, consumption and investment, fiscal deficits would often produce higher levels of public expenditure. The premise of this proposition is that public deficits reduce the perceived price of publicly provided goods and services to citizens, who, in response increase their demand for the goods and services, and thus expansion in public expenditure levels.

Over time, public expenditure in the United Arab Emirate (UAE)–a young confederation of seven emirates: Abu Dhabi, Ajman, Dubai, Fujairah, Ras Al Khaimah, Sharjah and Umm Al Quwain–has been expanding significantly (Mestareehih, 2017; Santos & Shukurov, 2015). Though, as an oil-dependent country, the expansion is due to the huge inflow of oil wealth. However, due to the fluctuation in oil price and the meagre tax revenue inflow, the increase in public expenditure often outpace the available resources, thus giving rise to persistent and rapid increase in fiscal deficit (Federal Competiveness and Statistical Authority [FSCA], 2020). For instance, between 1975 and 2020, statistics indicate that, whereas public expenditure (as a percentage of GDP) maintained an upwards trend, albeit fairly unstable. However, the overall fiscal balance was in deficits in thirty-three years; specifically, in 1982-2004, 2009-2017, and 2020 (see Figure 1).

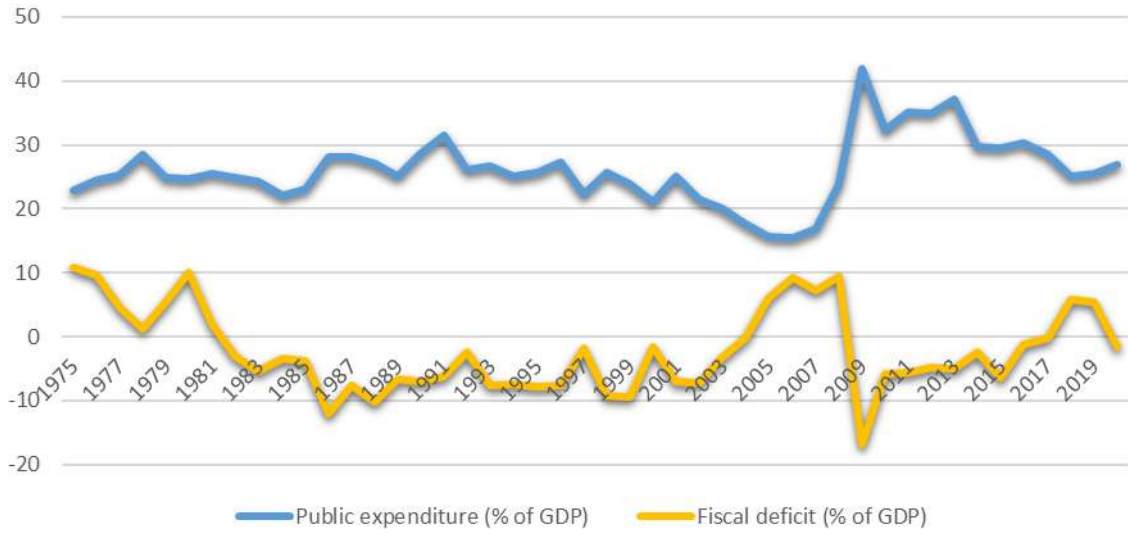

Figure 1. Plots of UAE's public expenditure and fiscal deficits in UAE:1975-2020

Source: FCSA and CBUAE annual reports, 2020

Though the behaviour of fiscal deficit and public expenditure in the UAE did not paint a clear picture on whether fiscal deficit is responsible for the expansion in public expenditure. However, researchers have paid little attention to the relationship between fiscal deficit and public expenditure in the country. Moreover, while studies on their relationship is sparse, the few attempts where outside of the UAE (see for instance, Ashworth, 1995; Craigwell & Rock, 1991; Hondroyiannis & Papapetrou, 2001; Jaén-García, 2016; Lee, 2016; Niskanen, 1978; Önal, 2021; Tridimas, 1992; Yay & Tastan, 2009). However, given the dissimilarities in structural, political and spending profile across countries, it therefore became imperative to specifically explore the connection between fiscal deficit and public expenditure in the UAE.

Moreover, though empirical studies on fiscal deficit-public expenditure nexus suggest that fiscal deficit is directly and linearly related to public expenditure (Önal, 2021). However, seeing that large fiscal deficit, especially debt-financed, beyond a specific "threshold" can generate diminution in public expenditure (especially social expenditures and public investment), either due to debt-induced liquidity

constraints, the need to ensure the continual service of debts, or because expenditure cuts are more quickly applicable in deficit reducing strategies than revenue generation (Krugman, 1988; Quattri & Fosu, 2012). Thus, given this scenario, perhaps, the fiscal deficit-public expenditure nexus may display an "inverted U-shaped" characteristic, with fiscal deficit giving rise to public expenditure in the early stage, and then fall in public expenditure in the subsequent phases (of rising fiscal deficit), instead of the definite direct effect of fiscal deficit reported in previous studies.

In essence, the main objective of this study is to examine the effect of fiscal deficit on public expenditure in the UAE for the period of 1975-2020, and also determine the threshold or peak-point of the relationship. The present study is relevant and contributes to the literature in many ways. For one, to the best of our knowledge, no study has examined the fiscal deficit-public expenditure nexus in the UAE, hence the present study constitutes the first attempt to evaluate the relationship for a long period in the country. Secondly, the present study is the first attempt in examining whether the relationship between the duo is non-linear, and then the identification of the threshold of the relationship. This is achieved by adopting the Kuznets curve approach to develop a self-styled public expenditure Kuznets curve (PECK). Lastly, aside from employing a robust estimation technique (the autoregressive distributed lag (ARDL) bound testing approach to cointegration) to estimate the relationship, post-estimation diagnostics are also conducted to verify the veracity, reliability and stability of the results generated.

Besides the introductory part, relevant empirical studies are reviewed in section one. In section two, theoretical framework, model formulation and econometric technique are considered. Results presentation and discussion are taken up in section three, and the paper is concluded in section four.

1. REVIEW OF RELEVANT EMPIRICAL STUDIES ON PUBLIC EXPENDITURE AND FISCAL DEFICIT

Since the 1970s after Buchanan and Wagner (1977) argued that fiscal deficit is responsible for public expenditure expansion, researchers have made frantic attempt to test this preposition empirically. However, the effect of fiscal deficit on public expenditure was first subjected to direct empirical tests by Niskanen (1978) based on post-war US federal budget deficits. Using the ordinary least squares (OLS) technique, the study concluded that fiscal deficit encourages higher levels of public expenditure in the United States. Later, researchers also confirmed similar outcome in developed and developing countries such as Greece, South Africa, Pakistan, Canada, France, Gernany, Italy, Japan, the United Kingdom, United States, Caribbean countries (Barbados and Trinidad and Tobago), and Turkey (see Ashworth, 1995; Craigwell & Rock, 1991; Diamond, 1989).

Recently, the effect of fiscal deficit on public expenditure has also been explored. For example, Hondroyiannis and Papapetrou (2001) examined the relationship between fiscal deficit and public expenditure in Greece over the 1961–1994 period. Using Johansen cointegration and vector error correction model (VECM), the findings indicate that high deficits encourage higher levels of public expenditure in the short- and long-run. Moreover, Yay and Tastan (2009) used the Engel-Granger, Johansen and ARDL techniques to ascertain the effects of fiscal deficit, income and revenue on public expenditure in Tukey during the 1950-2004 period. The findings demonstrate the existence of a long-run connection between public expenditure and fiscal deficit (and income, and revenue).

Furthermore, Jaén-García (2016) examined the relationship between public deficit and expenditure in Spain during the 1958-2014 period, using the Johansen cointegration and VECM techniques. The results demonstrate that fiscal deficit is an increasing function of public expenditure. In addition, Lee (2016) employed the Johansen approach to study the interrelationships between public expenditure, fiscal deficits, income, wages and population in Zhuhai between 1985 and 2014. Again, the findings validate the increasing effect of fiscal deficit on public expenditure. In exploring the determinants of public expenditure Imana (2017) discovered, using OLS estimator, that fiscal deficit amongst other factors is significant in influencing public expenditure. Also, Önal (2021) examined the fiscal deficit-expenditure relationship in Turkey between 1924 and 2008, using the ARDL approach. Interestingly, the results also corroborate the outcomes from earlier studies.

A survey of the literature thus indicates that, whereas empirical studies on the relationship between fiscal deficit and public expenditure abounds elsewhere, such studies on the UAE are scarce. Besides, the existing studies did not consider whether the relationship between fiscal deficit and public expenditure demonstrate a "U-shaped" feature, with fiscal deficit raising expenditure at the initial phase, and then reducing public expenditure in the later phase. Therefore, this study fills this research lacuna and contributes to the literature by evaluating the effect of fiscal deficit on public expenditure, and identifying the fiscal deficit-public expenditure threshold level in the UAE using the Kuznets curve approach. Furthermore, the study explores the effect of tax burden, outflow of money, foreign direct investment (FDI) outflow and interest rate on public expenditure in the country.

2. THEORETICAL FRAMEWORK, MODEL SPECIFICATION AND ECONOMETRIC TECHNIQUE

The theoretical framework of this study is based on the Kuznets curve hypothesis (Kuznets, 1955). The approach is important because all the empirical studies on the effect of fiscal deficit on public expenditure suggest that the relationship between the duo is linear in nature. However, evidence suggest that growing fiscal deficit, especially debt-based, beyond a specific threshold could generate large adjustments or diminution in public expenditure (especially social expenditures and public investment), due to debt-induced liquidity constraints and the need to ensure the continual service of debts (Quattri & Fosu, 2012). Hence, this suggest that the relationship between public expenditure and fiscal deficit may exhibit an "inverted U-shaped" feature, with an upward phase characterised by increase in public expenditure following rising fiscal deficit, and a downward phase characterised by falling public expenditure due to further increase in fiscal deficit beyond the "threshold."

Interestingly, researchers have fashioned the Kuznets curve hypothesis to observe the relationship between several phenomena, including the connection between shadow economy and economic growth (and environmental pollution, and urbanisation), environmental quality and income level relationship, and income inequality-protests nexus amongst others (see Elgin & Öztunali, 2014; Sulemana, James & Rikoon, 2016). In a similar manner, a PEKC could be estimated to explore the relationship between public expenditure and fiscal deficit in a view of identifying the threshold level of public expenditure as fiscal deficit rises.

To this end, a reduced logarithmic form of the quadratic specification of the PEKC, with the inclusion of the linear and quadratic term of the "x-axis," variable (fiscal deficit), and control variables, is given as:

$$ln(PEX_t) = \alpha + \beta_1 ln(DEF_t) + \beta_2 ln(DEF_t)^2 + \gamma ln(Z)_t + \varepsilon_t \quad (1)$$

where PEX_t represents public expenditure; DEF_t is fiscal deficit; α denote intercept; $\boldsymbol{\beta_1}$ and $\boldsymbol{\beta_2}$ are the linear and quadratic parameters of fiscal deficit; Z_t is vector of control variables (oil price, tax burden, outflow of money, FDI outflow and interest rate); ε_t is a random error term.

The signs of the coefficients $\boldsymbol{\beta_1}$ and $\boldsymbol{\beta_2}$, or specific relations between them determine the nature of relationship between public expenditure and fiscal deficit. In particular, for an inverted U-shaped relationship between the duo to be met (i.e. a PEKC to exist), it is expected that $\boldsymbol{\beta_1} > 0$ and $\boldsymbol{\beta_2} < 0$. In addition to the expect signs of the coefficients, they are also expected to be statistically significant.

If the PEKC exists, the "threshold," "peak" or "turning point" (τ), that is the point beyond which increase in fiscal deficit should ensure fall in public expenditure, can be obtained by setting the first derivative in equation (1) to zero, and solving for DEF_t. It is expressed in the following equation as:

$$\tau = exp\left({}^{-\beta_1}/_{2\beta_2}\right)$$

The study uses annual time-series datasets covering the 1975-2020 period. The data on public expenditure, GDP, public revenue, tax revenue and interest rate are collected from the FCSA and Central Bank of UAE (CBUAE) annual reports; while data for FDI outflow, outflow of money and interest rate were sourced from the UAE's Ministry of Economy statistical bulletin, GCC Secretary General annual report,

and OPEC annual statistical bulletin, respectively. The data are measured as follow: $lnPEX_t$ is log transformed non-adjusted absolute value of public expenditure in billions of UAE Dirhams; DEF_t is expressed as fiscal deficit as a percentage of GDP; $OILP_t$ is measured by the annual spot price of Murban crude oil; and TB_t is the ratio of tax revenue to the GDP. Also, OUM_t and $OFDI_t$ are measured as a ratio of outward remittance and FDI_t to the GDP_t, while INT_t is captured using nominal interest rate, respectively.

Suffice to say that the inclusion of the squared term of fiscal deficit in the PEKC model can lead to multicollinearity problem because it is calculated from the linear term (DEF_t) which is also present in the model, hence the likelihood of high correlation between them. Therefore, to eliminate multicollinearity, the quadratic term (DEF_t^2) is regressed on DEF_t, then the resulting residual is used in place of the quadratic term during estimation (see Abu, Karim & Aziz, 2013).

To estimate the PEKC model (i.e. the relationship between fiscal deficit and public expenditure), the ARDL approach to cointegration (Pesaran, Shin & Smith, 2001) is employed. This technique has numerous advantages over the traditional cointegration techniques. These advantages includes: its effectiveness whether the series are I(0), I(1) or mixture of I(0) and I(1) process; ability to determine cointegrating relationships when using small sample sizes; capacity of series to have different optimal lags; and the use of single reduced form equation for simultaneously estimation of both the short- and long-run parameters, whereas system of equations is required while using tradition approaches (see Abu & Gamal, 2020; Gamal et al., 2019; Sakanko & David, 2019).

3. RESULTS AND DISCUSSION

In this section, the estimation results are presented and discussed accordingly and the outcomes are stated in the appendix.

3.1 Results of Unit Root Tests

Prior to the estimation of the public expenditure and fiscal deficit relationship, the standard econometric procedure of stationarity diagnostics is undertaken using the Augmented Dickey-Fuller (ADF) test of Dickey and Fuller (1979) and the Zivot and Andrews's (1992) unit root test which account for the possibility of structural breaks in the series. Setting the maximum lag order to 4, which was selected based on Schwarz (1978) information criteria (SIC), the results of both tests with intercept (change in level shift) reported in Table 1 illustrate that fiscal deficit is stationary at level (that is, I(0) process) at 5 percent significance level, while other variables are stationary at 5 percent significance level after their first difference was taken.

Table 1. Results of Unit Root Tests

Variable	*ADF*		*ZA*				*I(d)*
	Level	*1st Diff.*	*Level*	T_b	*1st Diff.*	T_b	
$lnPEX$	-1.43	-4.79**	-4.14	2007	-5.27**	2012	I(1)
$OILP$	-1.46	-6.15**	-3.60	2005	-6.61**	2012	I(1)
TB	-1.66	-7.33**	4.22	2001	-8.08**	2010	I(1)
DEF	-3.71**	-8.65**	-4.97**	1987	-9.18**	2007	I(0)
OUM	-0.93	-4.71**	-2.03	2013	-5.75**	2012	I(1)
$OFDI$	-2.78*	-5.64**	-3.70	2008	-6.74**	2000	I(1)
IR	-2.01	-9.11**	-3.88	1985	9.12**	1987	I(1)

Notes: Both tests are conducted with intercept (random walk with drift). ADF's MacKinnon (1996) critical values for intercept are given as: −3.59, −2.93 and −2.60, at 1%, 5% and 10% levels, respectively. Zivot and Andrews (1992) critical values for intercept break are: -5.34 (1%), -4.93 (5%) and -4.58 (10%). The models are estimated by setting the maximum lag to 2, which was selected based on Schwarz (1978) information criteria (SIC). Asterisks (**) indicate significance at 5% level.

Source: Calculation by Author

3.2 Results of ARDL Bound Testing Approach to Cointegration

To determine the presence of long-run relationship between the variables, the bound testing mechanism within the ARDL framework is employed. The bound testing result presented in Table 2 illustrates that the computed F-statistic (3.27) exceeds the upper bound critical value of 3.21 provided by the Narayan (2005), at 5 percent level. Thus, this indicates the presence of a cointegrating (long-run) relationship between the variables.

Table 2. Results of ARDL Bounds Test

Model	*Calculated F-statistics*	*K*
$lnPEX = f(DEF, DEF^2, OILP, TB, OUM, OFDI, IR)$	3.27**	7
Critical values for Case II: restricted constant and no trend	I(0)	I(1)
10%	1.92	2.89
5%	2.17	3.21
1%	2.73	3.90

Notes: Critical bound values are provided by Narayan (2005). Asterisk (**) denotes significance at 5% level. $\mathbf{K}$ denotes the number of explanatory variables.

Source: Calculation by Author

3.3 Estimation Result of Public Expenditure Kuznets Curve (PECK)

Given the presence of long-run relationship between the variables as confirmed by the bound testing procedure, an ARDL model is estimated taking into consideration the optimal lag-length of (1,3,2,4,1,4,2,3), as suggested by Akaike's (1979) information criterion (AIC). The long-run, short-run and diagnostics test of the selected model are summarised in in panel A, B and C of Table 3, respectively.

The long-run results indicate that the effect of fiscal deficit on public expenditure is non-linear, with fiscal deficit influencing public expenditure positively, while fiscal deficit-squared (further increase in fiscal deficit) is inversely related to public expenditure, at 5 percent level of significance, respectively. Moreover, this suggests the existence of an inverted U-shaped PEKC in the long-term, because the coefficient of fiscal deficit $\boldsymbol{\beta}_1$ is positive whereas the coefficient of fiscal deficit-squared $\boldsymbol{\beta}_2$ is negative. Based on the size of the estimates, a percent increase in fiscal deficit and fiscal deficit-squared leads to 2.8 percent increase, and 0.4 percent reduction in public expenditure, respectively.

Interestingly, the discovery of a positive relationship between fiscal deficit and public expenditure is consistent with those reported in earlier studies in line with the Buchanan-Wagner hypothesis (see Ashworth, 1995; Craigwell & Rock, 1991; Hondroyiannis & Papapetrou, 2001; Jaén-García, 2016; Lee, 2016; Önal, 2021; Tridimas, 1992; Yay & Tastan, 2009). However, the reducing effect of fiscal deficit-squared (further increase beyond the threshold) can be explained from the perspective of rising fiscal deficit, especially debt-financed deficit, beyond a specific sustainable threshold or limit resulting to diminution or large adjustments in public expenditure (especially social expenditures and public investment), following debt-induced liquidity constraints or the need to ensure the continual service of debts (Quattri & Fosu, 2012).

Besides, the estimated trough (peak) turning point or threshold of fiscal deficit (as a percentage of the GDP) is 22.45 percent, and Dh. 6.583 billion for public expenditure. A graphical presentation of the quadratic function is presented in Figure 2. By and large, the results particularly imply that increase in fiscal deficit (as a share of the GDP) prior to its threshold (22.45 percent of GDP) will increase public expenditure due to the rising demand for public goods despite the mismatch in the available resource. However, over and above its 22.45 percent threshold, further increase in fiscal deficit (as a percentage of GDP) will be associated with declining public expenditure as the government reassess its commitment due to the unsustainability in the deficit, especially if financed through debt.

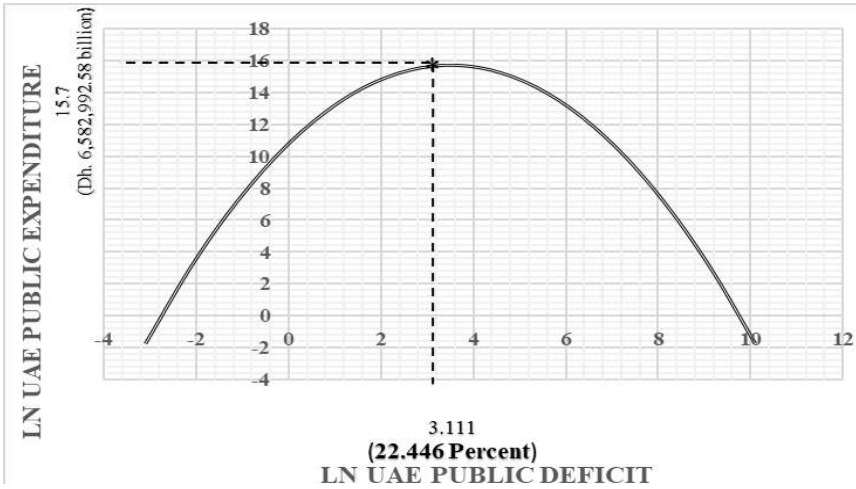

Figure 2. Plot of the Public Expenditure Kuznets Curve (PEKC)

Source: Authors' estimation

Regarding other variables, the long-run result demonstrates that oil price, outflow of money and FDI outflow are positively associated with public expenditure, and significant at 5 percent level, respectively. A dollar/percent increase in oil price, outflow of money and FDI outflow leads to increase in public expenditure by 3 percent, 8.5 percent and 0.61 percent, respectively. These outcomes lend support to research findings on oil-dependent countries (see Abdel-Latif, Osman & Ahmed, 2018; Aladejare, 2020; Dizaji, 2014; Hathroubi & Aloui, 2016). However, the results indicate that tax burden (ratio of tax revenue to GDP) and interest rate are not significant in influencing public expenditure in the long-run.

Table 3. Estimation Results of the PEKC using ARDL Model

Panel A: ARDL(1,3,2,4,1,4,2,3) Long-run Coefficient Estimates–Dependent variable: $lnPEX$							
$Cons$	DEF	DEF^2	$OILP$	TB	OUM	$OFDI$	IR
10.753 (23.10)	0.028** (2.38)	–0.004** (–1.90)	0.030** (10.62)	0.135 (1.18)	0.085** (2.86)	0.612** (7.33)	0.017 (0.41)
Turning point (Public Deficit):					3.11 (22.45 percent)		
Turning point (Public Expenditure):					15.64 (Dh. 6,194,423.44 billion)		
Panel B: ARDL(1,3,2,4,1,4,2,3) Short-Run Estimates – Dependent variable: $\Delta lnPEX$							
Lag order	0		1		2		3
ΔDEF	–0.018 (–4.50)**		–0.013 (–2.39)**		–0.021 (–4.78)**		
ΔDEF^2	–0.001 (–1.84)**		0.001 (3.33)**				
$\Delta OILP$	0.009 (5.85)**		–0.017 (–4.64)**		–0.008 (–3.11)**		–0.012 (–4.62)**
ΔTB	0.005 (0.12)						
ΔOUM	–0.036 (–2.45)**		–0.080 (–3.34)**		–0.093 (–4.18)**		–0.074 (–3.70)**
$\Delta OFDI$	0.042 (0.73)		–0.228 (–3.10)**				
ΔIR	0.016 (1.72)**		0.006 (0.60)		–0.001 (–0.09)		
Panel C: Diagnostic Statistics Tests							
ECT_{t-1}	$\chi^2_{SC}(1)$		$\chi^2_{FF}(1)$		$\chi^2_{HET}(1)$	$\chi^2_{NORM}(4)$	$Adj.R^2$
–0.66 (–6.81)**	0.25 [0.62]		0.018 [0.90]		21.52 [0.76]	29.26 [0.00]	0.76

Notes: The model is estimated by setting the maximum lag to 4, and the optimum lag-length is suggested by AIC. Δ is the first difference operator. Asterisk (**) denote significance at 5%, respectively. Values in parenthesis "()" in panel A and B are the t-ratio, and values in parenthesis "[]" in panel C are the probability values of the LM test statistics. χ^2_{SC}, χ^2_{HET}, χ^2_{N}, and χ^2_{FF} denote LM tests for serial correlation, heteroscedasticity, normality and functional form, respectively.

Source: Estimation by Author

Turning to the short-run estimates, the results suggest that current fiscal deficit (and fiscal deficit lagged by one and two periods) has negative effect on public expenditure, at 5 percent level. A percent increase in fiscal deficit in the current period (and fiscal deficit in past one and two periods) reduce public expenditure by 1.8 percent (and 1.3 percent and 2.1 percent), respectively. However, fiscal deficit-squared is a decreasing function of public expenditure, while fiscal deficit-squared lagged by one period has a significant positive effect on public expenditure. A percent changes in fiscal deficit-squared and fiscal deficit-square lagged by one period leads to reduction and increase in public expenditure by 0.1 percent and 0.1 percent, respectively. The negative and linear relationship between fiscal deficit and public expenditure in the short-run may not be unconnected to the series of fiscal rationalisation and consolidation strategies which was recently embarked upon by the UAE government in an attempt to reduce public expenditure in the country following the growing size of fiscal deficit and oil price fluctuation.

Moreover, the results illustrate that current oil price raise public expenditure, while oil price lagged by one, two and three periods reduce public expenditure, and significant at 5 percent level. A dollar increase in current oil price raise public expenditure by 0.9 percent, whereas changes in oil price in past one, two, and three periods lead to decline in public expenditure by 1.7 percent, 0.8 percent, and 1.2 percent, respectively. In addition, the results demonstrate that outflow of money (both current and lagged by one, two and three periods) and FDI outflow lagged by one period are negatively associated with public expenditure, while interest rate has a positive effect on public expenditure, and significant at 5 percent level, respectively. A percent increase in outflow of money (current and lagged by one, two and three periods) and FDI outflow reduce public expenditure by 3.6 percent (and 8 percent, 9.3 percent and 7.4 percent) and 0.23 percent, respectively. Also, a percent increase in interest rate raise public expenditure by 1.6 percent. More so, the coefficient of error correction term lagged by one period (ECT_{t-1}) is significant, correctly signed, and suggest that 66% of the deviation is corrected within a year.

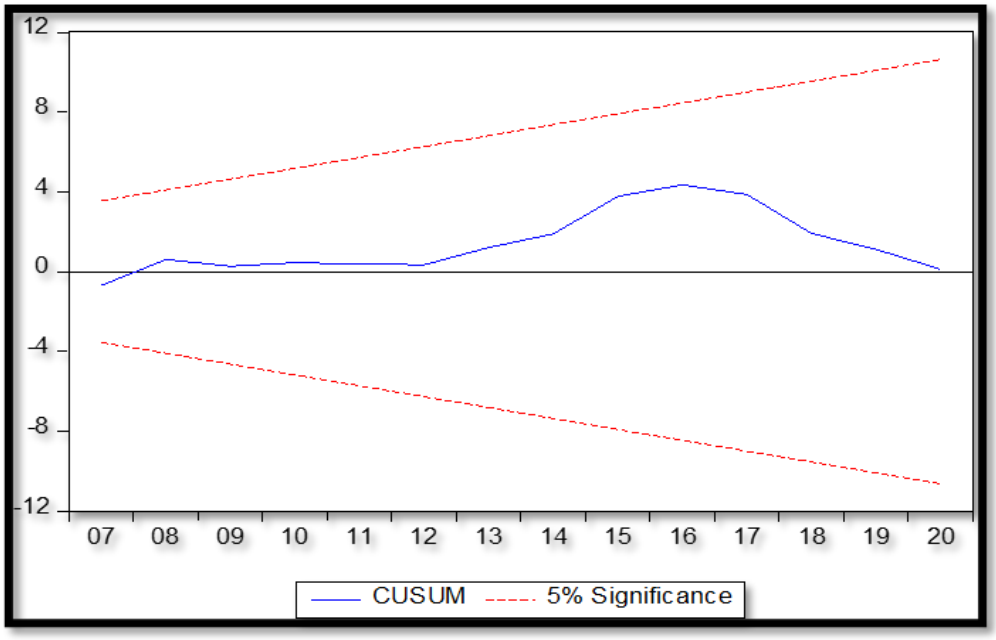

Figure 3. Plot of cumulative sum of recursive residuals

Source: Authors' estimation

The results of the diagnostic tests (panel C) indicate that the ARDL model is not suffering from the problems of serial-correlation, misspecification error or bias and heteroscedasticity. Moreover, though the Jarque-Bera test statistics suggest that the error terms are not normally distributed. However, given that the sample size is small, evidence suggest that this is not an issue (see for instance, Abu & Karim,

2021). Additionally, the adjusted R-squared (*Adj.R*^{2}) value shows that about 76 percent of changes in public expenditure is explained by fiscal deficit and the incorporated control variables. More so, the plots of the cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMQ) tests of Brown, Durbin and Evans (1975), in Figure 3 and 4, are well within the 5 percent critical value lines, therefore indicating that the parameters of the estimated model are stable over the long-run.

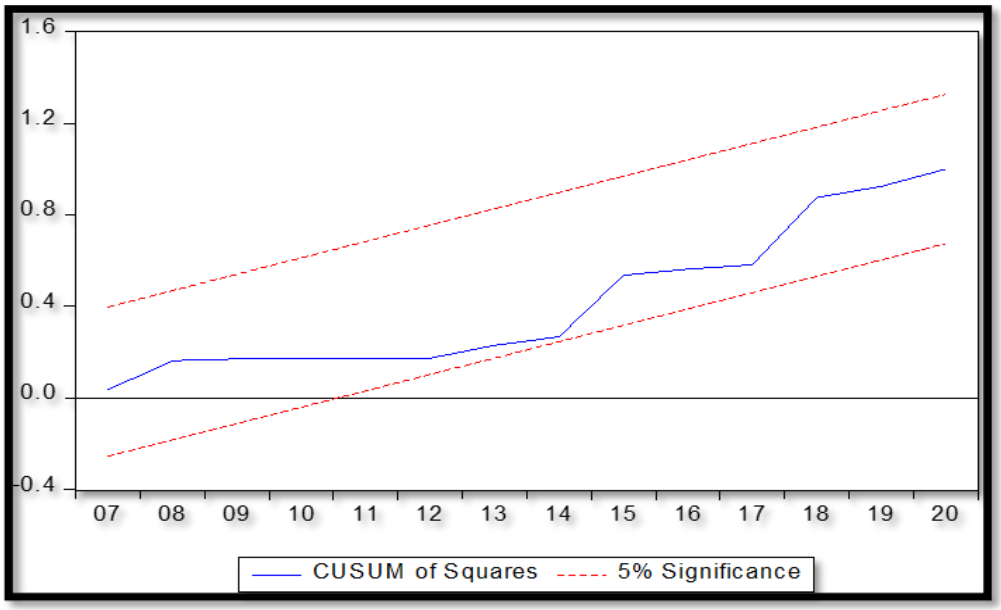

Figure 4. Plots of cumulative sum of squares of recursive residuals

Source: Authors' estimation

CONCLUSION

This study attempts to estimate the nature and threshold of the relationship between fiscal deficit and public expenditure in the UAE, using Kuznets curve hypothesis, during the 1975-2020. Employing the ARDL bound testing approach to cointegration, the results suggest the presence of a significant inverted U-shaped PEKC in the long-run, with fiscal deficit raising public expenditure at the early stage before its reach its peak-point, and reducing public expenditure at the later stage after reaching its maximum. Using the quadratic specification, the peak turning-point of 22.45 percent is obtained for fiscal deficit (as a percentage of GDP), and Dh. 6.583 billion for public expenditure. Moreover, besides fiscal deficit, the results illustrate that oil price, outflow of money, FDI outflow and interest rate are important factors which explain the expansion dynamics of public expenditure in the country.

In line with these findings, this study recommends policies to reduce the growing trend of fiscal deficit in the UAE. In particular, to avert the long-term unescapable consequence of large and excessive fiscal deficit on fiscal allocation, the re-introduction of the restrictive fiscal policy of the 1980s which is characterised by rationalisation of recurrent expenditure, elimination of unnecessary spending and concentration on basic development and maintenance of infrastructures is advanced. Moreover, it is recommended that the huge military expenditure in the country be reduced, while investment in human capital development which have long-term effect on economic growth and development be prioritise.

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Evolving Efficiency of Stock Returns and Market Conditions: The Case from Croatia

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ABSTRACT

The main purpose of this paper is to evaluate Croatian stock market under adaptive market hypothesis. Methodology/approach: Following recent and robust variance ratio test with stronger statistical power and fix-length rolling window on daily CROBEX returns from September 1997 up to July 2021 market (in)efficiency of Croatian stock market were considered. To establish a link between market conditions and its inefficiency classification problem was formulated and evaluated using logistic regression approach. Empirical findings suggested time-varying nature of stock market while price levels and trading volumes being significant signals of (in) efficiency. Conclusion: Findings from this paper supported validity of the adaptive market hypothesis for Croatian stock market. Furthermore, periods lower prices and higher liquidity were more likely to be inefficient and might serve as a signal of trading opportunities on Croatian stock market.

INTRODUCTION

E. Fama (1970) suggested that markets were efficient with random walk dynamics of prices. Numerous empirical papers followed and confirmed findings from Fama (1970). Consequently, debate about market efficiency or inefficiency has started supporting one or another hypothesis. A. Lo (2004; 2005) came up with adaptive market hypothesis as an alternative to efficient market hypothesis. Rational behind the adaptive market hypothesis were magnitude of profit opportunities and market participants adaptability. However, a financial market can hardly be consider as fully efficient or fully inefficient and the true is always somewhere in between. Hence, real question is to what extent a market is efficient and when and why its adaptivity starts. Another strand of literature formulates regression problem and evaluates various predictors of returns (Chen, 2012; Rapach and Zhou, 2013; Zhang et al., 2019; Jing et al., 2020; Zhao et al., 2020 and Khuong et al. 2019 among others).

Therefore, drivers of stock returns were studied in empirical literature while drivers of its predictability are still under-examined. This paper aims to make a step ahead while providing empirical evidence from Croatian stock market. Periods of inefficiency on Croatian stock market were detected firstly using a set of recent and robust tests with stronger power properties and a fixed-length rolling window. Afterwards, binary classification problem was formulated and using logistic regression approach periods of efficiency and adaptivity were further explained with market conditions or more precisely, with level of prices and trading volumes.

