

"Do not fear to be eccentric in opinion,
for every opinion now accepted was
once eccentric."

Bertrand Russell



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Editorial Foreword

The new developments in the economic and political landscape, at the planetary scale, worry not only political decision-makers but also business people and common people as well. The world is shaken by military conflicts (the Ukraine war and, more recently, Israel's army involvement against Iran), which can lead to bigger ones. Moreover, the economic decisions of the USA, such as differentiated tariffs, are reshaping international trade for many years ahead. And these are just a few examples of world instability.

It is a turbulent environment that requires a new strategic vision at the country and company levels. There is an urgent need to reevaluate how we do business, to prioritise certain industries that have been left aside – such as the defense industry. The EU is actively developing its defense industrial policy to bolster its security and strategic autonomy. European Defence Industrial Strategy (EDIS) and the European Defence Industry Programme (EDIP) focus on boosting joint procurement, strengthening the European Defence Technological and Industrial Base (EDTIB), and supporting the production of ammunition and other critical defense products. Recently, NATO concluded a historic Summit in The Hague on 25 June 2025. Allies decided to invest 5% of GDP in defence – laying the foundation for a strong, united NATO in the years to come. So, a legitimate question arose: Are we preparing for war? Didn't humanity understand a thing from past world wars?

Is the generous concept of Open Science vanishing? How can Open Science be fostered in a world dominated by army conflicts and instability, a lack of trust, and disregard for humankind's well-being? A shift of research interest will develop, from civil to military research, but how society/communities will benefit from it. We just went through the threat of a global pandemic, which affected many industries, people's circulation and human interaction. Are we healed? Not really. Society, local communities have just started to recover, and yet a new challenge has arisen: Should we fear a military conflict in Europe?

Despite all, the scientific community, from all over the world, should remain united for a generous purpose: to develop human knowledge for the benefit of people and society. Therefore, we strongly support publishing cutting-edge research papers as well as practical problem-solving approaches, looking to provide our readers with diverse content.

Our current issue hosts articles coming from all over the world, from Peru to Indonesia, from Northern Europe to South Africa, from Ecuador to South Korea, tackling interesting topics such as: international economic relations, innovation and competitiveness, trust, uncertainty and herd behaviour, cryptocurrency and financial health. We invite our readers to discover the content of these articles and to join our community of authors and reviewers.

Enjoy reading!

Manuela Epure, Deputy Editor-in-Chief

The Impact of International Economic Relations on Logistics Business Development

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Abstract. *The logistics industry accounts for a large part of the country's gross domestic product, so even a small change in the logistics sector can have huge consequences for the country and its economic level. Since the logistics business is an integral part of both national and international economic relations, it is important to study this sector and evaluate the opportunities for effective growth. The subject of this article is the factors influencing the international logistics business. The article aims to identify the factors that would facilitate the development of international economic relations between the Baltic States and South Korea in the logistics sector. After analyzing different factors, to achieve the goal of the article, it was decided to study the influence of customs, excise, minimum wage, changes in fuel prices, and the number of particulate emissions on the development of international economic relations in the logistics sector. Many of these indicators are becoming more and more relevant for the logistics sector, due to the new EU green policy perspective and the transition to renewable energy sources. In this study, it was chosen to conduct independent variable calculations between the Baltic States and South Korea. Using the ANOVA analysis method, the relationship between variables for international economic relations and logistics business development was determined. A test of Cook's measure was performed to find out whether there is an autocorrelation problem between the selected variables. Analyzing the literature, it was found that there is more than one factor that can affect international economic relations and logistics business. It has been proven that governments and international organizations have the strongest influence on the development of international economic relations. The calculations showed that the Baltic exports to South Korea are affected by all variables, i.e. fuel price changes, CO2 emissions, minimum wage changes, excise duties, customs duties and distance between the countries. Taking into account the obtained results, it could be recommended that the Baltic countries continue increasing the minimum wage, as this helps to promote greater consumption of goods, and strengthen political cooperation to reduce the level of tariffs applied by South Korea.*

Keywords: international economic relations, international trade, business development, international cooperation.

JEL Codes: B17, F29

1. Introduction

International cooperation is one of the most important aspects that can not only influence a country's geopolitical situation but also determine its economic level and its economic development. Trade and international economic cooperation are one of the most important components of the economy, with exports and imports accounting for the bulk of a country's gross domestic product in many cases. Logistics, imports, exports and international economic relations and cooperation are inseparable factors and factors which can influence each other closely.

Logistics is one of the most important factors in the economic interconnection of different countries, not only in international political relations but also in the delivery of goods and products from one country to another. It is mostly used to improve international economic relations between trading countries (Approach, 2018). It should be understood that companies that invest in the logistics business not only increase the volume of transportation of goods, but also indirectly increase the volume of production, reduce transportation and production costs (Jereb & Jereb, 2017), help to better control the inventory in the warehouses (Zhang et al., 2018), and often increase the satisfaction of both customers and suppliers, and improve the company's corporate image (Jiang, Zhang, & Meng, 2021).

When it comes to international economic cooperation, it is important to emphasise that it is not limited to the import or export of certain services or goods from one country to another. If an economy were strictly made up of services and goods sold and bought, it could not function smoothly and efficiently (Herfeld, 2021). Therefore, when analysing international economic cooperation and the logistics business, an attempt is made to go beyond the concepts of imports or exports. International economic relations are a rather complicated and sophisticated term that can combine not only certain political situations and political cooperation but also economic cooperation between different countries and between different multinational companies (Watson, 2019). In order to support the expanding economic cooperation, it is necessary to have a certain infrastructure in place that can withstand and cope with the constantly rising costs of transport. In this case, when large-scale trade is carried out between different countries, the logistics sector plays a key role in helping to deal with the complexities of transport from one country to another. It is the logistics business that, by solving transport problems, helps to keep the product still competitive in the importing country (Skender, Zaninović, & Lolić, 2019). Even if there are excellent economic relations between cooperating countries, without the help of the logistics business, this cooperation would in many cases be irrelevant when it would not be possible to transport certain products or raw materials from one country to another (Jiang et al., 2021).

The logistics industry accounts for the largest share of a country's gross domestic product. This is because many companies, or even the country itself, are directly responsible for the growth or decline in gross domestic product by importing certain products, goods or raw materials from foreign countries (Jankovic & Block, 2019). International political and economic relations between trading countries are also important for smooth economic cooperation between different countries, especially in large-scale economic transactions and exchanges (Dimmelmeier, Heussner, Pürckhauer, & Urban, 2017). States often enact certain laws that facilitate logistics business, provide certain subsidies to businesses, or even change customs and excise duties to make international economic cooperation easier. Even the smallest change in the logistics sector can have enormous consequences for a country and its economic level. Such large-scale economic failures are most often and most severely felt by all taxpayers in a country. Any mistakes help to spread distrust of the state and its governance policies (Takács-Györgyb, 2020). State regulation of customs duties, excise duties, and the issuance of certain laws or regulations can often ease the burden on logistics businesses by reducing operating costs. As logistics business is an integral part of both national and international economic relations, it often receives a lot of attention and funding to enable the sector to operate and grow more efficiently (Hong, 2020).

The subject of this article is the factors influencing the international logistics business. The paper aims to identify the factors that would facilitate the development of international economic relations between the Baltic States and South Korea in the logistics sector. The objectives of the study are: 1) to identify the factors influencing international logistics business and international economic relations; 2) to develop a research methodology to determine the influence of the identified factors; 3) to use the developed methodology to

assess the potential for the development of the Baltic-South Korea international economic relations in the logistics sector.

2. Literature review

Most companies involved in the transport of certain products, outputs or raw materials from one country to another are heavily dependent on cooperation between countries. This means that, in the event of certain international disagreements, there is always a risk that trade between cooperating countries may be reduced. This would have direct negative consequences for the logistics sector and companies involved in freight transport. States, through domestic and foreign policy assistance, try to maintain close and close political and economic relations on an ongoing basis. But other international cooperation organisations can help to develop international political and economic relations (Kim & Osgood, 2019).

When developing trade relations, countries often hope to improve international political relations between different countries. In the case of the Baltic States and South Korea, cross-border trade not only improves international economic relations between countries but also brings political benefits. This is due to the steadily increasing Baltic demand for certain products and raw materials, as well as the reduction of protectionist tariffs (Mon & Lim, 2019).

Actions and ideas initiated by the government itself play a key role in expanding international economic relations with foreign countries (Galadari, 2019). State initiative can be understood in many different ways, such as by enacting certain favourable laws, improving international relations with foreign countries, investing in domestic infrastructure, or even introducing certain changes to laws and regulations (Hampton & Adams, 2018). The existence of various elements within a country, such as fuel prices, customs duties, excise duties and many other things, can have a strong influence on international economic relations (Juliet, et al., 2020). The government is responsible for the importance and variation of these elements, and a change in these factors can have a significant impact on these spheres.

The most common and influential factors faced by international business are customs duties, taxes, quotas and, in exceptional cases, embargoes (Traverso & Schiavo, 2020). Customs duties remain one of the most frequently used taxation instruments. This tax is levied on every good, product or article that travels from one country to another (Kozyrin & Yalbulganov, 2019). This means that most products or products that are manufactured outside the country will be subject to customs duty. When analysing the destination of customs duties among the products exported by the Baltic countries to South Korea, it can be observed that the Baltic countries mainly export plastic, chemical and electronic products to South Korea, although the latter has imposed some of the highest customs duties on these particular products. In the case of South Korea, most of the duties are imposed to protect local businesses and the market, as foreign investors often want to penetrate the local market, potentially selling certain goods below market price (Osabuohien, Beecroft, & Efobi, 2018).

Another important tax is excise duty. This tax is one of several indirect taxes which, in most cases, consumers have to pay when they buy a particular good or product (Nguyen, 2019). Excise duties are usually introduced when a country hopes to raise more money for the state budget or is forced by certain regulations, such as the European Union (Futerman, 2020). It is also important to mention that excise duties, unlike customs duties, can be collected using another tax such as VAT. It should be noted that excise duties are often confused with customs duties because of their characteristics (Zoitsas, Valsamidis, & Toptsi, 2019). A customs duty is imposed to tax goods that are exported or imported from one country to another, while an excise duty is imposed by the government on goods that are produced within a country. It is also important to note that, unlike customs duty, excise duty is not levied on a wide variety of different and diverse goods,

products and raw materials (Randelović & Bisić, 2021). Excise duties are mostly applied to a narrow group of products and raw materials, which are usually purchased in large quantities by consumers.

When it comes to international economic relations and the logistics sector, the focus is usually on the import or export of certain goods and products from one country to another. This means that the logistics sector can move certain products from one country to another using certain means of transport. Planes, ships, trains, commercial vehicles and trucks make international economic cooperation easier. It should be pointed out that changes in the price of diesel, petrol or aviation fuel can have a significant impact on the cost of certain services, goods or even raw materials. This means that as fuel becomes more expensive, freight transport services may also become more expensive (Kar & Datta, 2020). This means that the logistics sector can be under a lot of stress from changes in fuel prices, certain political or economic events such as the COVID-19 pandemic and the war in Ukraine (Golovko & Sahin, 2021). Fuel price volatility forces companies to continuously adjust the prices of their services to avoid making a loss (Zaman & Shamsuddin, 2017). Changes in fuel prices make it difficult not only for companies that provide logistics services but also for companies that use these services. Fuel price stability is extremely important for the logistics sector, as it is one of the sectors that consumes the largest quantities of fuel. Vehicles such as ships, tankers, trains, planes and heavy vehicles such as lorries consume very large quantities of fuel (Eydi & Alavi, 2019). Also, the ever-changing political environment, which is increasingly promoting environmental protection, and the reduction of the number of vehicles with internal combustion engines is becoming more and more relevant for the logistics sector, as almost all freight transport vehicles use internal combustion engines. Replacing freight vehicles with less polluting ones would require significant funds, which are not always available for the necessary investments (Abdul et al., 2017). This factor is becoming increasingly important as the EU has adopted new and stringent emission reduction targets which it aims to meet by 2030. For these reasons, the logistics sector is forced to react and adapt (Shee, Miah, & Vass, 2021).

Another important factor that can have a significant impact on international economic relations and the logistics business is the minimum wage. This is a certain minimum amount of money that must be paid to every person who works. The minimum wage is usually approved by the government and by a resolution of a tripartite council. Also, when a national minimum wage is set, it is not uncommon for government authorities to turn to international organisations that provide assistance in determining the appropriate minimum wage. One such organisation is the International Labour Organisation, or ILO for short (Blau, 2019). When it comes to minimum wages, it can often be perceived that they are only relevant for individuals, but in the logistics sector, minimum wages can be interpreted in two ways. This means that it can have both positive and negative effects on the supply and demand for products and services (Himmelreicher, 2020). A change in the minimum wage in the logistics sector can be perceived as negative. This is because the logistics sector usually provides certain services, the cost of which may also increase due to an increase in the minimum wage. This means that a rising minimum wage may reduce the demand for services provided by the logistics sector (Nguyen, 2021). A rising minimum wage may be perceived as a guarantee for the growth of a country's economic level, but the rising cost of logistics services may even discourage foreign investors, where the prices of the services provided would simply be too expensive (Hidayah et al., 2021).

The increased cost of services in the logistics sector not only forces foreign investors to reduce the scope for cooperation but also often encourages them to choose other foreign countries where labour is cheaper. Rising service prices also have a direct impact on product competitiveness. This means that when the cost of transport in the logistics sector rises, the cost of transported products is also affected. This negative impact can make the product uncompetitive in the importing country, which can lead to huge losses for entrepreneurs (Blau, 2019). But when the minimum wage is analysed, its continuous but slow increase can bring not only negative but also positive results. The greatest benefit that the logistics sector experiences

through the minimum wage is through the prism of the individual citizen. This means that a rising minimum wage contributes more money to each family's household. It is a rising minimum wage that can help people save more and put money back into circulation, where consumers can buy more of the goods, products or services they want (Hidayah et al., 2021, Nguyen, 2021). To meet the growing interests of consumers, it is often the case that more products, raw materials or even certain services are imported and exported (Wang & Cheng, 2021). Such increased consumer demands and spending can directly increase the demand for services provided by the logistics sector.

International economic links between cooperating countries are not solely dependent on the logistics sector. International cooperation consists of many individual influencing elements such as culture, politics, economics, social indicators, geographical location and many other important factors (Abdul et al., 2020). International economic cooperation is also often based on the movement of certain goods, raw materials or services from one country to another. It is this movement of services and goods that is supported by the logistics sector, which helps to develop international economic relations. It is the direct and indirect support and assistance provided by governments to businesses and the logistics sector that helps to develop and improve international economic relations (Kozyrin & Yalbulganov, 2019). Every decision taken by a government must be wisely considered and taken when the impact of these decisions can affect every citizen, company or even international economic and political relations. This means that every decision taken by a government can not only help or hurt international economic relations but also have a major impact on the logistics sector (Abdul et al., 2020). The aim of the government is precisely to help expand international cooperation and economic relations and to try to establish new and beneficial relationships with other foreign countries. The stability of international economic relations depends to a large extent on the development strategies and ideas pursued by the government (Melnik et al., 2019). A good example of this would be Lithuania's initiative with Taiwan in the fourth quarter of 2021 and the political disagreements with China. Although Lithuania has established good political relations with Taiwan by opening an official representative office in Vilnius, Lithuania has received some sanctions from China, as well as a lot of pressure, which has not only affecting the country's economy but also its business community working with China, especially in the logistics sector. Maintaining good relations between cooperating countries can not only improve international economic relations between them, but it can also translate into a certain amount of economic growth between the cooperating countries. The development of good infrastructure is an important factor in which a country must necessarily invest to sustain a high level of freight traffic (Hunady & Pisar, 2021). The construction of good quality roads, the opening of new ports and terminals, investment in airports, and the upgrading of railways are mandatory, ongoing investments that help to keep the logistics sector running smoothly, and help it to develop and grow. In order to facilitate the operation of the logistics sector and to improve international economic relations between different countries, attention must also be paid to facilitating and simplifying access to information (Approach, 2018). The government is also responsible for making information available to the public so that the necessary data is available to engage in international trade with foreign companies. Easy access to the necessary information can make it easier for foreign investors to establish new or develop existing international economic relations with a country (Watson, 2019).

The government is not only responsible for developing infrastructure, adopting certain safety and quality regulations, or cooperating with foreign policy, but it is also responsible for approving and issuing certain laws (Crepaz, Hanegraaff, & Salgado, 2021). Depending on the law enacted, certain business sectors may begin to expand, diminish or even completely collapse. Often, the laws that are passed have the greatest impact on international economic relations or different business sectors. This is because, unlike a change in fuel prices or particulate emissions, laws apply to all businesses, regardless of their activities. Therefore, the

adoption of certain laws or their corrections may indirectly affect the logistics sector (Kuenzel, 2017). The adoption of favourable laws helps businesses to operate more efficiently and can help them to reduce costs, find more potential customers, and establish new contacts with foreign countries, which can further help them to develop further international economic relations.

3. Methodology

After analyzing the different factors, it was decided to investigate the impact of customs duties, excise duties, minimum wages, changes in fuel prices and particulate emissions on the development of international economic relations in the logistics sector.

Many of these indicators are becoming increasingly relevant for the logistics sector, due to the EU's new green policy perspective and the shift towards renewable energy sources. For this study, it was chosen to carry out independent variable estimations between the Baltic States and South Korea. In this study, the variables are coded in the following order:

Y - Average Baltic exports to South Korea

X₁ - Change in average tariffs

X₂ - Change in average excise duty rates

X₃ - Diesel price developments

X₄ - Aviation fuel prices

X₅ - Particulate matter emissions from vehicles

X₆ - Baltic average minimum wage

In this study, Y is coded as a fixed variable - Baltic exports to South Korea, while all the remaining indicators X, are independent variables that will be used to examine the association between Y and X. It is also important to mention that when the impact of fuel prices is analyzed, the majority of vehicles use diesel fuel, but this has been separated into aviation fuel as well because the other dominant vehicle in the logistics sector is the aeroplane, which uses aviation fuel rather than diesel. Therefore, it will also be sought to investigate the impact of the change in the price of this fuel.

First, the variance, mean and standard deviation of the variables X and Y are examined. Once the above tests have been carried out, the results can be used to construct a descriptive statistics table. In order to construct this table, one of the first variables to be calculated is the variance (Lu et al., 2020):

$$s^2 = \frac{\sum(x_i - \bar{x})^2}{n-1}, \quad (1)$$

here: s^2 - Sample variance;

x_i - the value of the i-th attribute of X;

$\bar{x}$ - the average of the sample;

n is the sample size.

Secondly, The ANOVA test can help to determine whether there is a relationship between different variables and whether there are statistically significant differences in the means between variables (Rouder et al., 2016). When an ANOVA test is performed, it is necessary to make certain assumptions, such as: that the variables are normally distributed, that the variables are independent, and that the variances of the variables are equal in order to obtain clear and correct results. It is also necessary when an ANOVA analysis is carried

out, to have an appropriate hypothesis which will be used for further calculations (Gurvich & Naumova, 2021). Therefore, the following hypothesis is raised in this case:

$$\begin{cases} H_0: \mu_1 = \mu_2 = \mu_3 \dots = \mu_n \\ H_1: \text{at least two averages differs} \end{cases}$$

The hypothesis contains two different indicators, H_0 and H_1 . In the case of the ANOVA analysis, hypothesis H_0 states that the means of the independent variables selected for this study must all be equal to each other. Otherwise, the H_1 hypothesis, which states that at least two means are different, would take effect, which would reject the H_0 hypothesis.

Also, when an ANOVA analysis is carried out, it is important to calculate all the necessary component variables that influence each other and determine the further results of the study. Therefore, to carry out this study correctly, it is mandatory to calculate the intermediate indicators of the ANOVA in the following order (Gurvich & Naumova, 2021). Due to this order, the following intermediate variables (SSB, SST, MSW, MSB) will be calculated first: sum of squares of the groups, internal sum of squares, and sum of squares to allow for further calculations.

Once all primary and secondary ANOVA variables have been calculated using SPSS, it will be possible to obtain the final result of the analysis, which is expressed by the Fisher criterion (Gurvich & Naumova, 2021):

$$F = \frac{MSB}{MSW}, \quad (2)$$

here: f is the Fisher criterion.

MSB - the internal variance estimates MSW- the external variance estimate

When the Fisher criterion is obtained, the Fisher distribution will also be searched to obtain the final result. Once the Fisher distribution has been obtained, the hypothesis of the ANOVA analysis raised earlier will be applied to test whether it is rejected or not. In the case of an ANOVA analysis, if the Fisher criterion is greater than the Fisher distribution, i.e. $F > F_\alpha$, then the H_0 hypothesis will be rejected, whereas in the opposite case, if $F < F_\alpha$, then the H_0 hypothesis will not be rejected, confirming that at least two means differ (Güven et al., 2019). Also, by conducting ANOVA analysis with the help of "SPSS" program, the P value "Sig." is obtained, which can alternatively help to determine the results of the study, as well as Fisher's criterion. In this study, a utility coefficient of 0.05α will be used. This means that if the P-value obtained is less than 0.05, hypothesis H_0 will be rejected, confirming that there is a significant relationship between Baltic exports and minimum wage, customs duties or other variables.

The ANOVA analysis between the selected independent variables X and the fixed variable Y will be followed by a correlation test between the independent variables X_1, X_2, X_3, X_4, X_5 and X_6 and the fixed variable Baltic exports. The correlation coefficient is calculated according to the formula (Ali & Al-Hameed, 2022):

$$r_{xy} = \frac{n \sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n \sum x_i^2 - (\sum x_i)^2} \sqrt{n \sum y_i^2 - (\sum y_i)^2}}, \quad (3)$$

here: r is the correlation coefficient;

x_i - independent variable;

y_i - dependent variable;

n - sample size.

Once the correlation coefficient has been established, the aim will be to determine its strength and directionality. However, to establish a more precise correlation between Baltic exports and the identified variables, Table 1 below will be taken into account.

Table 1: Correlation coefficient strength table

Correlation coefficient	[0 - 0,3]	[0,31 - 0,7]	[0,71 - 0,9]	[0,9 - 1]
Contact	Weak	Medium	Strong	Very strong

(Source: Ali & Al-Hameed, 2022)

Finally, once the ANOVA and correlation analyses have been performed, further calculations will be carried out to perform the last tests, i.e., pairwise regression. When the regression test is carried out, the corresponding equation is set up (see Formula 4) (Korkmaz, 2021). This equation will be constructed to assess the potential relationship between Baltic exports and the variables selected for the study, such as excise duties, distance between countries, or other variables. Once the relationship between the selected variables in the regression study is established, the corresponding regression curve formula is constructed:

$$y = a_x + b, \quad (4)$$

here: a - coefficient at x;

b - free member.

In addition, a Cook's measure test was carried out to investigate whether there is an autocorrelation problem between the selected variables. Autocorrelation can occur between the variables selected for the study when there is an undesirable correlation between the errors (Glu, 2019). To investigate whether there is a correlation between unwanted errors, the Durbin-Watson test will be performed.

4. Research results and discussion

This study aims to determine the impact of the independent variables X on the fixed variable Y. First, a descriptive statistics table is constructed (see Table 2):

Table 2: Descriptive statistics table for Y and X variables

	N	Average	Standard deviation	95% confidence interval for the mean		Min.	Max.
				Lower limit	Upper limit		
Y	31	28,6152	26,61363	18,8532	38,3771	1,93	79,97
X ₁ plastics	31	9,4798	4,39787	7,8667	11,0930	4,85	19,10
X ₁ Chemicals	31	4,3089	2,35641	3,4446	5,1732	1,41	11,13
X ₁ Electronics	31	4,7949	2,79800	3,7686	5,8213	2,57	15,21
X ₂	31	0,5052	0,04739	0,4878	0,5225	0,39	0,58
X ₃	31	0,8890	0,33954	0,7645	1,0136	0,42	1,34
X ₄	31	0,3268	0,14925	0,2720	0,3815	0,15	0,64
X ₅	31	1032,1290	78,13354	1003,4694	1060,7886	862,00	1137,00
X ₆	31	192,6232	151,71077	136,9753	248,2712	14,67	540,33
Total	279	141,5191	325,81859	103,1204	179,9178	0,15	1137,00

(Source: compiled by authors)

From the resulting table, it can be seen that the descriptive statistics of the identified independent variables X and the fixed variable Y were calculated. For this and subsequent analyses based on the

independent variables X and Y, it is important to note that the data for X_1 , i.e., the average customs duties for the Asian region, have been disaggregated in more detail to identify a more precise impact of the variables. This has been done because, according to the official, most recent Baltic export data, the Baltic countries mainly export to Asia, including South Korea, certain plastic products, chemical raw materials and certain electronics. For this reason, it was chosen to investigate in more detail the customs duties on Baltic exports from an Asian perspective to obtain more accurate results for this study, including descriptive statistics for Y and X variables. In Table 2, it can be seen that for the Y constant variable, the average export over 30 years amounts to about 28.6 million euros, while for $X_{1_plastics}$, i.e., the average duty granted by the Asian region to the Baltics for plastics products amounts to about 9.47%, the average duty on chemical products amounts to about 4.3%, and the average duty on electrical goods amounts to over 4.79%. Also, the average for X_2 is about 0.5 euro, the average for X_3 is 0.88 euro, while for X_4 it is only about 0.32 euro, the average CO2 emission is about 1032 million tons per year, and the average minimum wage is about 192.6 euro.