1. BRIEF LITERATURE OVERVIEW

As introductory emphasized there was a debate about market inefficiency. In this section, brief overview of contemporary literature will be provided. Ali et al. (2018) examined market efficiency hypothesis for Islamic and conventional stock markets and suggested Islamic stock markets more efficient in comparison to conventional stock markets. Similar aspects of Islamic conventional and non-conventional stock markets were investigated by many scholars (Yahya et al., 2021; Qizam, 2020). Mensi et al. (2018) considered five GCC stock markets, global, Islamic and regional markets and pointed out time-varying nature of persistence in returns. Tiwari et al. (2019) considered stock markets efficiency for developed markets (Canada, France, Germany, Italy, Japan, Switzerland, UK and USA) as well as for two emerging markets (India and South Africa). Also Khodaparasti (2014) and Yacob et al., (2020) presented also differences in the stock markets in developed and emerging markets.

The empirical findings suggested time-varying nature of stock market efficiency. Bhuyan et al. (2020) employed variance ratio test and considered market adaptivity hypothesis for Bombay Stock Exchange and the National Stock Exchange in India. The results suggested evolving predictability dependent on economic and non-economic events in global and regional economy. Lekhal and Oubani (2020) considered Moroccan financial market using linear and nonlinear statistical tests on rolling window samples. The empirical findings supported Adaptive Market Hypothesis. Therefore, depending on degree of market efficiency and market conditions profit opportunities appears from time to time.

A. Sonje et al. (2011) considered Croatian and US stock market during 2002-2010 period and found the markets inefficient. These findings were explained with 2008 financial crisis while in the period before the crisis both markets were found efficient. Sonje et al. (2011) concluded that inefficiency varied across markets as well as in the same markets over time. However, the driving factors behind inefficiency remained unexplained. Consequently, contemporary literature mainly suggests validity of adaptive market hypothesis. However, drivers of market adaptivity were carried out following narrative approach mostly.

Empirical literature dealing with stock market predictability considered several predictors and formulates the issue as a regression problem. D. Rapach and G. Zhou (2013) used inflation represented by consumer price index (CPI). M. Bosnjak et al. (2021) employed wavelet coherence approach and illustrated no link between CPI and CROBEX returns in Croatia. S. Gupta et al. (2018) and L. Nicolescu et al. (2020) suggested dynamic linkage between stock returns and trading volumes. T. Schabek et al. (2019) suggested the semi-strong form of Croatian stock-market efficiency in line with markets of advanced economies. I. Novak (2019) considered efficiency of CROBEX returns and found autocorrelation of returns dependent on sign and magnitude of its endogenous shocks pointing out asymmetries in returns predictability. Despite suitability of the approach for the topic under consideration quantile autoregression provides no time information about periods of market inefficiency. Conclusively, literature presented in this section suggest time-varying nature of market efficiency while drivers of inefficiency were not clear. This paper aims to identifies periods of efficiency and adaptivity in CROBEX returns and suggest potential drivers of market inefficiency.

2. METHODOLOGY

Financial time series usually exhibits non-normality and heteroscedasticity. These properties bear important implication for empirical evaluation of market efficiency. Therefore, to test autocorrelation among CROBEX returns and derive conclusions regarding stock market efficiency in Croatia automatic portmanteau test (Escanciano and Lubato, 2009) and wild bootstrap automatic variance ration test (Kim, 2009) were employed. Both test poses desirable properties in case of small samples with heteroscedasticity and non-normality Charleset al., 2011). Automatic portmanteau test (Escanciano and Lubato, 2009) is a version of Ljung-Box Q statistics that addresses assumption of independence and identical distribution of returns as well as an arbitrary selection of autocorrelation (ρ_k) considered as major weakness of conventional method. In case of the automatic portmanteau test) optimal lag selection is being determined following Bayesian information criterion (BIC) or Akaike information Criterion (AIC). Test statistic for the automatic portmanteau test was provided in equation (1):

$$AQ_k^* = T \cdot \sum_{i=1}^{k} \rho_i^2 \qquad (1)$$

Where T represents total number of observations, ρ_i represents ith order of autocorrelation and k optimal lag length. AQ statistics follow chi-square distribution with one degree of freedom. Automatic portmanteau test assumes no autocorrelation ($\rho_i = 0,$ for all i) under null hypothesis. To provide robustness of empirical results advanced version of variance ratio test (Choi, 1999) was employed. Kim (2009) illustrated weakness of variance ratio test (Choi, 1999) in case of small sample and presence of heteroscedasticity and suggested wild bootstrap procedure to overcome the issues. Test statistic of the wild bootstrap automatic variance ratio test was given in equation (2):

$$AVR(k) = \sqrt{\frac{T}{k}} \cdot \frac{[VR(K)-1]}{\sqrt{2}} \xrightarrow{d} N(0,1) \qquad (2)$$

Implementation of the wild bootstrap automatic variance ratio test follows procedure with three steps:

- Formation of bootstrap sample of size $T, Y_t^* = \eta_t Y_t$ for $t = 1, \cdots$,T, where η_t represents a rendom sequence withe zero mean and unit variance;
- Calculate $AVR^*(K)$ obtained from $\{Y_t^*\}_{t=1}^{T}$ and
- Repeat steps 1) and 2) BS times in order to generate bootstrap distribution of the AVR statistics$\{AVR^*(k,j)\}_{j=1}^{BS}$.

Two-tailed p-value for this test was calculated by deriving proportion of absolute values of $\{AVR^*(k,j)\}_{j=1}^{BS}$ greather than absolute values of$AVR(K)$.

To consider drivers of stock market inefficiency logistic regression model in equation (3) was estimated.

$$ME_t = \beta_1 \cdot AVGTO_t + \beta_1 \cdot AVGIL_t \qquad (3)$$

Where ME_t is a binary categorical variable taking value 1 in case of market inefficiency and 0 in case of market efficiency, AVGTO represents average trading volumes and AVGIL represents average CROBEX level.

3. RESEARCH DATA

Research data sample in this study consists of CROBEX daily data from the Zagreb Stock Exchange (ZSE) since September 1997 up to July 2021. Base value of CROBEX was set on 1000 points while its composition is changed and adjusted semi-annually to best represent dynamics of stock market. CROBEX returns (r_t) at day (t) was calculated as given in equation (4):

$$r_t = log\left(\frac{y_t}{y_{t-1}}\right) \cdot 100 \qquad (4)$$

Development of CROBEX returns (r_t) across period under consideration was provided in Figure A1 in Appendix while its descriptive statistics was provided in Table A1 in the appendix. Visual inspection of Figure A1 in the Appendix illustrates the highest volatility at the beginning of the observation period. Prominent volatility can be detected as contagion effect of 2008 financial crises as well as at beginning of covid-19 pandemic crises. Following Table A1 in the appendix, Jarque-Bera test results suggest non-normality in distribution of CROBEX returns while ARCH test results suggest heteroscedasticity of variance as it is often the case when observing financial time series. To consider market efficiency of CROBEX returns automatic portmanteau test and the wild bootstrap automatic variance ratio test were employed. The tests were performed using fixed-length rolling window of 500 observations (2 years approximately). Therefore, moving by one observation 5.378 successive samples were considered. When the p-value is less than 0.05 the sample was considered ineffective or in line with adaptive market hypothesis. Following Charles et al. (2011) and Lim et al. (2013) among others, this sample size is enough to hold statistical power and desired properties of test.

In order to put some light on drivers of Croatian stock market adaptivity, 500–days average trading volumes (5) and 500–days average index levels (6) were constructed. Trading volumes have been available from ZSE since beginning of 2010.

$$AVTO_t = \frac{\sum_{i=t-499}^{t} TV_i}{500} \quad (5)$$

$$AVIL_t = \frac{\sum_{i=t-499}^{t} IL_i}{500} \quad (6)$$

Where TV_i and IL_i represent trading volume and CROBEX index level at day i, respectively. Therefore, $AVTO_t$ (Figure A2 in the appendix) and $AVIL_t$ (Figure A3 in the appendix) represents 500–days average trading volumes and 500–days average index levels at day t, respectively. Descriptive statistics for $AVTO_t$ and $AVIL_t$ was provided in Table A2 in the appendix. Following results of the automatic portmanteau test and the wild bootstrap automatic variance ratio test with 1000 bootstrap samples, two variables were defined APT_t and WBAVR_t each representing market efficiency. In case of the p-value from automatic portmanteau test was less than 0.05 APT_t variable takes value 1 otherwise APT_t variable takes value 0. In a same way, if the p-value from the wild bootstrap automatic variance ratio test was less than 0.05 WBAVR_t takes value 1 otherwise WBAVR_{t_t} variable takes value 0. In order to provide to evaluate robustness of the results model specification in equation (3) was estimated using APT_t as dependent variable representing market inefficiency (ME_t) as well as using WBAVR_t as dependent variable representing market (in)efficiency (ME_t).

4. EMPIRICAL RESULTS AND DISCUSSION

Following methodological procedure, p-values obtained from the automatic portmanteau test and the wild bootstrap automatic variance ratio test were illustrated in Figure 1 and Figure 2, respectively. Horizontal lines parallel to x-axis represent 5% significance level. Therefore, p-value below the line represents existence of autocorrelation and market inefficiency while p-value on the line and above the line represents no autocorrelation and market efficiency I the corresponding period.

Empirical results in Figure 1 reveals periods of market efficiency and periods of market inefficiency. Therefore, empirical results were in line with adaptive market hypothesis. P-values falls below 5% as of April and May 2002 suggesting serial dependence of CROBEX returns for the period of previous two years. Therefore, it might be potentially attributed to contagion effect of dot-com bubble started to collapse in 1999. Second time p-values falls below 5% was in May 2007 suggesting another episode of market inefficiency for periods started in 2005 and lasted for about year and half. This period of inefficiency might be explained with strong growth of CROBEX level often considered as a bubble. The longest period of CROBEX returns inefficiency started in 2008 and can potentially be linked with global financial crises. This episode was the longest one that lasted for three years. Empirical results from the wild bootstrap automatic variance ratio test were illustrated Figure 2.

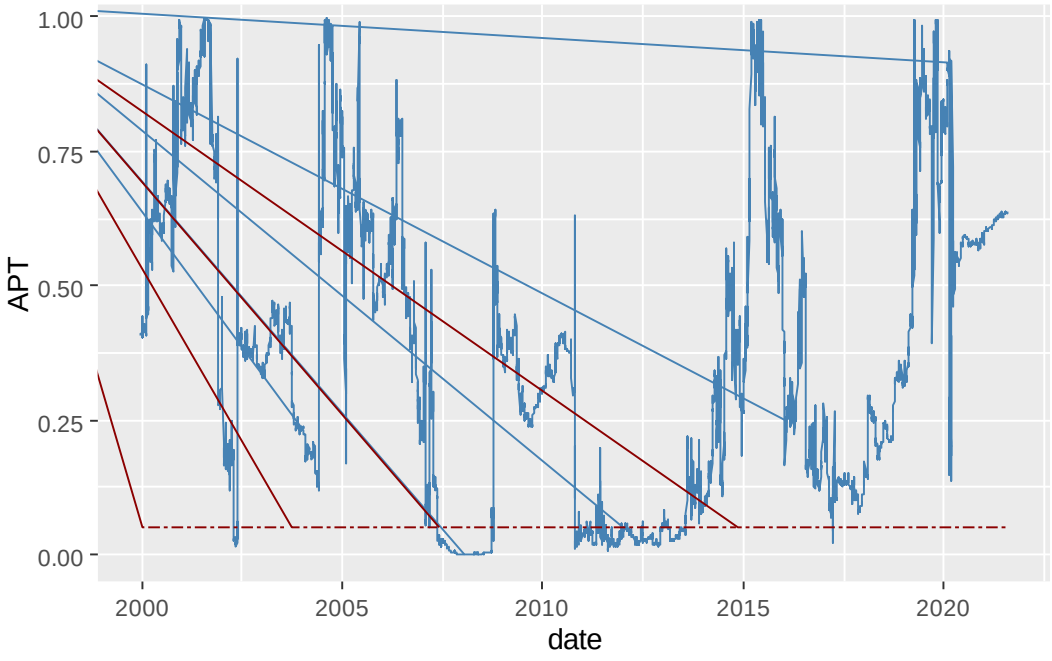

Figure 1. p-values from automatic portmanteau test

Source: Author.

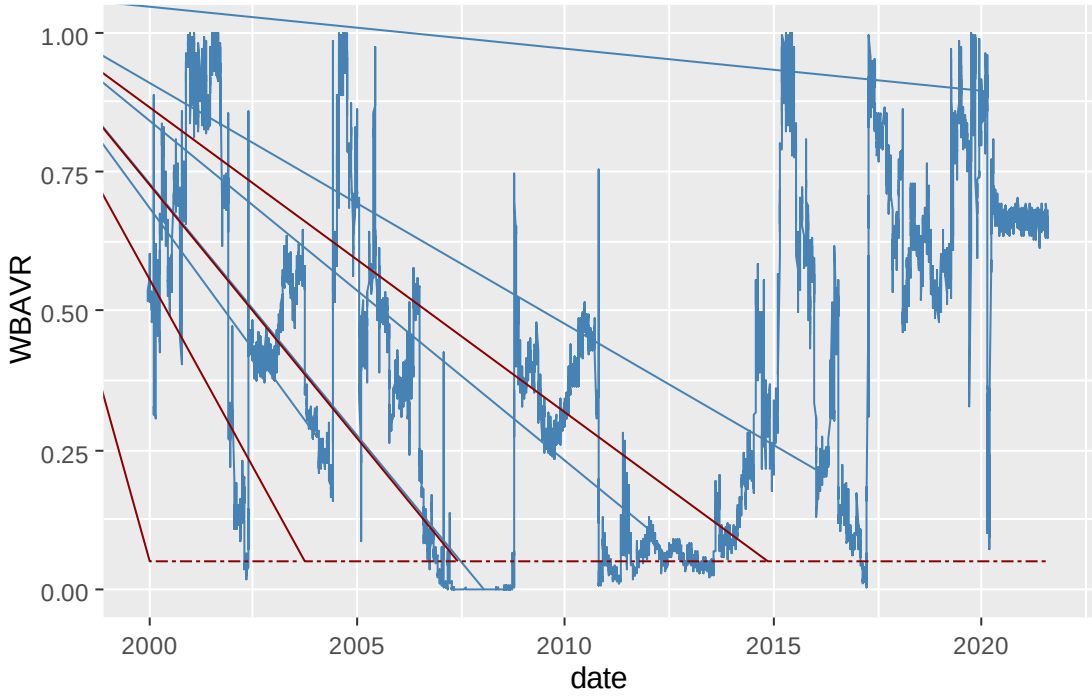

Figure 2. p-values from the wild bootstrap automatic variance ratio test with 1000 bootstrap samples

Source: Author.

The same conclusion can be derived from Figure 2 supporting validity of empirical finding. Visual inspection and comparison of Figure 1 and Figure 2 reveal similar results suggesting validity of adaptive market hypothesis. To illustrate level of efficiency of Croatian stock market efficient and inefficient 500-days periods were counted and reported in Table 1.

Table 1. Level of efficiency

Test	*Inefficiency*	*Efficiency*	*Total*
Automatic portmanteau test	942	4436	5378
Wild bootstrap automatic variance ratio test with 1000 bootstrap samples	768	4610	5378

Source: author.

Following results in Table 1 Croatian stock market was mostly efficient. Based on the automatic portmanteau test inefficiency appeared in 17,52% of cases while based on the Wild bootstrap automatic variance ratio test with 1000 bootstrap samples inefficiency appeared in 14,28% of cases. On average, Croatian stock returns were in line with efficient market hypothesis in 84,10% of cases.

As it is explained earlier in section entitled methodology, link between stock market inefficiency and market conditions described by CROBEX level and its trading volume (liquidity) were evaluated. Model specification in equation (3) was estimated while indicator of inefficiency was obtained using the automatic portmanteau test results. The estimates were summarized in Table 2.

Table 2. Drivers of inefficiency following the automatic portmanteau test results

	Estimate (Std. Error)	*t - value*	*p - value*
AVGTO	9.274e-08 (1.392e-09)	66.64	<2e-16
AVGIL	-3.291e-04 (6.556e-06)	-50.19	<2e-16

Source: author.

Following estimates in Table 2, periods with higher average trading volumes (liquidity) were more likely to be inefficient. More specifically, an increase of trading volume for 10,000.00 kuna was associated with increase of odds ratio for 0,93. Similarly, lower average CROBEX level was more likely to be inefficient. More precisely, a decrease of CROBEX for 1000 basis points increase odds ratio for 0,33. Both considered variables obtained statistical significance of 5%. To analyse robustness of the results model specification in equation (3) was estimated but this time indicator of inefficiency was obtained from the wild bootstrap automatic variance ratio test results. The estimates were reported in Table 3.

Table 3. Drivers of inefficiency following the wild bootstrap automatic variance ratio test

	Estimate (Std. Error)	*t - value*	*p - value*
AVGTO	2.175e-08 (1.732e-09)	12.553	< 2e-16
AVGIL	-5.489e-05 (8.160e-06)	-6.727	2.17e-11

Source: author.

Table 3 illustrated slightly smaller effect from average trading volumes as well as from average CROBEX level to stock market inefficiency. However, results in Table 3suggest that increase in average trading volumes increases likelihood of market inefficiency while decrease in average CROBEX level increases likelihood of market efficiency as well. Therefore, similar results were found in both cases. Con-

clusively, Croatian stock market exhibits properties of evolving efficiency. In about 85% cases CROBEX returns were not predictable. Periods of serial dependence or predictability might be associated with higher trading volumes and lower index level.

CONCLUSIONS

There are several conclusions that can be drown out of research presented in this paper. Firstly, Contemporary literature suggests validity of adaptive market hypothesis and evolving efficiency of financial markets. Empirical findings from recent and robust variance ratio test with stronger statistical power and fix-length rolling window supported validity of adaptive market hypothesis for Croatian stock market. Based on empirical findings from this paper, Croatian stock market was efficient in 85% of cases while serial dependence was detected in 15% of cases. Market conditions in terms of trading volumes (liquidity) and index level (prices) were further considered during periods of efficiency and predictability. Therefore, classification problem was formulated and following logistic regression approach estimates were obtained. The estimates revealed that periods with serial dependence were more likely to be present during the periods with higher trading volumes and lower prices. Conclusively, lower prices and higher liquidity might be a signal of trading opportunities for Croatian stock market.

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APPENDIX

Table A1. Descriptive statistics

CROBEX RETURNS	
Mean	0.009342
Median	0.017170
Maximum	17.57476
Minimum	-19.42264
Std. Dev.	1.435303
Skewness	-0.198519
Kurtosis	28.58011
Jarque-Bera	160270.6
Probability	0.000000
ARCH test:	
F-statistic: 141.0115	p-value: 0.0000
No. of observations	5877

Source: Author

Table A2. Descriptive statistics for average index level (AVGIL) and average trading volumes (AVGTO)

	AVGIL	*AVGTO*
Mean	1828.352	8006306.
Median	1817.899	6766577.
Maximum	2038.718	18157595
Minimum	1732.436	4918574.
Std. Dev.	63.13442	3189756.
Skewness	0.987193	1.984806
Kurtosis	3.792007	5.844563
Jarque-Bera	450.4732	2374.004
Probability	0.000000	0.000000
Observations	2389	2389

Source: Author.

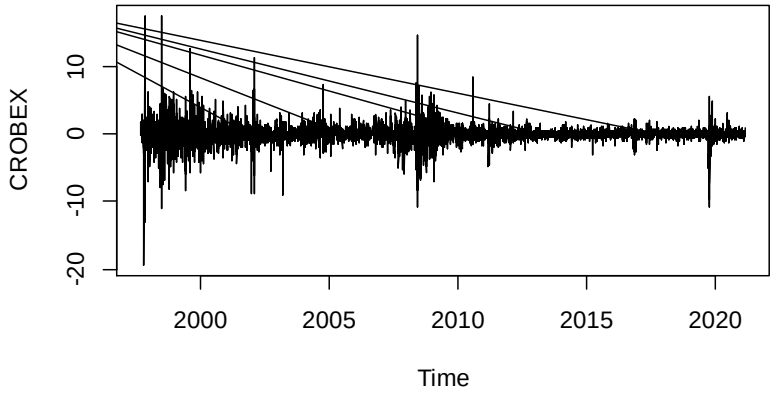

Figure A1. Development of CROBEX returns

Source: Author.

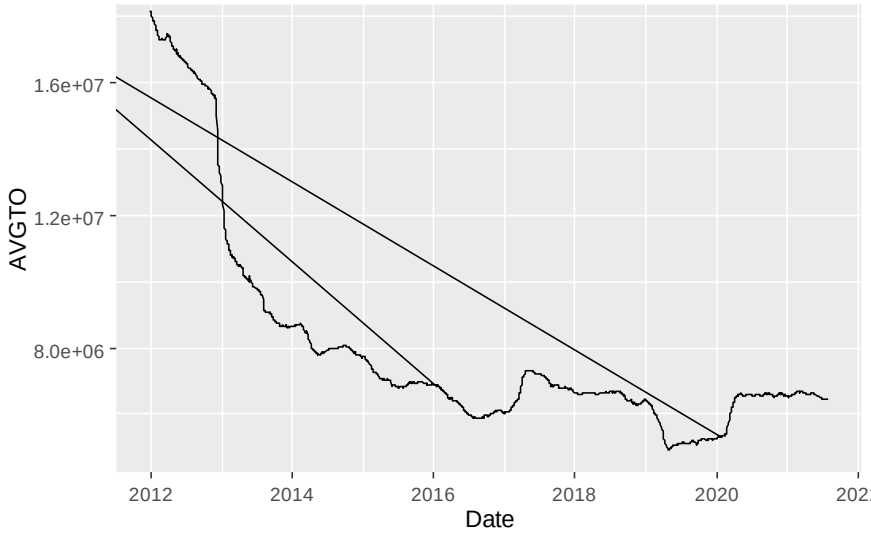

Figure A2. Development of average trading volumes

Source: Author.

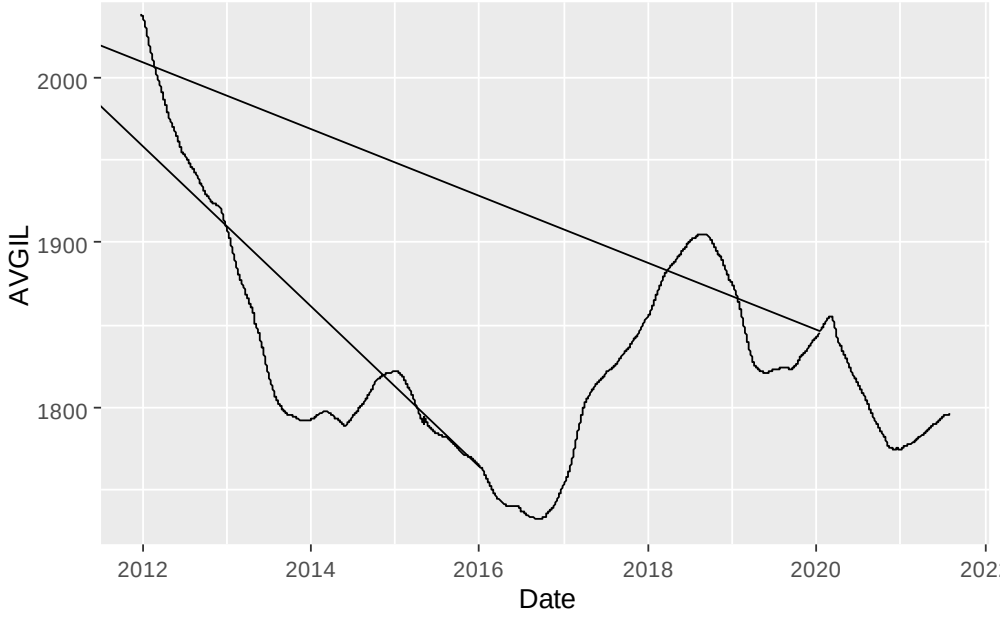

Figure A3. Development of average CROBEX level

Source: Author.

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The Effect Labor Wage and Exchange Rate on Inflation

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ABSTRACT

This study aims to analyze the effect of changes in exchange rates on inflation in Indonesia. It is discussed changes in the exchange rate will affect the use of production factors, especially labor production factors which in turn affect inflation. The research was conducted in Indonesia, with a time period of 2000.1-2020.1. The data used is secondary data published by Bank Indonesia. The data analysis method used is multiple regression analysis with the Error Correction Model (ECM) method. The results showed that Error Correction Term was significant, so it could be concluded that the model specification was correct. In the short term, foreign wages have a positive effect on the inflation , while in the long term, foreign wages have a negative effect on infation in Indonesia. Variable the level of domestic wages in the short term is not significant to inflation, while in the long term this variable has a negative and significant effect on inflation in Indonesia. The foreign price variable shows that the foreign price variable has an effect on n the short and long term. For the exchange rate variable, the results of the study show that the exchange rate has a positive effect in the short and long term on inflation. The long term effect is greater than the short term. This shows that the Exchange Rate Pass Through which works through the use of labor in Indonesia has a greater impact in the long term.

INTRODUCTION

The exchange rate is an important determinant of economic activity and prices in open economies. Depreciation (appreciation) of domestic currency increases (reduces) the cost of imports expressed in domestic currency which is transmitted to domestic prices. Moreover, depreciation (appreciation) may

stimulate (depress) net exports by lowering (increasing) the cost of domestic products for foreign consumers, stimulating (depressing) the demand for domestically produced goods and hence their domestic prices.

In an open economy, exchange rate fluctuations have an impact on inflation. The impact of changes in the exchange rate on inflation propagates through a transmission mechanism known as the Exchange Rate Pass Through (ERPT).

Research on ERPT has been very much done. Research on this grows and develops in line with the increasingly open economy of a country. With economic openness, changes in exchange rates between countries will increasingly affect the economic activities of a country, either affecting the domestic economy or the country's export conditions.

Many studies on ERPT show that there is no uniformity regarding the definition of "pass through". Some researchers focus on the relationship between changes in exchange rates and import prices (Parsley, 2003) (Campa & Goldberg, 2005). Some other researchers have linked changes in exchange rates with the consumer price index ((Bacchetta & Wincoop, 2003) (Beirne & Bijsterbosch, 2011) (Bouakez & Rebei, 2008); (Hüfner & Schröder, 2002; Schröder & PHüfner, 2002). From the research that has been done, it turns out that Exchange Rate Pass Through which works through the Consumer Price Index is usually less sensitive to changes in exchange rates. This is because the Consumer Price Index includes non-tradable goods ((Vigfusson, Sheets, & Gagnon, 2007); (Zorzi, Hahn, & Sánchez, 2007).

There are two transmission lines for the impact of changes in the exchange rate on inflation, namely direct and indirect channels. Indirect transmission works through the demand pull side. In this case, the increase in the foreign currency exchange rate against the domestic currency will cause an increase in the price of foreign goods (imports). With the increase in the price of imported goods, domestic consumers will increase demand for domestic goods or services and reduce goods originating from abroad. This is known as expenditure switching. If there is an increase in the demand for domestic goods and services, there will be an increase in domestic prices, which in turn will encourage an increase in domestic inflation.

In direct transmission, changes in exchange rates will affect inflation through rising prices of imported goods. These imported goods can be in the form of consumer goods, raw materials and capital goods. An increase in the price of imported products will result in domestic inflation.

The production process requires input in the form of raw materials, capital goods and labor. The use of labor in the production process can use labor from within the country as well as from abroad. Changes in the exchange rate will result in changes in the wage rate which is the price of labor. Changes in the use of labor caused by changes in wage levels are an expenditure switching mechanism. Changes in the wage rate caused by changes in the exchange rate will affect the inflation rate indirectly. Here there is an indirect pass through mechanism.

This change in the use of production factors has an impact on production costs and will subsequently have an impact on domestic prices in the country, especially on wholesale trade prices. The purpose of this study is to determine the use of labor production factors on inflation in Indonesia.

1. LITERATURE REVIEW

Over the past two decades a large economic literature on exchange rate pass-through (ERPT) has developed. Starting from different stand-points, the empirical literature examines the role played by ERPT in small and large economies. Studies conducted for the case of developed countries include (Campa & Goldberg, 2005), (Gagnon & Ihrig, 2004), and (Ihrig, Marazzi, & Rothenberg, 2006). There is also a burgeoning literature applied to emerging market economies, including cross-country comparisons as in (Choudhri & Hakura, 2012), (Frankel, Parsley, & Wei, 2005) (Martina Jašová, 2016) and (Vigfusson et al., 2007) .

In subsequent developments, the ERPT studies are related to industrial characteristics, such as market structure and the nature of competition. With increasingly imperfect market structure, it encouraged the researchers to examine the ERPT in industry. One of the studies that had been conducted was the research of Freenstra (1989). The research showed that in monopolistic foreign markets, the response was the same (symmetrically) between the changes in exchange rates and the value of import tariffs.

The further studies were conducted by (Auer & Schoenle, 2012) which examined the relationship between ERPT and market structure. The result of the study by (Auer & Schoenle, 2012)found that : First, exactly the firms that react the most with their prices to changes in their own costs are also the ones that react the least to changing prices of competing importers. Second, the response of import prices to exchange rate changes is U-shaped in our proxy for market share while it is hump-shaped in response to the prices of competing importers. It show that both facts are consistent with a model based on (Dornbusch, 1985) that generates variable markups through a nested-CES demand system. The subsequent research that examined ERPT and market structure was the research conducted by (Ibid.). Dornbusch identified four factors that affected the level of pass-through to prices, i.e.: (i) the level of market integration or segmentation, (ii) the level of product differentiation, (iii) the functional form of demand curve, and (iv) market structure and the level of interaction between suppliers.

2. RESEARCH METHOD

2.1 Data

The data used in this research was the secondary data published by the Bank of Indonesia and the International Financial Statistic. The data used was the quarterly data from 2000.1 to 2020.1. This period was chosen because during this period Indonesia used the floating exchange rate regime and in 2000.1 the macroeconomic data began to stabilize.

2.1 Research Model

To derive the research model, it begins by referring to the relationship between input and output shown in the Cobb Douglass production function which can be denoted as follows:

$$Y_t = A_t K L_t^{(1-\propto)} \quad (1)$$

Where Y is the level of output, A_t is the level of technology in period t, $K_t$is capital in period t and L_t is a factor of labor production. The production function of Cobb Douglas is a production function at a certain period (static). In fact, the level of production is dynamic, and the level of production is intertemporal. Then, the input used is also dynamic.

In carrying out the production process, producers need inputs (factors of production). In this study, the inputs used are capital and labor inputs. The capital used can be from domestic capital and foreign capital. The labor used by producers can be from domestic workers and foreign workers. In this study focused on the use of labor input. Producers in Indonesia in carrying out production are very sensitive to changes in exchange rates, because the inputs used by producers are mostly inputs that must be imported. If there is a change in the exchange rate, producers will respond to the composition of the use of capital inputs and labor used. Changes in input prices (capital and labor) affect the production costs incurred by producers. Thus changes in the cost of capital will affect price changes and the mechanism will work through Aggregate Supply.

This labor input (L) is an effective labor, namely the amount of labor requested where the amount depends on the goods and services produced (Romer, 2012). Effective labor can consist of workers who come from within the country (L^d) and workers who come from abroad (L^f).

$$L^t = L^d + L^f \quad (2)$$

Between these two types of labor can be substituted for each other. If there is a change in the price of labor, namely labor wages (w), for example due to changes in the exchange rate, it will affect producers in using labor inputs. In the equation, the factor that determines the combination of foreign workers and domestic workers is the foreign relative wage rate (w^f) relative to the domestic wage level (w^d). However, this is still conditional on another factor, namely the exchange rate (s).

The combination of foreign workers and domestic workers stated in equation (2) is a static balance. Under these conditions, investors' decisions have not taken into account the expectations in the future. In reality, investors will consider future expectations. When there is an increase in the wage rate of foreign workers, an investor still uses foreign workers more, if an investor expects that the domestic exchange rate will depreciate in the future. The same thing will be considered for investors if there is a change in the relative price between prices from abroad and domestic prices. Thus equation (2) can be expressed in intertemporal form as follows:

$$\left(L^f, L^d\right) = \int_{t=0}^{\infty} e^{-\rho t} u(\pi_t) dt \qquad (3)$$

$$\pi_t \left| \left(w^f / w^d\right), s_t, \left(p^f / p^d\right) \right. \qquad (4)$$

Where: $u(\pi_t)$ is the use of labor input in period of t. π_t is the total use of labor from abroad and from domestic.

L_t is the total of domestic workers (L^d) plus foreign workers (L^f).

$L_t = L^d + L^f$ (5)

u(*) is an instantaneous utility function, which shows the utility of labor at a given time.
(L^d, l^f) is the aggregate labor force at time t. (6)
e is a natural number = 2.7128.....
ρ is the discount factor

The equations (3) and (4) are theoretical frameworks that explain investors' decisions in combining foreign workers and domestic workers. Based on equations (5) and (6), the theoretical equations are as follows:

$$\left(L^f, L^d\right)_t = f\left[\left(w^f / w^d\right)_t, s_t, \left(p^d / p^f\right)_t\right] \qquad (7)$$

Empirically the change of (L^f , L^d) indicates worker remittances (labor remittances). $\left(w^f / w^d\right)$ is the ratio of the foreign wage rate to the domestic wage rate, s_t is the nominal exchange rate, $\left(p^d / p^f\right)$ is the ratio of foreign prices to domestic prices. From the equation (7) it can be interpreted that changes in the exchange rate will be responded to by producers in the use of labor inputs used. If there is a depreciation of the exchange rate, then the input price becomes more expensive, resulting in an expenditure switching mechanism. In this case, producers replace the use of labor inputs from abroad with labor inputs originating from within the country. However, labor inputs cannot be perfectly substituted, so producers cannot replace all workers from abroad with workers from within the country. With conditions like this, the cost of labor will increase, so that production costs will be more expensive. The increase in production costs due to the increase in labor costs will cause an increase in prices working through Aggregate Supply.

Furthermore, the equation (7) is transformed into logarithmic form so that the following equation is obtained:

$$p^d = \sigma_0 + \sigma_1 w^f - \sigma_2 w^d + \sigma_3 s_t - \sigma_4 p^f \qquad (8)$$

Where:

$$\sigma_0 = \frac{\mu_0}{\mu_4}$$

$$\sigma_1 = \frac{\mu_1}{\mu_4}$$

$$\sigma_2 = \frac{\mu_2}{\mu_4}$$

$$\sigma_3 = \frac{\mu_3}{\mu_4}$$

$$\sigma_4 = \frac{\mu_4}{\mu_4}$$

Where:

p^d is the domestic price.
w^d is the domestic wage rate.
w^f is the foreign wage rate.
s_t is the rupiah exchange rate to the dollar.
p^f is the foreign price.

Based on the equation (8) which is the basic model of the research, and then it is transformed to the Domowitz and Elbadawi Error Correction Model as follows:

$$\Delta p_t^d = c_0 + c_1 \Delta w_t^f - c_2 \Delta w_t^d + c_3 \Delta s_t - + c_4 \Delta p_t^f + c_5 w_{t-1}^f - c_6 w_{t-1}^d + c_7 s_{t-1} - c_8 p_{t-1}^f + c_9 ECT_{t-1} + \varepsilon_t \quad (9)$$

Where: $ECT_t = w_{t-1}^f - w_{t-1}^d + s_{t-1} - p_{t-1}^f - p_{t-1}^d$ (10)

2.3 Variable Operational Definitions

Variable	*Symbol*	*Measurement*	*Unit*	*Source*
Dependent variable				
Domestic Price	p^d	Wholesale Price Index	-	Internatioanal Financial Statistic
Independent variable				
Domestic wage rate	w^d	Average nominal wage for industrial workers under foreman (for all industries)	Thousand Rupiah	From the available data, then calculated in the index
Foreign Wage Rate	w^f	Hourly Wage Index in America	-	
Exchange Rate	s_t	Rupiah to Dollar exchange rate, middle exchange rate	Rupiah/US $	International Financial Statistic
Foreign Exchange Rate	w^f	Consumer Price Index in America	-	International Financial Statistic

2.4 Data Analysis Method

The methods and stages of analysis in this research included unit root test, integration test and cointegration test. The unit root test was used to observe whether the variables in the study are stationary in the long run. The rests were carried out using Augmented Dickey Fuller (ADF). The Dickey-Fuller unit root test model was used to determine whether time series data is stationary or not using autoregressive estimation, i.e.:

$\Delta X_0 = a_0 + a_1 BX_t + \sum_{i=1}^{k} d_i B^i \Delta X_t + e_i$ (11)

$\Delta X_0 = c_0 + c_1 T + C_2 BX_t + \sum_{i=1}^{K} d_i B^i \Delta X_t + e_i$ (12)

Note:

$\Delta X_t = X_t - X_{t-1}$

$BX_t = X_{t-1}$

T = time trend, Xt = observed variable in period t ,

B = lag time operation upstream

k = the amount of lag time where k = $N^{1/3}$, N is the number of samples

DF also helps to determine the degree of integration of the existing data whether the distribution is I(0), I(1), or I(2).

The degree of integration test is carried out if the data is not stationary at the time of the stationarity test. This test is intended to see to what degree the data is stationary. In general, if a data requires differentiation up to d to be stationary, it can be expressed as I(d).

The cointegration test is a continuation of the unit root test and the degree of integration. Cointegration test is intended to test whether the resulting regression residual is stationary or not [13]. To perform the cointegration test, the researcher first needs to observe the behavior of the time series economic data that will be used. This means that the researcher must be sure whether the data used is stationary or not. Tests that can be carried out are unit roots and degrees of integration (Insukindro, 1992). If one or more variables have different degrees of integration, then these variables cannot be cointegrated (Insukindro, 1992). In general, most discussions on related issues focus on variables that integrate 0,I(0) or first degree I(1). An important feature of first degree I(1) is that a variable can be a linear combination if integrated at the degree 0,I(0).

3.RESULT AND DISCUSSION

3.1 RESULT

3.1.1 Unit Roots and Integration Degree Tests

To test the stationarity of the data in this study, the testing of unit roots and the testing for integration degree were carried out.

Table 1. The testing of unit roots

Variable	Intercept	Trend and Intercept	Without Trend and Intercept
LPPI	-3,1302***	-3,3334***	3,6177#
LWf	-3,4609#	0,6288#	1,2483#
LWd	-2,7863***	-1,6263#	-5,6092#
LS	-4,8086*	-4,7410*	1,2858#
LPf	-3,9674*	-4,4239**	-1,1481#

Source: primary data processed (2021)

Note: *: stationary at 1%, ** : stationary at 5%, *** : stationary at 10%; #: not stationary at 10%

Considering the ADF value, it appears that all the variables used in the study, if detailed with the ADF calculation by paying attention to the intercept, trend and intercept elements and not using intercepts and trends, show that each variable used in the study is the wholesale price index, domestic wage levels, foreign wage rates, exchange rates, foreign prices there are still elements that are not stationary at 10%.

For this reason, it is necessary to test the degree of integration to determine to what degree the observed variables will be stationary. The following is a test of the degree of integration that is used to see to what degree the variables will be integrated.

Table 2. Testing of Integration Degree

Variabel	Intersep	Tren dan Intersep	Tanpa tren dan Intersep
D(LPPI)	-5,4179*	-5,7740*	-4,6108*
D(LWD)	-7,3878*	-7,8499*	-1,6762***
D(LWF)	-1,6930#	-7,6319*	-1,1581#
D(LS)	-6,1984*	-6,1954*	-6,1018*
D(LPf)	-6,5553*	-6,8593*	-6,5733*

Source: primary data processed (2021)
Note : *: stationary at 1%, ** : stationary at 5%, *** : stationary at 10%,
#: not stationary at 10%

Based on the calculation results in Table 6.9, it can be seen that the large trade price index, domestic wage rate, foreign wage rate, exchange rate, foreign price, forward exchange rate, domestic labor and foreign labor are integrated at degree 1, I(1). The next stage is a data cointegration test.

3.1.2 Cointegration Test

After finding that the variables used in this study have the same degree of integration, which is integrated at the first degree, then the next step is to perform a cointegration test. Based on the cointegration test, which can be seen in appendix 2, the results show that the trace statistic value is 159.5977 which is greater than the critical value (69.8189). Thus, it can be concluded that the large trade price index, domestic wage rate, foreign wage rate, exchange rate, and foreign price are cointegrated in the long run.

3.1.3 Exchange Pass Through Estimation results in terms of Labor Use.

The followings are the results of regression analysis using the Error Correction Model (ECM) to examine ERPT in terms of labor usage.

Table 4. ERPT Regression Estimation Results by using ECM

Dependent Variable: D(LPPI)

Variable	*Coefficient*	*t statistic*
C	-8,6612*	-7,0480
D(LWF)	0,5040*	13,2474
D(LWD)	7,53E-05#	0,1436
D(LS)	0,0738**	2,0441
D(LPF)	3,2750*	7,9845
LWF	- 0,4802*	-13,1347
LWD(-1)	0,4794*	13,0712
LS(-1)	0,3753*	10,2493
LPF(-1)	1,1130*	3,6420
ECT3A	-0,4786*	-13,0649
AR(1)	-0,5532*	-6,1632
R^2	0,9239	
F statistic	36,4645	
Breusch Godfrey	7,7976	
ARCH	2,0638	

Source: primary data processed (2021)
Note : *: stationary at 1%, ** : stationary at 5%, *** : stationary at 10%,
#: not stationary at 10%

The results of the analysis can be seen in Table 4. Based on Table 4 it can be seen that the value of the Breusch Godfrey serial correlation LM test, the Chi squared probability value is 0.0504 where this value is greater than 0.05. Thus, it can be concluded that the model is not subject to autocorrelation problems. Furthermore, for the detection of heteroscedasticity using the ARCH method, the Chi square probability value is 0.1508> 0.05, so it can be concluded that the model does not experience heteroscedasticity problems.

3.2 Discussion

The results of the analysis shown in Table 4 can be seen that the ECT (error correction term) value in the model is -0.478601 and significant at 0.00. The significance of the ECT value indicates that the model specification is valid and there is cointegration between the variables used in the model. The negative sign of the ECT value indicates that the trend in the analyzed model is toward equilibrium in the long run. How fast it goes to equilibrium is dependent on the coefficient of error term which indicates the speed of adjustment towards equilibrium.

Based on the estimation results in the short term, foreign wages (LWF) have a positive effect on the wholesale trade price index, meaning that an increase in foreign wages will increase the cost of foreign labor. With the increase in labor costs, it will cause an increase in production costs. This will result in an increase in the wholesale price index in Indonesia. This is in accordance with cost push inflation. The cost push inflation model is based on the idea that the main factor in price increases is rising costs (Banerji, 2005). Meanwhile, in the long term, foreign wages are responsive to the large trade price index, but the effect is negative. In the long run, if there is an increase in wages abroad, foreign workers will choose to work in countries with higher wages. Labor preferences will of course choose a higher wage than the Indonesian state. With the increase in the level of wages abroad, foreign workers will move abroad so that the cost of factors of production for foreign workers decreases, so that the wholesale trade price index in Indonesia decreases.

The domestic wage rate variable (LWD) in Indonesia based on the estimation results has shown insignificant results in the short term. This is because in Indonesia what happens is that the wage rate is determined by inflation. The adjustment of the Regional Minimum Wage (UMR) in Indonesia is corrected by the inflation rate in Indonesia, not the other way around. Meanwhile, the domestic wage level is responsive to the large trade price index in the long run. An increase in domestic wages will lower the wholesale price index. This indicates that wages in Indonesia in the long run are not a significant contributor to the increase in the wholesale price index in Indonesia. The results of this study are not in line with the theory of (Laflèche, 1996), 1996) regarding the Exchange Rate Pass Through path. In this theory, it is explained that in the direct path, the effect of changes in labor wages on inflation is positive, meaning that if there is an increase in labor wages, it will increase inflation. The results of this study are in line with research conducted in Mexico. The results of research in Mexico from 1980.1 to 2008.8 show that labor costs have a positive effect on inflation. Meanwhile, in the long term, the level of domestic wages in Indonesia has a positive effect on the large trading price index.

For the exchange rate variable (LS) the magnitude of the effect of the exchange rate on the wholesale price index in the short term is 0.07, meaning that when there is a depreciation of the exchange rate in Indonesia, it will cause an increase in the wholesale price index. In general, developing countries are dependent on imports of technology, intermediate goods and capital.

The depreciation of the local currency will greatly affect inflation, because the market power of domestic companies is strongly influenced by imported capital goods. Depreciation of the exchange rate will cause the price of goods to be cheaper abroad so that the demand price will increase. What is different is the result of the estimation of the long-term effect of the exchange rate on the wholesale price index, which is negative at 0.3753, meaning that when there is an appreciation of the exchange rate in Indonesia, it actually results in a decrease in domestic prices in Indonesia (deflation). The phenomenon that occurs in Indonesia is more often depreciation than appreciation. If there is an appreciation of the exchange rate, the prices of Indonesian products will be more expensive abroad. When the price of Indonesian products is more expensive, the demand for Indonesian products that do not have strong compet-

itiveness compared to products from developed countries causes production in Indonesia to decline. This will lead to a decrease in the wholesale price index in Indonesia in the long run.

The results of the foreign price variable (LPF) show that this variable is responsive to domestic prices in the short and long term. The influence of foreign prices is positive in the short and long term, meaning that when there is an increase in foreign prices, the wholesale price index will also increase. This is in line with the globalization of the world economy, changes in foreign prices will soon have an impact on domestic prices, which is known as imported inflation.

The results of the analysis of the effect of exchange rate changes on domestic prices from the labor market show that the influence of domestic variables from the labor market, namely the wages of domestic workers and the number of domestic workers, has no effect on the wholesale price index in the short term. Even in the long term, domestic wages and the number of domestic workers actually have a negative effect on the wholesale price index.

In the short term, factors that contributed to the wholesale price index came from abroad, namely foreign wages, exchange rates, foreign prices and the number of foreign workers. This indicates that in the short term changes in the wholesale price index are dominated by factors originating from abroad. Changes in macroeconomic variables from abroad have more of a role to play in changes in the wholesale price index. The results of this study indicate that the problem of inflation in Indonesia tends to be globe centric, meaning that inflation in Indonesia is caused more by global problems rather than by domestic sources of inflation.

CONCLUSION

Based on the analyzed before, it conclued that Exchange Rate Pass Through in the long run is bigger than in the short run. The results of the variables influencing the wholesale prices in the short term are tingkat upah luar negeri, nilai tukar dan tingkat harga luar negeri. Meanwhile, in the long term, the variables that affect the wholesale prices are the foreign wage rate, the domestic wage rate, the foreign exchange rate and prices. This indicates that in the short term changes in the wholesale price index are dominated by factors originating from abroad. Changes in macroeconomic variables from abroad have more of a role to play in changes in the wholesale price index. The results of this study indicate that the problem of inflation in Indonesia tends to be globe centric

Implication. The research results show that the effect exchange rate to inflation in Indonesia (as measured by whole price) is positive with the ERPT value of 0.2308 in the short run and 0,8373 i the long run. Then, it can be taken into the consideration for determining the inflation control policy in Indonesia. The direct effect of exchange rate changes on inflation is quite high so that the Bank of Indonesia should pay more attention to the changes in exchange rates in order to maintain the inflation rate in Indonesia.

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Causal Relationship between Africa's Growth and Chinese Debt Financing for Infrastructure Development

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ABSTRACT

The contribution of this study is two-fold. First, the study is conducted in response to the growing concerns about the surge of Chinese debt financing for infrastructure development in Africa. Second, while addressing the latter, the study concurrently adds to the ongoing debate on the economic growth-public debt nexus in Africa, typically external public debt. We propose a theoretical argument based on literature that the source of debt and prioritized sectors ought to be explicitly considered when analysing the link between economic growth and public debt. Hence, this study explores the causal relationship between economic growth and Chinese debt financing for infrastructure development in Africa. In general, the literature confirms that optimal external debt investment in productive sectors such as infrastructure development can enhance fiscal stimulus and the growth payoffs are more sustainable to relatively less developed countries. It can, thus, be argued that Chinese debt financing for infrastructure projects can stimulate Africa's economic growth in the long-run. Against the expectation, our results using the VAR technique in the endogenous growth framework for the period (2000-2019) indicate that a one-time shock to Chinese loans on transport infrastructure in the short-run bears a long-run negative impact on Africa's growth, whereas the impact of Chinese loans on power and communication infrastructure is insignificant. These findings suggest a lack of productivity in all Chinese debt-financed infrastructure projects, and government corruption is assumed to be the main cause.

INTRODUCTION

Despite the considerable empirical literature, there is still no consensus on the link between economic growth and public debt in developing countries. Past studies used aggregate public debt in their analysis, assuming that all creditors in the host economy are homogeneous. This assumption may not hold true in Africa, as the priorities of the continent's major financiers appear to differ significantly. Chi-

nese lenders emphasize infrastructure projects, whilst Western lenders favour social development (Morris et al., 2020). The literature indicates that the projects in which the public debt is committed matter in the establishment of growth-public debt nexus (see, for example, Hilton, 2021; Senadza et al., 2018). As a result, the relationship between these variables is likely to vary depending on the prioritized projects. This calls for the need to revisit the growth-public debt nexus using disaggregated public debt data to take account of the source of debt and the prioritized sectors, hence the current study.

Over the last two decades, China has continued to grant billions of infrastructure projects loans to African countries (see Figure 1 below) despite their risk profiles in repayment. Several studies attest to this development, suggesting that China has emerged as a major financier of Africa's infrastructure projects, replacing the United States (US) (see, for example, Gill and Karakülah, 2019; Were, 2018). This surge of Chinese loans in Africa has prompted worries among analysts, researchers and international organizations such as the International Monetary Fund (IMF) about the sustainability of African governments' finances and their reliance on Chinese financiers, which could have geopolitical implications. Although debt trap concerns should not be easily dismissed, for economies such as Africa that are characterized by low levels of domestic investment, the acquisition of external debts is one main governments' technique for raising capital to expand and upgrade prioritized hard infrastructure projects (transport, energy, and communication).

Governments, typically in developing countries, borrow to finance infrastructure projects due to the projects' perceived capacity of generating surplus returns (see, for example Pattillo, et al., 2002; Senadza et al., 2018). Thus, infrastructure development is a crucial factor for stimulating economic growth in developing countries. For Africa in particular, Calderón (2009) and Kodongo and Ojah (2016), provide empirical evidence that infrastructure development is a significant engine of economic growth in Africa, as well as a necessary enabler of productivity and long-term economic growth. Likewise, African Development Bank (AFDB) (n.d.) points that investment in infrastructure contributes to the accomplishment of the Millennium Development Goals (MDGs) and "*accounts for over half of the recent improvement in economic growth in Africa and has the potential to achieve even more*."

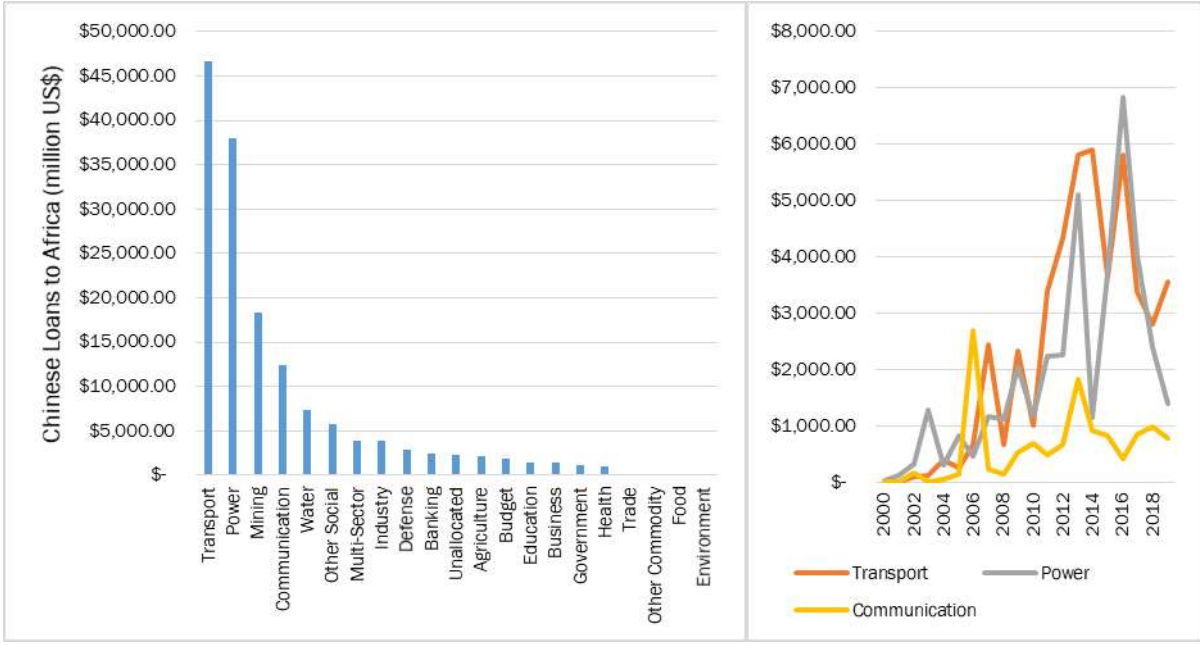


Figure 1: Chinese loans committed to Africa for the period (2000-2019), by sector.

Source: Authors' computation using CARI's dataset on Chinese loans to Africa (CARI, 2021).

However, several studies have focussed on scrutinizing the borrowing spree and overlooked the impact of Chinese debt financing for infrastructure development on economic growth in Africa. Gill and

Karakülah (2019) argued that the lack of reliable data on Chinese loans to Africa has been the major constraining factor to conduct an empirical analysis on China-Africa debt dynamics. The launch of the China Africa Research Initiative (CARI) and the Global Chinese Official Finance Database of AidData has provided a considerable solution to this data problem. As a result, this paper provides an empirically based analysis on the causal relationship between Africa's economic growth rate and Chinese loans provisioned for infrastructure projects using CARI's dataset for the period (2000-2019).

The graph on the left side of Figure 1 summarizes the total amounts of Chinese loans committed to various sectors in Africa from 2000 to 2019 while on the right are periodic trends of Chinese loans provisioned for transport, power, and communication infrastructure projects in Africa. In terms of infrastructure projects, Figure 1 indicates that Chinese creditors prioritize transport and power, respectively, while the amounts committed towards communication are relatively small. In general, the top five sectors in which Chinese loans were committed in the period (2000-2019) are transport, power, mining, communication, and water, respectively.

According to Gill and Karakülah (2019) and Were (2018), Chinese loans to African countries are prioritized for power and transport infrastructure projects to enhance production in their mining activities and transportation of natural resources from Africa to China, respectively. Following the assertion by the aforementioned authors, it can be argued that the loans committed towards communication infrastructure projects are meant to enhance networking mostly for the benefit of Chinese economic activities in Africa. It is also asserted that Chinese loans to some African countries (Angola for example) are backed by natural resources such that repayment is made through extraction enabled by the infrastructure provided (Were, 2018). Infrastructure and mining sectors are characterized by extensive construction activities and Were (2018) suggested that Chinese loans are prioritized for construction-related projects mainly to provide business opportunities for Chinese contractors. This explains why there are few amounts of Chinese loans committed towards social development, agriculture, and service sectors (see Figure 1). While some analysts may criticize the opportunities created for Chinese contractors, it can be argued that the participation of Chinese contractors in Chinese loans-receiving African countries can be accompanied by the transfer of advanced technology and knowledge. Both exogenous and endogenous growth theories confirm that knowledge and technology advancement are essential sources of technological progress in an economy's production function.

The above assertions provide an account of how China cements its 'win-win' economic diplomacy theme; nonetheless, it remains unclear whether the narrative does apply to Africa. Therefore, there is a need to empirically verify if Chinese loans on transport, power, and communication can enhance Africa's growth taking into account that infrastructure access and quality enhance economic growth through trade competitiveness and domestic production (Calderón, 2009; Kodongo and Ojah, 2016). This paper is organized as follows: Succeeding this introduction is the discussion on the relationship between economic growth and external public debt. Section 2 specifies the model and the empirical strategy. The study's findings are presented, interpreted and discussed in section 3 followed by a conclusion.

1. TRANSMISSION CHANNELS OF EXTERNAL PUBLIC DEBT TO ECONOMIC GROWTH

Considering the demand for capital in developing economies, the causal link between their economic growth and external public debt can be theoretically underpinned in the Neo-classical growth theories (exogenous growth model of Solow (1956) and endogenous growth model of Roma (1986), the Classical school of thought (Domar, 1944) and the Ricardian Equivalence Hypothesis (Ricardo, 1951). Neoclassical growth theories stress the critical role of productivity in achieving long term growth, however, their major difference lies in how the productivity parameters are accounted for in each framework. Exogenous growth models posit external debt as additional stock of physical capital in the production function and therefore its hypothetical decisive impact on the economic growth of the host country is transitory in the absence of an exogenous productivity factor. In endogenous growth models, external debt is expected to enhance productivity within the economic system, hence, boosting economic growth in the long-run. External debt may be accompanied by technology and knowledge spillovers. For instance, in the

present study, the participation of Chinese contractors in Chinese loans-receiving African countries can be accompanied by the transfer of advanced technology and knowledge. Thus, following the endogenous growth theories, Chinese debt financing for infrastructure development can serve simultaneously as physical capital and productivity factor in Africa's production function. In view of the Classical school of thought, public debt obstructs economic growth because its repayments curtail savings and therefore crowds out government expenditure. However, Senadza et al. (2018) argue that investing external public debt stock in productive sectors can generate enough returns for repayments and financing other projects. Perhaps it is due to this offset that Saungweme and Odhiambo (2019) found no causality between public debt service and economic growth. Finally, assuming the Ricardian Equivalence Hypothesis, external public debt bears a neutral impact on the host country's economic growth because fluctuations in government expenditure and revenues resulting from external debt are offset by changes in private savings.

1.1 Economic growth and public debt in Africa

Despite the considerable empirical literature on the economic growth-public debt nexus in Africa particularly and developing economies in general (see, for example, Hilton, 2021; Ndoricimpa, 2020, Olamide and Maredza, 2021; Saungweme and Odhiambo, 2019; Senadza et al., 2018), up to date there is still no clear link between these variables. Using the case of Ghana, Hilton (2021) found a unidirectional Granger causality running from public debt to economic growth but in the long-run only. The author, therefore, encouraged developing countries' governments to exercise fiscal discipline in borrowing and invest public loans in productive projects. Fiscal indiscipline resulting in excessive borrowing can be detrimental to economic growth (Ndoricimpa, 2020) while optimal public debt levels (typically external debt) effectively invested in productive projects such as infrastructure development, manufacturing, agriculture and mining can boost economic growth in the long-run (Senadza et al., 2018). In contrast to Hilton's findings, Saungweme and Odhiambo (2019) found that in Zambia's economic growth Granger cause public debt, irrespective of the time frame, and not the other way round. They concluded that the rate of economic growth drives public debt levels. Findings from Olamide and Maredza (2021) reveal that the impact of public debt on South Africa's economic growth shifts from positive in the short run to negative in the long-run. The authors emphasized public institutional reforms as a solution to maintain decisive outcomes even in the long-run. Thus, misuse of public debt or any public funds is most likely when public corruption is high in the host country (Bong and Premaratne, 2018 and Olamide and Maredza, 2021).

Past empirics on growth-public debt nexus assumed homogeneity of creditors in the host economy and therefore utilised aggregate public debt to pursue their analysis. For Africa in particular, this assumption might fail to hold as continent's main creditors (China and the Western lenders) seem to be heterogeneous in several aspects and this could contribute to other pertinent reasons why there is still no consensus on growth-public debt nexus in Africa and other developing economies. First, the Western financiers are concessional while China is less sensitive to institutional quality and pragmatic in its approach (Morris et al., 2020). Second, whereas Chinese lenders prioritize hard infrastructure projects (mainly transport, energy and communication) and mining (see Figure 1), the main focus of Western lenders is social development (mainly water, sanitation, health and education) (Morris et al., 2020). If the projects in which the public debt is committed matter in the determination of growth-public debt nexus as discussed above, it is likely that the growth-public debt nexus can differ subject to the prioritized projects. This calls for the need to revisit this phenomenon using disaggregated public debt data. Hence, the current study seeks to establish a causal relationship between Africa's growth and Chinese debt financing for infrastructure development.

2. MODEL SPECIFICATION

In light of the background provided in the introduction and literature, Chinese loans committed towards transport, power, and communication are considered for examination. The study follows the endogenous growth model (equation 1) pioneered by Romer (1986), whereby physical domestic capital

accumulation (*K*) and technological progress (*A*) are not explicitly differentiated in the production function. Suidarma and Yasa (2021) followed the same model to analyze the external debt-growth nexus in Indonesia arguing that external debt is a capital factor that can enhance the productivity of domestic investment and subsequently lead to economic growth in the long-run.

$$Y = AK \quad (1)$$

Both *A* and *K* enter the model as endogenous variables. *A* is constant.

In line with Barro (1990) and Suidarma and Yasa (2021), we argue that additional capital towards productive sectors such as infrastructure development can enhance constant returns to scale and counteract growth-destroying forces of diminishing returns in the long-run. In other words, infrastructure development is a critical enabler for productivity. Moreover, since Chinese contractors' participation in infrastructure projects can facilitate knowledge and technology transfer in Africa, Chinese loans can be thought of as serving simultaneously as physical capital (*K*) and technological progress (*A*) input in the production function of Africa.

Chinese loans on transport, power, and communication are expected to promote economic growth in Africa because they enhance the region's infrastructure in terms of stock and quality. Calderón (2009) found that infrastructure development in terms of stock and quality boosts economic growth in Africa with significant contributions from telephone density, electricity-generating capacity, road network length, and road quality. Likewise et al. (2016) found that spending on infrastructure development enhances economic growth in sub-Sahara Africa and the growth payoffs are more crucial to relatively less developed countries. This paper, therefore, models Africa's output growth (*Y*) as a function of domestic investment (*k*), Chinese loans on transport (*clt*), power (*clp*), and communication (*clc*) over the 2000 – 2019 period.

$$Y(t) = k(t)^{\emptyset}, clt(t)^{\vartheta}, clp(t)^{\gamma}, clc(t)^{\varphi} \quad (2)$$

where *t* represents the time dimension.

2.1 Estimation Technique

To establish a causal relationship between Africa's growth and Chinese loans on infrastructure development, equation (2) is estimated using the vector autoregression (VAR) model. Using the VAR model also allows us to simulate shocks of Chinese loans on infrastructure projects to the system and measure their effects on Africa's growth over time (Brandt and Williams, 2007). The model is 'vector' because it assumes a multivariate system, and it is 'autoregressive' because it contains lagged values of the dependent variable on the right side of the model (Alzyadat and Al-Nsour, 2020; Chapman et al., 2015). Hence, the linear function of equation (2) can be decomposed into five (5) econometric equations with each variable modelled as a function of other variables in the model. Since this paper is interested in the causal relationship between Africa's growth and Chinese loans on infrastructure projects, attention is given to a function with Africa's growth rate (*Y*) as a dependent variable. The function is specified below.

$$\ln(y_t) = \alpha + \sum_{g=1}^{k} \beta_g lny_{t-g} + \sum_{h=1}^{k} \emptyset_h lnk_{t-h} + \sum_{i=1}^{k} \vartheta_i lnclt_{t-i} + \sum_{j=1}^{k} \gamma_j lnclp_{t-k} + \sum_{m=1}^{k} \varphi_m lnclc_{t-m} + \mu_{1t} \quad (3)$$

In line with Barro (1990) and other endogenous growth theorists, we expect Chinese debt financing for infrastructure to enhance productivity in Africa's production function and promote growth in the long-run.

The data for Chinese loans on infrastructure projects in Africa was extracted from CARI's database (CARI, 2021) and the variables were normalized as a percentage of Africa's GDP. We quantified Africa's growth using the GDP growth rate (UNCTAD, 2021) while domestic capital investment was measured using gross fixed capital formation as a percentage of GDP (AFDB, 2021). All variables are in logarithms.

3. ESTIMATED RESULTS

As a preliminary check, we verify the stationarity of all variables. To be cautious, we include one lagged difference to eliminate serial correlation in the Dickey-Fuller regression error term. The results are presented in Table 1 below.

Table 1: Augmented Dickey-Fuller (ADF) test for unit root

	Level		*First Differences*	
Variables	*Test Statistic*	*5% Critical Value*	*Test Statistic*	*5% Critical Value*
GDP growth rate	-1.000	-3.000	-4.995	-3.000
Gross Fixed Capital Formation, % GDP	-2.017	-3.000	-3.212	-3.000
Chinese loans on transport infrastructure, % GDP	1.351	-3.000	-3.111	-3.000
Chinese loans on power infrastructure, % GDP	-0.116	-3.000	-5.490	-3.000
Chinese loans on communication infrastructure, % GDP	-2.883	-3.000	-3.714	-3.000

Source: own

Notes: H_0: The variable has a unit root. H_0 is rejected if the 5% critical value < the test statistic's value in absolute terms.

Table 1 indicates that the null hypothesis cannot be rejected if the variables are tested for stationarity at level; however, they become stationary after first differencing. These results suggest that all the variables satisfy the stationarity condition required to perform VAR analysis; we thus estimate the VAR regression as specified in equation (3).

Table 2: VAR Results

Dependent variable: *ln* (GDP growth rate)	
Lagged Dependent Variable	-0.052
	(0.266)
L1 *ln*(Gross Fixed Capital Formation, % GDP)	2.234
	(1.954)
L1 *ln*(Chinese loans on transport infrastructure, % GDP)	-0.224*
	(1.133)
L1 *ln*(Chinese loans on power infrastructure, % GDP)	-0.164
	(0.175)
L1 *ln*(Chinese loans on communication infrastructure, % GDP)	0.072
	(0.102)
Constant	-6.175
	(6.066)
Number of observations	18

Source: own

Notes: The VAR model was estimated with one lag.*significant at 10% level. Standard errors are in parentheses.

Table 2 above shows that the 1st lag of *ln*(Chinese loans on transport infrastructure, % GDP) has a negative impact on *ln*(GDP growth rate) at a 10% significant level, *ceteris paribus*. The estimated coefficients of other variables are statistically insignificant; this implies that only Chinese loans on transport infrastructure have a causal relationship with Africa's economic growth rate. We perform Granger causali-

ty tests using the VAR results in Table 3 above to confirm the causal direction between these variables. The results are presented in the subsequent table below.