The standard deviation of each variable - "S" - is also calculated. The standard deviation of the Y variable is 26.6, the S for the independent variable $X_{1_Plastics}$ is 4.39, while $X_{1_Chemistry}$ is about 2.35 and $X_{1_Electronics}$ is about 2.79. The standard deviation of the variable X_2 is 0.04, the standard deviation of X_3 is 0.33, the standard deviation of X_4 is 0.14, the standard deviation of CO2 emissions is 78.13 and the standard deviation of X_6 is about 151.71. Once the standard deviation has been calculated, the variance of each variable is calculated. Using the data from the descriptive statistics table, the variance of the constant variable is found to be 707.56. The variances of the independent variables X are also calculated in the same way, where the variance of $X_{1_plastics}$ is around 19.27, the variance of $X_{1_Chemistry}$ is around 5.52 and the variance of $X_{1_Electronics}$ is over 7.78, The variance of the variable X_2 is also calculated to be 0.0016, the variance of X_3 is 0.1089, the variance of X_4 is 0.0196, the variance of the variable X_5 for CO2 emissions is as high as 6104.29, while the variance of the average minimum wage in the Baltic countries is as high as 23015.92. From the above table (see Table 2), it can also be seen that the total variance of the independent variables X and the fixed variable Y is calculated in the same order, which is as high as 106152.15.

To see whether there were statistically significant differences between the means of the identified variables X and Y, an ANOVA test was performed and the corresponding table was obtained (see Table 3):

Table 3: ANOVA analysis between Baltic exports to South Korea and all independent X variables

	Square amounts	Degree of freedom	Square of medians	Criterion F	P value
Sum of squares of groups	28615991,624	8	3576998,953	1078,053	,000
sum of squares	895864,614	270	3318,017		
the total sum of squares	29511856,238	278			

(Source: compiled by authors)

Looking at the table (see Table 3), it can be seen that the primary indicators such as "SSB", which is over 286,151,991.62, were calculated first. The inner sum of squares was also calculated, which is only 895864.61; and the total sum of squares was calculated, i.e., "SST", which is over 29511856.23. Once the initial ANOVA indicators have been calculated, it is possible to obtain the following 'MSW' and 'MSB' indicators, as the results of the latter are needed to calculate these indicators. Looking at the results obtained from the ANOVA analysis table, it can be seen that the variance estimate for 'MSW' is around 3576998,95 whereas for 'MSB', the internal variance estimate is only 3318,01.

Once all the intermediate ANOVA variables have been calculated, the Fisher criterion is obtained. This is an indicator that will help to determine whether there is a relationship between the selected variables and

whether there are statistically significant differences between the means of the variables. It can be seen from the table below (see Table 3) that the 'MSW' and 'MSB' indicators are used to obtain a Fisher criterion of 1078,05. Once the Fisher criterion is calculated, the Fisher distribution is also calculated in order to obtain the final results of the ANOVA analysis. The Fisher distribution is found in the following order:

$$F_{0,05}(8 - 1; 279 - 8) = F_{0,05}(7; 271) \approx 2,010$$

When all the data from the ANOVA analysis are available and the Fisher criterion and Fisher distribution are taken into account, hypothesis H_0 is rejected. This helps to confirm hypothesis H_1 when at least two means are different. This can be said because, given the survey data, $F > F_{0,05}$, i.e., $1078.05 > 2.010$.

The study shows that there is a relationship between Baltic exports and selected variables such as minimum wage, customs duties or excise duties and that there are statistically significant differences between the means of the variables.

The correlation between the selected variables is then examined. This correlation test and the correlation coefficient r_{xy} itself help to determine the strength of the relationship between the selected variables. In this case, the correlation test will be carried out between the constant variable Y and the independent variables $X_{1_Plastics}$, $X_{1_Chemistry}$, $X_{1_Electronics}$, X_2 , X_3 , X_4 , X_5 and X_6 . The following correlation table of the variables was obtained (see Table 4):

Table 4: Table of correlation coefficients between selected Y and X variables

		$X_{1_plastics}$	$X_{1_Chemistry}$	$X_{1_Electronics}$	X_2	X_3	X_4	X_5	X_6
Baltic exports to South Korea	Correlation coefficient	-0,721	-0,415	-0,581	0,785	0,668	0,646	0,487	0,912
	P value	0,000	0,020	0,001	0,000	0,000	0,000	0,005	0,000
	N	31	31	31	31	31	31	31	31

(Source: compiled by authors)

First of all, from the correlation coefficients table (see Table 4), we can see the most important indicator, the P-value, which symbolizes that all variables are statistically significant for this study, as all variables have P-values less than the significance level of 0.05. When the significance of the variables has been checked, it can be seen that the data falls into two groups. One of these groups is customs duties, where customs duties decrease as Baltic exports increase. Applying the assumption, it can be argued that increasing Baltic exports to South Korea reduces existing protectionist tariffs. Also, due to decreasing tariffs, exports increase year by year. Since all the variables in the above table have a relationship with Baltic exports, the hypothesis is that hypothesis H_0 is rejected and hypothesis H_1 is accepted, since no variable can satisfy the condition of hypothesis H_0 - " $\rho = 0$ ".

Next, a pairwise and a polynomial regression will be carried out. However, it is important to note that before running both pairwise and polynomial regression tests, it is important to perform other important intermediate calculations that will help to identify whether there are unwanted outliers in the data and whether there are unwanted correlations between variables. For this reason, an outlier identification test is first performed. In this case, the Cook's measure test can help to identify whether unwanted outliers exist between the fixed variable Y and the independent variables $X_{1_plastic}$, $X_{1_Chemistry}$, $X_{1_Electronics}$, X_2 , X_3 , X_4 , X_5 and X_6 which could distort the final results of the pairwise and multivariate regression analysis. In this case, the Cook's measure test produced corresponding results which show that there are no outliers among the selected variables, as there are no Cook's measure coefficients that exceed 1.

When the Cook's test is performed, the multicollinearity test is also performed. This test will be carried out until there is no longer any independent variable X that could cause a multicollinearity problem. It is also important to note that when there were several variables at the same time that caused a multicollinearity

problem, only one was removed and the test was repeated. The variable with the highest VIF was removed first, the variable $X_{1_plastic}$. After the second multicollinearity table was constructed, it was decided to remove the variable X_3 . The third multicollinearity table was constructed by removing the variable X_2 . After removing the variable X_2 , the last multicollinearity table was obtained (see Table 5):

Table 5: Fourth table of multicollinearity results for Y and X variables

Non-standardised coefficients		Standardised coefficients	The meaning of Student's divider	P value	Collinearity statistics		
Regressors	Standard error	Beta			Tolerance	VIF	
Y	87,889	54,729		1,606	0,121		
$X_{1_Chemistry}$	-1,074	1,372	-0,095	-0,783	0,441	0,397	2,520
$X_{1_Electronics}$	-0,740	1,321	-0,078	-0,561	0,580	0,303	3,296
X_4	15,291	18,267	0,086	0,837	0,410	0,558	1,793
X_5	-0,084	0,048	-0,247	-1,746	0,093	0,291	3,432
X_6	0,160	0,021	0,914	7,687	0,000	0,414	2,418

(Source: compiled by authors)

When the last independent variable X_2 , i.e., excise duty on diesel fuel, is removed, it can be seen that there is no longer any independent variable X that would cause an undesirable relationship with Baltic exports to South Korea (see Table 5). This is because there is no longer any variable that satisfies the condition of $VIF \geq 4$. Therefore, from the multicollinearity table, it can be seen that only five independent variables will be used in the pairwise and multicollinear regressions, which are $X_{1_Chemistry}$, $X_{1_Electronics}$, X_4 , X_5 and X_6 .

Looking first at Table 4, it can be seen that the first statistically significant independent variable X that correlates with the fixed variable Y is $X_{1_Chemistry}$. Taking this into account and the last multicollinearity table (see Table 5), the first step is to establish the relationship between Baltic exports to South Korea and the duty imposed by the Asian region on chemical products (see Table 6):

Table 6: Pairwise correlation between Baltic exports to South Korea and the Asian region's duty on Baltic chemical products

Model	Correlation coefficient	Coefficient of determination	Adjusted coefficient of determination	Durbin Watson test
1	0,415	0,172	0,144	0,201

(Source: compiled by authors)

Before a pairwise regression is performed, a pairwise correlation table is created. This table allows us to see the coefficient of determination, which allows us to decide whether it is possible to set up a pairwise or a polynomial regression equation. In this case, the coefficient of determination - R^2 - is 0,17. According to the rule - $R^2 > 0.20$, it can be said that in this case a pairwise regression cannot be constructed because $0.17 < 0.2$.

If the pairwise regression equation between the independent variable $X_{1_Chemistry}$ and Baltic exports to South Korea is not possible, the next regression will be performed between the variable $X_{1_Electronics}$ and the variable Y. As in the first pairwise regression, a pairwise correlation table is first constructed (see Table 7):

Table 7: Pairwise correlation between Baltic exports to South Korea and the Asian region's duty on electronics products for the Baltic States

Model	Correlation coefficient	Coefficient of determination	Adjusted coefficient of determination	Durbin Watson test
1	0,581	0,337	0,315	0,434

(Source: compiled by authors)

When a pairwise correlation table was constructed between the constant variable Y and the independent variable X1_Electronics, it can be seen that in this case, it is possible to construct a pairwise regression equation, because the coefficient of determination reaches around 0.33 when looking at the constructed model. This model can be used because it satisfies the condition $R^2 > 0,20$. Also looking at the table, it can be seen that the tariffs imposed by the Asian region on electronic products explained about 33% of Baltic exports to South Korea. When the coefficient of determination meets the conditions of the study, it is possible to construct a table of pairwise regression coefficients between the selected variables (see Table 8):

Table 8: Coefficient values between Baltic exports to South Korea and the Asian region's duty on electronics products for the Baltic States

Model		Non-standardised coefficients B	P - value
1	Baltic exports to South Korea	55,106	0,000
	X ₁ _Electronics	-5,525	0,001

(Source: compiled by authors)

From the table of paired regression coefficients (see Table 8), it can be seen that the P-values of the variables are below the significance level of 0.05. Taking this criterion into account, a pairwise regression equation is constructed between the fixed variable Y and the independent variable X₁_Electronics:

$$y = 55,1 - 5,525x$$

This resulting pairwise regression equation can accurately reflect the impact of the Asian region's duty on electronics products on Baltic exports to South Korea. In this case, the Baltic countries can save as much as €44.3 million as a result of the decreasing tariffs on electronics products. This is because, in 2020, the duty rate was only about 1.35%. According to the above formula, if customs duties were reduced to 1%, the Baltic countries could save as much as €46.4 million on exports to South Korea. On the other hand, the Baltic countries would start to incur losses when exporting to South Korea if the duty rate for electronic goods exceeds 10%. This means that the Baltic countries would start generating a loss of 140 thousand euros per year if a 10% tariff rate were imposed. Therefore, from the equation and the trend of the data, it can be assumed and argued that the decreasing customs duties help the Baltic countries to collect more and more revenue from exports to South Korea.

A second pairwise regression equation between the fixed variable Y and the independent variable X is then constructed X₄. First, a pairwise correlation table is constructed between the selected variables (see Table 9):

Table 9: Pairwise correlation between Baltic exports to South Korea and the average price of aviation fuel in Europe

Model	Correlation coefficient	Coefficient of determination	Adjusted coefficient of determination	Durbin Watson test
1	0,646	0,417	0,397	0,314

(Source: compiled by authors)

When the second pairwise correlation table between Baltic exports and the average price of aviation fuel in Europe was constructed, it can be seen that this model can also be used to construct a pairwise regression coefficient table, as the coefficient of determination is greater than 0.2. It can also be seen from the above table (see Table 9) that the average price of aviation fuel in Europe explains as much as 41.7% of Baltic exports to South Korea. Taking into account the data obtained, a pairwise regression coefficients table was also constructed (see Table 10):

Table 10: Coefficient values between Baltic exports to South Korea and the average price of aviation fuel in Europe

Model		Non-standardised coefficients B	P - value
1	Baltic exports to South Korea	-9,016	0,328
	X ₄	115,159	0,000

(Source: compiled by authors)

From the coefficient table, it can be seen that the value of the independent variable X₄ P is less than the 0.05 significance level. This allows us to construct a pairwise regression equation between Baltic exports to South Korea and the average price of aviation fuel in Europe:

$$y = -9,01 + 115,159x$$

The resulting paired regression equation shows a significant relationship between the average price of aviation fuel in Europe and Baltic exports to South Korea. The equation shows that, based on data for 2020, when the price of a liter of aviation fuel was €0.42, the Baltic countries earned an additional €39.6 million from exports to South Korea. While this increase shows the benefits to be gained, rising fuel prices may slow down export growth. This is because the cost of fuel and transport costs are included in the cost of goods or raw materials. In this case, where the distance between the countries under consideration is large, even the slightest change in fuel prices could have a significant impact on exports to South Korea, potentially making the product less competitive. If the price of fuel were to rise to €0.6 per liter, the Baltic countries could potentially earn an additional €56.3 million, but this would also increase the likelihood that the competitiveness of the goods or raw materials would be reduced in South Korea by reducing the volume of imports.