Table 3: Granger causality Wald tests

Equation	*Excluded*	*chi²*	*df*	*Prob>chi²*
ln(GDP growth rate)	*ln*(Gross Fixed Capital Formation, % GDP)	1.308	1	0.253
	ln(Chinese loans on transport infrastructure, % GDP)	2.817	1	0.093
	ln(Chinese loans on power infrastructure, % GDP)	0.876	1	0.349
	ln(Chinese loans on communication infrastructure, % GDP)	0.490	1	0.484
	All	7.839	4	0.098
ln(Chinese loans on transport infrastructure, % GDP)	*ln*(GDP growth rate)	0.182	1	0.670
	ln(Gross Fixed Capital Formation, % GDP)	0.999	1	0.318
	ln(Chinese loans on power infrastructure, % GDP)	0.397	1	0.529
	ln(Chinese loans on communication infrastructure, % GDP)	1.143	1	0.285
	All	3.196	4	0.526

Source: own

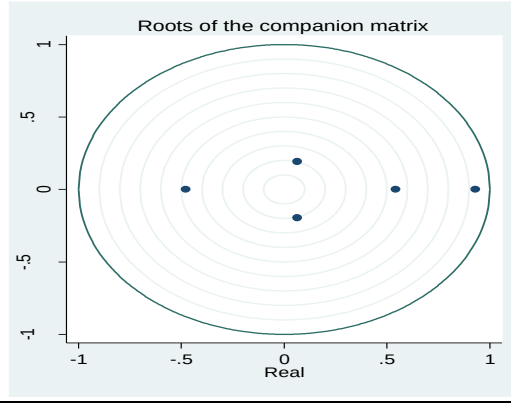
Notes: Since we only have one lag in our VAR, the Granger causality tests only have one degree of freedom and match the single-coefficient tests in the VAR regression table.

Table 3 shows that the causal relationship between Africa's GDP growth rate and Chinese loans on transport infrastructure is unidirectional: Chinese loans on transport infrastructure granger cause Africa's GDP growth rate (the *p*-value is 0.093) and not vice versa (the *p*-value is 0.670). Thus, it can be argued that the negative correlation between Africa's growth rate and Chinese loans on transport infrastructure results from the negative impact of Chinese debt financing for transport infrastructure on Africa's growth rate, rather than the opposite. These results provide evidence that Chinese loans on transport infrastructure can help predict the GDP growth rate in Africa.

To assess our VAR results' validity, we test the dynamic stability of the system using the Eigenvalue stability test, and the results are presented in Table 4 below.

Table 4: Stability test

Eigenvalue	*Modulus*
0.910	0.910
0.543	0.543
-0.478	0.478
0.0632 + 0.194i	0.204
0.0632 + 0.194i	0.204



Notes: All the eigenvalues lie inside the unit circle. VAR satisfies stability conditions.

Table 4 indicates that all the calculated eigenvalues (which can be complex) are less than one (in modulus if they have imaginary parts). This implies that our model is stable and therefore we can proceed to compute orthogonalized impulse response functions (OIRFs). OIRFs trace the dynamic impacts of changes in each of the endogenous variables over time, taking into account the contemporaneous correlations between them (Hoenders et al., 2011). Based on the VAR results presented in Table 2, this study traces the response of Africa's GDP growth rate to Chinese loans on transport infrastructure shock, and the results are illustrated in Figure 2 below.

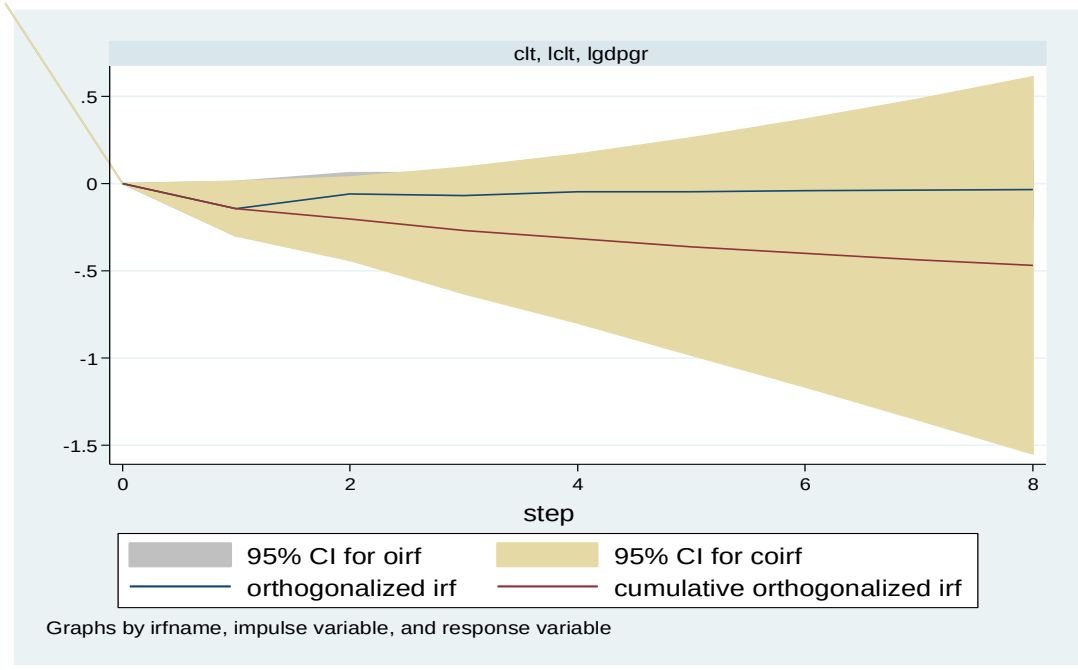


Figure 2: OIRF graph

Source: own

Notes: irf name: Chinese loans on transport infrastructure (*clt*), impulse variable: *ln*(Chinese loans on transport infrastructure, % GDP), and response variable: *ln*(GDP growth rate).

Figure 2 illustrates the response of *ln*(GDP growth rate) to *ln*(Chinese loans on transport infrastructure, % GDP) shock for eight (8) years. The OIRF graph shows that a one-standard-deviation shock to *ln*(Chinese loans on transport infrastructure, % GDP) decreases *ln*(GDP growth rate) by approximately 0.2 percentage points in the first year. Between the first and second year, *ln*(GDP growth rate) recovers gradually by approximately 0.1 percentage point then remains constant up to the 8th year. This trend indicates that the impact of Chinese debt financing for transport infrastructure on Africa's growth rate is negative both in the short and long-run. A one-time shock to Chinese loans on transport infrastructure in the short-run bears a long-run negative impact on Africa's growth. Similarly, the cumulative OIRF graph shows that Africa's GDP growth rate is negatively affected by one-standard-deviation Chinese loans on transport infrastructure shock upon impact and that as time goes on Africa's GDP growth rate continues to be negatively affected by this one-time shock.

3.1 Discussion of research findings

Various studies (see, for example, Pattillo et al., 2002; Senadza et al., 2018; Suidarma and Yasa, 2021) attest that optimal levels of external debt financing for productive investments can boost developing countries' economic growth in the long-run. The literature acknowledges that infrastructure develop-

ment is among the productive investments that can enhance economic growth in developing countries. In Africa, particularly, Calderón (2009) showed that the infrastructure stock and quality enhance the continent's economic growth. Likewise, Kodongo and Ojah, (2016) found that government spending on transport, power, and communication infrastructure boosts the economic growth in sub-Sahara Africa and the growth payoffs are more vital to relatively less developed countries. In contrast, this study found that Chinese debt financing for transport infrastructure is deleterious for Africa's economic growth, while Chinese debt financing for power and communication infrastructure does not bear a significant impact. Generally, our findings indicate that generalizing the causal relationship between economic growth and external public debt can mislead policy developments, the relationship is subject to various factors including the source of debt and the prioritized sectors.

Some analysts might interpret the finding on Chinese loans invested in power and communication based on the Ricardian Equivalence Hypothesis. However, in light of the endogenous growth models utilized in the current study, sustainable growth is most likely where the optimal level of external debt is committed in prioritized projects such as infrastructure development. This finding, therefore implies one or both of the following scenarios. First, there was a lack of productivity in energy and communication infrastructure projects. Second, Chinese loans committed towards these sectors were below the optimal level; low public debt is growth neutral according to Ndoricimpa (2020).

The outcome on Chinese loans invested in transport infrastructure can be discussed in three dimensions. First, in light of the OIRF graph (Figure 2) and the endogenous growth models, Chinese debt financing for transport infrastructure tends to have the potential to enhance Africa's economic growth in the long-run, but productivity appears to be constrained. Considering the deteriorating quality of Africa's institutions and the notion that Chinese loans in Africa are relatively less concessional, chances are that Chinese loans are misused and not effectively utilized for the provisioned purpose. Thus, it is logical to assume that productivity in all the infrastructure projects financed using Chinese loans is constrained due to a lack of accountability and government corruption. As indicated in Bong and Premaratne (2018) and Olamide and Maredza (2021), government corruption is toxic to capital allocation and economic growth.

Second, one can discuss the cumulative OIRF graph (Figure 2) based on the Classical school of thought that servicing of Chinese loans on transport infrastructure is straining Africa's economic growth rate. According to classicalists, external debt servicing reflects capital outflows, and thus external debt financing may be expected to negatively affect Africa's growth. However, following Neo-classical growth theories, Senadza et al., (2018) and Suidarma and Yasa (2021) argued that investing external debt in productive projects such as infrastructure development can generate enough returns to service the debt, reinvest and invest in other projects consequently contributing positively to economic growth in the long-run. Thus, in this study, the unsustainability question of Chinese loans can be argued away because a larger share of Chinese loans in Africa is provisioned for infrastructure development (see Figure 1). It follows that Africa is not generating sufficient returns from the infrastructure projects financed by Chinese loans due to a lack of productivity and fiscal discipline. If Chinese loans are misused then obvious repayment will be strenuous to the economy.

The third dimension is linked to the assertions that Chinese loans for infrastructure projects are offered on conditions and motives to benefit their economic activities in Africa (Gill and Karakülah, 2019; Were, 2018). Could this be the case, our results provide evidence that Chinese debt financing conditions might be deliberated to benefit the financier at the borrower's expense. In this respect, debt trap worries are justified; nonetheless, it remains Africa's responsibility to negotiate for fair debt financing conditions that can effectively lead to a 'win-win' outcome.

CONCLUSION

Using CARI's dataset for the period (2000-2019) and the VAR model in the endogenous growth framework, this study provides an empirical analysis of the causal relationship between Chinese debt financing for infrastructure projects and Africa's economic growth. VAR model was considered as an appropriate tool to simulate shocks of Chinese loans on infrastructure projects and measure their effects

on Africa's growth over time. Our results indicate that only Chinese loans on transport infrastructure can help predict GDP growth rate in Africa albeit with a negative impact both in the short and long-run, whereas the impact of Chinese loans on power and communication is insignificant. The trend derived from the OIRF and cumulative OIRF graphs shows that a one-time shock to Chinese loans on transport infrastructure in the short-run bears a long-run negative impact on Africa's growth. Some analysts may link these findings to the unsustainability notion of Chinese loans. However, Chinese loans are mainly provisioned for infrastructure development as depicted in Figure 1, and there are considerable literature justifications that external debt financing for infrastructure development can generate enough returns to repay the debt and save for other investments. Therefore, following the endogenous growth theories, our perspective is that productivity is constrained in all infrastructure projects financed using Chinese loans, and lack of accountability as well as government corruption at home is assumed to be the leading cause. In light of this conclusion, we suggest the following policy recommendations:

i) Chinese debt financing for infrastructure projects should be effectively utilized for the provisioned purpose.
ii) It remains Africa's responsibility to negotiate for Chinese debt financing conditions that can lead to a 'win-win' outcome and create productivity-enhancing economic externalities in Africa.

These initiatives should be complemented by reforms of institutions involved in the Chinese debt acquisition, investing, and servicing. Future studies are recommended to develop an optimal threshold level/(s) of Chinese debt financing for infrastructure projects required to enhance economic growth in Africa.

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Artificial Intelligence Development: Implications for China*

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ABSTRACT

The Chinese government has developed ambitious policies for global leadership in the field of AI and economic growth. While China has made progress in several areas, it is lagging in developing its microelectronics sector. The purpose of the article is to advance the understanding of the relationship between technologies to manufacture integrated circuits (ICs) and the production capabilities of the Chinese AI industry. To this end, using the latest data on high-tech chip manufacturing in China from 2010 to 2019, this study examined the influence of import restrictions on the manufacture of high-tech equipment and the current state of IC production, and analyzed the opportunity to overcome dependence on foreign equipment and technologies. The results of the research show that (a) China has enough resources for production, especially in comparison with the leading chip-making countries; (b) since 2016, there has, indeed, been a decline in the actual value of the chip market in China, which confirms the difficulties in connection with the imposed restrictive measures; and (c) there is a gap in the production chain in China precisely at the stage of creating the latest-generation chips. To fully harness and scale the power of AI to achieve sustainable economic growth, Chinese policymakers should align import substitution strategies with appropriate business models and incentive structures.

INTRODUCTION

The consistent implementation of reforms and industrial policies has made China a global player in a historically insignificant period. Foreign investment has played an important role, for which China has become the largest destination.

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The end of the initial economic boom led by cheap manufacturing, worsened by the 2008 crisis, triggered a change in direction towards a domestic-consumer orientation for the Chinese economy. This process required higher wages for ordinary workers, and "Chinese screwdriver" has risen in price. The export-oriented economy based on the large-scale production of cheap and low-quality consumer goods is no longer growing. The time has come for innovative industry and modern technologies that produce goods with high added value.

The indicated necessity to reorient the Chinese economy coincided with the development of the global AI sector. By the mid-2010s, AI had become an innovative trigger that boosted the growth rates of leading economies (Furman and Seamans, 2019).

Experts in Chinese studies often define July 2017 as a "Sputnik Moment" (Lee, 2018) for developing the AI sector (Ding, 2018). We suggest that this moment, following the Chinese specifics, took a whole decade. Sections in government-innovation strategies have been devoted to national AI, smart sensors, robots, and augmented-reality technologies since the mid-2010s.

In 2015, the "Made-in-China 2025" program started, with USD 300 billion allocated to developing the high-tech sector (Zenglein and Holzmann, 2019). The program's goal was to intensify R&D in the creation of new materials, 5G telecommunications, and the expansion of robotics. Special attention was paid to the development of AI technologies. In 2016, the Government initiated the “Internet Plus” Artificial Intelligence Initiative to foster AI development to be in line with global AI technology and industries. Finally, in July 2017, the State Council launched the "New Generation Artificial Intelligence Development Plan”. We believe that this document is extremely ambitious. Today, this is a defining point in conceptualizing China's approach in the competition for global AI leadership. Like a plan for military combat, the program defines everything necessary for victory: strategic goals and the timing of their achievement, the detailed bureaucratic mechanisms, approved volumes, and sources of finance (Gill, 2020). Perhaps only the consequences for state and local officials for disrupting its implementation are not indicated. In terms of speed, we believe that the development of Chinese innovations has not been so rapid since Deng Xiaoping.

It may seem that China's goal of becoming a global center for AI by 2030 has every chance of becoming a reality. However, there is one very significant obstacle. There is a considerable lag in developing the microelectronics sector, namely, in producing semiconductors. The situation worsened after the US imposed prohibitive measures on technological, industrial, and trade cooperation with China in this area (Bown, 2020). The Chinese government responded by changes in industrial policy in technological innovation, which began in 2019 (Allen, 2019). Its main goal is to overcome the dependence of semiconductor production on foreign technologies. To solve this problem, Beijing allocated an additional USD 1.2 billion and created an unprecedented level of government preference for companies involved in their production (Roberts et al., 2021).

However, the situation has not yet been reversed. The question of creating a Chinese prototype of the American microcircuit (chip) Nvidia Tesla M40 GPU is not even on the agenda. Furthermore, without the production of national high-speed and highly energy-efficient chips, the path to the AI Olympus will remain closed. Therefore, what prevents China, with its experience in developing the high-tech sector, from overcoming the backwardness in developing semiconductor-based products?

This study aimed to determine the reasons that led to this lag. The paper focuses on assessing Beijing's actions towards implementing the plan for AI global leadership and identifying problems that block it. The paper focuses on the reasons that led to the backwardness and technological dependence in IC manufacturing as well as assessing the prospects for revitalizing this sector.

The methodological approach of this study employed the econometrics modeling method. It involved the formulation of two basic models combined into a system of recursive equations based on an available dataset covering the performance of high-tech chip manufacturing in China from 2010 to 2019.

1. LITERATURE REVIEW

Technology is considered the driving force for national economic development (Autio, 1998; Malecki, 1991), and the role of innovation is emphasized by many economists, from Schumpeter (1954) to Romer (1994). The growth theory and endogenous growth theory (Grossman and Helpman, 1994; Romer, 1994) have highlighted the strategic role of technological advances in economic development. Industrial innovation plays a crucial role in a country's national innovation system (NIS) and can come from different sources, such as in-house R&D, and domestic and international technology transfer (Sun, 2002).

For emerging economies, technology transfers from advanced countries (Young and Lam, 1997) and benefits from foreign investment (Hu and Jefferson, 2002; Du et al., 2020; Rutkauskas et al., 2021) have been regarded the most appropriate sources of innovation, as these economies lack the capital and scientific talent required to perform advanced studies.

Nevertheless, the importance of in-house R&D is critical for developing countries if they do not want to fall behind the innovation leaders and want to sustain evolutional growth. First of all, the ability to perform in-house R&D can enhance absorptive capabilities (Malerba, 1992; Nelson, 1959; Rosenberg, 2009) for monitoring up-to-date external technologies and scientific opportunities. By successfully implementing and converting them, domestic companies will finally be able to build their innovative capabilities. At the same time, it is natural for developing countries to transition away from technological dependency on other countries and, thus, promote domestic technological development (Katz, 2001; Lemoine and Ünal-Kesenci, 2004; Lema and Lema, 2012; Pasaribu et al., 2021; Wojciechowski & Korjonen-Kuusipuro, 2021).

Though technological innovations foster economic development, their complex structures and multilevel relationships do not guarantee that all in-house R&D results in breakthrough innovations or market success. In many countries, the path from in-house R&D to technological innovation and market success is hampered by institutional, regulatory, and organization failures (Sun, 2002).

The consistent implementation of reforms and industrial policies has made China a global player in a historically insignificant period. Foreign investment has played an important role, for which China has become the largest destination. Since 2005, many scientists have started questioning whether China has gone too far in using this strategy and have found mixed empirical evidence regarding the role of FDI on domestic firms and in-house R&D (Sun, 2012, Sułkowski et al., 2021).

Since the mid-1990s, China has tried to build an industry-oriented national innovation system with a decisive role played by government institutions. It has significantly increased the investment in science and technology (S&T) and launched "S&T take-off".

China's strategy allowed it to enter the race for global AI leadership at a speed unprecedented in the history of innovation (Lee, 2018) and even outperform its closest rival, the United States, in some areas. However, there is still a considerable lag in developing the microelectronics sector, namely, in producing semiconductors, which requires strong in-house R&D and breakthrough innovations (Li et al., 2019).

The Chinese government relied for too long on the technology-borrowing strategy. In the case of semiconductor-based products, borrowing meant unprecedented imports from flagship vendors.

Until 2018, the role of national technologies in this innovative gambit had not been decisive. The question of their nationality was certainly considered, but it was not critically essential. In addition, our attention is drawn to the fact that, despite the main strategic goals for developing national AI, the importance of modern national technologies, quality, and the technological level of the semiconductor base were not fully considered.

3. RESEARCH DESIGN

3.1 Data Sample

The study focused on confirming hypotheses based on data for the turnover of high-tech products and indirect indicators characterizing the conditions for the development and production of microchips. The production of semiconductors involves various stages related to different segments in terms of complexity and production technologies. As a result, it is necessary to consider the possibility of using resources, production capacities, and technologies, as a consequence of the development of scientific thought in specific areas. After the production and/or purchase of the various components, they are expected to be combined into the final product. This is followed by an analysis of the production possibilities regarding the quantity of products produced and the market needs for these products.

Thus, to realize the maximum possible coverage of this cycle, data for the country under study were collected from statistical resources and aggregated into a single database. As a result, the sample was artificially limited by the time frame from 2010 to 2019. Additionally, due to Gauss–Markov limitations, most of the data had to be discarded regarding their significance in the process of correlation analysis.

3.2 Methodology

We assumed that the development of technologies to produce chips and semiconductors directly depended on the demand and production capabilities of the Chinese high-tech industry. This is due to the following. A) The restriction of import opportunities severely limits and restrains the production of high-tech equipment in the absence of a sufficiently developed production of high-end products. B) The need to meet consumer demand must be accompanied by an increase in scientific activity in the region. As a leading country in high technologies, China must achieve a high level of scientific and technological progress and be able to set market trends. Therefore, we posit the following research hypothesis:

Hypothesis 1 (H1). *There should be a decrease in activity at one of the stages of chip production in China, before, after, or at the stage of semiconductor production.*

Hypothesis 2 (H2). *In the case that all resources and capacities are available, the volume of chip and semiconductor production depends on industrial demand.*

3.3 Data Description and Variables

The dataset covers China's high-tech IC manufacturing records from 2010 to 2019. We gathered data from sources including the OECD database and statistical reports of different agencies such as the Semiconductor Industry Association. All the data included in the database were considered and analyzed. To test these assumptions, we formulated two basic models and then combined them into a system of recursive equations based on data availability.

$$\begin{cases} Y_{1i} = \beta_1 + \beta_2 X_{1i} + \beta_3 X_{2i} + \varepsilon \\ Y_{2i} = \beta_1 + \beta_2 Y_{1i} + \beta_3 X_{3i} + u \end{cases}$$, where:

Y_{1i} – SCp_i, Y_{2i} – ICp_i, X_{1i} – $PATi/RDpers_i$, X_{2i} – SCc_i, X_{3i} – $ICgm_i$.

Table 1 lists the definitions of the variables used in the empirical procedure, while above, we discuss why we chose these variables.

Table 1. Description of variables.

Variable	*Description*
ICp	Integrated circuit (IC) production, US dollars, billions, current prices
RDexp	Research and development expenditure (% of GDP)
Manuf	Manufacturing, value added (% of GDP)
GDPp	GDP per person employed (US dollars, PPPs)
RDpers	Quantity of researchers in R&D per million people
AIf	Quantity of AI startups
ICm	Integrated circuit market, US dollars, billions, current prices
SILIp	Silicon production volume, metric tons
ICgm	Integrated circuit market, global, US dollars, billions, current prices
Pat	Patents statistics in China
EXP	Semiconductors' (SC) export from China, US dollars, billions, current prices (2014-2019)
IMP	Semiconductors' import in China, US dollars, billions, current prices (2014-2019).
SCp	Semiconductors' production, US dollars, billions, current prices
SCc	Semiconductors' consumption, US dollars, billions, current prices
VCinv	Venture capital (VC) investments, US dollars, billions, current prices (2014-2019)
VCd	Quantity of VC deals (2014-2019)
Funds	Venture capital funds raised, US dollars, billions, current prices
SCf	Quantity of semiconductors' firms

Table 2 and Table 3 present the means and standard deviations, while Table 3 presents the Pearson correlation coefficients for our variables.

Table 2. Descriptive statistics.

	Mean	*Median*	*Std. Dev.*	*Skewness*	*Kurtosis*
ICp	13.36	12.35	5.812668	0.530178	2.129457
ICm	89.3	80	30.37927	0.665621	2.064804
ICgm	349.9	335.5	60.4565	0.857776	2.397819
Manuf	29.60194	29.67406	1.876458	-0.05878	1.521493
Pat	880,660.4	884,693.5	388580	-0.16783	1.606504
RDexp	1.96132	2.013745	0.185605	-0.44738	1.767663
RDpers	1098.029	1089.098	127.2669	-0.04712	2.252631
SCc	153.66	159.1	40.58522	-0.30868	2.00315
SCp	49.34	44.95	26.04958	0.4514	2.088538
Silip	4995	5000	456.6849	-0.63313	3.682924
AIf	86	59.5	74.82869	0.865227	2.366798
GDPp	22,703.97	22452	4668.108	0.14019	1.827895

Table 3. Correlation matrix.

	ICP	*ICM*	*ICMGL*	*MAN-NUF*	*PAT*	*RDEXP*	*RDPERS*	*SCC*	*SCP*	*SILIP*	*AIF*	*GDPP*
ICp	1.00											
ICm	0.99	1.00										
ICgm	0.98	0.99	1.00									
Manuf	-0.88	-0.90	-0.83	1.00								
Pat	0.93	0.93	0.87	-0.96	1.00							
RDexp	0.90	0.88	0.82	-0.95	0.97	1.00						
RDpers	0.86	0.83	0.79	-0.79	0.93	0.87	1.00					
SCc	0.91	0.90	0.83	-0.96	0.97	0.98	0.85	1.00				
SCp	0.93	0.94	0.89	-0.96	0.93	0.93	0.75	0.96	1.00			
SILIP	-0.15	-0.14	-0.18	-0.02	-0.10	0.05	-0.27	0.04	0.08	1.00		
AIf	0.86	0.87	0.86	-0.77	0.86	0.77	0.86	0.76	0.75	-0.52	1.00	
GDPp	0.94	0.94	0.89	-0.97	0.96	0.97	0.81	0.98	0.99	0.04	0.78	1.00

Table 3 shows a high correlation between the chip production and all the other factors, except for silicon mining, which partly confirms our assumption that there are more than enough resources for production in China, especially in comparison with the leading chip and IC manufacturers.

4. RESULTS

4.1 Dependency on IC Imports

Despite all the efforts, the dependence of the Chinese high-tech sector on foreign, primarily American, technologies remains very high. The "leader" is the microelectronics sector (Chen and Dong 2020). This dependency is especially severe for national IC production. The realities of the current scene for Chinese innovation are technological backwardness and a reliance on licensed obsolescent hardware. This is happening amid the growing consumption by Chinese companies of microelectronic products, primarily chips and microprocessors (chipsets) made on their basis. Moreover, this growth is becoming ever more widespread from year to year. According to The General Administration of Customs of the People's Republic of China (GACC), in 2020, the IC import value in China was USD 350 billion, a 14.6 percent increase compared to the previous year. As of February 2021, the import value was already 34.3 percent higher in a year-on-year comparison (Figure 1).

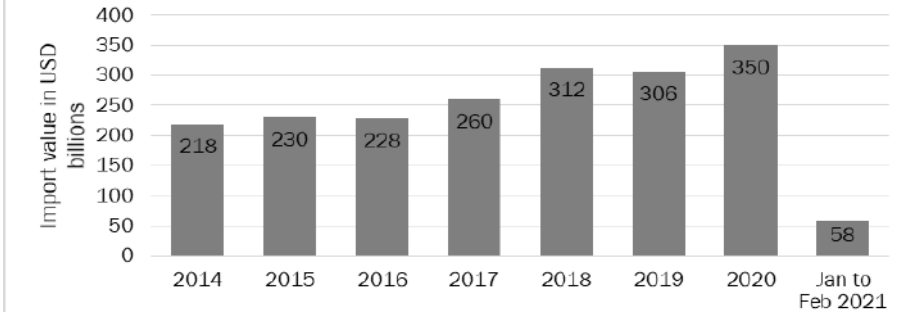

Figure 1. IC import value in China from 2014 to Feb 2021 (in USD billions). *Source:* Trading economics, China customs.

The reason for such rapid growth in IC imports is the fact that, without them, it would be impossible to produce household appliances or smartphones and tablets, develop the AI sector, and explore the surface of the Moon. The production scale has moved ICs from single-piece electronic products to the category of industrial raw materials, with a very contrasting price gradation. The price is influenced by the dimensions of the chip (nanometer (nm)), which are determined by their production technology. The smaller the size and the higher the speed and energy efficiency of the chip, the higher its cost.

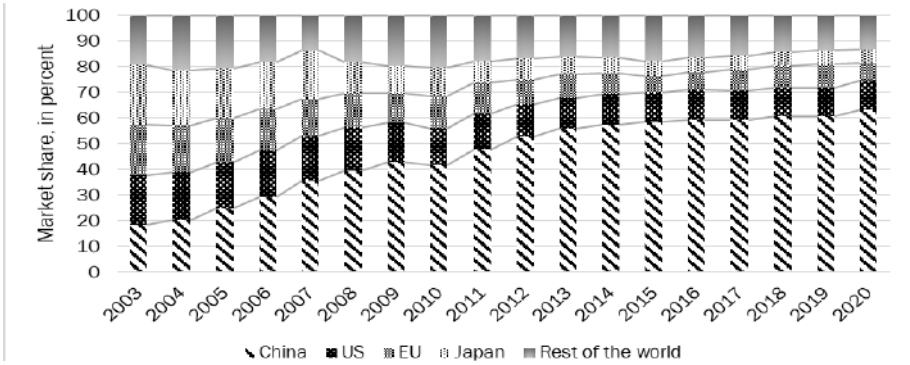

Figure 2. IC consumption market share worldwide, from 2003 to 2020, by region. *Sources:* PwC; SIA; IC Insights, Gartner; CCID Consulting.

Today, for high-tech products, both for the domestic market and for export production, China consumes approximately 61% of the world's ICs (Figure 2). At the same time, by the end of 2020, Chinese chipmakers mainly produced chips in low and medium price ranges. These were 130 and 100 nm microcircuits—widely used in the auto industry, household appliances, and smartphones. The IT and AI industry need chips with 65 nm and below. Moreover, their production in China today does not exceed 20% of that required. Fewer than 2% of national chipmakers produce 43 nm medium-speed and energy-efficient microcircuits. Their quality does not satisfy even national vendors (primarily ZTE and Huawei) that work on IT and AI solutions. National chipmakers produce flagship (5 nm technologies) microchips crucial for AI development as experimental single-part samples.

Figure 3 depicts the dynamics of chip production depending on all the indicators that cover the same time range from our dataset.

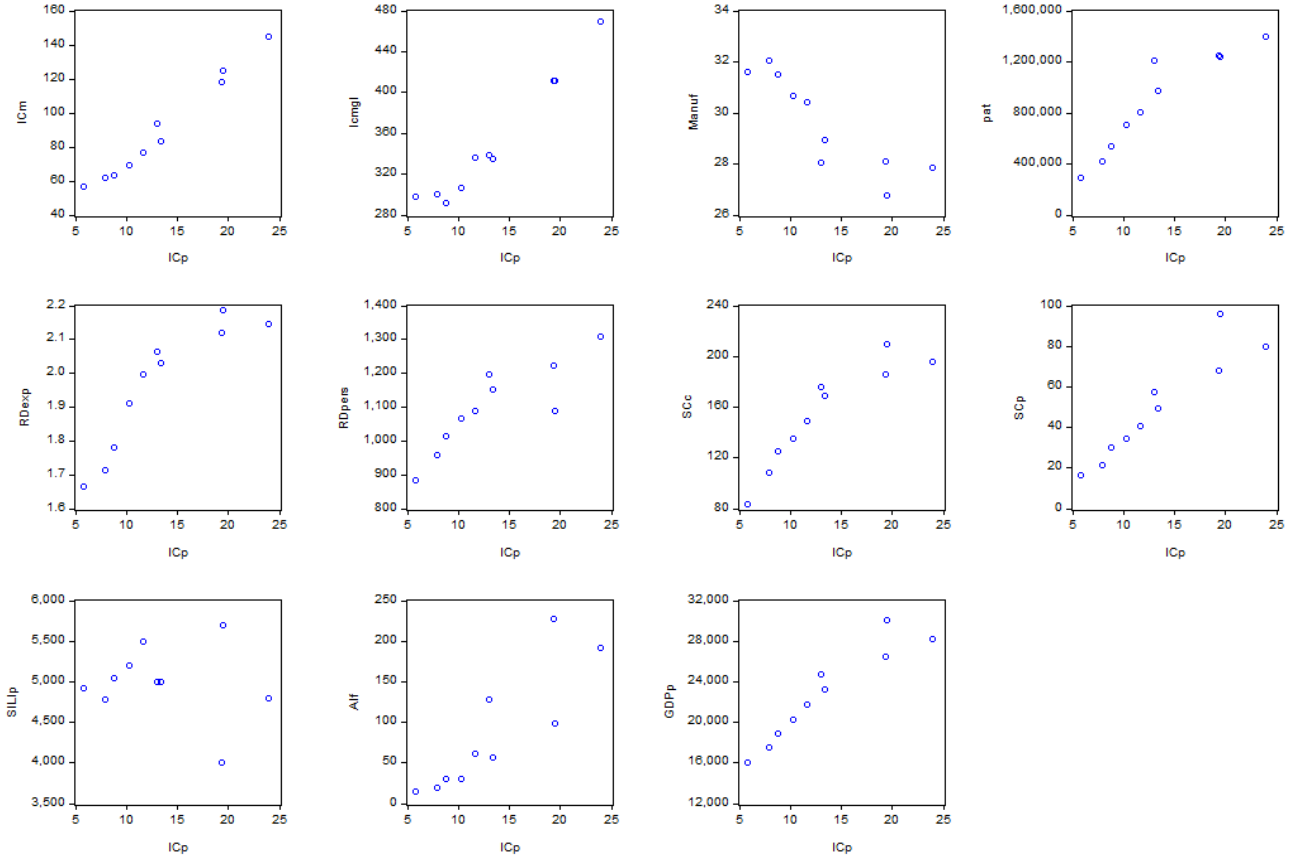

Figure 3. Scatter graphs of chip production vs. all other indicators.

As we can observe, almost all the factors have a strong dependence on chip production. Only manufacturing has reverse dependence, which can hint at the lag of technological development with respect to world trends. However, it should be noted that the Chinese government attempted to overcome the lag in the national semiconductor industry. We considered Chinese innovation strategies and can conclude that there is a clear understanding of the drastic situation at the government level.

To overcome the lag in microelectronics and the dependence on IC imports, in 2014, the government set up the China Integrated Circuit Industry Investment Fund (CICF) and issued the «Guidelines to Promote National Integrated Circuit Industry Development". This was, perhaps, the first attempt to determine the prospects for national flagship microchip manufacturing. In May 2015, the «Made-in-China 2025» program came into effect. In this document, the national semiconductor industry was assigned quantitative tasks to overcome the dependence on IC imports for the first time. The share of national chips was supposed to, by 2020, be 40% of that required and, by 2025, reach 70%. We noted that the program's priority is, again, scaling up production with no attention paid to the quality issue. The model, traditional for China, has been preserved—quantity prevails over quality. In total, China planned to spend USD 1.980 billion on developing the semiconductor base in 2015. A primary role was given to venture capital, and in 2016 alone, about USD 2.6 billion in private investment was attracted. By 2018, the government accepted more than 70 investment programs intended for IC factories' construction and the acquisition of foreign companies and startups.

In addition to direct financial investments, the Chinese government also uses indirect methods, such as income tax incentives—the traditional scheme of supporting manufacturers in China. The government began to reduce taxes for chipmakers in 2012. However, the list of companies eligible for the deduction was insignificant until recently and included only 12 companies. By 2020, the list of beneficiaries included more than 1300 enterprises. The tax preferences have a gradation that depends on the quality of the products. Companies producing chips based on the non-modern 130 nm technology are exempt from taxes for two years. Chipmakers producing microcircuits using 65 nm technology and below are exempt for five years. As a result of these actions, China improved its position in IC manufacturing, increasing its share in global production to 9%. In 2018 alone, the profit of Chinese chipmakers amounted to USD 26.1 billion. The presented figures may look optimistic for the external market. The situation in the domestic IC market has practically not changed. In 2020, chipmakers were able to meet internal needs for only 20.1% of the required microcircuits. If the growth rates for chip productivity continue, then, by 2025, national chipmakers will be able to meet only 25% of the domestic market demand. This situation is rather unfortunate. Despite all the government efforts, the targets of the "Made in China 2025" program for national microelectronics will not be met. Our investigation also shows that this growth covers the lowest price segment of semiconductor-based products. The results of evaluating the system of recursive equations are presented in Table 4. The r-squared is 0.097 in the full model, suggesting that our findings are reliable.

Table 4. The basic model's estimation using LS methods

Regressors	*Least squares*
PAT/RDpers	0.001136**
	(0.000381)
LOG(SCc)	0.869141***
	(0.371269)
R2	0.988147
Obs.	10
Regressors	*Least squares*
LOG(SCp)	0.459919*
	(0.08433)
LOG(ICgm)	1.179912**
	(0.29393)
R2	0.975861
Obs.	10

Standard errors in parentheses. *** p < 0.1, ** p < 0.05, * p < 0.01

The situation is aggravated by the quality of Chinese chips and chipsets. The situation in the domestic chip market for the IT and AI industry is very worrisome. Despite an additional USD 29 billion allocated in 2019 by the government as a subsidy to companies involved in the production of CPUs, GPUs, network cards, and modems, the production growth was only 3% (Zenglein and Holzmann, 2019). Furthermore, this is happening amid the rapid growth of China's AI sector in connection with the COVID-19 pandemic. By the beginning of 2021, Chinese chipmakers were only planning to comprehensively master 45 nm technologies. For even such a non-modern technological level, the cost of the equipment, technology, and training of specialists is USD 2.39 billion per production line (McClean, 2021). Additionally, it is believed that the main problems with IC production began with the introduction of prohibitive measures by the United States on technological, industrial, and trade cooperation with China (Shattuck, 2021).

The technological confrontation only lasted two years, and the Chinese IC problem is a systemic issue. We suppose that the Chinese leadership hoped to continue to use the achievements of innovative leaders in semiconductor production despite certain efforts. The actions of the White House government dealt a severe blow to the prospects of Chinese IT vendors, leaving them without modern components. Traditional importers, leading American semiconductor giants, notably, Intel, Qualcomm, Xilinx, and Broadcom, were banned from technological interaction and the supply of high-performance chips. However, the apogee of the problems was the introduction in May 2020 of changes to the Foreign Direct Product Rule. It practically deprived China of the opportunity to cooperate with Taiwan Semiconductor Manufacturing Co (TSMC). The estimates support our hypothesis that the industrial demand and the development of science are contributing to the increase in chip production in China. To confirm this and identify the impact of the restrictive measures, we estimated the growth rates for supply and demand in China's chip and semiconductor markets by evaluating trend patterns. The results are presented in Figure 4 and Table 5.

Table 5. Trend model estimation output

SCp	0.188752* (0.007772)	ICp	0.141957* (0.009746)
SCc	0.092926* (0.008745)	ICm	0.103969* (0.012999)

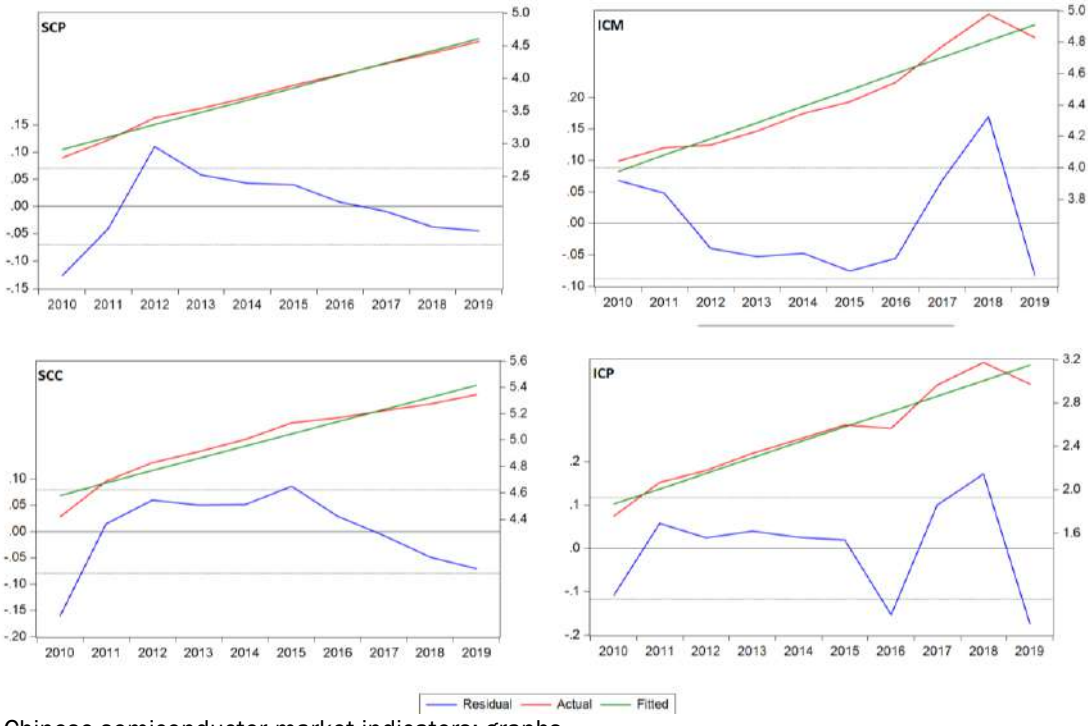

Figure 4. Chinese semiconductor market indicators: graphs

Standard errors in parentheses. * p = 0.0000

As we can see from the graphs in 2016 and 2018, indeed, there has been a decline in the actual values of the Chinese chip market indicators, which confirms the difficulties in connection with the imposed restrictive measures. Nevertheless, the obtained coefficients reflecting the calculated growth rates show that, in the reviewed period, the production of semiconductors had twice the growth rate compared to the demand for them. The growth rates for chip production were 1.5 times higher than their consumption. Thus, it can be assumed that, in China, there is a gap in the production chain precisely at the stage of creating the latest-generation chips.

The pessimistic situation looks more complicated, as these percentages are not represented by national companies. Chipmakers, headquartered in China, produced only 6.1% (USD 7.6 billion) of all the sales in the local market. Branches of foreign firms located in the country (TSMC, SK Hynix, Samsung, and Intel) made a decisive contribution.

Under pressure, the Chinese government and vendors in the IT and AI sectors are forced to pay. However, we assume that this amount may simply not be increasing, even for them. Moreover, it may not only be a matter of finances. To meet modern AI requirements, the Chinese semiconductor industry must catch up with the flagships that have proceeded for 13 years. The question of whether it will be able to make this leap forward remains open.

4.2 Current Trends in Chip Production in China. SMIC Case Study

The only way to overcome the catastrophic situation in China's semiconductor sector is to implement rapid and large-scale import substitution.

Import substitution should cover the entire production chain: equipment, technologies, and the scientific and business competencies of personnel. The situation is complicated because it is a race against time. Introduced by the Biden administration, more arduous trade restrictions for high-tech goods did not allow China much time to act.

To overcome the mentioned problems, it is practically impossible to use the strategy of innovative borrowing. Beijing needs to develop new innovative strategies to rescue the national microelectronics sector. We suppose that one of them could be the financial and legal support of national companies with economic and industrial success in AI. We define this form of interaction as the BAT strategy derived from Baidu, Alibaba, and Tencent, the leading players in this field.

We must pay tribute to the fact that the first steps for implementing this strategy have already been taken. In 2019, amendments to the "AI Program" were adopted at a State Council of China meeting. First, it was planned to allocate an additional USD 1.4 trillion, adding new members such as Huawei, Xiaomi, and SMIC and 87 other high-tech national unicorns. Now, the primary goal is to solve the problem of IC import substitution.

However, as always, the coin has two sides. The positive one is, ultimately, national production. The equipment is supplied by the national giant Semiconductor Manufacturing International (SMIC). The technology is overseen by the research company Shanghai IC R&D Center, the leader in the Chinese processor architecture market. The negative side is that chips of this size were relevant 13 years ago, indicating significant backwardness in Chinese specialists' technological competence.

In addition, SMIC, under the auspices of the government, in 2020, began the construction of a semiconductor plant in Shanghai implementing 28 nm technology. State support is even more ambitious. The Chinese Association of the Semiconductor Industry alone allocated USD 48 billion for the construction and technological launch. Another USD 40 billion for construction will be allocated by the National Investment Fund of China. The first products are expected to roll off the chipmaker's conveyor belt at the end of 2022.

The Chinese government, implementing the BAT strategy, hopes to close the gap in the microelectronics sector to fit the “Made-in-China 2025” program. However, Huawei's entry into the team of chipmakers "from scratch" will take several years. Complicating the situation is the absence, even in the

plans, of mastering the fifth flagship technology, without which the further development of the national AI sector may stop.

We cannot provide a comforting forecast regarding Huawei's ability to exit without losses, even considering the colossal government assistance. There may simply not be enough time left for the BAT strategy to succeed. However, there is still the question of AI talents and their scientific and practical competencies necessary to implement these breakthrough technologies. The preparation and training of such specialists will also take a long time.

The only way for Beijing to rapidly overcome the backlog in IC production is not to create new unicorns but to strengthen the existing ones. However, today in China, there is only one successful example: SMIC.

SMIC was a successful company producing reliable mid-range chips primarily for the domestic market. The quality of its 14 nm chips left much to be desired and did not satisfy even domestic consumers. The incipient race for technological superiority certainly gave the chipmaker a chance to get into the top league of IC manufacturers. However, the company could realize this chance only with the financial and legal support of the state. It came to the aid to rapidly grow SMIC to the level of a world-class semiconductor unicorn. Since 2018, more than USD 9.6 billion has been invested in SMIC through the China Integrated Circuit Investment Industry Fund and Yizhuang Guotou.

In addition, the company received government approval to issue an additional 1.69 million shares for sale through the Shanghai STAR Market (a kind of Nasdaq). Following the announcement of a relisting through the Big Fund, Beijing has invested more than USD 2 billion in SMIC. As a result, by the beginning of 2021, this operation brought the company an additional USD 7.8 billion. Following changes in its charter, adopted under pressure from government regulators, 60% of the investments newly received by SMIC are directed to internal R&D. In 2020 alone, this amount was USD 4.3 billion: 40% went to the improvement of the 14th technology; 55%, to developing 7 and 5 nm technologies. The remaining 5% is for accelerated personnel training to improve their scientific and practical competencies.

The result of such large-scale financial injections was the rapid growth of both the production and technological preferences of the company. Today, SMIC is the main hope of the Chinese AI sector. The company is the only one in the country with a productivity of 6000 300 mm wafers per month, and it produces 14 nm chips of world-renowned quality.

We examined how China raised a top unicorn in IC production from an average company little-known in the world market. The Chinese government has poured billions of dollars into helping SMIC to master advanced technology.

The considered trigger strategies for the recovery of the Chinese microelectronics sector could change the situation globally. However, another outcome may also develop. Technology does not stand still. China may not have enough time to catch up with the innovation leaders who have spent more than 13 years developing and commercializing their flagship chips. However, the AI market is changing so rapidly that, while China's chipmakers keep up, they can start using completely new principles to improve processors. Reductions in the sizes of elements cannot be infinite. Chinese microelectronics has every chance not to remain in the status of catch up but to leap to a new period of AI technological leadership.

DISCUSSION AND CONCLUSIONS

This study reveals that, amid the current innovative realities, Beijing has relied on AI as one of the most important triggers for stimulating national economic growth. In addition to unprecedented financial support, the government has developed a particular strategy to stimulate the AI business ecosystem (BAT strategy).

As a result of these actions, China was able to bring its AI sector on a par with the innovative leaders. Moreover, in terms of funding, the number of scientific and applied developments, and the scale of the business ecosystem, national chipmakers were able to increase their share of semiconductor production.

This study also confirms the findings from previous studies that the optimistic portrayal of China's AI sector is not entirely realistic. The United States has begun "reforming" the innovation field. The US' future actions may bury Chinese plans for the AI leadership and completely halt its development.

The analysis presented in this study confirms that China's problems were formed due to the erroneousness of the chosen strategy based on an original way of creating innovative products with "Chinese characteristics". From the outset, China's innovation strategies for creating its new technologies have defined the path of "borrowing, digesting, absorbing, refining and renovating".

Such results, on the one hand, confirm the observation that advanced technologies cannot really be imported from foreign countries but can only be developed internally. This raises concerns about the efficiency of China's R&D activity. It turned out that, without appropriate institutional reforms, tech talents, new management practices, and new business model resources that have been devoted to S&T development generated less significant scientific and economic contributions than expected.

The results of this study can be extrapolated to similar problems in the high-tech industries of developing countries. The study expands the understanding of how much industrial policy in innovation technology requires a diversified approach in the conditions of globalization, accelerating digitalization and the redistribution of knowledge, information, and labor.

The question of whether China can become an AI leader by 2030 is still open. The main reason is the ability to overcome the 13-year gap in producing advanced semiconductor-based products. The study shows that it has not been possible to date despite all the state and private business efforts. Moreover, without technological independence in advanced semiconductor production, AI leadership is impossible.

However, we will also discuss another option. The study has highlighted a particular specificity of the global IC market. Today, it is perhaps the most eventful. For its implementation, exclusively high-tech production is used. The most complex technological processes, the equipment that implements them, and the scientific and practical competence of the service specialists are costly. Government patronage is a decisive factor for its development. Naturally, in the current conditions, the price of an entrance ticket to such a market for a new player is prohibitively high. For those entering the market later, all the R&D costs must be paid. These are colossal funds that more than one company cannot provide on its own. At the present stage of technology development, it is possible to start from scratch, entering the world semiconductor space only with the support of the state.

Moreover, the state can provide it only for strategic reasons. The Chinese government and private investors have postponed these strategic decisions for an unacceptably long time. The prevailing opinion was that the R&D costs of national microelectronics should and could be avoided.

However, it must be said that the Chinese government postponed financial support for semiconductor R&D companies until "better times". This is evidenced by the approximately USD 218 trillion accumulated by the Big Fund and the Association of Semiconductor Manufacturers by 2018. Private investment funds, in pursuit of rapid commercialization, simply refused to invest in fundamental research. An analysis of investment flows shows that, up to 2019, it was easier to receive loans for companies that were engaged in implementation projects but not in fundamental research.

It becomes apparent that the way to the flagship semiconductor heights for China is hindered by its experience in the high-tech sector. The strategy of borrowing the incremental technological and hardware achievements of world leaders, which is the basis for China, simply does not work today.

Today, the Chinese government seems to be doing everything possible to make the national IC sector jump over its head. Will Chinese semiconductor flagships be able to seize this opportunity and overcome technological addiction? Furthermore, will the Chinese AI sector have enough time to remove this technological obstacle?

The time factor here may not be at all decisive. Do not forget about the national mental characteristics of innovators from China. The maxim put into upbringing and education plays a cruel joke with them (Lindtner, 2014). The absence of doubt about what those of superior age or status say and do is detrimental to the development of disruptive technologies. The Chinese AI talents lead in the improvement and modernization of borrowed incremental innovations, but there are practically no fundamental break-

throughs. It may so happen that this feature of China will become a stumbling block on the path to its AI world leadership. Breaking this national mentality may be necessary, and there is no such experience in innovation yet.

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The Political Stability – Inflation Nexus in South East Asia countries: Does Shadow Economy Moderate?

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ABSTRACT

In recent years, the issues of the shadow economy and inflation, particularly in developing countries, have gained relevance and attracted huge attention in economic debates. This study investigates the relationship between political stability, shadow economy and inflation while explicitly accounting for the presence of the shadow economy in 8 ASEAN countries over the 2000 to 2017 period. The research analyzed data derived from the World Development Indicators of the World Bank and Medina & Schneider (2019). The study employs the dynamic ordinary least squares (DOLS) and fully modified ordinary least squares (FMOLS), which allow cross-sectional dependence and slope homogeneity in panel data analysis to investigate the relationship between shadow economy, political stability, and inflation. The results indicate that the higher level of the shadow economy contributes to the increasing inflation rate. However, the more political stability leads to the lower level of inflation. In addition, the impact of political stability on inflation rate really depends on the size of the shadow economy. The research could make substantial contributions to the ASEAN economies. The study provides empirical evidence for policymaker to consider when choosing optimal policies to manage inflation, political stability and policies related to limiting the size of shadow economy for sustainable development.

INTRODUCTION

The issue of inflation, particularly in emerging market, continues to attract lot of attention of economist as well as non-economists. Although there are some dissents regarding the particular reasons and channels through which inflation happens, it is generally accepted that inflation is impacted by two essential sources, including excess aggregate demand surplus, and the cost-push effect (Durguti et al., 2021). However, due to its strong political economy aspects, inflation requires a wider context to understand its determinants (Leeper, 2010). Our literature review indicates that one key variable which has largely been neglected in existing empirical studies is the shadow economy.

The shadow economy refers all legal, economic, and productive activities contributing to official GDP if recorded (Hassan & Schneider, 2016). The more shadow economy is neglected in public policies, the more its growth in the developing countries (La Porta & Shleifer, 2014). In these countries, shadow economy outputs constitute about 30 per cent of GDP and account on average 70 per cent of employment (Loayza, 2016).

A large shadow economy not only makes erosions in the tax base but also impedes implications for stabilization policy. In these circumstances, the government that is uncertain about its revenue base is more likely to reach for short term measures at the cost of policy consistency. The shadow economy impact monetary policy outcomes because it is related with a higher demand for currency, and fiscal policy outcomes because of its effect on the collected tax revenue. The existence of a shadow economy undermines policy outcomes even in the presence of political stability (Buehn et al., 2015).

This line of reasoning leads to the conjecture that the systemic weaknesses entailed by a considerable shadow economy undermine the advantages of political stability. Thus, this study empirically tests the relationship between inflation, the shadow economy, and political stability. This is done in the context of 8 countries in the Association of Southeast Asian Nations (ASEAN) over the 2000 to 2017 period with the multivariate econometric model.

The study contributes to several strands of the extant literature. First, to the best of our knowledge, this is the first paper to explore the impact of political stability on inflation with the presence of the shadow economy in the ASEAN countries. Second, it contributes to the empirical research on drivers of inflation, including Edwards & Tabellini (1991), Cukierman et al. (1992). Although Cukierman et al. (1992) stress that political stability is one of the prerequisites for reforms that improve the efficiency of the tax system, they do not provide any evidence of a relation between the shadow economy, inflation, and political stability. By specifically incorporating the informal economy in our model, we fulfill this gap. Third, we focus on a long-term relationship between public expenditure and the shadow economy using the dynamic ordinary least square (DOLS) and fully modified ordinary least square (FMOLS) estimation methods.

Besides this introduction, the remaining part of the paper is divided into five sections. Literature review is presented in Section 2. Section 3 discusses the data and research methodology. Empirical findings and discussions are shown in Section 4, while the conclusions and policy implications in Section 5.

1. LITERATURE REVIEW

Shadow economy or the informal economy is a set of economic activities that take place outside the mainstream economic context. Dada & Ajide (2021) argue that although income in this sector is derived from the production of legitimate goods and services, it is still considered an illegal economy because most activities are not recorded in national account. It is a challenging task for economists to measure the size of the shadow economy (Bashlakova & Bashlakov, 2021). The measurement to estimate the size of shadow economy can be categorized into direct, indirect, and model-based techniques (Schneider & Buehn, 2018).

A high degree of the shadow economy has caused many issues foe societies and governments in several ways (Özgür et al., 2021). First, it makes erosion in tax revenue that is important for providing public goods, developing infrastructure (Elgin & Erturk, 2019). Second, a larger shadow economy tends to be linked with lower productivity, slower human capital accumulation (Docquier et al., 2017), lack economies of scales (Loayza, 2018).

Political instability has been exanimated in some studies as a variable to investigate the determinants of fiscal deficits. Larger deficits are correlated with political factors (Roubini & Sachs, 1989). Similarly, Cukierman et al. (1992a) argue that more unstable or polarized political systems are more prone to scenarios where the revenue collection capabilities of authorities are constrained deliberately by inefficient tax system. Campillo & Miron (1997) found a positive relationship between political instability and higher inflation. The revenue of government is used more frequently in political unstable societies than it is stable and homogenous countries because given tax evasion or high collection costs (Cukierman et al., 1992b)

Furthermore, the presence of a larger shadow economy can be inflationary due to the inducement to use inflation tax to meet the budgetary requirements when large sections of the economy are unrecorded and thus untaxed (Canzoneri & Rogerss, 1991; Goel & Nelson, 2016). To raise its income, the government will create money which makes appear the inflationary tax or seignorage. As a result, the price level will increase and each holder of the currency pays the tax in the form of a decrease in the buying power of the currency (Phelps, 1973; Sargent & Wallace, 1981). Koreshkova (2006) and Ergene (2015) adopted similar arguments in the case of a system of tax evasion and insufficient tax collection. A positive relationship between the size of shadow economy and inflation rate is confirmed in the study of Mazhar & Meon (2017).

The existing literature mentioned above denotes that the inflation rate effect of political stability is determined by the size of shadow economy of the country. Hence, it is interesting to empirically test the nature of the relationship among these variables of interest.

2. RESEARCH METHODOLOGY AND DATA

2.1 Research model

This paper explores the impact of political stability, shadow economy on the inflation rate. We will also investigate whether the impact of political stability on inflation rate fluctuates at the different size of shadow economy. The DOLS and FMOLS estimator are employed on a sample of 8 ASEAN countries from 2000 to 2017. The following general equation is used:

$$INF_{it} = \beta_0 + \beta_1 PS_{it} + \beta_2 SE_{it} + \beta_3 PS_{it} * SE_{it} + \beta_4 X_{it} + \varepsilon_{it} \quad (1)$$

in which *i* and *t* represents a country and time, respectively. INF stands for inflation rate. POL denotes political stability; SE represents shadow economy. SE*POL represents the interaction term between political stability and shadow economy. The intuition behind including an interaction term is that the impact of political stability on inflation rate varies with the levels of shadow economy. By making a partial derivative of Equation (1) with respect of political stability, we get the total impact of political stability on inflation in the existence of the shadow economy, as below:

$$\frac{\partial(INF_{it})}{\partial(PS_{it})} = \beta_1 + \beta_3 SE_{it} \quad (2)$$

As the control variables (X), the study employs economic growth (GDP per capita), trade openness (TO), unemployment (UE). GDP per capita is measured on a logarithmic scale.

2.2 Data source

This study analyzes ASEAN-8 countries including Brunei Darussalam, Cambodia, Malaysia, Indonesia, the Philippines, Singapore, Thailand and Vietnam from 2000 to 2017. All the data were sourced from the World Development Indicators of the World Bank, except the data on the size of shadow economy is collected from Medina & Schneider (2019). These estimates are derived using MIMIC methodology which is considered superior to other methods used to estimate the size of shadow economy. Table 1 summarizes the measurement of the variables used in this paper.

Table 1. Measurements of variables and data sources

Variables	*Abbreviation*	*Measurement*	*Data source*
Dependent variable			
Inflation	INF	Inflation, consumer prices (annual %)	WDI
Independent variables			
Shadow economy	SE	Shadow economy (per cent of GDP)	Medina and Schneider (2019)
Political stability	PS	Political stability index (ranges from -	WGI

		2.5 (high political instability) to 2.5 (greater political stability and lack of violence)	
Control variables			
Economic growth	LGDPP	Natural logarithm of GDP per capita (constant 2010 US$)	WDI
Trade openness	TR	Trade (per cent of GDP)	WDI
Bank credit	CE	Domestic credit provided by the banking sector (per cent of GDP)	WDI

Table 2 presents the descriptive statistics of data for this study. The highest, lowest values of inflation are 24.9 per cent and -2.3 per cent respectively, the mean value is 0.035. The size of shadow economy ranges from 9.4 per cent of GDP to 54.6 per cent of GDP during the period of research and across countries in the sample. The mean value of political stability, proxied by the PS, is -0.075 with a standard deviation of 0.977, a minimum of -2.094, and a maximum of 1.615.

Table 2. Descriptive statistics of the full sample

Variables	*Observations*	*Mean*	*Min.*	*Max.*	*Std. Dev.*
SE	144	0.302	0.094	0.546	0.130
CE	144	0.668	0.059	1.307	0.386
TR	144	1.461	0.374	4.373	0.948
LGDPP	144	8.506	6.06	10.96	1.417
INF	144	0.035	-0.023	0.249	0.041
PS	144	-0.075	-2.094	1.615	0.977
PS*SE	144	-0.090	-0.721	0.413	0.299

SE: Shadow economy; **CE:** Bank credit; **TR:** trade openness; **LGDPP:** economy growth; **INF**: Inflation; **PS**: Political stability **PS*SE:** interaction variable between political stability and shadow economy

3. RESULTS

3.1 Cross-sectional dependence test

Cross-sectional dependence often happens in panel estimation. When cross-sectional dependencies in regression are omitted, the estimation may cause loss of the efficiency and invalid test statistics. We utilize the Pesaran CD (2021) test to examine the presence of cross-sectional dependence. Table 3 shows the results of the test. At the 1 per cent significance level, the hypothesis of cross-sectional dependence cannot be accepted. This finding indicates that the panel unit root test is more reliable when the first difference of variables is used in the analysis.

Table 3. Cross-section dependence test results

Variables	*SE*	*CE*	*TR*	*LGDPP*	*INF*	*PS*	*PS*SE*
CD test	16.159***	9.145***	2.801***	12.192***	10.992***	11.415***	11.154***
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: **** significance at 1% level.*

SE: Shadow economy; **CE:** Bank credit; **TR:** trade openness; **LGDPP:** economy growth; **INF**: Inflation; **PS**: Political stability **PS*SE:** interaction variable between political stability and shadow economy

3.2 Panel unit root test

Next, we conduct the unit-root tests proposed by Pesaran (2007) to examine the stationarity and determine the integration order of the variables used in this paper. The empirical results reported in Table 5 reveal that all the variables have a unit root at level. However, all variables used in our analysis become stationary when the first differences are considered. Overall, our results suggest that the variables employed are integrated at I(1). A long-run equilibrium relationship between the variables may be present.

Table 4. Panel unit root test results

Variables	*Level*		*First Difference*		*Order of Integration*
	Constant (1)	*Constant and Trend (2)*	*Constant (3)*	*Constant and Trend (4)*	
SE	0.622 (0.733)	1.596 (0.945)	-1.797** (0.036)	-6.128*** (0.000)	I (1)
CE	0.374 (0.646)	2.012 (0.978)	-0.308* (0.079)	-3.256*** (0.001)	I (1)
TR	1.545 (0.939)	2.345 (0.990)	2.204*** (0.006)	-2.971*** (0.001)	I (1)
LGDPP	1.265 (0.897)	2.379 (0.991)	1.265*** (0.007)	-2.572*** (0.005)	I (1)
INF	-3.330 (0.760)	-3.032 (0.247)	-3.300*** (0.000)	-4.351*** (0.000)	I (1)
PS	-2.478 (0.327)	-2.830 (0.233)	-2.478*** (0.000)	-4.096*** (0.000)	I (1)
PS*SE	-2.950 (0.221)	-2.561 (0.133)	-2.950*** (0.002)	-4.862*** (0.000)	I (1)

Notes: **, *** significant at 5% and 1% level, respectively. The p-values are shown in parentheses. The Z[t-bar] is reported. **SE:** Shadow economy; **CE:** Bank credit; **TR:** trade openness; **LGDPP:** economy growth; **INF**: Inflation; **PS**: Political stability **PS*SE:** interaction variable between political stability and shadow economy

3.3 Panel cointegration test

This study employs various panel cointegration tests developed by Pedroni's (1999, 2004), Kao's (1999), and Westerlund (2005) to examine the existence of a long-run equilibrium relationship between the variables. Table 5 shows the results from these tests. Our results confirm that the null hypothesis of no cointegration cannot be accepted at the 5 per cent significance level. These findings imply a long-run nexus between variables.

Table 5. Results of the cointegration test

	Statistics
Pedroni	
Modified Phillips-Perron t	3.3790***
Phillips-Perron t	-2.8675**
Augmented Dickey-Fuller t	-1.1921**
Kao	
Modified Dickey-Fuller t	-11.124***
Dickey-Fuller t	-7.2673***

Augmented Dickey-Fuller t	-5.6518***
Unadjusted modified Dickey-Fuller t	-10.9813***
Unadjusted Dickey-Fuller t	-7.2537***
Westerlund	
Variance Ratio	2.1992**

Notes: **, *** significant at 5% and 1% level, respectively

3.4 Empirical findings using the dynamic ordinary least squares (DOLS) and fully modified ordinary least squares (FMOLS)

In this section, we employ the panel DOLS estimator suggested by Kao & Chiang (2000) and the panel FMOLS estimator developed by Phillips & Hansen (1990) to examine the relationship between shadow economy, political stability and inflation. The results in Table 6 indicate that the size of shadow economy impact positively and significantly on the level of inflation. However, the more political stability leads to the lower level of inflation. In addition, our findings also indicate that an increase in economic growth and trade openness will lead to a smaller inflation rate. In contrast, an increase in bank credit appears to link with the ASEAN countries' higher level of inflation.

Most interestingly, the coefficients of political stability and the interaction between political stability and shadow economy carry the different signs. This means the impact of political stability on inflation rate really depends on the size of the shadow economy. This is the main contribution of this study. The total effect of political stability on the inflation with the shadow economy is the sum of the estimated coefficients β_1 and β_3, as shown in equation (2).

Table 6. The effect of political stability, shadow economy on inflation using DOLS, FMOLS method

	DOLS	*FMOLS*
SE	0.061***	0.077***
CE	0.155***	0.225***
TR	-0.135***	-0.214***
LGDPP	-0.216**	-0.627***
PS	-1.601*	-1.551*
PS*SE	0.329**	0.368***

Notes: *, **, *** significant at 10%, 5% and 1% level, respectively.

SE: Shadow economy; **CE:** Bank credit; **TR:** trade openness; **LGDPP:** economy growth; **INF**: Inflation; **PS**: Political stability **PS*SE:** interaction variable between political stability and shadow economy

CONCLUSION

ASEAN countries have a large shadow economy and high level of inflation. Taking 8 ASESAN countries as a case study and relying on a balanced panel data set over the period 2000 to 2017, this study empirically investigates the nexus between political stability, shadow economy and inflation. It additionally examines the moderating role of shadow economy in the political stability and inflation relationship by using DOLS, FMOLS method. The results indicate that shadow economy and bank credit positively contribute to the increase in the inflation rate. Meanwhile, trade openness, economic growth, and political stability reduce the level of inflation in 8 countries during the study period. The novel contribution of the study is the finding that inflation is determined not only by the shadow economy and political stability independently, but that there is an interaction effect between the two variables.

From the experimental results, the author suggests some policy implications as follows. Firstly, shadow economy contributes to an increase in inflation. Thus, the governments of the Southeast Asian

countries should formulate and implement policies to control the size of the shadow economy. These policies will also play an essential role in reducing the inflation rate in the long term. Secondly, political stability has a negative impact on the inflation. The political environment must meet the condition of stability which assures job creation, higher state revenues, poverty reduction, increased welfare and education level. All these mentioned achievements will bring benefits to all citizens of any country; therefore the probability of violence will significantly decrease. Thirdly, policies related to promoting trade, and increasing trade openness should also be planned to control the inflation.

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Capital Structure and Profitability of Listed Firms in a Transition Market, Does Debt Maturity Matter?

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ABSTRACT

Our study estimates how capital structure and debt maturity affect the profitability of enterprises listed on the Vietnamese stock exchange. Prior studies have not included the state ownership and debt maturity variables in estimating corporate profitability in Vietnam. We collect data from 631 non-financial companies in Vietnam from 2016 to 2020. However, the Traditional Least Square violates heteroskedasticity and autocorrelation assumptions, so we use the Feasible Generalized Least Squares to generate reliable findings. Our crucial findings suggest that the capital structure negatively impacts ROA and ROE. Our findings also figure out that the ratio of short-term debt to total assets reduces the profitability of companies in Vietnam. Vietnamese companies depend on short-term loans because the conditions for issuing short-term terms will be more straightforward, and the borrowing rate is lower than long-term debt. Finally, our findings indicate a reverse relationship between the long-term debt ratio and profitability. Our findings are consistent with trade-off theory, pecking order theory, and prior literature. This paper provides managers of companies and lending institutions with helpful information based on empirical results. The lenders and managers need to understand the impact of factors, such as capital structure, firm size, and state ownership, on the firm performance.

INTRODUCTION

Many articles have discussed capital structure, but the results are still controversial. Some authors conclude that debt in the capital structure positively impacts the company's profitability (Abor, 2005;

Jaisinghani and Kanjilal, 2017). Specifically, Jaisinghani and Kanjilal (2017) report that large companies increase debt in the overall capital structure, leading to a positive effect on profitability in the Indian market.