A third pairwise correlation coefficient table is then constructed between the fixed variable Y and the particulate matter emissions of vehicles (see Table 11):

Table 11: Pairwise correlation between Baltic exports to South Korea and vehicle particulate matter emissions

Model	Correlation coefficient	Coefficient of determination	Adjusted coefficient of determination	Durbin Watson test
1	0,487	0,237	0,211	0,191

(Source: compiled by authors)

From the resulting pairwise correlation table between the fixed variable Y and the independent variable X₅, it can be seen that this model is suitable for use in the development of a pairwise regression equation, since R² > 0.20. In this case, vehicle particulate matter emissions explained only about 23% of Baltic exports to South Korea. As the coefficient of determination allows, a table of paired regression coefficients is also constructed (see Table 12):

Table 12: Coefficient values between Baltic exports to South Korea and vehicle particulate matter emissions

Model		Non-standardized coefficients B	P - value
1	Baltic exports to South Korea	-142,515	0,019
	Co2 emissions (X) ₅	0,166	0,005

(Source: compiled by authors)

From the table above (see Table 12) it can be seen that the X_5 variable is still less than and equal to the significance level of 0.05. Taking this condition into account, a third pairwise regression equation is nevertheless developed:

$$y = -142,51x + 0,166$$

The third pairwise regression equation shows that rising carbon dioxide emissions contribute, albeit weakly, to the growth of Baltic exports to South Korea. This means that in 2020, when the EU emitted over 1082 million tons of CO₂, it helped generate an additional €34.7 million in Baltic exports. On the other hand, while reducing CO₂ emissions would be good for the ecology and would help the EU to meet its new targets for protecting nature and reducing pollution more quickly, if emissions were to fall to 750 million tons per year, the Baltic exports would lose over €16.7 million. Although rising CO₂ emissions have a positive impact on exports, looking at the results from an ecological rather than an economic point of view and from the perspective of the logistics sector, especially in the long term, this could cause significant difficulties for the logistics sector. The EU is determined to drastically reduce CO₂ emissions by 2030-2040. Many vehicle manufacturers are also determined to stop producing vehicles that use internal combustion engines by 2030-2040. This has the potential to become a huge problem and burden for the logistics sector, which will have to switch to less polluting or electric trucks, potentially requiring huge investments.

Finally, a final table of the pairwise regression coefficients between the fixed variable Y and the independent variable X_6 is produced (see Table 13):

Table 13: Pairwise correlation between Baltic exports to South Korea and the Baltic average minimum wage

Model	Correlation coefficient	Coefficient of determination	Adjusted coefficient of determination	Durbin Watson test
1	0,912	0,832	0,826	0,808

(Source: compiled by authors)

From these data, it is also possible to construct a table of paired regression coefficients, as the coefficient of determination is $0.83 > 0.2$. This coefficient of determination also suggests that the average Baltic minimum wage explains 83.2% of Baltic exports to South Korea. Taking these data into account, a final pairwise regression coefficients table is constructed (see Table 14):

Table 14: Coefficient values between Baltic exports to South Korea and the Baltic average minimum wage

Model		Non-standardised coefficients, B	P - value
1	Baltic exports to South Korea	-2,207	0,503
	Baltic average minimum wage X_6	0,160	0,000

(Source: compiled by authors)

The value of the independent variable X_6 P is 0, which allows the last - fourth - pairwise regression equation to be created:

$$y = -2,207x + 0,16$$

From the last pairwise regression equation, it is possible to determine how the Baltic minimum wage affects Baltic exports to South Korea. According to the data for 2020, when the average minimum wage in the Baltics was around €540, the increase in the Baltic minimum wage contributed the most to the increase in Baltic exports to South Korea, with an increase of around €79 million. This large increase can also be explained by the determination coefficient obtained, which explains 83.2% of Baltic exports to South Korea. If the average minimum wage in the Baltic States were to rise to €700, this would potentially raise an additional €103 million for the Baltic States. A rising minimum wage can encourage consumers to spend

more and put money back into circulation. Increasing the affordability of goods and services may encourage entrepreneurs to participate more intensively in international trade by increasing exports and imports of certain products to meet the growing consumer demand for services and goods. Therefore, the results suggest that the minimum wage is the strongest contributor to the growth of Baltic exports to South Korea.

5. Conclusions

The literature review has identified a number of factors that can affect international economic relations and the logistics business. Governments and international organizations are the strongest influences on the development of international economic relations. The World Trade Organization assists countries in developing international economic relations and logistics business, monitors the smooth flow of international trade exchanges and monitors national trade policies. The government can enact laws favorable to the logistics sector and introduce regulations on the quality of goods, which can help attract more foreign investors. Also, low fluctuations in fuel prices, lower excise duties, increases in the minimum wage, and changes in particulate matter emissions can help to expand international economic links. Decreasing protectionist tariffs in South Korea are also a strong contributor to increasing Baltic exports to South Korea.

The calculations showed that all variables, i.e. fuel price changes, CO₂ emissions, minimum wage changes, excise duties, customs duties and distance between countries have an impact on Baltic exports to South Korea. This can be said because the ANOVA test showed that the P-value is $< 0.05\alpha$. It was also found that decreasing customs duties in the Asian region helped to generate more profits for the Baltic countries, with customs duties of 1.35% saving as much as 44.3 million Euros. On the other hand, rising CO₂ emissions, thanks to the logistics sector, generate €34.5 million more from exports. Assuming this is the case, this is due to the increasing use of commercial vehicles. Although this helps the State to raise more money from exports, in the long term it may have a negative impact on the logistics sector due to new EU environmental laws and targets.

It was also found that the rising minimum wage helps explain 83.2% of all Baltic exports to South Korea. Minimum wage increases contribute to an additional €79 million in revenue. Applying the assumption, it can be argued that a rising minimum wage encourages consumers to be more active in spending money to meet their needs, which can lead to increased exports and imports of goods between different countries, improving international economic relations between the Baltic States and South Korea. The rising price of aviation fuel, which explains as much as 41.7% of exports, contributes to an additional €39.6 million in Baltic exports. However, this may have a negative impact on the competitiveness of the commodity, as the rising cost of fuel is normally included in the cost of the commodity.

In light of the results, it could be recommended that the Baltic countries should continue to raise the minimum wage, which helps to promote greater consumption of goods, and through political cooperation, reduce the level of tariffs imposed by South Korea so that international economic ties between the cooperating countries can continue to expand, as the distance between the countries cannot be reduced.

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Does Innovation really enhance National Competitiveness in Developing countries? Evidence from Asia

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Abstract. *Enhancing national competitiveness is an important issue for supporting economies in the context of globalization. Although some empirical studies done in developed countries, the link between innovation and national competitiveness in developing countries has not received enough academic attention yet. To fill this empirical research gap, this study aims to investigate the impact of innovation on national competitiveness in Asia. We use the Generalized Double Diamond (GDD) approach to establish the theoretical framework of the study. The panel data estimations including Pooled OLS, Fixed effects, Random effects, and Driscoll-Kraay standard error are employed to calculate the effects of innovation on national competitiveness with a dataset covering 21 Asian developing economies from 2011 to 2022. The results confirm that innovation positively affects the competitiveness of developing countries. Besides, other domestic elements including tax, infrastructure, and institutions have positive effects on national competitiveness. On the other hand, in international factors, export helps increase national competitiveness but foreign direct investment can harm the competition of countries. This study may be the first one which analyzes the impact of innovation on the competitiveness of developing countries in Asia. The results provide valuable information for policymakers to handle innovation like a long-term developing strategy for enhancing national competitiveness in the future. Besides, governments should evaluate their competitive position and identify critical technology areas for improvement in national competitiveness.*

Keywords: Innovation, research and development, national competitiveness, development strategy, technology development.

JEL Codes: F15, F41, F63

1. Introduction

The competitiveness of economies in the context of increasingly rapid globalization has become a global research topic (Rusu & Roman, 2018; Aiginger, 2021; Simionescu et al., 2021). Besides, increasing competitiveness based on innovation is receiving huge attention not only from academics but also from policymakers in many countries (Powell & Snellman, 2004; Bae & Yoo, 2015). In the era of the Fourth Industrial Revolution, countries must constantly develop high technologies and increase investment in critical areas to improve their competitiveness (Dima et al., 2018). Under the explosion of the revolution in information technology and the internet, countries have become increasingly closely linked, and the globalization process has helped accelerate the technology transfer process. As a result of the Fourth Industrial Revolution, innovation has facilitated access to domestic and international markets, significantly impacting national competitiveness (Szeles & Simionescu, 2020).

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Therefore, to improve the country's current position, it is necessary to consider development and innovation to build a strong and sustainable economy (Carayannis & Grigoroudis, 2014).

Today's main concern of policymakers in developed and developing countries is national competitiveness and how to enhance it (Rusu & Roman, 2018). In the context of an increasingly interconnected and market-sharing world, countries compete to improve innovation capacity to achieve growth and economic efficiency of the economy (Diebolt & Hippe, 2019). Competition and innovation are essential for countries to build innovation capacity because they provide viable pathways to accelerate technological catch-up and sustain productivity and capability growth competition (Khyareh & Rostami, 2022). The innovation index chart can help developing economies keep pace with global innovation trends, as it is the basis for providing the overall innovation performance of countries (Wonglimpiyarat, 2010). The innovation index can also help assess what countries should do to promote innovation, leading to economic growth and employment.

Furthermore, the innovation index highlights policy challenges – national policies for building new national innovation strategies. Innovation is essential to sustainable competitiveness and strengthening the knowledge economy, a pillar of knowledge progress and social, environmental, and economic efficiency. In the literature, there is no unified approach to national competitiveness; many studies have dealt with this topic and come up with different opinions; for example, Krugman (1995) equates competitiveness with productivity. This article mainly applies an innovation-based perspective to understand improving national competitiveness and, thereby, countries gaining competitive advantage. External technological knowledge can be spread across firms, regions, and countries through various transmission mechanisms (Pietrubelli, 1996). Additionally, knowledge is embodied in technology, such as patents, paperwork, and information from the market and the organization's management (Spender, 1996). However, to date, there has been little research on whether the interaction between internal and external knowledge facilitates this process.

To better understand the trends in catch-up development across countries, it would be interesting to examine whether there is a promotion or antagonism between internal technological innovation capacity and the absorption of outside knowledge. Furthermore, we assume that developing and emerging countries are actors in global competition. Based on previous discussions, there is some concern that the current competition model in developing and emerging economies needs to be better for the path to prosperity in emerging economies, such as helping Join the development team. The general problem is that a fast-growing country will fall into the middle-income trap and get stuck at that income level (Awdeh & Hamadi, 2018; Lee, 2020); the middle-income trap is the biggest challenge when it comes to the situation where a country has a middle income (Tung & Hoang, 2024). Therefore, improving the competitiveness of these countries is a complex problem, which currently has few studies to help clarify, especially in the global innovation trend.

This study makes several contributions to disciplinary theories. Firstly, through empirical research in 21 developing and emerging Asian countries in 2011-2022, the role of innovation as an essential factor for improving capacity in national competition will be clarified. This finding is a significant contribution to the current literature. Although innovation is a critical topic that has been discussed recently when some studies

considered this factor's impact on the firm's competitiveness (at the microeconomics level), there is a demand for clarifying this effect at the macroeconomics aspect, for example, innovation and national competitiveness. In the case of Asian developing countries, the link between innovation and national competitiveness is a real empirical research gap and our study would fill this research gap. Second, the econometric model not only considers the effect of innovation, but also separates the variables into two groups: internal and external factors. The result shows that the interaction between internal factors positively influences national competitiveness. Regarding external factors, we have provided an essential discovery that the international environment also plays a significant role in promoting competition, but foreign direct investment is an issue that creates obstacles. Finally, some implications should help to improve the quality of related policies in the future.

The paper is structured in 5 parts. Section 2 presents an overview of the related studies. The econometric model, methodology, and data source are presented in Section 3. Next, Section 4 presents the estimative results and discussion. Finally, Section 5 is the conclusion as well as provides policy implications.

2. Literature Review

Innovation is now a progressive trend in a lot of countries in integrating the world economy (Galindo & Méndez, 2014). The impact of innovation on economic growth positively enhances the competitiveness of countries (Bae & Yoo, 2015; Kaynak et al., 2017). National competitiveness is achieved by producing the highest significant quantity of goods and services that can successfully compete worldwide (Krugman, 1994). The competitiveness of an economy helps us to understand how the products of a country can have a high demand in the international market (Farinha et al., 2018).