However, others argue that increasing debt will negatively affect profitability (Alarussi and Alhaderi, 2018; Duong et al., 2021; Jarallah et al., 2019). Some studies indicate an optimal capital structure level that maximizes the profitability of listed firms. However, if the debt ratio continues to rise beyond the optimal level, it could cause a higher distress risk and erode profitability. The results also demonstrate the non-linear relationship between capital structure and profitability of the business (Margaritis and Psillaki, 2010). Hirdinis (2019); Singh and Singh (2018) document that capital structure has a fragile effect or does not affect profitability. The different results come from the observed data samples and research methods difference.

Several motivations motivate us to conduct this study in Vietnam. According to the above arguments, studies on the influence of firm size, growth rate, leverage, capital structure on profitability are still not homogenous. Besides, most of their results were studied abroad and even contrasted with the situation in Vietnam. Moreover, Vietnam is an economically developing and emerging country, so studying the impact of financial components of enterprises is essential for companies, especially Vietnamese firms. Furthermore, few studies examine the relationship between capital structure and profitability of enterprises in Vietnam (Dang et al., 2019; Nga and Nguyen, 2020; Nguyen and Nguyen, 2020). Thus, this study examines whether the capital structure and debt maturity affect the performance of listed firms in Vietnam.

Our paper is unique in the following ways. Firstly, our data expanded in terms of the number of non-financial companies. The survey period (2016-2020) is not the same as in previous research in Vietnam (Dang et al., 2019; Nguyen and Nguyen, 2018; Nguyen and Nguyen, 2020). Besides, we employ the Feasible Generalized Least Square (FGLS) regression instead of FEM, REM, OLS regression (Dang et al., 2019; Nguyen and Nguyen, 2018; Nga and Nguyen, 2020) and GLS regression (Nguyen and Nguyen, 2020). Specifically, the Feasible Generalized Least Square (FGLS) estimator can repair the heteroscedasticity and autocorrelation issue in models than the OLS estimator (Panda et al., 2021). Moreover, previous research papers in the Vietnam market have not included the state ownership and debt maturity variables in estimating corporate profitability in Vietnam.

The study collects data from 631 non-financial businesses listed on the Vietnamese stock exchanges (including the Hanoi Stock Exchange - HNX and Ho Chi Minh City Stock Exchange - HOSE) between 2016 and 2020. We follow Abor (2005) and several previous studies to test the effect of capital structure on the profitability of listed companies. Moreover, we mainly employ the Feasible Generalized Least Square (FGLS) regression to examine their impact on profitability.

Our preliminary results imply that the capital structure negatively impacts ROA and ROE. Moreover, we report that the short-term debt to total assets ratio also reduces the profitability of listed companies in Vietnam. Vietnamese companies mainly depend on short-term loans because the conditions for issuing short-term terms will be more straightforward, and the borrowing rate is lower than long-term debt. Finally, our findings indicate a reverse relation between the long-term debt ratio and profitability. Our findings are consistent with trade-off theory, pecking order theory, and prior literature.

Based on the research results, this paper provides some implications. Our paper will give monitors of corporates and lending institutions helpful knowledge to understand the association between capital structure and profitability of Vietnamese enterprises. That helps the companies create business strategies and manage the company's process effectively.

Although our study extends the data and methodology in models, it has some limitations. Firstly, according to Nguyen and Nguyen (2018), the study mainly examines returns on assets (ROA) and returns on equity (ROE) as a measure of profitability. Because other studies can retest the hypothesis using alternative profitability measures. Secondly, the model we use in this study may not be the most suitable. Specifically, future studies can employ alternative models with more control variables to retest the hypothesis. Finally, Reed and Ye (2011) show that FGLS was the most efficient overall but the worst when calculating confidence intervals.

This paper proceeds as follows: the next section provides the literature review. Section 2 mentions data and methodology. Section 3 offers the empirical findings and discussion, and the final section is the conclusion.

1. LITERATURE REVIEW

1.1 Capital structure theory

Abor (2005) suggests that the capital structure of an enterprise is essentially a combination of many types of capital related to the variety of debt and equity that the company applies in its corporate activities. Based on the concept in corporate finance, the capital structure is understood not only to include debt and equity but is made up of a variety of debts and a variety of equity capital and convertible bonds of the company. Debt can be classified by term, including long-term debt for loans over one year and short-term debt for one year or less. Therefore, it is essential to understand and identify a suitable target capital structure from balancing capital types in each stage and industry. An efficient capital structure will lower the cost of capital utilization, increasing the company's profitability.

1.2 Profitability proxies

Batra and Kalia (2016) show that profitability is essential in evaluating a company's performance. Besides, profitability has a close association with the capital structure. Specifically, an increase in profits can lead to the rise of corporate spending, retained earnings, and dividend payments. Similarly, Nanda and Panda (2018) also imply that profitability is the most crucial goal of the business and a testament to the existence of that business because no company can continue to operate without profit in the long run. Today, in research using various methods of measuring profitability, the most common measure is the returns on equity (ROE) which indicates how many units of equity invested in a company will yield after-tax profit. Prior studies employ returns on total assets (ROA) to evaluate the company's ability to generate a profit per dollar of assets. When investing one dollar in the assets, how much profit can the company earn after tax?

1.3 Capital structure and profitability of listed firms

Mohammad et al. (2019) study the effect of capital structure on business performance through the relationship between ROA and ROE with short-term debt, long-term debt, and total debt. The empirical data was collected from 41 construction businesses listed on Bursa Malaysia's main board from 2011 to 2015. The findings show that short-term debt is inverse to ROE, while long-term debt is significant for ROE and carries positive results.

Jaisinghani and Kanjilal (2017) examine the relationship between capital structure and firm profitability in the Indian market from 2005 to 2014. The results indicate the correlation between capital structure and profitability mainly driven by the firm size. Specifically, large firms (assets greater than 148 million rupees) show a positive effect of capital structure on profitability through increasing the debt in their capital.

Abor (2005) examines the association between capital structure and profitability of 20 companies listed on the stock market in Ghana. He applies the ROE variable to represent profitability, and the findings suggest that the ROE has a favorable relationship with total debt and short-term debt. Meanwhile, long-term debt has a reverse effect on the profitability of businesses. Abor (2005) explains that short-term debt is often less expensive than long-term debt, so using short-term debt will help companies increase profits and vice versa; long-term debt will reduce profitability.

Le and Phan (2017) examine the correlation between capital structure and the performance of Vietnamese non-financial firms during the period 2007-2012. The paper points out that the inherent struc-

ture harms ROA, ROE, and Tobin'Q. Mohammad et al. (2019) report the negative impact of capital structure on financial performance (represented by ROA, ROE). Their findings are consistent with the pecking order theory when managers prefer debt before issuing shares. However, the capital structure with more debt will reduce a company's profitability.

2. DATA AND METHODOLOGY

2.1 Data

We collect the data of non-financial firms listed on the HOSE and HNX within ten years, from 2016 to 2020. Secondary data is collected from audited financial statements and statistical sources such as Vietstock.vn, a free source data in Vietnam. We follow Baraldi and Enders (2010) to exclude observations with insufficient data to calculate variables. To mitigate the outlier issue, we follow Duong et al. (2021) to winsorize data at the 5 and 95 percentiles. Our final sample has 3,155 observations from 631 non-financial firms listed on the Vietnamese stock exchanges, such as HOSE and HNX, from 2016 to 2020.

2.2 Research methods and models

We follow Alarussi and Alhaderi (2018) to evaluate the association between capital structure and profitability. Moreover, Panda et al. (2021) apply the Feasible Generalized Least Square (FGLS) regression instead of OLS regression to fix the heteroscedasticity and autocorrelation problem. Finally, we build two models that include:

Model (1) examines the influence of the debt-to-total asset ratio on the company's profitability. This study is also interested in the types of debt maturities, so we include short-term and long-term debt ratio variables into the model (2) to investigate their impact on profitability.

$$Y_{i,t} = \beta_0 + \beta_1 TD_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 AG_{i,t} + \beta_4 TANG_{i,t} + \beta_5 SOE_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$Y_{i,t} = \beta_0 + \beta_1 STD_{i,t} + \beta_2 LTD_{i,t} + \beta_3 SIZEi,t + \beta_4 AG_{i,t} + \beta_5 TANG_{i,t} + \beta_6 SOE_{i,t} + \varepsilon_{i,t} \quad (2)$$

2.3 Variables definition

2.3.1 Dependent variables (ROA, ROE)

Investors are often interested in the business's profitability. However, if only considering this aspect, there is not enough basis for evaluating the performance and profitability of a business. According to research by Abor (2005), the author evaluates the performance of companies through the after-tax return on equity (ROE) index. Moreover, Herciu and Ogrean (2017) also applied ROE and used the after-tax earnings-to-assets index (ROA) to represent profitability. Many authors also apply these two measurements, such as Nguyen and Nguyen (2020), Sakr and Bedeir (2019), Mohammad et al. (2019), Herciu and Ogrean (2017).

2.3.2 Independent variables

Based on popular capital structure measurement formulas such as Abor (2005), Matias and Serrasqueiro (2017), Mohammad et al. (2019). The study applied the Debt-to-Asset ratio (TD). We also include the short-term debt to total assets ratio (STD) and long-term debt-to-asset ratio (LTD) as representatives of the capital structure of companies in Vietnam.

2.3.3 Control variables

Through the synthesis of scientific studies at home country and abroad, we decided to add control variables such as asset growth rate (AG), enterprise size (SIZE), tangible fixed asset ratio (TANG), and state ownership (SOE) to the model.

Asset growth rate (AG)

The rate of asset growth is expressed as a percentage that changes over the years and is computed by taking the total asset value of the year "t" minus the total assets of the year "t – 1", all divided by the total assets of the year "t – 1".

Most managers want to increase their total assets over the years to demonstrate the signal that businesses are growing. Ali et al. (2019) indicate that the growth rate of assets positively impacts the business's profitability. This result aligns with Nga and Nguyen (2020); Panda and Nanda (2018).

Firm size (SIZE)

Firm size (SIZE) is an inevitable factor that directly impacts the performance of the business in the process of existence and development. Nguyen and Nguyen (2018) show that SIZE is the natural logarithm of the total assets. Large-scale companies often generate higher profits than smaller companies (Dang et al., 2019).

Tangible fixed asset ratio to total assets (TANG)

Tangible fixed assets make up an equally important part of creating the value of businesses in general, especially non-financial enterprises. We follow Prasad et al. (2019) to measure this ratio by tangible fixed assets to total assets. Focusing on investing to increase this asset class requires companies to effectively manage and use the strategy. In a market with many changes, the increase of tangible fixed assets can cause pressure and risk for businesses. Prasad et al. (2019) indicate the inversed correlation between the tangible fixed assets-to-asset index (TANG) and the profitability.

State ownership (SOE)

This paper expands to look at the association between ownership structure and the profitability of enterprises, typically state ownership (SOE). Centralized ownership allows the State to have stricter control and control over the company's plans, strategies, and investment decisions. We use the dummy variable, which has a value of 1 for companies with state ownership is above 50% and 0 for the remaining cases.

3. EMPIRICAL FINDINGS AND DISCUSSIONS

3.1 Description statistics

Table 1: Descriptive Statistics

Variable	*N*	*Mean*	*Min*	*Max*
ROA	3,155	0.0560	-0.0115	0.1845
ROE	3,155	0.1088	-0.0179	0.3051
STD	3,155	0.3828	0.0660	0.7640
LTD	3,155	0.0896	0.0000	0.4114
TD	3,155	0.4789	0.0841	0.8226
SIZE	3,155	13.6273	11.1843	16.4386
AG	3,155	0.0887	-0.1957	0.5958
TANG	3,155	0.1927	0.0033	0.6551
SOE	3,155	0.2450	0.0000	1.0000

Table 1 presents the statistics of 3,155 observations on the average value, smallest value, the most significant value of all variables in the model from 2016 to 2020 of 631 companies on the HNX and HOSE stock exchanges. Table 1 reports the average value of ROA value of 5.6%. In comparison, the return on equity (ROE) has a mean value of 10.88% and is in the broader range, with the smallest value reaching -1.79% and the most significant value reaching 30.52%.

Table 1 reports that the mean debt-to-asset (TD) ratio is 47.89%. However, this ratio fluctuates in enormous amounts from 8.4% to 82.26%, indicating that the goal of using leverage between companies is vastly different; some companies are equity-oriented and companies that borrow a lot. When dividing debt into two categories, the result indicates that short-term debt per total asset (STD) has an average value of 38.28% and large fluctuations from 6.60% to 76.40%. The mean value of long-term debt variables on total assets (LTD) is 8.96% and is in the range of 0% to 41.14%. Table 1 shows that companies in Vietnam mainly use short-term debt, possibly because businesses have difficulty accessing long-term loans because of strict issuance conditions and higher interest rates.

3.2 Pearson correlation matrix

Table 2 indicates the correlation coefficient between the variables. Overall, the correlation coefficients between independent variables were lower than 0.6, indicating little signal multicollinearity problem. We also performed the VIF test, and the results showed that our sample does not have any multicollinearity issues.

Table 2. Pearson Correlation Matrix

	ROA	*ROE*	*STD*	*LTD*	*TD*	*TANG*	*AG*	*SIZE*	*SOE*
ROA	1								
ROE	0.867	1							
STD	-0.324	-0.024	1						
LTD	-0.157	-0.006	-0.235	1					
TD	-0.408	-0.205	0.084	-0.374	1				
TANG	0.107	0.079	-0.245	0.335	-0.038	1			
AG	0.092	0.201	0.111	0.113	0.172	-0.142	1		
SIZE	-0.045	0.108	0.098	0.439	0.351	0.049	0.145	1	
SOE	0.03	0.055	0.018	0.073	0.057	0.212	-0.174	0.026	1

Source: Authors calculations

Table 3. VIF test

Variable	*Model (1)*	*Model (2)*
STD	-	1.17
LTD	-	1.53
TD	1.17	-
SIZE	1.16	1.32
AG	1.09	1.10
TANG	1.07	1.25
SOE	1.08	1.08
Mean VIF	1.11	1.24

Source: Authors calculations

3.3 Regression estimation results

We performed a regression of the research models (1) and (2) to estimate OLS, FEM, REM. To determine which method is better, we performed the F-test; the results obtained with P-value = 0.000 < 0.05 confirm the FEM is better than OLS. The Hausman test suggests that the fixed impact model is more consistent with sample data than the OLS and REM models. Finally, we perform FGLS to address autocorrelation and heteroskedasticity issues.

3.3.1 The impact of capital structure on profitability

Table 4. The impact of total debt-to-asset on ROA and ROE

	ROA		*ROE*	
	FEM	*FGLS*	*FEM*	*FGLS*
TD	-0.124***	-0.119***	-0.046***	-0.047***
	(-16.14)	(-44.96)	(-3.12)	(-7.72)
SIZE	-0.0023	0.002***	-0.004	0.006***
	(-0.98)	(6.7)	(-0.89)	(-7.17)
AG	0.034***	0.015***	0.070***	0.038***
	(11.13)	(10.51)	(-11.74)	(-9.99)
TANG	-0.0097	0.011***	-0.0267	0.0079
	(-1.07)	(4.04)	(-1.51)	(-1.23)
SOE	-0.0025	0.003***	0.0051	0.011***
	(0.39)	(3.25)	(-0.41)	(-3.97)
Constant	0.148***	0.068***	0.187***	0.025**
	(4.92)	(12.24)	(3.23)	(-2.16)
Obs	3,155	3,155	3,155	3,155
Adj.R^2	0.23		0.07	

Table 4 illustrates the model's regression results (1) between the ratio of debt to total assets (TD) for variables dependent on profitability (ROA, ROE) by methods of FEM and FGLS, respectively.

Table 4 reports that the total debt-to-asset (TD) variable has a negative coefficient with statistical significance. This result demonstrates that increasing leverage will reduce profitability. Our results are consistent with the trade-off theory developed by Myers (1977). However, companies with higher debt ratios will have difficulty raising more capital from the outside. At this time, creditors and investors require higher returns to offset risks. Therefore, companies will have to ignore investment opportunities that bring large cash flow, thereby reducing profitability in the future.

Our results are similar Alarussi and Alhaderi (2018). The result indicates that an increase in debt can lead to a rise in financial risk. Financial leverage is part of the company's strategies. Therefore, the trade-off between company ownership and debt to finance projects can lead to financial risk. Thus, the result also indicates an inverse relationship between leverage and ROE. Ibhagui and Olokoyo (2018) also produce similar results. The result also shows the negative impact of the debt ratio (TD) on ROA and ROE as the article of Dalci (2018); Batool and Sahi (2019). However, our results are inconsistent with Abor (2005); Jaisinghani and Kanjilal (2017).

Table 4 also presents the impact of the control variables on profitability indicators. Asset growth (AG) has positive and significant effects on profitability. Large-scale companies and high-growth assets can

create trust among customers and investors. The business is more efficient and profitable than other companies. This result is consistent with Ting et al. (2014).

The proportion of tangible fixed assets (TANG) also improves profitability. Although businesses did not invest in fixed assets during this period, they used them effectively, bringing profits. This result is not similar to previous studies. Positive results in the State ownership variable (SOE) show that State-owned enterprises come up with effective strategies in management. In addition, abundant capital and extensive relationships give these companies an advantage in accessing good information and profitable investment opportunities. This conclusion is similar to Prasad et al. (2019).

3.3.2 The impact of short-term debt and long-term debt on profitability

Table 5. The impact of debt maturity on ROA and ROE

	ROA		*ROE*	
	FEM	*FGLS*	*FEM*	*FGLS*
STD	-0.115***	-0.122***	-0.025*	-0.121***
	(-14.48)	(-42.82)	(-1.67)	(-21.11)
LTD	-0.149***	-0.152***	-0.053**	-0.164***
	(-12.58)	(-31.48)	(-2.33)	(-16.74)
SIZE	-0.004*	-0.003***	-0.0066	-0.003***
	(-1.77)	(-7.25)	(-1.5)	(-3.09)
AG	0.036***	0.016***	0.075***	0.038***
	(11.65)	(10.15)	(12.48)	(12.88)
TANG	-0.0057	0.015***	-0.0252	-0.019***
	(-0.43)	(-4.96)	(-1.39)	(-2.97)
SOE	-0.002	-0.005***	-0.0053	-0.006**
	(-0.32)	(-4.52)	(-0.43)	(-2.07)
Constant	0.175***	0.066***	0.224***	0.070***
	(5.82)	(10.60)	(3.87)	(5.02)
Obs	3,155	3,155	3,155	3,155
Adj.R^2	0.09		0.12	

Table 5 reports the results of model (2) to consider the association between the capital structure represented by the short-term debt ratio (STD) and the long-term debt ratio (LTD) with the ROA and ROE of enterprises in Vietnam during the period of 2016 - 2020.

Table 5 reports similar results to table 4. The coefficients of the STD and LTD variables are negative in all columns. Currently, most bonds are issued by the government and state-owned commercial banks (Le and Phan, 2017). Only a small number of significant joint-stock companies can raise capital by issuing bonds, so the external loans of the business mainly come from commercial banks. According to the bank's policy, short-term loans have simple requirements and lower lending interest rates, so companies in Vietnam most like to use this term, specifically, the ratio of short-term debt (STD) has an average value of 48.28%, accounting for about 80% of the total debt. Statistics and regression results show that, during this period, managers used excessive short-term debt appropriately, putting the company at risk of liquidity and profitability. In addition, companies that use short-term debt regularly repeat the old repayment cycle and new debt. Short-term debt is extremely sensitive to market interest rates, so the company's

capital is not stable. On the other hand, long-term investment plans can yield future returns, often requiring large sums of money. Our findings are consistent with Alarussi and Alhaderi (2018) and Nakatani (2019).

The results of control variables in table 5 are also similar to table 4. Specifically, company size (SIZE), asset growth (AG), tangible fixed assets (TANG) all have a positive impact on the profitability of the company. The SOE variable also shows that state control positively affects the firm's profitability. State-owned companies often receive financial support, tax rebates, and foreign exchange assistance from the government (Attia et al., 2018).-Therefore, companies controlled by the State often have trust and easy access to loans, state-owned commercial banks with preferential loan interest rates.

CONCLUSION

Our study investigates the effect of capital structure on the profitability of listed enterprises in Vietnam, a transition economy in Asia. We are motivated to perform this research in Vietnam for various reasons. Firstly, research on business size, growth rate, leverage, and capital structure on profitability is still not uniform. Secondly, most of their findings were investigated outside of Vietnam, and even the results differed from the situation there. Thirdly, Vietnam is a rising and emerging economy, understanding the influence of financial components of enterprises is critical for businesses, particularly Vietnamese businesses. Finally, there has not been much research in Vietnam on the effect of capital structure on profitability. As a result, this research aims to examine the impact of various factors on profitability.

Following Alarussi and Alhaderi (2018), we examine the impact of capital structure on a business's profitability. To solve the heteroscedasticity and autocorrelation problem, we follow Panda et al. (2021) and use the Feasible Generalized Least Square (FGLS) estimations instead of OLS regression. Our sample data are collected from 631 non-financial firms listed on the Vietnam Stock Exchange (HOSE and HNX) from 2016 to 2020. Our findings indicate an inverse relationship between Vietnamese firms' capital structure and profitability. The findings reveal that a higher leverage position is related to lower profitability. Specifically, the profits of Vietnamese firms rely more on short-term debt as their main financing option than long-term debt. It is difficult for businesses to approach long-term loans because of strict conditions and higher interest rates than short-term debt.

This study determines some of the consequences of the research findings. Our research will provide important information to corporate monitors and lending institutions to better understand the relationship between capital structure and profitability in Vietnamese enterprises. This study also supports businesses in developing business strategies and efficiently managing business processes.

Despite expanding the data and methods used in models, our paper has certain limitations. Firstly, the research only focuses on return on assets (ROA) and returns on equity (ROE) to measure a company's profitability. Secondly, the models we use in this study are not the best ones (Nguyen and Nguyen, 2018). Finally, according to Reed and Ye (2011), FGLS was the most efficient overall, but it was the worst at estimating confidence intervals.

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How Important is Intangible assets for the Global Value Chain in the EU-15 and CEE Region

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ABSTRACT

This article investigates the impact of intangible asset accumulation on the global value chains (GVC) participation in the EU countries. The role of intangible assets in globally organized production is analyzed and compared within two groups of the EU-15 and CEE countries. Data for intangible assets for the period 1995-2016 are retrieved from INTAN-Invest. The main source of GVC data is OECD-TIVA database. This paper used panel regression analysis with fixed effect. In summary, our results show that the accumulation of intangibles is positively associated with participation in the GVC. The same result is confirmed separately for forward and backward participation. The results of panel regression analysis for the EU-15 suggest that innovative property is the most important factor that has a positive impact on the creation and value-added appropriation within the GVC. The impact of specific types of intangibles on participation and position in the GVC varies between the EU-15 and the CEECs. In some cases, we observe several similarities. R&D and organizational capital are positively associated with participation and position in the GVC in EU-15 and CEECs. Intangible ICT assets, R&D and organizational capital are positively associated with the country's position in the GVC thus supporting the value-added appropriation.

INTRODUCTION

The Central-East European countries (CEECs) integrated in global value chains (GVC) almost 20 years ago. Their competitive advantage was based on low wages and rising labor productivity. However, labor costs in this region have become more expensive over time. Moreover, the position of CEECs in GVC concentrates on downstream activities with lower value added (VA) generation. On the other hand, the position of EU-15 in GVC concentrates on upstream activities with higher domestic value added (DVA) generation, thus creating the so-called intellectual monopoly. This means that the EU-15 countries have concentrated knowledge-intensive activities based on intangible assets (intangibles). Accumulation of

intangibles could allow to become more competitive and increase the position in GVC to benefit more from international trade.

Nowadays, it is not a matter of whether to participate in the global economy, but how to do so gainfully (Fernandez-Stark and Gereffi, 2018). Therefore, it is crucial for the countries to produce sophisticated products to compete in high VA activities across GVC. So, if the country wants to increase the participation in GVC in more valuable activities, it is important to support the development, infrastructure, and human capital.

Jona-Lasinio et al. (2019b) examined the role of intangibles in the EU. They confirmed the positive impact of intangibles on country's participation in the GVC. Vrh (2018) analyzes the impact of intangible assets i.e. R&D expenditure, and the inflow of foreign direct investment on the creation of DVA in exports, between EU-15 and the CEECs. She used aggregated values of total intangibles and confirms that while in the EU-15 they are positively associated with DVA, in CEECs it is negative. Investment in intangibles in CEECs is sufficient to ensure the country's participation in the GVC, but insufficient for GVC upgrading (Vrh, 2018). Durand and Milberg (2018) confirm the same through the theory of intellectual monopoly.

Therefore, we examine the possible differences in the impact of intangibles on the GVC participation separately for the EU-15 and CEECs. These groups of countries are heterogeneous not only in the building knowledge-based economies, but also in the form of participation and position in the GVC. The aim of this article is to examine whether the impact of the intangibles on the GVC participation differs for the EU-15 countries and the CEECs and to identify specific types of intangibles that have a positive impact on participation as well as on improving the position in the GVC, i.e., the appropriation of VA in the GVC.

The paper is organized as follows: the introduction, the review of empirical literature; GVC participation and intangibles: measurement and data; the research methodology; presentation and discussion of the results; and concluding remarks.

1. LITERATURE REVIEW

The definition of GVC is based on the interpretation of Koopman et al. (2010). They define the GVC as a system of VA resources from various areas in globally organized and integrated production network. Empirical studies examining the GVC, e.g., Johnson and Noguera (2012), Gereffi (2018), focused mainly on the definition, organization, and development, the economic benefits of the country's participation in the GVC, the policy that affects their functioning and geographical organization of international trade in intermediates and value added. Porter (1985) defined innovation and knowledge components as a factor that creates a competitive advantage and the DVA in the production process. Value added is increasingly concentrated on the pre-production and post-production activities. Countries engaged in these types of activities, achieve higher position in the GVC as well as competitive advantage in the knowledge economy. These countries are also characteristic by higher accumulation of intangibles.

The accumulation of intangibles can drive country's participation and position in the GVC (Tsakanikas, 2020; Durand and Milberg, 2018). Intangibles can be split into three basic groups: Innovative property, Computerized information, and Economic competencies (Corrado et al., 2017). Economic competencies represent a specific type of intangibles, not reported in traditional statistics or national accounts due to complexity of quantification. According to Corrado et al. (2017) this type of intangibles has impact on business performance as it increases production efficiency and allow country to participate in the production of technologically and highly sophisticated products with a high value added.

For example, Marcolin et al. (2016) analyzed the interaction between GVC and investment in intangibles based on knowledge capital. They showed that investment in organizational capital is significantly positively correlated with the country's backward (BL) participation in the GVC. They concluded that investment in knowledge capital and integration into the GVC can be mutually emphasized. Jona- Lasinio et al. (2019b) find that, intangibles have a positive effect on the participation in GVC and complement tangible assets. Intangibles influence-both forward (FL) and BL participation. In the empirical literature, the comparative analysis studying the impact of the accumulation of specific intangibles on the GVC partici-

pation between the EU-15 and CEECs is still missing. We assume that the impact of intangibles on the GVC participation between the EU-15 and CEECs will vary. Therefore, we formulate our first hypothesis:

HP.1. The accumulation of intangibles has a positive effect on the participation and position in the GVC. However, the effect of intangibles differs among EU-15 and CEECs.

Adarov and Stehrer (2020) concluded that the accumulation of specific types of intangibles has positive effects on productivity growth, increased participation, and position in GVC. For example economic competencies are positively associated with participation in the GVC, although the effect is stronger in CEECs than in the EU-15. The comparative advantage of the CEECs lies in the relatively cheap and skilled workforce. Pellényi (2020), demonstrates, that CEECs are specialized in fabrication tasks. This specialization assumes a limitation of the final volume of DVA in exports, and therefore it is necessary to move to a higher degree of specialization in more knowledge-intensive tasks, which are associated with more sophisticated services. This can be achieved by increasing investment to improve the quality of human capital through the accumulation of intangibles such as economic competencies. Based on this, we formulate our second hypothesis:

HP.2. The accumulation of investment in economic competencies has a stronger positive impact on participation in the GVC in CEECs than in EU-15.

Jaax and Miroudot (2021) stated that the fragmentation of production and, consequently, the catch-up in the value chain, globally as well as regionally (e.g., CEECs), depends on the development of domestic innovation capabilities. This can be influenced by specific government policies, that can affect how innovation is shared across countries and the potential for knowledge spillovers. Building an innovative environment is associated with a specific category of intangibles - innovative property. We assume that this type of intangibles is primarily associated with the EU-15 countries, gradually forming their knowledge economies, and creating the intellectual monopoly (Durand and Milberg, 2018). Based on this, we formulate the third hypothesis:

HP.3. The accumulation of innovative property is positively associated with the country's participation in the GVC, mainly FL participation in the EU-15.

Edquist and Henrekson (2017) analyze the impact of ICT assets and R&D on productivity. They used intangible ICT assets and R&D and confirm that their accumulation is positively associated with VA growth. Corrado et al. (2017) stated that between ICT and intangible capital (such as R&D and innovative property) exist a complementary relationship. Intangible capital has a direct impact on the total factor productivity, increases production efficiency and generates spillovers. This leads to the fourth hypothesis:

HP.4. The impact of intangible ICT asset and R&D on the GVC participation is primarily positively associated with the EU-15 while this impact on GVC position is more positively associated with CEECs.

The next section will provide a deeper definition of GVC measurement and types of intangibles used in our analysis.

2. MEASUREMENT AND DATA

Our analysis is based on data retrieved from OECD – TIVA database. The indicators of GVC are specified according to Koopman et al. (2010) and Johnson (2017). BL participation (downstream) index in GVC's, expresses the foreign value added (FVA) embodied in domestic exports. FL participation (upstream) index in GVC's indicates the DVA in foreign exports. Total GVC participation is the sum of a BL and FL participation indexes. Due to the heterogeneity, we standardized the participation indicators in the GVC with the total hours worked retrieved from the EU-KLEMS. Jona-Lasinio et al (2019b), and Banerjee and Zeman (2020), define GVC position index as the ration of FL to BL and as a country's ability to appropriate the share of VA created within the GVC. CEECs participate in the GVC more intensively than the EU-15. The EU-15 have a higher FL index, while CEECs have a higher BL index. In Figure 1 we can observe a positive correlation between the accumulation of intangibles and the total participation in the GVC.

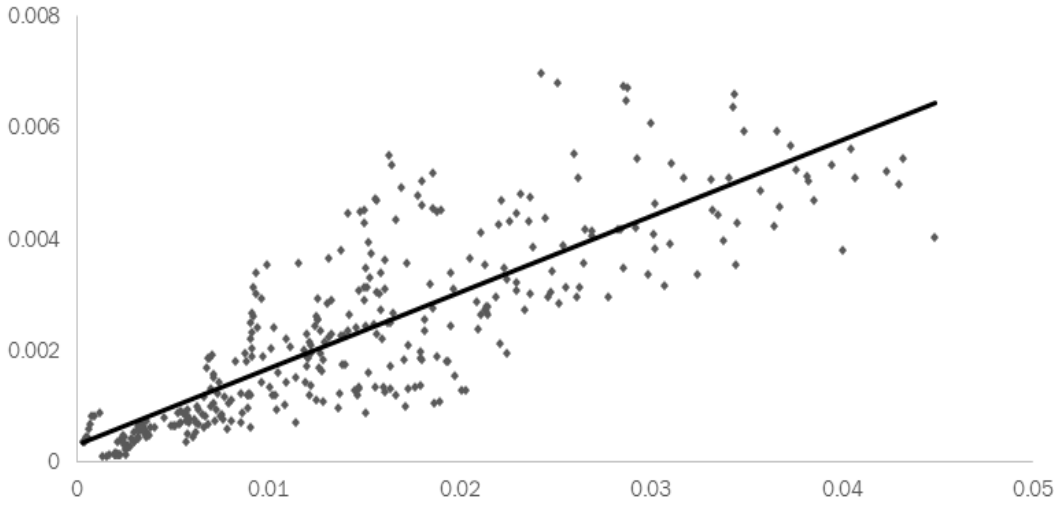

Figure 1. GVC vs. Total Intangibles

Source: Data from INTAN-Invest and OECD-TIVA

Figure 2 and 3 shows the relationship between the accumulation of total intangibles and standardized BL and FL participation index. As we expected, we observe a positive correlation between indicators. The accumulation of intangibles is higher in the EU-15 than in the CEECs.