National strategies for promoting innovation should appropriate policies to enhance the business environment and economic freedom and create a knowledge economy based on advanced technologies. In recent decades, many small enterprises have appeared in the service industry and have focused on innovative elements that have the potential to promote vigorous competitiveness and enhance the business's position (Amorós & Bosma, 2014). The macroeconomic environment is the driving force to promote national competitiveness, however, the competitiveness of a country will depend on the level of economic development of that country because there is a vast difference in competitiveness between countries (Liu, 2017). A stable economic environment is not necessarily the only factor that makes a country develop, but an unstable macroeconomic environment will be a great danger to a country (Khyareh, 2021).

Macroeconomic factors can influence competitiveness, and include internal factors and international factors that can increase or weaken the competitiveness of a country (Galindo & Mendez, 2014). In the current trend, economies, especially in developing countries, must also improve the domestic economic environment by enhancing the knowledge base in economic fields such as technical innovation, research, and development (Dima, 2018). Powell and Snellman (2004) also clarified this relationship through the knowledge economy that would give the country more robust economic development than economies dependent on natural resources.

Nowadays, economic development based on knowledge and innovation is no longer the exclusive playground of high-income developed countries. Developing countries are also constantly improving institutions and innovative policies to improve competitiveness in the international market (Khyareh, 2021). Innovation has become decisive in creating a stable and growing knowledge economy. From here, it is possible to build solid foundations such as improving professional knowledge, increasing labor productivity and creating jobs, reducing unemployment, and avoiding waste of resources. At the corporate level, investment in research and development (R&D) and innovation helps companies build new business models, new products, new services, new production processes, and new management styles. Thereby, they change the domestic microeconomic environment in a positive direction (Fernandes & Ferreira, 2013). When countries innovate, they create smart economies with competitive advantages and enhance national influences (Koc & Ceylan, 2007). Businesses are the pillars of the national economy, and these production capabilities demonstrate the ability to expand markets and increase product competitive advantage and profits (Hu & Hsu, 2008; Kaminski et al., 2008). As countries increase integration, international competition becomes increasingly fierce to improve national position, therefore, innovation is vital. Therefore, innovation will be a critical factor in improving national competitiveness and sustainable economic development based on knowledge (Kaynak et al., 2017).

Marčeta and Bojnec (2020) analyzed the key elements of the Global Competitiveness Index (GCI) in 28 EU countries. The study investigated the relationship between research in universities-industries and cluster development on competitiveness. The result indicates that innovation and workforce training as essential drivers of competitiveness in the EU region. On the other hand, countries with economic policies and strategies based on technological innovation not only have a considerable advantage and sustainable competitive advantage in terms of global competitiveness but also growth and development of the economy leads to prosperity and national welfare (Şener & Sarıdoğan, 2011). A country's competitiveness can increase when there are policies to build a flexible modern macroeconomic environment based on a foundation of innovation and technological development (Carayannis & Grigoroudis, 2014; Voinescu & Moisoiu, 2015; Ciocanel & Pavalescu, 2015; Dima et al., 2018).

When considering external factors that can impact the competitiveness of an economy, first of all, global openness through trade, investment, and labor mobility is essential for improving competitiveness (World Economic Forum, 2015). Fontagné and Pajot (1997) clarified the relationship between foreign direct investment (FDI), international trade, and national competitiveness. However, FDI has both positive and negative sides, and this external factor can be a factor that will overwhelm domestic enterprises. With substantial financial resources and rich experiences, multinational corporations will be a direct competitor to domestic enterprises and host countries' industries, weakening national competitiveness (Law et al., 2018).

Besides, FDI plays a positive role when the country has a certain level of development, good institutions, and modern infrastructure systems (Meyer & Sinani, 2009; Kim & Li, 2014). Sekuloska (2015) investigated the different FDI flows between two European regions by analyzing the influence of innovation (R&D) in the business sector. The findings reflect that stimulating innovation through technology transfer depends on the quality of FDI and R&D activities. The differences in regions in R&D levels are due to differences in the quantity and quality of FDI in those regions.

Other macro factors have an external impact on the domestic economy, such as international trade. As international trade expands, a country has access to global resources and expands its consumption markets, improving efficiency and increasing economic benefits (Bloom et al., 2016). When a country receives more international investments, it can learn innovative educational experiences, which leads to a better economy (Fetahi-Vehapi et al., 2015). The more regulations an economy has on the labor market, the lower the unemployment rate, and the labor market meet the needs of international investors, there are reasonable business regulations, the costs will be decreased, and competitiveness will increase (Krammer, 2009; Diebolt & Hippe, 2019; Rodríguez-Pose & Wilkie, 2019).

In summary, previous studies highlighted the role of innovation in improving competitiveness, but most of them were at the microeconomics level, which focused on competitiveness in firms. Therefore, this topic is rarely studied at the macroeconomics level. Besides, previous studies have been done based on old databases that did not keep up with the trends of the world economy. Following these studies, the policies may need to be more accurate. Furthermore, there needs to be more evidence of the relationship between innovation and national competitiveness in Asia, which has booming economies. In this region, the effects of internal factors, and international factors on national competitiveness are undiscovered.

3. Research Objectives and Methodology

This study used a panel database covering the period of 2011–2022. The data has been screened for reflecting the general trends and removed potential impacts of any outliers. This study evaluates the competitiveness of Asian developing countries in the context that this region is considered a new pole in the world's development trend. The variables used are based on the factors included in the GDD approach (Moon et al., 1995) as the primary theoretical basis for the competitiveness model (Porter, 1990). Our study presents two econometric models that followed the GDD model (Castro-González et al., 2016; Moon et al., 1998; Moon & Lee, 2004). The first one is a local diamond, and the second one is a combination with an international diamond.

The impact of innovation on national competitiveness in 21 developing Asian economies will be quantitatively identified by some panel data estimation methods. First, the Pearson correlation analysis method is applied to explore the correlation relationships between variables in the econometric models. Second, the Pooled-OLS, Fixed effects model (FEM), and the Random effects model (REM) are conducted. In the next step, some diagnostic tests are done to select appropriate results. If estimated results meet econometric problems such as the serial-correlation or heteroskedasticity, the Driscoll-Kraay standard errors method will be employed for estimating the most reliable results.

4. Theoretical Framework

For researching competitiveness, Porter's diamond model (1990) is popularly known, but this model has some disadvantaged aspects and should be improved for more suitable small countries or developing economies (Rugman, 1991). Moon et al. (1995) proposed the Generalized Double Diamond (GDD) model which combined the activities of multinational companies and the roles of governments. Moon et al. (1998) asserted that the GDD model helped analyze the competitiveness of small countries with a high export intensity (Lagrosen, 2007). The GDD model has been employed in some previous studies (Castro-González et al., 2013; Moon et al., 1998; Moon & Lee, 2004).

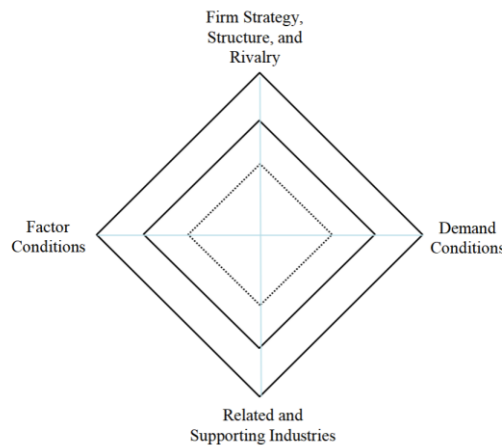


Figure 1: Generalized Double Diamond model (Sourced from Moon et al., 1998)

5. Empirical Analysis

a. Empirical Model and Data Set

Specifically, in model 1, the dependent variable is national competitiveness and it is denoted by the Global Sustainable Competitiveness Index (GSCI). Innovation is an independent variable and it is presented by the Global Innovation Index (GII). The GII is a popular index for measuring a country's innovation. The impact of domestic diamonds is represented by internal factors that influence national competitiveness. A domestic diamond has four elements: "Local factor conditions," "Local demand conditions," "Local related and supporting industries," and "Strategy, structure, and competition of local companies". Denote the four elements of the domestic diamond, independent variables include the four component elements of this diamond: Innovation (Global Innovation Index), Tax (Total taxes on profits), Infrastructure, and Institutions (National institutional quality).

$$Competitiveness_{i,t} = \varphi_0 + \varphi_1 Innovation_{i,t} + \varphi_2 Institution_{i,t} + \varphi_3 Tax_{i,t} + \varphi_4 Infrastructure_{i,t} + \varepsilon_{i,t} \quad (1)$$

In model 2, besides internal elements, the international diamond has four external elements: "International factor conditions", "International demand conditions", "International related and supporting industries", and "Strategy, structure, and competition of international companies". Four component elements of the external diamond have been added: FDI (foreign direct investment),

Unemployment (unemployment rate), Export (Export rate of goods and services to developed countries), and Openness (Trade openness).

$$\begin{aligned} Competitiveness_{i,t} = & \beta_0 + \beta_1 Innovation_{i,t} + \beta_2 Institution_{i,t} + \beta_3 Tax_{i,t} + \beta_4 Infrastructure_{i,t} + \\ & + \beta_5 FDI_{i,t} + \beta_6 Export_{i,t} + \beta_7 Openness_{i,t} + \beta_8 Unemployment_{i,t} + \mu_{i,t} \end{aligned} \quad (2)$$

Where ε and μ are the error terms, i is the i country in the data sample, and t is the t year in the study period.

A data set of 21 developing and emerging economies in Asia is used for this research. The study period is 2011-2022. The list of 21 countries includes Azerbaijan, Bangladesh, China, Indonesia, India, Iran, Jordan, Kazakhstan, Kyrgyz Republic, Cambodia, Lebanon, Sri Lanka, Mongolia, Malaysia, Nepal, Pakistan, Philippines, Thailand, Tajikistan, Uzbekistan, Vietnam. Descriptive statistics of the research variables are presented in Table 2. The measurements of the variables in the econometric models are summarized in Table 1.

Table 1: Definition and measure of variables

Variable symbol	Definition and measure	Source
Competitiveness	Global Sustainable Competitiveness Index (GSCI) (1 to 100)	Solability (Solability.com, 2023)
Innovation	Global Innovation Index (GII) (1=low to 100=high)	World Intellectual Property Organization (2023)
Institution	Evaluate the effectiveness of the economy (1=low to 100=high)	Heritage Foundation (2023)
Tax	Other taxes payable by businesses (% of commercial profits)	World Development Indicators (World Bank, 2023)
Infrastructure	Individuals using the Internet (% of the population)	
FDI	Foreign direct investment (% GDP)	
Export	Merchandise exports to high-income economies (% of total merchandise exports)	
Openness	Merchandise trade (% of GDP)	
Unemployment	Unemployment, total (% of total labor force) (modeled ILO estimate)	

Source: Authors' calculation using the study data

b. Testing of the Model and Estimates

All variables in our econometric functions are presented by a database sourced from the Solability (2023), World Intellectual Property Organization (2023), Heritage Foundation (2023) and World Development Indicators (World Bank, 2023). The descriptive statistics of all variables are presented in Table 2.

Table 2: Descriptive statistics of variables in the econometric models

Variable	Max	Min	Mean	Std. Dev.	Obs
Competitiveness	51.4	31.8	41.9	3.85	231
Innovation	55.3	17.6	31.3	7.16	245

Institution	70.3	0.1	7.59	14.2	245
Tax	96.7	3.1	44.4	24.6	223
Infrastructure	55.4	12.3	31.9	9.50	252
FDI	43.9	-37.1	3.50	5.64	246
Export	89.2	3.78	52.5	22.3	210
Openness	182.3	21.4	65.3	37.9	252
Unemployment	19.2	0.14	5.71	3.82	330

Source: Authors' calculation using the research data

In the first step of the study process, the Pearson Correlation matrix is employed to unveil the correlation coefficients among variables. Table 3 shows the direction of the correlation between variables and helps detect multicollinearity in the models. This econometric problem can strongly influence the results of the econometric regression.

Table 3: Correlation coefficient matrix of the econometric models

Variables	Competitiveness	Innovation	Tax	Infrastructure	Institution	FDI	Export	Openness	Unemployment
Competitiveness	1.000								
Innovation	0.3577	1.000							
Tax	0.1639	-0.1793	1.0000						
Infrastructure	0.3474	0.3327	-0.2854	1.0000					
Institution	0.2738	0.5529	-0.1494	0.4441	1.0000				
FDI	-0.0891	0.0380	-0.1201	0.0034	-0.1905	1.0000			
Export	-0.1466	0.1478	-0.1794	0.0715	0.1711	-0.0173	1.0000		
Openness	0.1104	0.2590	-0.2370	0.2428	0.0935	0.3929	0.1312	1.0000	
Unemployment	-0.2149	-0.1646	0.0096	0.1267	0.1643	-0.1717	-0.4113	-0.3814	1.0000

Source: Authors' calculation using the research data

The internal elements will be considered first; the correlation coefficient between Competitiveness and Innovation is positive (0.3577), demonstrating a positive relationship between the two variables; it means that a country has a good innovation capacity, so its competitiveness will be higher. The correlation coefficient between Tax and Competitiveness has a positive sign (0.1639) and confirms a positive relationship among these variables; a total tax increase can lead to an increase in the national competitiveness index. The correlation coefficient between Infrastructure and Competitiveness is 0.3474 and shows that the more development in infrastructure level, the higher the national competitiveness. The correlation coefficient between Institution and Competitiveness is 0.2783, which implies that good institutional quality will compete strongly in the international market and vice versa.