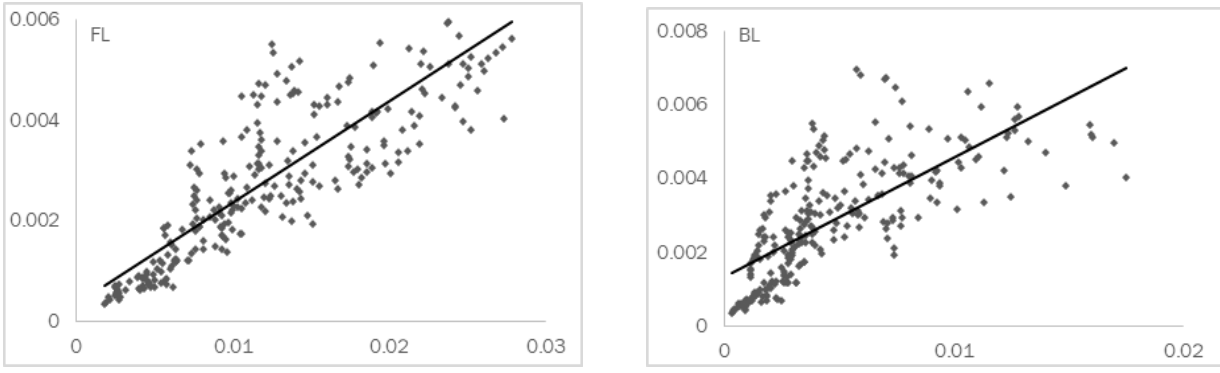

Figure 2. FL and BL participation in the GVC vs. Total Intangibles in EU-15

Source: Data from INTAN-Invest and OECD-TIVA

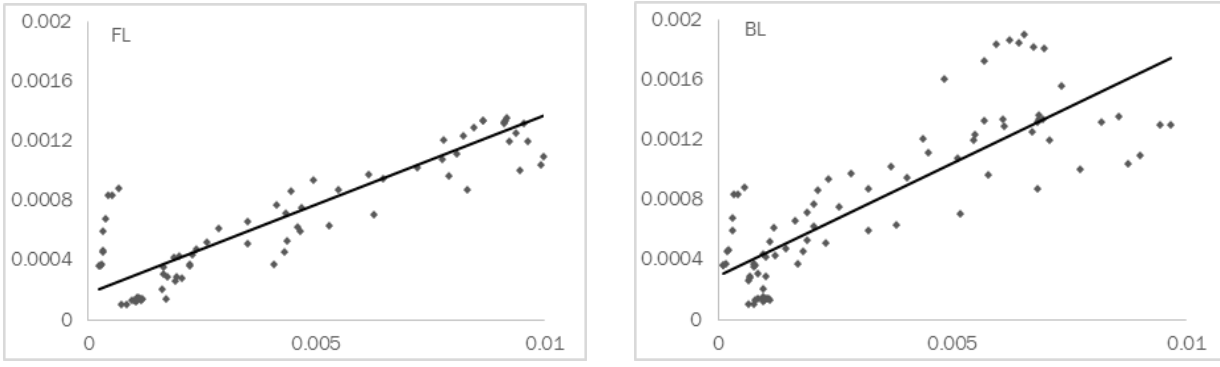

Figure 3. FL and BL participation in the GVC vs. Total Intangibles in CEECs

Source: Data from INTAN-Invest and OECD-TIVA

We use the classification of intangibles according to Corrado et al. (2016). The source of data is INTAN-Invest and EU-KLEMS. The variables used in econometric analysis are described in Tab. 1.

Table 1. Type and source of variables.

Name	*Definition*
DVAFEX_TH_ln	DVA embodied in foreign exports
FVADEX_TH_ln	FVA embodied in domestic exports
Δ TANG_ln	Total tangibles
Δ INTANG_ln	Total intangibles
Δ SoftDB_ln	Intangible ICT assets
Δ InovProp_ln	Innovative property
Δ EconComp_ln	Economic Competencies
Δ Design_ln	Design
Δ R&D_ln	Research and development
Δ BRAND_ln	Brand
Δ OrgCap_ln	Organizational capital
Δ Train_ln	Vocational Training
CIT	Corporate income tax rate
RI	Regulatory index –
DVAFFD_TH_ln	DVA embodied in foreign final demand
FVAFFD_TH_ln	FVA embodied in domestic final demand

Note: TH = Total hours worked

The dataset contains 16 EU countries upon availability of data in INTAN-Invest. The EU-15 countries represent Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherland, Portugal, Spain, and Sweden; CEECs - Slovak Republic, Czech Republic Slovenia and Hungary. Data for other EU-15 countries and CEECs were not available at the time of analysis.

3. RESEARCH METHODOLOGY

In the previous chapter, we demonstrate a positive correlation between the accumulation of intangibles and participation in the GVC (Fig. 1). To test our hypotheses, we estimate equation for the GVC participation considering the simultaneous effect of tangibles and intangibles. Our benchmark equation is as follows:

$$lnY_{c,i,t}^{GVC} = \sum_{q\in Q} \beta_1 \Delta \ln K_{c,i,t}^{Intang} + \alpha_2 \Delta ln K_{c,i,t}^{Tang} + \alpha_3 X_{c,i,t} + \delta_{i,t} + \varepsilon_{c,i,t} \qquad (1)$$

where c = country, i = industry; t = time; Y^{GVC} represents different forms of GVC position and participation (BL, FL). GVC variable are standardized by the number of total hours worked. K^{tang} stands for tangibles; $K^{totintg}$ for intangibles; X for control variables; δ is the industry and time fixed effects; ε is the random error term (Tab. 1). As a control variable, we use a corporate income tax rate (CIT). CIT can influence the decision of multinational company to locate a foreign affiliate. We assume that the higher the tax rate, the lower the probability of placing a foreign affiliate in the country. As the second control variable we use the Regulatory index (RI) from World Bank. The RI includes barriers that may have a negative impact on cross-border trade and relocation decisions for multinational affiliates. The decline in the index means that the regulatory requirements are increasing thus causing a decline in competitiveness of a country.

We use balanced panel data for the period 1995 – 2016 (1,760 total observations). The equation (1) is the basis to test our hypotheses. We use a panel robust Hausman test (Hausman, 1978), this test confirmed the fixed effect panel regression. The choice of using fixed effects estimator is in line with

Jona-Lasinio et al (2019b); Vrh (2018) or Tsakanikas et al. (2020). The data set is robust to heteroscedasticity, autocorrelation, and cross-sectoral dependence. Results of tests are not reported here to save space. They are available upon request from the authors. We express the participation in the GVC indexes (DVAFFD, FVADFD; see Tab.1) based on the final demand as a robustness check according to Jona-Lasinio et al (2019b). These indexes have a less restrictive definition including not only gross export but also total final demand.

4. RESULTS AND DISCUSSION

The first regression results for the total tangibles (Tang) and total intangibles (Intang) are represented in Table 2 and the individual effects of computerized information (SoftDb), innovative property (InovProp) and economic competencies (EconComp) are represented in Table 3. The individual effect of specific type of intangibles (SoftDb, Design, R&D, Brand, OrgCap, Train) are represent in Table 4. The robustness check is presented in Tab. 5. Our results are consistent with findings of Jona-Lasinio et al. (2019b), Durand and Milberg (2018), Corrado et al. (2016), Tsakanikas et al. (2020) emphasizing positive effect of intangibles on participation in the GVC.

Table 2. The effect of tangibles and intangibles on participation in the GVC

Dependent variable	*DVAFEX (1)*	*FVADEX (2)*	*DVAFEX+FVADEX (3)*	*DVAFEX/FVADEX (4)*
Δ TANG_ln_*EU*	0.357***	0.422***	0.370***	0.065***
	(0.041)	(0.049)	(0.042)	(0.022)
EU-15	0.304***	0.431***	0.323***	0.127***
	(0.047)	(0.057)	(0.048)	(0.025)
CEECs	0.444***	0.452***	0.455***	0.008
	(0.081)	(0.097)	(0.084)	(0.039)
Δ INTANG_ln_*EU*	0.476***	0.597***	0.515***	0.122***
	(0.032)	(0.038)	(0.033)	(0.017)
EU-15	0.504***	0.653***	0.540***	0.148***
	(0.038)	(0.046)	(0.039)	(0.021)
CEECs	0.407***	0.537***	0.454***	0.130***
	(0.059)	(0.072)	(0.062)	(0.029)
CIT_EU	-1.038***	-1.369***	-1.087***	-0.331***
CIT_EU-15	-0.904***	-1.317***	-0.967***	-0.413***
CIT_CEECs	-1.288***	-1.313***	-1.287***	-0.025
RI_ EU	-1.655***	-2.116***	-1.756***	-0.462***
RI_EU-15	-2.429***	-2.711***	-2.528***	-0.282**
RI_CEECs	-0.693*	-1.021**	-0.727*	-0.328*
R_EU	0.654	0.681	0.666	0.321
R_EU-15	0.622	0.679	0.641	0.443
R_CEECs	0.726	0.695	0.726	0.259

Note: *p<0.1; **p<0.05; ***p<0.01. N.O EU = 1,760; EU-15 = 1,320; CEECs = 440.

Source: own calculations

In Table 2 we report the results of total tangibles and intangibles impact on the participation in the GVC. The findings of Durand and Milberg (2018) confirm that countries create natural monopolies during GVC formation, Based on data for the US, Japan, and EU-15, they show that these countries created the intellectual monopoly. Therefore, we expect the different impacts of the tangibles and intangibles in the

EU-15 and CEECs. Our results show that intangible assets are positively associated with participation and position in the GVC. Tangibles are positively associated with the participation and position in the GVC (Tab. 2 column 3) however in the case of CEECs, the coefficient for position is insignificant. This can imply that the accumulation of tangibles in CEECs is not associated with the appropriation of VA in the GVC. Intangibles have a higher impact on participation in the GVC than tangibles.

Coefficient of tangibles is 0.370 meaning that a 10% rise of tangibles is ceteris paribus correlated with 3.7 % rise of total participation in the GVC (DVAFEX+FVADEX). Coefficient for intangibles is 0.515 which indicate that a 10 % rise of intangibles is ceteris paribus correlated with 5.15 % rise of total participation in the GVC. When the dependent variable is position in the GVC, the estimated coefficient for tangibles is 0.065 (Tab 2 column 4) which indicate that a 10% rise of tangibles is ceteris paribus correlated with 0.65 % rise of the position in the GVC. Coefficient for intangibles is 0.122 indicating that a 10 % rise of intangibles is ceteris paribus correlated with 1.12 % rise of the position in the GVC. In addition, our results suggest that intangibles have a higher impact than tangibles in the EU-15, *vice versa* in the CEECs. Based on this we confirm our first hypothesis.

Table 3. The effect of broad categories of intangible assets on participation and position in the GVC

Dependent variable	*DVAFEX (1)*	*FVADEX (2)*	*DVAFEX+FVADEX (3)*	*DVAFEX/FVADEX (4)*
Δ SoftDB_ln_*EU*	0.040**	0.113***	0.048***	0.073***
	(0.020)	(0.024)	(0.021)	(0.010)
EU-15	0.096***	0.148***	0.100***	0.053***
	(0.023)	(0.027)	(0.023)	(0.012)
CEECs	-0.022	0.048	-0.010	0.070***
	(0.041)	(0.049)	(0.043)	(0.019)
Δ InovProp_ln_*EU*	0.306***	0.407***	0.334***	0.101***
	(0.033)	(0.038)	(0.033)	(0.017)
EU-15	0.432***	0.400***	0.455***	0.068***
	(0.036)	(0.044)	(0.037)	(0.019)
CEECs	0.077	0.176**	0.113	0.099***
	(0.068)	(0.082)	(0.071)	(0.032)
Δ EconComp_ln_*EU*	0.355***	0.334***	0.367***	-0.022
	(0.037)	(0.043)	(0.038)	(0.019)
EU-15	0.098***	0.206***	0.120***	0.107***
	(0.051)	(0.061)	(0.052)	(0.027)
CEECs	0.596***	0.572***	0.605***	-0.024
	(0.067)	(0.080)	(0.070)	(0.031)
CIT_EU	-1.068***	-1.393***	-1.116***	-0.325***
CIT_EU-15	-0.925***	-1.330***	-0.987***	-0.405***
CIT_CEECs	-1.316***	-1.354***	-1.319***	-0.038*
RI_EU	-1.185***	-1.400***	-1.252***	-0.215***
RI_EU-15	-1.669***	-1.719***	-1.735***	-0.050
RI_CEECs	-0.274	-0.518	-0.290	-0.244
R_EU	0.640	0.673	0.653	0.343
R_EU-15	0.620	0.675	0.638	0.444
R_CEECs	0.720	0.687	0.718	0.296

Note: *p<0.1; **p<0.05; ***p<0.01. N.O EU = 1,760; EU-15 = 1,320; CEECs = 440.

Source: own calculation

As expected, the CIT coefficient is negative (Tab 2). Moreover, CEECs are more sensitive to changes in CIT. Increasing the tax rate can have a negative impact on participation in the GVC. The same is true for the regulatory index. Increasing regulation, state intervention and control may lead to a decrease in participation in the GVC.

Intangible ICT assets are positively associated with the participation in the GVC in the EU-15 and negatively associated in CEECs (Tab.3, column 3). We expected these results as the CEECs are specializing in basic manufacturing activities requiring more tangibles than intangibles. Innovative property is positively associated with total and FL (DVAFEX) participation in the GVC in the EU-15 while the impact in CEECs is insignificant. Finally, economic competencies are positively associated with participation in the GVC in the EU-15 and CEE. However, the impact in CEECs is stronger than in the EU-15. The coefficients of economic competencies are higher for FL than BL participation (Tab.3, column 1,2). This is in line with the findings of Jona-Lasinio et al (2019b).

Results for GVC position (Tab. 3, column 4) suggest that innovative property is the most important factor, having a positive effect on the VA appropriation within the GVC. Innovative property and intangible ICT assets have positive impact in both the EU-15 and the CEECs. Results for economic competencies suggest that they are negatively associated with the position in the GVC (for all EU and CEECs) surprisingly, they have positive impact in the EU-15. Based on this we confirm our second and third hypothesis.

Table 4. The effect of specific types of intangible assets on participation and position in the GVC.

Dependent variable	*DVAFEX (1)*	*FVADEX (2)*	*DVAFEX+FVADEX (3)*	*DVAFEX/FVADEX (4)*
Δ SoftDB_ln_*EU*	0.031*	0.095***	0.040*	0.064***
	(0.020)	(0.024)	(0.021)	(0.011)
EU-15	0.050**	0.101***	0.056*	0.052***
	(0.022)	(0.028)	(0.023)	(0.012)
CEECs	-0.036	0.051	-0.018	0.086**
	(0.039)	(0.047)	(0.041)	(0.019)
Δ Design_ln_*EU*	0.104***	0.143***	0.104***	0.040**
	(0.038)	(0.045)	(0.039)	(0.020)
EU-15	0.175***	0.251***	0.171***	0.076***
	(0.045)	(0.056)	(0.047)	(0.025)
CEECs	-0.188**	-0.211**	-0.178**	-0.023
	(0.077)	(0.094)	(0.081)	(0.038)
Δ R&D_ln_*EU*	0.171***	0.217***	0.182***	0.046***
	(0.017)	(0.020)	(0.017)	(0.009)
EU-15	0.248***	0.269***	0.255***	0.021*
	(0.021)	(0.025)	(0.021)	(0.011)
CEECs	0.106***	0.160***	0.121***	0.054***
	(0.027)	(0.033)	(0.029)	(0.013)
Δ Brand_ln_*EU*	0.166***	0.064***	0.150***	-0.102***
	(0.027)	(0.033)	(0.028)	(0.014)
EU-15	-0.144***	-0.147**	-0.149***	-0.003
	(0.051)	(0.063)	(0.053)	(0.030)
CEECs	0.418***	0.343***	0.390***	-0.075**
	(0.060)	(0.074)	(0.064)	(0.030)
Δ OrgCap_ln_*EU*	0.156***	0.282***	0.194***	0.126***
	(0.047)	(0.056)	(0.048)	(0.024)
EU-15	0.340***	0.361***	0.373***	0.021
	(0.055)	(0.068)	(0.057)	(0.030)

CEECs	0.054	0.140	0.098	0.086
	(0.108)	(0.131)	(0.113)	(0.053)
Δ Train_ln_*EU*	0.043***	0.039***	0.047***	-0.003
	(0.008)	(0.009)	(0.008)	(0.004)
EU-15	-0.122***	-0.035	-0.109***	0.087***
	(0.028)	(0.034)	(0.029)	(0.015)
CEECs	0.061***	0.066***	0.064***	0.005
	(0.011)	(0.013)	(0.011)	(0.005)
CIT_EU	-1.022***	-1.336***	-1.065***	-0.314***
CIT_EU-15	-0.825***	-1.208***	-0.880***	-0.383***
CIT_CEECs	-0.959***	-1.069***	-0.980***	-0.110
RI_EU	-0.906***	-1.056***	-0.953***	-0.314***
RI_EU-15	-1.780***	-1.693***	-1.847***	0.087
RI_CEECs	0.536	0.541	0.572	0.005
R_EU	0.660	0.687	0.671	0.375
R_EU-15	0.652	0.694	0.666	0.460
R_CEECs	0.756	0.721	0.752	0.325

Note: *p<0.1; **p<0.05; ***p<0.01. N.O EU = 1760; EU-15 = 1320; CEECs = 440.

Source: own calculation

The results for specific types of intangibles are presented in Table 4. Intangible ICT assets have positive impact on participation (FL, BL) in the GVC only in the EU-15. In the case of CEECS they have high positive impact on position in GVC. Considering R&D, we expect that they support economic and productivity growth. We confirm that the intangibles associated with R&D increase participation and VA appropriation within the GVC. The impact of R&D is higher for the EU-15 (0.255) than for the CEECs (0.121) (Tab. 4 column 3). Vrh (2018) also confirms that investment in R&D are positively associated with the DVA. However, Jona-Lasinio et al (2019b) distinguish between R&D and non R&D intangibles and confirm that non R&D intangibles have a higher impact on participation in the GVC. We also confirm this assumption. In Tab. 4 column 3 the coefficient of organizational capital (0.194) is higher than the coefficient of R&D (0.182). This difference is higher in the EU-15 than CEECs. The impact of R&D and organizational capital to FL (DVAFEX) have a higher impact in EU-15 than in CEECs. This also confirms that economic competencies are the most important types of intangibles, positively associated with a participation in the GVC. We can confirm our fourth hypothesis.

The robustness check with the dependent variables based on the final demand verifies our results (Tab. 5).

Table 5. The Robustness check regression analysis based on final demand.

Dependent variable	*DVAFFD (1)*	*FVADFD (2)*	*DVAFFD+FVADFD (3)*
Δ SoftDB_ln_*EU*	0.036***	0.064***	0.051***
	(0.016)	(0.018)	(0.017)
EU-15	0.067***	0.056***	0.055***
	(0.017)	(0.021)	(0.019)
CEECs	-0.028	0.066*	0.034
	(0.032)	(0.034)	(0.032)
Δ Design_ln_*EU*	0.085***	0.152***	0.144***
	(0.029)	(0.034)	(0.031)
EU-15	0.134***	0.308***	0.265***

	(0.034)	(0.043)	(0.039)
CEECs	-0.109*	-0.129*	-0.120*
	(0.064)	(0.067)	(0.064)
Δ R&D_ln_*EU*	0.121***	0.117***	0.122***
	(0.013)	(0.015)	(0.014)
EU-15	0.168***	0.138***	0.156***
	(0.015)	(0.019)	(0.017)
CEECs	0.094***	0.095***	0.092***
	(0.023)	(0.024)	(0.023)
Δ Brand_ln_*EU*	0.167***	0.115***	0.139***
	(0.021)	(0.024)	(0.023)
EU-15	-0.153***	-0.193***	-0.168***
	(0.038)	(0.048)	(0.043)
CEECs	0.327***	0.342***	0.334***
	(0.050)	(0.052)	(0.050)
Δ OrgCap_ln_*EU*	0.191***	0.203***	0.177***
	(0.037)	(0.042)	(0.039)
EU-15	0.361***	0.318***	0.292***
	(0.041)	(0.051)	(0.047)
CEECs	0.161***	0.019	0.075
	(0.089)	(0.093)	(0.009)
Δ Train_ln_*EU*	0.051***	0.032***	0.041***
	(0.006)	(0.007)	(0.006)
EU-15	-0.051**	-0.054**	-0.029
	(0.021)	(0.026)	(0.024)
CEECs	0.053***	0.047***	0.050***
	(0.009)	(0.009)	(0.009)
CIT_EU	-0.851***	-0.770***	-0.839***
CIT_EU-15	-0.661***	-0.654***	-0.695***
CIT_CEECs	-0.916***	-0.695***	-0.825***
RI_EU	-0.683***	0.203	-0.224
RI_EU-15	-1.573***	-0.153	-0.733***
RI_CEECs	0.778**	1.062**	0.858***
R_EU	0.726	0.657	0.702
R_EU-15	0.717	0.627	0.675
R_CEECs	0.807	0.745	0.780

Note: *p<0.1; **p<0.05; ***p<0.01. N.O EU = 1760; EU-15 = 1320; CEECs = 440.

Source: own calculation

CONCLUSION

The form of the country's participation in the GVC is crucial. The main interest of a country is to participate in global organized production activities and tasks characterized by a high level of value added. To increase the competitiveness and profit from the participation in the GVC, is to support the robust innovation environment, quality human capital as well as ICT infrastructure, in other words to ensure the accumulation of intangible assets.

Our results confirm that the accumulation of intangibles are positively associated with participation and position in the GVC. In the EU-15, the accumulation of intangibles has a higher positive impact on participation in the GVC than in CEECs. Our results suggest that the accumulation of economic competencies and innovative property is positively associated with participation, while intangible ICT assets and innovative property is positively linked with the position in the GVC. Moreover, innovative property has positive impact on FL (DVAFEX) participation in the GVC.

In the EU-15 innovative property has the highest impact on participation and economic competencies have the highest impact on the position in the GVC. Intangible ICT assets, design, and R&D are positively associated with participation in the GVC. Organizational capital supports total participation and FL participation but has a negative impact on the country's position in the GVC. On the contrary, there is training with negative impact on participation although increases the position in the GVC.

CEECs are characterized by a high level of participation in the GVC. However, their participation is largely generated by the content of FVA. Thus, their production depends on the import of foreign intermediates. It is not important to increases the involvement of CEECs in the GVC but improve their position, i.e., the value-added appropriation within the GVC. Economic competencies are positively associated with total and FL participation in the GVC. On the contrary, they have a negative impact on the position in the GVC. Their accumulation thus increases the total participation but does not improve the VA appropriation. Improving the position in the GVC is possible by accumulation of intangible ICT assets and innovative property. Our results suggest that R&D, brand, and training are positively associated with total participation in the GVC. These intangibles can also improve FL participation. The accumulation of intangible ICT assets and investment in R&D can increase the VA appropriation within the GVC.

Further research could be extended to a more detailed examination of the impact of intangibles on sectors according to the ISIC rev. 4 classification.

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Comparative Assessment of Energy Poverty in Baltic States and Visegrad Countries

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ABSTRACT

The paper analyses energy poverty development in two groups of countries: Baltic States, namely Lithuania, Latvia and Estonia and Visegrad countries (V4), namely Poland, Hungary, Slovakia and Czech Republic. All 7 countries are EU Member States since 2004. The biggest difference between group of countries is that Baltic States were formed Soviet Union republics and encountered more severe problems with regain of independence. The paper provides comparative assessment of energy poverty indicators dynamics in both groups by defining the leaders in energy poverty reduction as well as lagging behind countries and tries to provide the main reasons of such situation. Comparative assessment of individual countries and groups of countries allows to define the best practices in mitigating energy poverty and provides policy recommendations for the countries experiencing problems in energy poverty mitigation based on analysis performed.

INTRODUCTION

Reduction of energy poverty is the most important social issue of sustainable energy development. The main environmental dimension of sustainable energy development is greenhouse gas (GHG) emission reduction, the main economic dimension is surge of competitiveness of energy sector. All these social, environmental and economic issues are closely interlinked (Wach et al., 2021). As GHG emission reduction and implementation of carbon free technologies such as renewables have impact on energy prices and consequently on competitiveness of energy sector as well on energy poverty in the country (Pach – Gurgul and Ulbrych, 2019; Rus et al., 2020; Istudor et al., 2021). Scholars argue that energy poverty is related to material deprivation of vulnerable groups of population in the countries and is linked to income poverty (Liddell et al., 2012; Moore, 2012; Bouzarovski, Petrova, 2015; Pye et al., 2015; Thomson, et al., 2016; Thomson, Snell, 2013). Energy poverty is being analysed by the scholars based on energy deprivation and energy inequality including income indicators (Hills, 2011; Tirrado Herrero, Urge-Vorsatz, 2012; Thomson,

Snell, 2013; Bouzarovski, 2013; 2014; Bouzarovski et al., 2012; Simcock et al., 2016). It is promising to analyse energy poverty in terms of energy affordability and high energy prices for households together with low income and low energy consumption per capita indicators as this shows the main reasons of energy poverty in the country. Therefore, low income, high prices and poor dwellings are the main reasons to be considered then analysing energy poverty.

Energy poverty is currently widely discussed in scientific papers and policy documents due to sharp increase of energy prices due to Russian-Ukrainian war and problems linked to energy import dependency. The Covid-19 pandemics had also negative impact on income and energy poverty in EU Member States. The current Russian-Ukrainian war just excavated the negative impact due to sharp increase in energy prices and growth of inflation.

The Baltic states include Estonia, Latvia and Lithuania. These countries have joined EU in 2004 and are situation in Central Europe. The main feature of this group countries is that they were former US member states and regained independence after collapse of US in 1990. The another group of countries - Visegrád Four countries have socialistic past but they were never integrated in US. They all joined EU in 2004 as well. So called V4 group – the Czech Republic, Hungary, Poland and Slovakia – is a group of Central Europe countries covering the same geographical area, similar experiences in transition from socialistic past towards EU.

Comparison of situation between group of countries allows to capture the main differences within the group and among the groups of countries having similarities and differences caused by they past and economic and social development circumstances before and after joining EU in 2004. There are also many policies and measures developed to address energy poverty discussed by various studies (Bouzarovski, 2013; 2014; Simcock et al., 2016). The Baltic States and Visegrad countries have many likenesses and significant distinctions therefore it is important to analyse and compare them in terms of their success in combating energy poverty and to determine the main causes of good achievements or failures in addressing energy poverty in the country.

Though, there are many papers analysing energy poverty issues (Liddell et al., 2012; Maxim et all, 2012; lMoore, 2012; Bouzarovski, Petrova, 2015; Pye et al., 2015; Thomson, 2016; Tirrado Herrero, Urge-Vorsatz, 2012; Tirrado Herrero, 2013; Thomson, Snell, 2013; Bouzarovski, 2013; 2014; Simcock et al., 2016) however , there is lack of studies providing comparative assessments of group of countries in combating energy poverty based on the similar indicators and policies analysis. The paper aims to overcome this gap and provides comparative analysis of energy poverty situation in Baltic States and Visegrad countries based on the main indicators of energy poverty and their dynamics during 2010-2020 year period.

The rest of the paper is structured in the following way: section 1 presents literature review, section 2 introduces methods and data; section 3 provides results of comparative analysis; and section 4 provides discussion and section 5 concludes.

1. LITERATURE REVIEW

Energy poverty is a very complex socio-economic problem and it is difficult to select the best definition of energy poverty or to define the best indicators for measuring energy poverty. In addition, there is bi difference in defining energy poverty in developing and developed countries (Siksnelyte-Butkiene et al., 2021 a). In developing countries the major issues of energy poverty are linked to access to modern energy services and in developed countries the main problems of energy poverty are linked to low income and high energy prices (Siksnelyte-Butkiene et al., 2021, Siksnelyte-Butkiene, 2021).

In European Union reduction of energy poverty is among the most important policies aiming at achievement of sustainable energy development. Majority of studies on energy poverty were conducted in EU (Bouzarovski, 2013; 2014; Maxim et al., 2016; Streimikiene et al., 2020; 2021; Dagoumas, Kitsios, 2014; Lampietti, Meyear, 2022). There are few studies conducted in Nerw Zeland (Howden-Chapman et al., 2012; O'Sullivan et al., 2012); US (Heally, 2004; Day, Hitchings, 2011) and in several developing countries like Indoenesia (Chaudhuri et al., 2002); Ethiopia (Dercon et al., 2000) etc. (Modi et al., 2005; Kaygusuz, 2011).

There are several indicators frameworks proposed by scholars ranging from composite indexes to single energy poverty indicators (Siksnelyte-Butkiene et al., 2021). It is necessary to stress that single indicators are widely used, sometimes they are punished scholars due to narrowing problem of energy poverty and inability to capture all important aspects of energy poverty (Bouzarovski & Herrero, 2017). The EU-SILC indicators are widely applied in empyrical studies however are also being criticized due to high subjectivity as there are assessed based on household's surveys. In Europe the main data source of energy poverty is Eurostat's Survey on Income and Living Conditions (SILC), covering all EU Member States and other (Bouzarovski, 2014). The biggest advantage of single energy poverty indicators are linked to their ability to be adapted to different countries. The main disadvantages of single indicators is the lack of ability to get final evaluation of energy poverty and to compare countries (Streimikiene et al., 2021).

Composite energy indicators were widely applied for developing countries. Nussbaumer et al., 2012) has developed a Multi-dimensional Energy Poverty Index (MEPI). The MEPI methodology is based on multi-dimensional poverty measures. MEPI was applied in Latin American countries and African countries. The MEPI consists of 8 indicators linked to energy availability and evaluated the access to modern service. All indicators are grouped according main 3 categories: cooking, lighting and additional measures. The choice of energy poverty indicators is based on the aim of the study. Usually, energy poverty indicators are used for informed policy making as they are supposed to provide reliable information about energy poverty situation in selected country or group of countries. Energy poverty indicators can be also used for effectiveness of already implemented policies therefore the dynamics of energy poverty indicators is crucial in this context.

This paper aims to perform comparative assessment of energy poverty in two groups of countries by applying energy poverty indicators and comparative assessment approach. The main approach applied in this paper and data used is described in following section.

2. DATA AND METHODOLOGY

The main approach applied in this paper – comparative analysis of the main energy poverty indicators and their dynamics including policies and measures aiming at energy poverty reduction within and among group of selected countries. The quantitative indicators of energy poverty were selected from Eurostat based on data availability. Some important energy poverty indicators like 2M or 1/2M were skipped from analysis due to lack of recent data. The selected indicators covers three main areas: energy deprivation (Inability to keep home warm; population considering their dwelling as too dark; population living in a dwelling with leaking roof, damp walls income poverty (Areas on utility bills; Actual individual consumption; energy consumption per capita) and energy affordability expressed by energy prices (electricity prices for households; natural gas prices for households).

Therefore, the EUROSTAT and Energy Poverty observatory data was used for comparative analysis of energy poverty trends in Baltic States and Visegrad countries. The countries were ranked based on energy poverty reduction achievements according each indicator and by summing up all ranks to achieve final ranking based on all energy poverty indicators.

Table 1 presents the framework of indicators applied for energy poverty analysis between countries in the group and between group of countries. In table also desirable trend of indicators is identified by the direction of arrow.

Table 1. Main energy poverty indicators and desirable trends

Indicator of energy poverty	*Description of indicators*	*Unit of measurement*	*Desirable trend*
Areas on utility bills	The share of total population having arrears (mortgage or rent, utility bills or hire purchase) based on EU-SILC survey	%	↓
Inability to keep home warm	The share of total population that is unable to keep their home adequately warm	%	↓
Population considering their dwelling as too dark	The share of total population considering their dwelling as too dark based on EU-SILC survey	%	↓
Population living in a dwelling with leaking roof, damp walls etc.	The share of total population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor was assessed based on EU-SILC survey	%	↓
Energy consumption per capita	Final energy consumption in households per capita	kgoe	↑
Actual individual consumption	GDP in current prices, purchasing power standard (PPS, EU27 from 2020) per capita	PPS per capita	↑
Electricity prices for households	Electricity prices for medium size households	EUR/Kilowatt-hour	↓
Natural gas prices for households	Gas prices for medium size household	EUR/Gigajoule	↓

The results of comparative analysis of energy poverty of Baltic States and Visegrad 4 countries is presented in the next section of paper.

3. RESULTS

The trends of the main energy poverty indicators of Baltic States were provided Table 2 by using 2010 and 2020 data.

Table 2. Energy poverty indicators Baltic States in 2010 and 2021

Energy poverty indicators	*Estonia*		*Latvia*		*Lithuania*	
	2010	*2021*	*2010*	*2021*	*2010*	*2021*
Areas on utility bills, %	13.3	5.7	25.2	7.2	11.9	6.6
Inability to keep home warm, %	3.1	2.0	19.1	4.9	25.2	22.5
Population considering their dwelling as too dark, %	4.1	3.4	10.8	5.2	8.2	6.6
Population living in a dwelling with leaking roof, damp walls etc., %	18.8	10.2	24.7	17.5	19.2	10.9
Energy consumption per capita, kgoe	771	711	662	587	514	513
Actual individual consumption, PPP per capita	9874	16437	9647	14865	11471	19885
Electricity prices for households, EUR/Kilowatt-hour	0. 10	0.13	0.11	0.14	0.12	0.15
Natural gas prices for households, EUR/ Gigajoule	10.07	12.10	8.73	8.26	10.43	7.74

Source: created by authors based on Eurostat (2022)

Comparative analysis of energy poverty indicators representing energy deprivation situation like Inability to keep home warm, share of population considering their dwelling as too dark and population living in a dwelling with leaking roof, damp walls etc. shows that Lithuania distinguishes with very high indicator of inability to keep home warm from other Baltic States, especially in 2021, which indicates some problems in national statistics. According to share of population living in poor dwellings, Lithuania takes second position after Estonia and in the worst situation during investigated period was Latvia.

Though according to income per capita Lithuania was leading country among Baltic States during all investigated period, according energy consumption per capita the country was in the worst situation among analysed states during the same period. According to the areas of utility bills indicator, Lithuania was in the second position after Estonia which was leading according all indicators except individual consumption of GDP per capita indicator and natural gas prices for households which were the highest among Baltic States In 2021. In Table 3 the main energy poverty indicators for Visegrad countries in 2010 and 2021 are given

Table 3. Energy poverty indicators in Visegrad countries in 2010 and 2021

Energy poverty indicators	*Czech Republic*		*Hungary*		*Poland*		*Slovakia*	
	2010	*2021*	*2010*	*2021*	*2010*	*2021*	*2010*	*2021*
Areas on utility bills, %	6.1	2.4	24.3	11.2	15.3	7.0	12.1	6.7
Inability to keep home warm, %	5.2	2.2	10.7	5.4	14.8	3.2	4.4	5.8
Population considering their dwelling as too dark , %	3.7	3.1	8.7	7.7	7.7	3.9	2.6	2.6
Population living in a dwelling with leaking roof, damp walls etc., %	11.8	6.8	24.2	20.4	15.6	6.0	5.8	4.9
Energy consumption per capita, kgoe	710	668	665	612	578	557	429	503
Actual individual consumption, PPP per capita	12521	17085	10386	14132	11293	16671	12517	14920
Electricity prices for households, EUR/Kilowatt-hour	0.15	0.18	0.17	0.10	0.13	0.16	0.15	0.17
Natural gas prices for households, EUR/ Gigajoule	13.04	15.61	14.87	8.52	11.81	10.45	12.11	11.41

Source: created by authors based on Eurostat (2022)

As data in Table 3 shows, Czech Republic had the lowest energy poverty indicators in terms of energy deprivation and highest energy and individual consumption indicators showing higher energy affordability then in other Visegrad countries. The energy prices in 2010 were also among the lowest in the group after Poland in 2010, however in 2021 the country was leading in terms of high energy prices though other indicators just improved and country was able to maintain the leading position in combating energy poverty among V-4 countries. The Hungary distinguished among other V-4 countries with highest energy poverty indicators in 2010 however in 2021 the country had the lowest energy prices for households in the group due to state policies linked to the growth of energy import dependency on Russian fossil fuels and favorable energy prices set for Hungary by Russia.