From the views for international factors, the correlation coefficients between FDI, Export, Unemployment, and national competitiveness are negative (-0.0891, -0.1466, and -0.2149, respectively). These values demonstrate negative relationships between international factors and national competitiveness; this implies that the participation of multinational corporations has created fierce competition that harmed the

competitiveness of the host country. However, the correlation coefficient between Openness and Competitiveness is positive (0.1104) and suggests an increase in competitiveness when a country strengthens its integration. The country's competitiveness will rise when the domestic market is highly open to the outside.

Finally, the multicollinearity test shows that the independent variables have VIF values that are quite small (lower than 2), and the mean value of VIF is 1.66. Therefore, it can be concluded that there is no multicollinearity phenomenon among the independent variables in the functions.

Table 4 presents the regressive results of all methods and the diagnosis tests for checking the results. Besides, some tests are employed to select the most reliable result for the study. Model 1 represents a domestic diamond with internal factors and helps to identify the effect of innovation on national competitiveness.

In the regressive step, the Pooled_OLS, FEM, and REM methods are used to estimate the panel data. The Pooled-OLS regression focuses on the average impact of independent variables on competitiveness. However, this method has received some concern as it may produce biased and inconsistent coefficients. The Wooldridge test is applied to check the auto-correlation problem, and the testing result confirms no such phenomenon in the model. The Breusch-Pagan test also concludes that the estimated result met the heteroskedasticity problem. We conducted the regression with FEM and REM models to choose the appropriate result; then, the Hausman test showed that FEM was the better one. To choose between the Pooled_OLS and FEM, the F_test was used and showed that FEM is more reliable; therefore, FEM is chosen as the best result of these methodologies.

Table 4: The estimated results of model 1

Dependent variable: Competitiveness			
Variables	Pooled_OLS	FEM	REM
Innovation	0.222*** [4.21]	0.152** [2.04]	0.125** [1.97]
Tax	0.069*** [3.07]	0.075*** [3.31]	0.078*** [3.64]
Infrastructure	0.022 [1.65]	0.085*** [6.09]	0.077*** [5.80]
Institution	-0.024 [-0.66]	0.073** [2.26]	0.063*** [2.04]
_Cons	33.58*** [24.78]	30.15***[12.31]	31.78***[15.1]
Prob > F	0.0000	0.0000	0.0000
R-squared	0.2121	0.3683	0.1534
Number of countries	21	21	21
Observations	154	154	154
F-test	u_i=0: F(20, 125) = 23.84 Prob > F = 0.0000		
Hausman-test		$\chi^2(4)=18.28$ Prob> $\chi^2= 0.0011$	
Breusch–Pagan test	$\chi^2(1)=5,34$ Prob> $\chi^2 = 0.0208$	$\chi^2(1) = 1027.15$ Prob> $\chi^2 = 0.0000$	$\chi^2(1) = 212.8$ Prob> $\chi^2 = 0.000$

Wooldridge test	F(1, 20) = 48.2 Prob > F = 0.0000	$\chi^2(1) = 48.2$ Prob> $\chi^2 = 0.0000$	$\chi^2(1) = 4.52$ Prob> $\chi^2 = 0.0334$
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Note: *, **, *** significant at 10%, 5%, 1%. The t statistical values are in parentheses below the coefficients.

Source: Authors' calculation using the research data

The estimated result, based on the FEM model, indicates that innovation is the spotlight factor that has the positively most robust effect on national competitiveness. This evidence supports the development strategy that the more a country has in innovation activities, the more its competitiveness level increases. Other internal variables, including tax, infrastructure, and institution, statistically positively affect national competitiveness. Their coefficients imply that when businesses are operating favorably, the business-economic activities promote trade, which causes total taxes to increase. Besides, the result concludes that the improvement of the infrastructure system would promote national competitiveness. The estimated evidence confirms that an economy with good institutions, transparent public policies, and a high degree of business freedom also has a strong competitiveness.

On the other hand, a country can increase its competitiveness through open-door policies that enhance other countries' transactions. To consider the role of innovation in competitiveness, the econometric model should not only include internal factors but also cover the effect of external factors. Therefore, Model 2, which includes all the factors of the Generalized Double Diamond (GDD), will be estimated. The regressive results are presented in Table 5.

Table 5: The estimated results of model 2

Dependent variable: Competitiveness			
Variables	Pooled_OLS	FEM	REM
Innovation	0.152*** [2.77]	0.195** [2.39]	0.133** [1.95]
Tax	0.054** [2.47]	0.075*** [3.30]	0.076*** [3.60]
Infrastructure	0.039*** [2.97]	0.085*** [5.90]	0.081*** [6.10]
Institution	0.031 [0.80]	0.05 [1.53]	0.041 [1.32]
FDI	-0.085* [-1.72]	-0.083*** [-2.85]	-0.093*** [-3,24]
Export	-0.060*** [-4.09]	0.029 [0.75]	0.008 [-0.33]
Openness	-0.006 [-0.68]	0.005 [0.25]	-0.001 [-0,1]
Unemployment	-0.386*** [-4.11]	0.132 [0.62]	-0,042 [-0.29]
_Cons	39.52*** [22.43]	27.27*** [7.06]	33.07.*** [11.22]
Prob > F	0.0000	0.0000	0.0000
R-squared	0.3306	0.4247	0.1823
Number of countries	21	21	21
Observations	154	154	154
F-test	u_i=0: F(20, 125) = 21.13 Prob > F = 0.0000		

Hausman test		$\chi^2(8) = 16.94$ Prob > $\chi^2 = 0.0308$	
Breusch–Pagan test	$\chi^2(1) = 2.89$ Prob> $\chi^2 = 0.0889$	$\chi^2(1) = 666.07$ Prob> $\chi^2 = 0.0000$	$\chi^2(1) = 209.39$ Prob> $\chi^2 = 0.0000$
Wooldridge test	F(1, 20) = 35.524 Prob>F = 0.0000	$\chi^2(1) = 35.524$ Prob> $\chi^2 = 0.0000$	$\chi^2(1) = 3.64$ Prob> $\chi^2 = 0.0563$

Note: *, **, *** significant at 10%, 5%, 1%. The t statistical values are in parentheses below the coefficients.

Source: Authors' calculation using the research data

According to the testing results (F test and Hausman test), the FEM model is the most reliable one, and it should be chosen as the estimated result for model 2. Both internal and external factors are included in the econometric model for investigating national competitiveness. Innovation has a statistically positive effect on national competitiveness; the effect of innovation on competitiveness remains unchanged. It is still the critical variable having a robust impact on national competitiveness, and this evidence is supported by previous studies (Bae & Yoo, 2015; Kaynak et al., 2017). Because the coefficient has a negative sign, FDI hurts national competitiveness, and this result is supported by the finding of Law et al. (2018).

Table 6: Estimated results of the Driscoll-Kraay method

Dependent variable: Competitiveness		
Variables	Driscoll-Kraay estimation	
	Model 1	Model 2
Innovation	0.152** [3.39]	0.195*** [3.85]
Tax	0.075*** [8.69]	0.074*** [7.98]
Infrastructure	0.085*** [3.97]	0.084*** [4.46]
Institution	0.073* [2.88]	0.05** [2.60]
FDI		-0.083*** [-3.32]
Export		0.029* [1.95]
Openness		0.005 [0.43]
Unemployment		0.132 [1.62]
_Cons	30.15*** [29.29]	27.27*** [12.80]
Prob > F	0.0000	0.0000
R-squared	0.3683	0.4247
Number of countries	21	21
Observations	154	154

Note: *, **, *** significant at 10%, 5%, 1%. The t statistical values are in parentheses below the coefficients.

Source: Authors' calculation using the research data

Because the estimated result met the heteroskedasticity and autocorrelation problems, this situation leads

to uncertainty in study outcomes. To overcome the problem, the Driscoll-Kraay standard errors technique is employed to investigate the models.

In line with our previous estimated results, the Driscoll-Kraay standard errors method continuously concludes that innovation has a statistically positive effect on national competitiveness. This evidence highlights the role of innovation in improving national competitiveness. The internal and generalized models have the same direction regarding the effect of innovation on national competitiveness. It unveils that the higher the level of innovation operation, the more robust the level of competitiveness in a country. After that, the more competitiveness that economies have, the more benefits for the business environment and people's livelihoods. This result expands the evidence of previous studies (Marčeta & Bojnec, 2020; Szeles & Simionescu, 2020; Dima et al., 2018; Ciocanel & Pavalescu, 2015). Some existing research agrees with us on the role of innovation, which is the foundation of solid national economic development and necessary for survival in today's dynamic world (Şener & Sarıdoğan, 2011; Ciocanel & Pavalescu, 2015; Ferreira et al., 2017; Hadj, 2020). Creativity is a significant driving force that significantly contributes to economic growth and development sociolect-economic. Creativity and innovation create new values, increase human labor's value and productivity, and promote national economic growth and development. Creation exists in all aspects of the economy; this confirms a significant contribution. In the knowledge economy, innovation and creativity are of particular importance to economic growth and the ability to competitiveness of the economy. This assessment is supported by previous related studies such as Voinescu & Moisoiu (2015), Ciocanel & Pavalescu (2015), and Dima et al. (2018). From another perspective, innovation capacity, primarily scientific and technological innovation capacity, are decisive factors in national competitive advantage. In recent decades, countries have attached great importance to promoting economic innovation. At the same time, they propose strategies, policies, and measures to encourage innovation. Our research confirms a robust and complete answer that the impact of innovation on economic growth will positively enhance the competitiveness of countries in the knowledge economy and is Completely consistent with the study of Kaynak et al. (2017).

Second, the remaining components of the domestic diamond present statistically positive impacts on promoting national competitiveness. Specifically, the tax variable substantially impacts competitiveness, with its regression coefficient of 0.075 at a significance level of 1%. It means that when total taxes rise, the public financial resources come from dynamic business activities. Increasing taxes is always understood that countries produce more types of goods and services; thereby, this process enhances national competitiveness. As a result, the competition of that economy in the global market also automatically increased.

The following variable in the model is infrastructure, whose coefficients are positive and significant at the 1% level. According to Moon and Lee (2004) emphasize that transportation infrastructure is critical to the development of industries. Our research results show that a country with a high-quality infrastructure system can enjoy a robust competitive position compared to other countries (Aiginger, 2021; Astikè, 2022). Besides, the impact of the institutional variable is found in a positive direction between this variable and national competitiveness. The results promote a development model based on high institutional quality; the better the institutional quality, the more efficient the economy, leading to greater national competitiveness. Flachenecker (2018) and Camagni and Capello (2010) argue that national competitiveness must be encouraged by factors such as good institutions and appropriate economic policies because this will be the foundation to promote the development of Countries.

Third, the factors of international diamonds that can influence national competitiveness are considered. The regression coefficient of innovation to competitiveness shows a significant contribution when increasing from 0.152 to 0.195. In the GDD model, innovation is essential in promoting national competitiveness when placed among international factors. The model involves international trade by exporting goods and services to high-income countries; the coefficient of the export variable has a positive value and is statistically significant, positively impacting national competitiveness. This finding indicates that this is a mutually supportive direction, in which the more value of goods and services a country sells to developed countries, the more competitive its economy becomes. Low export incentives can weaken national competitiveness (Ilzkovitz et al., 2008). As trade improves a country's access to global resources and expands market access, its business performance depends on its strong competitiveness (Taner et al., 2006).

Next, in previous studies on the same topic, FDI has supported local manufacturers to increase R&D and absorb more knowledge, leading to more substantial innovation and increased competition (Fu & Yang, 2009) that according to Rusu and Roman (2018), the authors demonstrated that increasing FDI encourages competitiveness. The positive impact of foreign direct investment on national competitiveness and entrepreneurship depends on the country's level of development (Meyer & Sinani, 2009; Kim & Li, 2014). However, our study discovered the impact of FDI on competitiveness represented by a negative coefficient (-0.083). That means increasing FDI in this Asian region could reduce the competitiveness of countries. On the other hand, foreign direct investment can lead to the absorption of skilled and technical talent abroad, crowd out small businesses, and reduce domestic innovation (Law et al., 2018). If the technological foundation of domestic enterprises is not good, foreign multinational corporations with enormous resources can become competitors of domestic enterprises when investing in the host country. at (García et al., 2013). This situation will lead to adverse reactions to national competitiveness; therefore, FDI harms the host country's competitiveness in this study, and our results contradict previous studies (Peña-Vinces, 2009). The remaining variables in the international factor group, Openness, and Unemployment, have positive impacts on the dependent variable, but the coefficients are not statistically significant, so there is not enough evidence to conclude the relationships.

6. Conclusion

The purpose of this research is to identify the impact of innovation on national competitiveness in the Asia region with a panel database collected from 2011 to 2022. Besides, the study models also examine the effect of other macroeconomic factors on the dependent variable. The study finds that innovation increases national competitiveness in the countries. From the estimated results, some policy implications are suggested for the policymakers in developing countries.

Firstly, innovation is the factor that has the most substantial impact on national competitiveness, so to keep up with the current innovation trend, developing countries need to focus on improving their internal technological capacity, including knowledge creation capacity and knowledge absorption capacity (Şener & Saridoğan, 2011; Ciocanel & Pavelescu, 2015; Ferreira et al., 2017; Hadj, 2020). The government and companies must have strategies and priorities to promote R&D research activities because knowledge creation capacity provides a knowledge base and a solid foundation for a developed country. In the Global Innovation Index (GII) and represented by INO in the research model with the criterion of whole-of-society innovation, the richness lies in not only traditional innovations such as improving the quality of education, promoting scientific articles, building research centers, granting patents and increasing R&D costs.

Innovation is broader, more general, and includes social and business model innovation. Therefore, governments need to promote more in both the public and private sectors, innovating in knowledge and people to keep up with the trends of the times.

Secondly, given the domestic environment, countries need to promote the production of goods and services. When a country produces many products, prosperity, and competitiveness in the social trend, come with it, and imports are also increasingly strong. Investment in complete infrastructure is a factor that promotes development (Aiginger, 2021; Astiké, 2022). When people and businesses can do business and produce in a country with policies prioritizing infrastructure development, people and businesses will receive great benefits toward wealth and prosperity. Institutional quality is also essential to promote competitiveness in developing Asian countries. Governments must promote transparency in public policies, ensure integrity and social justice, and promote economic freedom because these factors will strengthen a country's position when integrating.

Thirdly, international factors are also issues that governments must pay attention to and develop policies in the context of increasingly fierce competition between corporations and countries. When attracting foreign investment (FDI) in developed Asian countries, it is necessary to pay attention to technology transfer and knowledge diffusion policies through which businesses and people of the host country will gain a lot of experience and technology from more advanced countries (Meyer & Sinani, 2009; Kim & Li, 2014). However, for FDI projects that are labor-intensive, have outdated technology, and have the potential to cause environmental pollution, countries need to make a careful assessment and only accept investment when it benefits the country and its people in a long-term and sustainable way. Governments must prioritize exporting goods and services to more developed countries in international trade because this also promotes national competitiveness.

In such an economic context, developing countries must seize investment opportunities, innovate, and produce goods that will help increase assets quickly and become powerful countries globally and internationally. Therefore, national governments or economies need innovation policies to guide creative development while limiting factors that affect national competitiveness.

Authors' contribution

All authors equally contributed to the study's concepts, designed the study framework, and calculated and discussed the results. All authors read and approved the final manuscript.

Disclosure statement

No potential conflicts of interest were reported by the authors.

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Relationship between Shareholder Financial Health and Productivity in Ecuadorian Companies: An Analysis Based on Solow Residuals (2021-2022)

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Abstract. *This study investigates the relationship between the financial health of shareholders and the productivity of Ecuadorian companies during the post-pandemic period (2021-2022). Using panel data and the Solow residual method to measure productivity, greater shareholder financial health, measured through indicators such as sustained profit, shareholding, and return on assets, was found to be associated with greater business productivity. The results suggest that shareholders with a strong financial position can boost the efficiency and growth of companies by facilitating investments in technology, improving decision-making, and strengthening the alignment between the interests of shareholders and management.*

Keywords: Interests of Shareholders, Post-Pandemic, Productivity, Shareholder financial health, Solow Residuals.

JEL Codes: D24 – G32 – L25 – O47

1. Introduction

The relationship between shareholder financial health and corporate productivity has been the subject of increasing interest in economic and financial research. In a context of economic volatility and constant change, understanding how the financial characteristics of shareholders influence the efficiency and productive performance of companies is crucial. Productivity inside an organization can be significantly impacted by a shareholder's financial status or by the business's capacity to finance, invest, and manage resources. (Smith and others, 2022).

It has been demonstrated in recent years that companies with solid finances are better able to manage their resources, make more strategic choices, and address market difficulties. (Lee and Johnson, 2023). Utilizing Solow residuals, a method that provides a clear picture of residual efficiency and enables the evaluation of the portion of productivity that cannot be fully explained by the measured inputs is crucial for assessing productivity (Nguyen et al., 2021).

The time between 2021 and 2022 has been particularly important for Ecuadorian firms because of the COVID-19 pandemic's economic effects and changes in the world market.

Due to the particular difficulties these circumstances have presented for businesses and their investors, it is a good time to examine the relationship between shareholder wealth and corporate productivity (Martínez and Rodríguez, 2023).

Using Solow residuals as a productivity metric, this study attempts to explore the relationship between shareholder financial health and productivity in Ecuadorian businesses. By doing this, we hope to provide a current and pertinent viewpoint on how, in a post-pandemic environment, the financial circumstances of shareholders might affect the profitable operation of businesses.

2. Literature Review

The relationship between shareholder financial health and firm productivity has been an area of growing interest in economic research. The financial health of shareholders can be evaluated using a wide range of indicators, including return on assets, share ownership, and consistent earnings. Every one of these components influences how productive a business is. One of the most important indicators for evaluating the financial health of shareholders is sustained profit.

The long-term growth and stability of a corporation are contingent upon the provision of sustainable benefits (García and Pérez, 2022; Brown and Davis, 2023). Long-standing, profitable businesses can use their profits to create new goods and enhance current ones, boosting output and efficiency. Singh and Sharma (2023); Chavez et al. (2021). Companies with constant considerable earnings have the financial resilience to handle market volatility and make growth-oriented investments (Sánchez and Martínez, 2022; Kim et al., 2024).

Possession of shares affects productivity significantly in addition to long-term profit. The degree to which shareholders own and manage the business is referred to as shareholding. The classic outcome of ownership shares across holders is more strategic decision-making. Stakeholder engagement in managerial monitoring and decision-making can increase productivity and operational efficiency. When analyzing a company's financial health, the return on assets is important. This ratio measures how good a company is at turning its assets into sales. A high Return on Assets indicates better use of the resources by business and increased output. (Zhang and Lee, 2022; Smith et al., 2022).

A significant return on assets helps firms to improve operational efficiency, and increase productive capacity which are two key factors for them to create and sustain competitive advantage in the market (Nguyen et al., 2021; Kim et al., 2014). The interaction between these metrics and business productivity becomes even clearer when Solow residuals are used to measure residual productivity. Solow residuals allow us to evaluate the part of productivity that cannot be explained solely by traditional inputs, offering a more complete view of productive efficiency (Nguyen et al., 2021; Kumar et al., 2023). Companies with solid financial health, reflected in high sustained profits, significant shareholding and high return on assets, tend to exhibit greater residual efficiency in terms of productivity (Sharma and Kumar, 2023; López and Wang, 2023).

Recent literature has shown that better shareholder financial health, measured through these metrics, is associated with greater productive efficiency. According to this research, having a solid financial position helps businesses be more productive than they would be with traditional inputs. It also assures stability (Chen et al., 2023; Singh and Sharma, 2023). Financially stable firms can invest in

operational and technological advances that increase productivity (Garcia et al., 2022; Kim et al., 2024).

Moreover, the financial stability provided by high and sustained profits and good shareholder ownership allows firms to better manage market uncertainties and adapt their strategies to improve efficiency (Brown and Davis, 2023; Martinez and Rodriguez, 2023). The literature has documented that these companies are more likely to make strategic investments in resources and technology that increase productivity (Chen and Zhao, 2022; Zhang and Lee, 2024).

The ability of companies to generate additional value beyond the explained inputs is key evidence of the effectiveness of their financial and operational practices. Companies with solid financial health show greater residual efficiency in their productivity, which is an indicator of their ability to optimize resources and processes (García et al., 2022; Singh and Sharma, 2023). This residual efficiency also reflects the company's ability to use its resources effectively to improve its productive performance (Nguyen et al., 2021; Kim et al., 2024).

According to recent research, productivity is significantly impacted by shareholders' financial health, and residual productivity metrics clearly show this impact. Research has shown that financially stable companies can boost productivity through technological investments and operational simplification. Sharma and Kumar (2023); Garcia et al. (2024).

The significance of financial stability for enterprises to optimize their output capacity is underscored by this study (Lee and Kim, 2022; Zhang and Lee, 2024).

In summary, the literature review indicates that shareholder financial health, measured through sustained profit, shareholding, and return on assets, has a significant impact on business productivity. Solow residuals provide detailed insight into how these financial metrics affect firms' residual efficiency (Nguyen et al., 2021; Kumar et al., 2023). The body of research supports the notion that stable financial standing boosts a company's ability to be productive, which is essential for preserving a competitive edge in the marketplace (Chen et al., 2023; Singh and Sharma, 2023).

3. Method

3.1. Research Design

To examine the relationship between shareholder financial health and productivity in Ecuadorian enterprises throughout the years 2021 and 2022, this study used a quantitative research approach employing panel data. The methodology is divided into two stages of analysis. In the first stage, productivity is estimated based on Solow residuals using a regression model for panel data. In the second stage, we evaluate how the financial health of the shareholder influences productivity measured through Solow residuals.

3.2. Population

The study population consists of all companies registered in Ecuador during the years 2021 and 2022. This population offers a full depiction of the business environment in the nation, with a large assortment of enterprises from all industries and sizes.

3.3. Sample

In the two phases of the investigation, two distinct samples were used for the analysis:

1. **First Stage:** 521 Ecuadorian firms were included in the sample. At this point, Solow residuals were used in a panel data regression model to estimate productivity. The dependent variable in this model was TOTALIncome (company income), while the independent variables included FIXED ASSETS (capital) and NumberEmployed (labor).
2. **Second Stage:** In this stage, a regression model for panel data was used with a sample of 459 companies per year (2021 and 2022). In this model, the dependent variable was ProductivitySolow (PD), while the independent variables considered were Shwealth (shareholder financial health), OwnerShare (shareholder participation), Sharebenroa (profitability) and Sharebenefmnet (earned profit).

3.4. Information Gathering

Information was gathered from secondary sources, including official firm websites and publicly accessible data from Ecuador's Superintendency of Companies, Securities, and Insurance. The data used pertains to the years 2021 and 2022 and was obtained from publicly available yearly financial reports and business records. Below is a table with a description of each variable used in the study and how it was measured:

Table 1. Variables used in the study

Variable	Description	How it was measured
TOTAL income	Total income of the company in one year.	Measured from companies' annual financial reports.
FIXED ASSETS	Capital invested in fixed assets of the company.	Extracted from the companies' general balance sheets.
Number of Employees	Total number of company employees.	Obtained from annual reports and employment reports of companies.
ProductivitySolow	Productivity is measured through Solow residuals.	Calculated from the regression model for panel data.
Shwealth	The financial health of the shareholder.	Measured using a dummy variable that indicates 1 if there was a sustained presence of utility in the period analyzed.
OwnerShare	Shareholder participation in the company.	Measured as the percentage of stock ownership in the company.
Sharebenroa	Company profitability is measured by return on assets (ROA).	Calculated from the relationship between net profit and total assets.
Sharebenefmnet	Profit obtained by the shareholder.	Measured as the net profit attributed to shareholders in financial reports.

Source: Resource Created by the Authors

3.5. Data Analysis

Data analysis was carried out in two different stages, using STATA software for the estimation of regression models.

1. First Stage:

At this stage, a panel data regression model was constructed to estimate productivity using Solow residuals. The model is specified as follows:

$$\text{ProductivitySolow}_{it} = \beta_0 + \beta_1 \text{FIXED ASSETS}_{it} + \beta_2 \text{CantEmployees}_{it} + \epsilon_{it} \quad (1)$$

where:

- **ProductivitySolow**_{it} is the productivity of firm *i* at time *t*, measured by the Solow residuals.
- **FIXED ASSETS**_{it} is the capital invested in fixed assets.
- **CantEmployees**_{it} is the total number of employees.
- β_0 is the intercept.
- β_1 and β_2 are the coefficients of the independent variables.
- ϵ_{it} is the error term.

This model allowed us to estimate the residual productivity not explained by capital and labor.