4. DISCUSSIONS

The data provided in Table 2 allows to rank Baltic States based on energy poverty indicators and address the success of countries in combating energy poverty in the country during 10 years period since 2010. The ranking of Baltic States according energy poverty indicators within group in 2010 and 2021 is provided in Table 4. The ranking was performed based on desirable trends of energy poverty indicators provided in Table 1.

Table 4. The ranking of Baltic States based on energy poverty indicators in 2010 and 2021

Energy poverty indicators	*Estonia*		*Latvia*		*Lithuania*	
	2010	*2021*	*2010*	*2021*	*2010*	*2021*
Areas on utility bills, %	2	1	3	3	1	2
Inability to keep home warm, %	1	1	2	2	3	3
Population considering their dwelling as too dark , %	1	1	3	2	2	3
Population living in a dwelling with leaking roof, damp walls etc., %	1	1	3	3	2	2
Energy consumption per capita, kgoe	1	1	2	2	3	3
Actual individual consumption, PPP per capita	2	2	3	3	1	1
Electricity prices for households, EUR/Kilowatt-hour	1	1	2	2	3	3
Natural gas prices for households, EUR/ Gigajoule	2	3	1	2	3	1
Total number of ranks	11	11	19	19	18	18
Final ranking	1	1	3	3	2	2

Source: created by authors

As one can see from Table 1, the best situation with energy poverty in 2010 and 2021 was in Estonia. The situation has not changed during 10 years and in 2010 and 2021 the worst performing country in terms of energy poverty was Latvia. Lithuanian position also has not changed though country is distinguishing according some indicators of energy poverty like inability to keep home warm between Baltic States.

The ranking of Visegrad according energy poverty indicators within group in 2010 and 2021 is provided in Table 5.

Table 5. The ranking of Visegrad countries based on energy poverty indicators in 2010 and 2021

Energy poverty indicators	*Czech Republic*		*Hungary*		*Poland*		*Slovakia*	
	2010	*2021*	*2010*	*2021*	*2010*	*2021*	*2010*	*2021*
Areas on utility bills, %	1	1	4	4	3	3	2	2
Inability to keep home warm, %	2	1	3	3	4	2	1	4
Population considering their dwelling as too dark, %	2	2	4	4	3	3	1	1
Population living in a dwelling with leaking roof, damp walls etc., %	2	3	4	4	3	2	1	1
Energy consumption per capita, kgoe	1	1	2	2	3	3	4	4
Actual individual consumption, PPP per capita	1	1	4	4	3	2	2	3
Electricity prices for households, EUR/Kilowatt-hour	2	4	4	1	1	2	3	3
Natural gas prices for households, EUR/ Gigajoule	2	4	4	1	1	2	2	3
Total number of ranks	13	17	33	23	21	19	16	21
Final ranking	1	1	4	4	3	2	2	3

Source: created by authors

One can notice from Table 4 that Czech Republic was the best performing country in terms of energy poverty among Visegrad countries during all investigated period. The Hungary was the worst performing country in terms of energy poverty during investigated period among Visegrad countries. Just Poland has improved it‘s energy poverty indicators in 2021 and was in second position after Czech Republic though in 2010 the Slovakia was in second best position in terms of energy poverty after Czechia among V4 countries.

The ranking of Baltic States and Visegrad country groups according energy poverty indicators in 2010 and 2021 is provided in Table 6. The ranking was performed by using average data for each country group assessed for each indicator for 2010 and 2020 year period.

Table 5. The ranking of Baltic and Visegrad country groups based on average energy poverty indicators per group of countries in 2010 and 2021

Energy poverty indicators	*Baltic States average data*		*Visegrad countries average data*		*Baltic States ranking*		*Visegrad countries ranking*	
	2010	*2021*	*2010*	*2021*	*2010*	*2021*	*2010*	*2021*
Areas on utility bills, %	16.8	6.5	14.5	6.8	2	1	1	2
Inability to keep home warm, %	15.8	9.8	8.8	4.2	2	2	1	1
Population considering their dwelling as too dark , %	7.7	5.1	5.7	4.3	2	2	1	1
Population living in a dwelling with leaking roof, damp walls etc., %	20.9	12.9	14.3	8.6	2	2	1	1
Energy consumption per capita, kgoe	649	604	596	585	1	1	2	2
Actual individual consumption, PPP per capita	10330	17062	11679	15702	2	1	1	2
Electricity prices for households, EUR/Kilowatt-hour	0.11	0.14	0.15	0.15	1	1	2	2
Natural gas prices for households, EUR/ Gigajoule	9.74	9.37	13.00	11.50	1	1	2	2
Total number of ranks	-	-	-	-	13	11	11	13
Final ranking	-	-	-	-	2	1	1	2

Source: created by authors

Data provided in Table 5 shows that in 2010 Visegrad countries were performing better in terms of energy poverty assessment but in 2021 situation has changed and Baltic States showed better results according overall ranking in energy poverty indicators. The main changes of better performance of Baltic States in 2021 were linked to lower share of areas in utility bills of Baltic States and ,higher actual individual consumption. Such indicators as energy consumption per capita was always higher in Baltic States and energy prices for households were always lower in Baltic region than in V-4 countries.

CONCLUSIONS

Comparative analysis of energy poverty indicators in Baltic States revealed that best performing country in terms of low energy poverty indicators in 2010 and 2021 was Estonia. Lithuania distinguishes with very high indicator of inability to keep home warm from other Baltic States, especially in 2021, which shows clear problems with data collection. Though according to income per capita Lithuania was the best performing country among Baltic States in 2010 and 2021, according energy consumption per capita the country was in the worst situation during the same years in Baltic region. According to the areas of utility bills indicator, Lithuania was in the second position after Estonia which was leading according all indicators except individual consumption of GDP per capita indicator and natural gas prices for households which were the highest among Baltic States In 2021. According to the share of population living in poor dwellings, Lithuania takes second position after Estonia and in the worst situation during investigated period was Latvia.

The energy poverty situation remained the same from 2010 to 2021 in Baltic States and the worst performing country in terms of energy poverty was Latvia during investigated period. Lithuanian position also has not changed though country is distinguishing according some indicators of energy poverty like inability to keep home warm between Baltic States.

Among Visegrad countries the best performing country in 2010 and 2021 was Czech Republic having the lowest energy poverty indicators in terms of energy deprivation and highest energy and individual consumption indicators. The energy prices in Czechia in 2010 were also among the lowest in the group after Poland, however in 2021 the country was leading in terms of high energy prices though other indicators just improved and country maintained the leading position in combating energy poverty among Visegrad countries. The Hungary was the worst performing country in terms of energy poverty indicators during investigated period though in 2021 the country had the lowest energy prices for households due to state policies promoting energy import from Russia under the favorable energy prices set for Hungary by Russia.

The situation in Visegrad region has not changed in terms of countries ranking on energy poverty performance except Poland and Slovakia. Poland has improved it's energy poverty indicators in 2021 and was in second position after Czech Republic though in 2010 the Slovakia was in the second best position in terms of energy poverty among Visegrad countries.

Comparative assessment of energy poverty in Baltic states and Visegard countries by applying average energy poverty indicators in 2010 and 2021 for regions showed that Visegard countries were in better position in terms of energy poverty mitigation in 2010, however in 2021 situation has changed and Baltic States were performing better according energy poverty indicators. The major changes were linked to reduction of in the shares of areas in utility bills and increased actual individual consumption level in Baltic States in 2021.

The main policy recommendations for Baltic States are linked improvement of measurements of energy poverty indicators as it is obvious that indicator of inability to keep home warm in Lithuania is assessed due to wrong formulation of question in surveys therefore this indicator does not provide policy makers with necessary information to shape the policies for combating energy poverty.

For V-4 countries the main attention should be paid for energy affordability in terms of high indicators of areas on utility bills and high energy prices except Hungary as according other energy poverty indicators V-4 is in better position than Baltic States.

The study has limitations as comparative assessment was performed just for two years: 2010 and 2021. The future research is necessary to address issues of dynamics as well as provide in-depth assessments of policies and measures aiming at energy poverty reduction in selected countries. This would allow to asses energy poverty reduction policies in terms of effectiveness.

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Economic Effects Reforms of the Legal System in the Transitional Countries of Southeast Europe

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ABSTRACT

This paper investigates relationships between legal reforms intended to create a market-friendly regulatory business environment and their impact on economic and financial outcomes in Southeast Europe (SEE) transition economies. We started from the hypothesis that legal reforms in SEE countries in transition were supposed to contribute to their significant economic growth. However, several factors have had negatives influence to legal reforms, and reduce their expected positive impact on economic outcomes in SEE. We identified the dominant factors which have negative influence: socialist heritage, unsatisfactory application of legal regulations, and corruption. We estimate fixed-effects panel regressions to analyse the relationship between changes in legal rules and regulations and changes in the real economy and determine the functional dependence between changes in economic effects and above mentioned factors of influence. Our findings point to that selected factors reduced systematic effects of legal rules and regulations on economic outcomes in SEE counties. The selected factors largely explain the low economic effects of legal system reforms in SEE countries.

INTRODUCTION

Today, it is widely accepted in both the academic and legislative spheres that legal reforms aimed at creating a market-friendly regulatory environment are key to economic growth. The opinion that law is important, that is, that legal reforms can make a difference in improving the economic performance of countries, is expressed in numerous scientific works. Several works (La Porta et al., 1998, 2004) show that countries whose legal systems provide stronger protection of the rights of investors and creditors (usually common law countries) have more developed financial markets and more dynamic market economies. The conclusion reached by many scientists is that legal reforms aimed at improving the protection of the rights of investors and creditors should lead to financial development, and therefore economic growth. All of the above has been proven in developed countries. However, the subject of research in this paper is the situation in SEE countries, what is the impact of legal system reforms on economic results. The data show that

the economic results of the SEE countries are very unsatisfactory and they are far from expected. The economic decline of these countries has been drastic since the beginning of the transition that began in the 90s, and the GDP of 1990 was only reached after 15 years. We believe that the main cause of this is right on the slow change in the legal system, and this raises the question of why this is so? Economic effects in these countries measured by economic growth rates in the period 1996-2019 are given in table 1, with descriptive statistics in table 2.

Table 1. Average annual GDP growth rate (in %) in the period 1996-2019.

Country	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*
Alb.	9,1	-7,0	8,0	7,3	7,8	7,3	2,9	5,7	5,9	5,5	5,0	6,0
B & H	86,0	37,0	10,0	10,0	5,5	4,3	5,3	4,0	5,8	5,0	6,2	6,8
MON.	5,9	6,3	1,9	-15,7	5,0	5,5	4,3	2,4	8,8	4,7	8,6	10,3
Ser.	5,9	6,3	1,9	-15,7	5,0	5,5	4,3	2,4	8,8	4,7	5,2	6,9
N. Mak.	1,2	1,4	3,4	4,3	4,5	-4,5	0,9	2,8	4,1	4,1	4,0	5,9

Country	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Alb.	6,5	2,2	3,0	4,0	1,6	1,4	1,4	1,9	1,3	2	2	1,4
B & H	5,4	- 3,4	0,5	2,0	- 0,5	1,5	2,0	3	2,9	3,1	3,8	0,6
MON.	6,9	- 5,3	- 0,5	2,5	-2,5	3,3	1,8	3,4	2,9	4	4.9	4,1
Ser.	5,5	- 3,0	2,0	3,0	- 1,6	1,5	2,0	1,8	3,3	2	4	1,9
N. Mac.	4,8	- 0,7	2,0	2,8	0,8	1,7	2,2	4,7	2,1	1,1	2,9	3,2

Source: 1) *Transition Report Update*, p. 17; 2) *Statistical Yearbook of Yugoslavia*, 2001. 3) www. imf,org, 4) M. Draskovic, R. Jovovic & V. Draskovic, 2021.

Table 2. Descriptive statistics of economic effects (GDP growth rate (in %) in the period 1996-2019.

	Range	*Minimum*	*Maximum*	*Mean*		*Std. Deviation*	*Variance*
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
Rate of Growth	26,00	-15,70	10,30	3,2513	,36375	3,96809	15,746

Source: author's calculation

It is noticeable that the economic results are very modest, as shown by the average growth rate 3,25% over the period 1996-2019. The following countries were taken for the analysis: Montenegro (MN), Serbia (SER), Bosnia and Herzegovina (B&H), Albania (AL) and North Macedonia (NM).

The purpose of this paper is to identify and explain factors in the legal system (and its environment) of SEE countries that have a limiting effect on the outcomes of economic development that is not at the achieved level, as planned in the transition strategies of those countries. In doing so, we first examine the literature on the impact of legal system reforms in developed economies to confirm our starting assumption that a high-quality legal system is the main condition for economic progress. Then the situation in SEE countries is investigated. The evidence seems to indicate that there has been a serious lag in the implementation of new legal solutions in the following areas: the law on books measured by indices of the strength of creditor rights and investor protection, the depth of credit information, and the regulatory burden for starting a business, property registration. Obtaining building permits, paying taxes and cross-border trade. After that, the factors that dominantly influenced it are identified, using estimate fixed-effects panel regressions to analyse the relationship between changes in factors influencing legal rules and regulations and changes in the real economy.

1. LITERATURE REVIEW

Interest in legal institutions and their influence on economic dynamics has a long history, dating back to the 17th century. Questions about the connections between legal frameworks and economic systems go back to the works of Adam Smith or Jeremy Bentham. More serious interest in this relationship begin with the works of J. R. Commons (1924) and other institutionalist economists (for ex. J. M. Clark (1926)). Nevertheless, consideration of that relationship came to the forefront in the work of D. North (1990) and with the expansion of the paradigm of the new institutional economy. The dilemma about the economic importance of institutions, which was present for a long time, was eliminated. B. Cross (2002) considers institutions central to economic dynamics and performance, pointing to the role of property rights, as a tool for securing transactions, extending agents' waiting periods, and appropriating investment returns. H. De Soto (2005) shows that the decline of the shadow economy and the growth of economic activity with regular business increase the accumulation of capital and provide the basis for getting out of poverty in the Third World.

The above mentioned authors and many others develop in-depth analyses of legal and political institutions, from various angles of their impact on economic performance. In the analyses of the determinants of institutional arrangements (Wei, et al., 2021), many authors after 1990 tend to distance themselves from F Hayek (the theory of natural selection of efficient institutions). The research perspective is broadened and the consequences of different institutional configurations related to legal systems are analysed not only qualitatively but also quantitatively. Different areas are treated, first of all, financial market law, company law and banking regulations. Several authors (La Porta et al., Vishni, 1997; Levine, 1999) place law regulations as decisive factors in the development of efficient capital markets. New areas are also being explored: judicial organization, regulation of dismissal, separation of executive, legislative and judicial powers, political institutions, the Constitution, etc. Legal systems (Anglo-American-common law, Romano-Germanic-civil law) are analysed from the aspect of quantitative measurement of legal institutions, whereby in the Anglo-Saxon legal system macroeconomic indicators are more appropriate for that measurement and economic analysis of the impact of legal regulations to economic results.

The indicator method has become common both in academic circles and in multilateral institutions, above all the World Bank, which entrusted its subsidiary, the International Finance Corporation, with responsibility for a program to measure and evaluate the legal systems of almost 150 countries: the Doing Business program, inspired by the work and method of R. Djankova, F. La Porte, L Lopez-de-Silanes and A. Shleifer. The OECD has also developed, in the more limited area of labour market regulation, a synthetic indicator called "Employment Protection Law" (EPL). Within this work dedicated to legal systems and institutions, a more detailed examination allows distinguishing several approaches:

- first, those that focus on indicators of the rule of law, defined in relation to several institutions involved in public administration, and consider the relationship between the rule of law and growth,
- then those related to families of laws, those from common law and civil law in particular, and consider the impact on growth, investment or economic financing systems,
- finally those that measure the performance of the legal systems themselves, by going to a very fine level of detail in the study of legal systems or labour market regulation.

The conceptual framework for analysing the relationship between the law and the economy is most often based on behavioural models inspired by rational choice theory. The focus of the analysis is on the effectiveness of legal arrangements involving rational individuals focused on their individual interests. Social norms, habits, customs have also been researched in the literature - social norms that are defined as rules that do not originate from state institutions and are not imposed by legal sanctions (Posner 1997, 1998). The role of social norms was also investigated by R.C. Sunstein (1997) and R. Cooter (2002). An important point is that social norms are often seen as "substitutes for law" (McAdams, Rasmussen, 2005).

Some works in the field of law and economics therefore explain good or bad growth performance by the adoption of different legal systems, especially that of civil law and that of so-called customary law. R. La Porta et al. (2008) therefore underline that legal systems can be quantified and synthesized in indicators that would show that common law is more efficient, more favourable to the market, private contracts and growth than civil law, which would be more formalistic, slower, dependent on governments and less

fair. Colonized countries often adopted the legal systems of the colonizers, and this different "legal origin" would explain differences in growth in developing countries (Sindzingre, 2007).

SEE countries are undergoing a transition to a market economy and simultaneous drastic reforms to which their economic and legal systems are undergoing. The effectiveness of institutions depends on how they are designed, taking into account the characteristics of the environment (for example, the availability of public funds, or the level of corruption). The examples of privatization and liberalization reforms in SEE countries have shown that it is easy to transfer legal systems "on paper", but that the problem of their implementation remains, due to limited resources, corruption of the institutions in charge of this application and the weakness of regulatory agencies.

A key problem in SEE countries is the large number of unforeseen situations that affect contracts and the resulting transaction costs; many actions specified in the contracts cannot be verified, nor be the subject of the contract, thus bribery, lying, concealing (Laffrot, 2001). J.J. Laffont therefore seeks to understand whether formal legal systems can solve these specific issues, in particular whether the application of the legal obligation of a contract ("legal enforcement") can solve the problems of asymmetric information (namely, the very high costs of solving these problems), in the context limited public resources, all of which characterize developing countries. For J,J. Laffont (Ibid.), the more corrupt a country is, the lower the level of respect ("enforcement").

The literature on development economics often realises corruption as an essential determinant of the impact of the introduction of legal systems in developing countries. Many works highlight the "poverty traps" caused by "corruption equilibria" (Shkolnyk et al., 2020; Jovovic, 2021) and the inability of legal or economic incentives (for example, higher wages) to modify these generalized corruption equilibria once they have stabilized (Besley and McLaren, 1993; Van Rijckeghem and Weder, 1997).

Researching the extensive literature and practices of the transition countries of the SEE, we have identified the key factors that inhibit the establishment of a legal system in transition countries that would enable greater economic effects in accordance with the resources these countries possess. These are the following factors: historical legacy (path dependence), unbuilt formal institutions, and corruption. They are discussed in the next section.

3. METHODOLOGY

3.1 The model

As above mentioned, we defined the independent variables starting from appropriate theoretical research and practical insights related to the key issues of the transition of the SEE countries. The key research question is how the selected factors (independent variables) affect the dependent variable / economic development (Y). The independent variables are:

- historical legacy of socialism(path dependence (X_1)
- undeveloped formal institutions (X_2), and
- corruption *(X_3).*

Historical legacy of socialism. We found that the historical heritage is a very complex factor that affects the change of the legal system. Many authors confirm this (e.g. M. Dzunic & N. Golubovic, 2018; Lj. Madzar, 2000; V. Draskovic, 2014; 2018, 2021; J. Kornai, 2006; M. Draskovic, M. Delibasic, & V. Draskovic, 2019; V. Draskovic, R. Jovovic & J. Rychlik, 2020; M. Draskovic, R. Jovovic & V. Draskovic, 2021; M. Draskovic, M., Delibasic, & V. Draskovic, 2021; V. Draskovic, R. Jovovic, M. Delibasic & A. Sherstobitova, 2021). It is woven from many layers of historical processes. I. Berend (2000) rightly points out that SEE countries are not in a position to simply discard unpleasant and unsuccessful episodes in the development of the last half century and "return to normal".

According to G. Ekiert and D. Ziblatt (2013), it is the basis for understanding the goals of the transition in the SEE countries, because obviously the choice in the transition is strongly related to the patterns of

the past. We believe that the results of socialism cannot be ignored, and it is logical that it left deep traces, which we have listed above. M. Draskovic et al. (2019; 2021; 2021a) rightly believes that socialism certainly represents a temporary deviation from the long-term political process and economic changes within Europe.

Thus, SEE countries are faced with historical legacies, limitations, a set of habits and cognitive frameworks inherited from the socialist period, as well as social and cultural patterns that preceded socialism. Several decades spent under the redistributive and paternalistic system certainly influenced the social structure, behavioural patterns and culture of these countries, in the transition period. This period of apparent balance and forced uniformity is punctuated by episodes of liberalization and centralization, expectations of political changes and bitter disappointments, partial reforms and abandonment of reforms. All that left lasting consequences, which shaped the democratic and economic transformation.

SEE countries inherited socialist ballasts (path dependence), the most important of which are: inefficient economic system, undeveloped property structures, redistributive behaviour, tight financial and nonexistent factor market, tendency to paternalism, underdeveloped entrepreneurial culture, socio-pathological phenomena, high hyperinflation, the absence of political consensus, pronounced internal political and other divisions, administrative control, the manifestation of some anachronistic behaviours characteristic of a patriarchal society, dogmatic ideas about non-alternative development, the dominance of politics over the economy and all areas of life and work, the institutionalization of privileges, procedural forms of domination and totalitarianism, unlimited political power, tendencies towards a soft budget policy, redistribution of factor incomes, etc.

Underdeveloped institutions. In developed countries like the US, entrepreneurs enjoy all the benefits of good economic institutions, including securing their property rights, supportive policies for market entry, contracts based on competition for the private sector. Entrepreneurs in SEE countries in transition, which do not have good economic institutions, face many difficulties (Acemoglu and Robinson, 2012). They struggle with asset insecurity, barriers to market entry and a two-way supply of contracts. Good economic institutions provide people with a favourable environment for saving, learning, innovating and investing (Acemoglu and Robinson, 2012). Furthermore, a country with good economic institutions has a stable financial system, low interest rates and a low inflation rate, a consistent macroeconomic policy, etc. This increases investor confidence and as a result, higher investment, lower unemployment, higher income and improvement in socio-economic indicators can be achieved. Furthermore, efficient allocation of resources can be observed in a country that has good economic institutions (Acemoglu, Johnson and Robinson, 2004). Based on the way they contribute to economic development, two types of economic institutions are distinguished: inclusive and extractive.

Numerous authors believe that the main development limitation in SEE countries was the slow and insufficient pace of systemic, institutional and other civilizational changes (M. Draskovic, R. Jovovic & V. Draskovic, 2021,). It slowed down the convergence towards developed countries (Draskovic, 2018).

Corruption. To be fair, improving institutions in SEE countries is not enough, as there is no guarantee that the rules will be applied correctly and consistently. A number of circumstances affect it. Corruption is often involved in obstructing the implementation of a legal act, which increases the cost that a citizen must bear in order to implement a legally defined procedure. It does not have to be a question of corruption alone. Sometimes it is about avoiding responsibility, so government officials deliberately delay or multiply the levels of decision-making. Bureaucrats often adapt the rules to their views and requirements, motivated by the desire for discretionary decision-making, in accordance with man's natural desire for prestige and power, and the interest of officials to advance in their careers.

Only the judiciary can undermine the credibility of legal rules. It is logical that credibility depends on the characteristics of implementation, which include openness and transparency, but also on the interpretation of what the legal precepts actually mean. Based on their own convictions, they know how to adapt the rules of the judiciary to specific circumstances. Of course, if the majority of cases qualify as "specific", the application of the same rule may generate different outcomes, which leads to the ambiguity of its application, i.e., lack of credibility. As legislation is increasingly the result of political exchange of favours and compromises, this issue becomes more complicated. This leads to unclear texts in the laws, and possible loopholes and inconsistencies in the law. Such practice creates a wide field for interpretation and

complicates the relationship between the judiciary and the legislature. Judiciary and legislation were expected to evolve faster in SEE countries.

The persistence of corruption is a characteristic of many transitional states with major economic and political changes, but also of many others (Murphy, Shleifer and Vishni, 1993). Based on the previous analysis, we defined the appropriate research model (Figure 1).

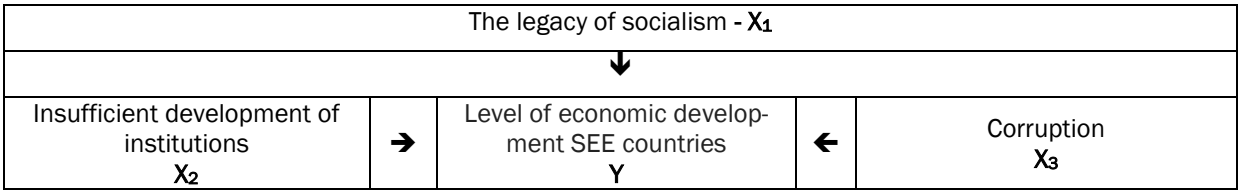

Figure 1. Research model

Source: author's creation

3.2 Data

The data panels were prepared in accordance with database of the World Bank and the National statistics. Linear regression was applied to determine the interdependence of the selected variables.

Data of five countries (Montenegro, Serbia, Bosnia and Herzegovina, North Macedonia, and Albania) were analysed. If we view the data for the five considered countries, the observation unit i = 1,2, … N, where N = 120, and time period t = 1,2, ..., T.

In our research, the dependent variable is GDP per capita. Independent variables are: presence of socialist legacy, level of legal system and level of corruption. Thus, they can be used to analyse the economic impact of legal system on growth in a dynamic perspective.

Primary data were collected on the basis of the following statistics:

(1) Socialistic heritage (path dependence (X1). Source: https://www.heritage.org/index/,

https://freedomhouse.org/,https//freedomhouse.org/sites/defult/2021-02/Country _and_ Territory_Ratings_and_Statuses_FIW1973-2021, scale: 1 – 10, 1 the least presence, 10-the greatest presence.

(2) Undeveloped formal institutions (X_2). It is evaluated on the basis of governance indicators in the world - government effectiveness, Source: www.govindicators.org, scale: 1-most effective, 100 least effective.

(3) Corruption (X_3). It is evaluated based on the Corruption Perception Index - (CPI); source: https://www.transparency.org/, corruption is measured as follows: scale: 1 – the least corruption, 10 – the greatest corruption.

The starting hypothesis is: legal reforms in transition economies are affected by specific restrictive factors, which are specific for SEE countries, and they explained low level of economics effect SEE countries.

4. EMPIRICAL RESULTS AND DISCUSSION

The idea is to determine the functional relationship between the dependent variable (Y): the level of economic development, and the independent variables (X_1, X_2, and X_3). Our goal is to estimate the realistically expected mean value of the dependent variable $\overline{Y}$ based on multiple linear regression. Our task is to determine the coefficients: b_0, b_1, b_2 and b_3, as well as to calculate $\overline{Y}$, using the expression (1):

$$\bar{Y}_{i,t}, = b_{0i} + \sum_{j=i}^{3} b_{i,j}\, x_{ji} \qquad (1)$$

Where is/are:

i – country,
t – time,
$\bar{Y}_{i,t}$ - mean expected value of the dependent variable;
b_{01} – section on the ordinate, determined based on the input data;
b_1, b_2, b_3 – coefficients with independent variables X_1, X_2, X_3, which in fact represent the slopes of the corresponding lines on the abscissa.

The results obtained by analysing the data panels using linear regression and time series for the dependent variable (economic development) and the independent variables are given in Table 3 and Table 4.According to the calculated coefficients (table 4), the following model was set along with the independent variables:

$$\overline{Y_1} = \mathbf{17.845,38 - 202,541 \times X_1 - 20,43 \times X_2 - 1744,42 \times X_3} \qquad (2)$$

The average GDP per capita in observed period is 4.148 $ (SD=2029,32). To decide between fixed or random effects, the Hausman test was done where the null hypothesis is that the model with random effects is in relation to the fixed effects alternative (Greene, 2008). It basically tests whether unique errors are correlated with regressors, the null hypothesis is that they are not. The Hausman test showed that a model of data panel regression analysis with random effects can be applied.

Hausman test results.

Coefficients	(b) Fixed	B) random	(b-B) Difference
X1 –Corruption	-10.49616	- 10.24512	- 0.25104

chi2(1) = (b-B)'[(V_b-V_B)^(-1)](b-B)

Prob>chi2 = 0,0611

In this model, the time variable is taken into account (panel data). Simply put, the results of the assumed model indicate, in the case of the SEE countries, if there is a change in some examined factor in the model in a negative direction, the economic effects decrease, ceteris paribus. It is in accordance with the theoretical claims and the starting hypothesis in this paper that the strengthening of the negative influence of the explanatory factors reduces the economic effects. The model is qualitative and significant, which means that the variables have a significant influence on the dependent variable ($p<0.05$, $R^2=0.685$), as shown in table 3. What is particularly important is the knowledge that these factors explain on a large extent the economic effects, 68% of the variation in economic effects is explained by the studied factors.

Table 3. Summary indicators at the model level

R		*R^2*	*Adjusted R^2*	*Standard error*	*F*
0,827		0,685	0,676	1155	102.90

Source: author's calculation

Table 4. Descriptive model statistics

Variables	Arithmetic mean	Standard deviation	Min	Max	coefficients
Economic development	4148,36	2029,32	717,38	9367,02	17845,82
Socialist legacy	3,2414	0,76750	2,00	6,00	-202,541
Institution (level of achieved changes)	58,8634	15,48	36,78	92,8	-20,43
Level of corruption	6,7862	0,78	5,40	8,40	-1744,42

Source: author's calculation

Observed at the level of the overall model, the p-value (p=0.000) is low, while the F-statistic is high (F=102.90), which clearly indicates the high significance of the set model. The conclusion is that in the observed SEE countries, the selected factors significantly explain the low level of economic development

4.1 Results by countries

The analysis of the linear dependence between the dependent variable and the average values of the independent variables shows the following: the socialist legacy variable has the greatest limiting influence in the case of Bosnia and Herzegovina. Corruption is most prevalent in Albania. The underdevelopment of institutions is the biggest limitation in Bosnia and Herzegovina. In general, the influence of selected factors limiting competition is very pronounced in all countries. Based on statistical modelling, it was shown that the mean expected values of the dependent variables by countries are: Montenegro 5.713$, Serbia 4.761$, Bosnia and Herzegovina 3.605$, Albania 3.100$ and North Macedonia 3.821$.

Table 5. Average values of variables by country

Variables	*Arithmetic mean*				
	Montenegro	*Serbia*	*Bosnia and Herzegovina*	*Albania*	*North Macedonia*
Economic development	5.713,96	4.761,43	3.605,14	3.100,68	3.821,54
Socialist legacy	2,80	2,93	3,89	3,31	3,18
Institution (level of achieved changes)	41,51	58,37	75,32	60,52	55,68
Corruption	6,26	6,93	6,67	7,07	6,90

Source: author's calculation

CONCLUSION

This paper presents a theoretical and methodological framework for quantitative modelling of relationships of law system and economic development in the SEE countries. For modelling purposes we used the following: statistical analysis, linear regression method, and time series analysis.

Functional dependencies between the dependent variable and the independent variable were determined. Based on the conducted analysis, it was concluded that the restrictive effect of selected factors (socialist heritage, institutions, corruption) on economic development in the SEE countries is high. Based on statistical modelling, it is shown that the average expected values of the dependent variable is: Montenegro 5.713$; Serbia 4.761$; Bosnia and Herzegovina 3.605$; Albania 3.100$; North Macedonia 3.821 $. According to the above, the initial hypothesis has been fully verified. The desired level of economic development has not been achieved due to the effects of selected factors.

From the perspective of the economic development in the SEE countries, the findings of this research provide reliable knowledge that selected factors should be considered and its impact as perhaps the most important in the strategy of further transition of the SEE countries. In addition to confirming the initial hypothesis based on theoretical consideration, it has also been proven quantitatively using regression analysis. The model explains as much as 68% of the variation of the dependent variable ($R^2 = 0.685$). If the countries under study strive to higher level of economic development, understanding these factors influencing economic effects is valuable knowledge.

Despite some limitations, this research makes a significant contribution. First, it fills the gap of lack of research in this area. Second, an analysis of influencing factors is given with new findings from the previous research. Third, it provides a theoretical framework for further research.

Further research should be conducted with the focus on deeper research related to independent variables. There are significant internal reserves for improvement in order to achieve a higher level economic effects in the SEE countries. From the perspective of improving economic effects, this research findings support the decision-making on the course of action, that when setting a good development strategy, the selected factors and its impact should be considered extremely important.

We propose the following three important policy implications for moving forward towards good governance reforms in SEE countries in order achieve higher economic effects: the stringent regulatory policies, autonomous judicial decisions, the self-governing rule of law, and timely decisions of the cases are the ultimate solutions to support combat for sustainable development these countries.

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