2. Second Stage:

At this stage, a regression model was built for panel data for the years 2021 and 2022, with the following specification:

$$\text{ProductivitySolow}_{it} = \beta_0 + \beta_1 \text{Shwealth}_{it} + \beta_2 \text{OwnerShare}_{it} + \beta_3 \text{Sharebenroa}_{it} + \epsilon_{it} \quad (2)$$

Where:

- **ProductivityJustow**_{it} is the productivity measured by the Solow residuals.
- **Shwealth**_{it} is the financial health of the shareholder, measured by a dummy variable.
- **OwnerShare**_{it} It is the shareholder's participation in the company.
- **Sharebenroa**_{it} is the profitability of the company, measured by the return on assets (ROA).
- **Sharebenefmnet**_{it} is the benefit obtained by the shareholder.
- β_0 is the intercept.
- $\beta_1, \beta_2, \beta_3$, and β_4 are the coefficients of the independent variables.
- ϵ_{it} is the error term.

$$w_{it} = \beta_0 + \beta_1 \text{Shwealth}_{it} + \beta_2 \text{OwnerShare}_{it} + \beta_3 \text{Sharebenefit}_{it} + \beta_4 \text{Sharebenefmnet}_{it} + \epsilon_{it} \quad (3)$$

w_{it} is the productivity measured by the Solow residuals.

d financial of the shareholder, measured by a dummy variable.

shareholder participation in the company.

company profitability, measured by return on assets

s the profit obtained by the shareholder.

s coefficients of the independent variables.

This model allowed us to explore how financial health metrics and shareholding affect productivity measured through Solow residuals. Both stages of the analysis were performed using STATA software, which facilitated the estimation of the regression models and the analysis of the data. The results obtained were interpreted to identify patterns and significant relationships between the variables of interest and the productivity of the companies.

4. Results

Table 2. Model estimating Solow residual productivity

Number of obs	=	521
F(2, 518)	=	407.26
18 Prob > F	=	0.0000
15 R-squared	=	0.6113
Adj R-squared	=	0.6098
16 Root MSE	=	7.2e+07

IncomeTOTAL	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Number of Employees FIXED	47234.46	3,579,534	13.20	0.000	40202.27	54266.65
ASSETSSN	.6261102	.031216	20.06	0.000	.5647847	.6874358
_cons	1.46e+07	3859738	3.78	0.000	7002577	2.22e+07

Source: The author's calculation using the data

Table 2 shows a multiple linear regression that estimates productivity based on Solow residuals. It can be seen that the global statistical value is 707.26 and the p-value is 0.0000, that is, the p-value is <0.05, which indicates that at least one of the variables is significant.

On the other hand, the coefficients show a positive relationship, that is, if the number of employees increases, total income will increase and if fixed assets increase, income will also increase. In both variables the value $p < 0.05$, this indicates that the production factor variables are significant in determining productivity. It is important to mention that the standard errors of this regression represent productivity using the Solow model.

Table 3. Shapiro Wilk normality test

Variable	obs	W	V	z	Prob>z
PRODUCTIV I~D	918	0.651	203,404	13,116	0.000
P.S	918	0.709	169,975	12,673	0.000
incomeemplo yment	918	0.505	288,995	13,983	0.000
incomeact~s	918	0.292	412,770	14,863	0.000
ownershare	918	0.837	95,343	11,247	0.000
sharebenef~t	918	0.547	264,351	13,763	0.000
sharebenroa	918	0.417	340,014	14,384	0.000

Source: The author's calculation using the data

Table 3 indicates that the analyzed variables do not follow a normal distribution, according to the Shapiro-Wilk normality test. The W statistic, the critical values of the z test, and the p values (Prob>z) for all variables consistently show that the null hypothesis of normality is rejected. This suggests that the data are not symmetrical and are not evenly distributed around the mean. This conclusion should be kept in mind since certain tests and procedures involve assumptions about normalcy. It should also be kept in mind when evaluating the findings of future statistical analyses. When dealing with non-normal distributions, it may be helpful to take into account alternatives or data transformations.

Table 4. Defining Time Series Data

Panel	variable:	expediente	(strongly balanced)
Time	variable:	43period,	2021 to 2022
Delta: 1 unit			

Source: The author's calculation using the data

‘Panel variable’ refers to the use of panel data, which are observations made over a long period on a number of different entities or individuals. The variable now used as a panel variable is called ‘Docket’. ‘Very balanced’ means that for the given period, the number of observations for each entity (or panel member) is equal. ‘Period’ is the time variable, and covers the years 2021-2022.

Table 5. Modified Wald test for heteroscedasticity in the fixed effects regression model where Y= Productivity of Solow residuals.

P.S	Coef.	St.Err.	t-value	p-value	[95% Conf	[Interval]	Next
Shwealth	1747627.5	3497480.6	0.50	.618	-5125591.4	8620846.5	
Ownershare	1.034e+13	1.016e+14	0.10	.919	-1.894e+14	2.101e+14	
Sharebenroa	2275087.7	5453627.7	0.42	.677	-8442334.8	12992510	
sharebenefmnet	-1366086.1	9209081.2	-0.15	.882	-19463694	16731521	
constant	-7.831e+12	7,700e+13	-0.10	.919	-1,592e+14	1.435e+14	
Mean dependent var	444024.576		SD dependent var		80671451.449		
R-squared	0.002		Number of obs		918		
F-test	0.281		Prob > F		1,000		
Akaike crit. (AIC)	33026.061		Bayesian crit. (BIC)		33045.349		

$p < .01, p < .05, p < .1$

H0: $\sigma(i)^2 = \sigma^2$ for all i

chi2 (459) = 1.1e+25

Prob>chi2 = 0.0000

Source: The author's calculation using the data

Table 5 indicates a chi-square (chi2) statistic of approximately 1.1e+25 with 459 degrees of freedom. Since the associated p-value (Prob>chi2) is 0.0000, the null hypothesis is rejected at a conventional significance level of 0.05. This suggests the presence of heteroscedasticity in the model residuals. When heteroscedasticity problems occur, they are corrected by applying a robust model that corrects the standard errors.

Table 6. Linear regression, standard errors corrected by heteroscedastic panels - Productivity Solow residuals

Group variable: file	Number of obs	=	918
Variable time: period	Number of groups	=	459
Panels: heteroskedastic (balanced)	Obs per group:		
Autocorrelation: no autocorrelation	min	=	2
	Avg	=	2
	Max	=	2
Estimated covariances = 459	R-squared	=	0.0366
Estimated autocorrelations = 0	Wald chi2(4)	=	37.47
Estimated coefficients = 5	Prob > chi2	=	0.0000

Het-corrected

P.S	Coef.	Std. Err.	z	P>z	[95% Conf.	[Interval]
shwealth	3.03e+07	6766907	4.48	0.000	1.71e+07	4.36e+07
ownershare	1.73e+07	7503728	2.30	0.021	2581965	3.20e+07
sharebenroa	-5.09e+07	2.36e+07	-2.16	0.031	-9.72e+07	-4693211
sharebenefmnet	4.99e+07	3.31e+07	1.51	0.132	-1.50e+07	1.15e+08
_cons	-3.70e+07	8046611	-4.59	0.000	-5.27e+07	-2.12e+07

Source: The author's calculation using the data

Table 6 shows a regression, this indicates that the variable *pd* is significantly related to the explanatory variables included in the model, with an R-squared of 0.0366, which suggests that the explanatory variables explain a small but significant proportion of the variability in the dependent variable. The Wald $\chi^2(4)$ test for homoscedasticity suggests that there is heteroscedasticity in the model errors, and therefore the standard errors have been corrected to account for this heteroscedasticity.

In the panel regression analysis with correction for heteroscedasticity, the results indicate that the variables "shwealth" and "ownershare" have statistically significant effects on the productivity of Solow residuals ("pd"), with positive and negative coefficients, respectively. These results suggest that an increase in "shwealth" is associated with a significant increase in productivity, while an increase in "ownershare" is related to a significant decrease. The variable "sharebenroa" also significantly and negatively influences "pd". However, the variable "sharebenefmnet" shows a significant coefficient, but with a p-value of 0.132, indicating some uncertainty in its relationship with productivity.

5. Discussion

The results of the study provide a detailed view of how shareholder financial health and other variables impact productivity in Ecuadorian companies. In the first stage, the regression model for panel data estimates productivity based on Solow residuals, showing that both FIXED ASSETS (capital) and NumberEmployed (labor) have a significant impact on TOTALIncome (company income). The positive and significant coefficients for these variables indicate that an increase in fixed assets and the number of employees is associated with an increase in total income. This finding confirms that production factors, as predicted in the Solow model, are fundamental in explaining productivity (Solow, 1956; Mankiw et al., 1992).

However, the first-stage regression also reveals that the standard errors of the regression represent productivity as measured by the Solow model, suggesting that residual productivity, that is, productivity not explained by capital and labor, remains an important part of the analysis. This underlines the relevance of considering residual productivity as a key metric in the evaluation of business efficiency (Hall, 1988; Olley and Pakes, 1996).

In the second stage of the analysis, the regression model for panel data shows that the variables Shwealth (shareholder financial health), OwnerShare (shareholder participation), Sharebenroa (profitability) and Sharebenefmnet (earned profit) have different effects on productivity measured through Solow residuals (Solow Productivity or PD). Normality analysis using the Shapiro-Wilk test reveals that the variables do not follow a normal distribution, which may indicate the need to perform additional transformations of the data or apply robust techniques that fit the distribution of the residuals (Shapiro and Wilk, 1965; Welsch and Kuh, 1977).

The presence of heteroskedasticity, confirmed by the Wald test, suggests that the variability of the errors is not constant, which may affect the validity of statistical inferences. Correcting for heteroskedasticity in the regression shows that Shwealth has a significant positive effect on productivity, indicating that higher shareholder financial health is associated with higher productivity. In contrast, OwnerShare has a significant negative effect, suggesting that greater

shareholder participation is related to a decrease in productivity. These results are consistent with literature suggesting that ownership structure can affect decision-making and operational efficiency (Jensen and Meckling, 1976; La Porta et al., 2000).

The Sharebenroa variable also shows a significant negative effect on productivity, which could indicate that higher profitability does not always translate into higher residual productivity, and may be associated with an overestimation of profits that are not reflected in effective productivity. On the other hand, Sharebenefmnet shows a significant coefficient, but with a high p-value, suggesting that its impact on productivity is less clear and requires cautious interpretation.

6. Conclusion

The analysis carried out provides a comprehensive understanding of how the financial health of the shareholder and other variables influence the productivity of Ecuadorian companies. The results confirm that both capital and labor are key factors in determining productivity, as expected according to the Solow model. However, the impact of shareholder financial health and shareholding on productivity suggests that these variables play complex roles in the business environment.

The presence of heteroskedasticity and the lack of normality in the data underline the importance of applying robust techniques to obtain valid inferences. Correction for heteroskedasticity reveals that higher shareholder financial health is associated with higher productivity, while higher shareholding tends to reduce productivity, which could imply a detrimental effect of ownership structure on firm efficiency.

These findings have significant implications for shareholders and business managers in Ecuador, suggesting that improving financial health can be an effective strategy to increase productivity. Furthermore, the implications for ownership structure and profitability must be carefully considered in management strategies to optimize productive performance. Future research could further explore the causal relationships and consider additional variables that may affect productivity in different contexts.

This study, while insightful, has limitations. First, it relies on cross-sectional data, which limits the ability to establish causality between shareholder financial health, ownership structure, and productivity. Second, the analysis does not consider sectoral dynamics or macroeconomic factors that may influence firm performance. Finally, potential endogeneity issues, such as reverse causality between productivity and financial health, remain a concern.

Future research could benefit from panel data to better capture dynamic relationships over time and strengthen causal inferences. Furthermore, expanding the model to include qualitative variables such as corporate governance practices, managerial competence, or market competition could provide a more nuanced understanding of the determinants of productivity. Comparative studies across different regions or countries in Latin America could also shed light on whether these findings are context-specific or part of broader regional patterns.

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Counterplan Research of Oil Firms on Continuing Expansion of Substitute Energy for Petroleum

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Abstract. *The global energy market is undergoing a rapid transformation. Oil and substitute energy are becoming increasingly important due to their great influence on the global economy. Meanwhile, the COVID-19 pandemic has become a significant factor affecting the energy market and global economy. Therefore, the establishment of management strategies for oil companies is becoming increasingly important as substitute energy supply and development expand. For this reason, we present and discuss the counterplan research of oil firms on continuing the expansion of substitute energy for petroleum.*

Keywords: management, strategy, counterplan, oil firm, substitute energy, petroleum

JEL Codes: O13, P18

1. Introduction

The sudden increase in the oil production of North America, as well as shale oil in the United States and oil sands in Canada, increased global supply, thus affecting oil prices and oil firm profits. The excessively long duration of COVID-19 has significantly influenced oil firms worldwide. The current trend in global inflation has resulted in a sudden increase in the price of resources, raw materials, and oil. Supply and development for substitute energy are being supported worldwide. As the phenomenon of global resource depletion intensifies, all countries are striving to develop and secure resources. Global trends are used to assess the competitiveness of a country concerning resource preservation, serving as an important factor for a country's economic development. However, issues surrounding environmental pollution also increased. It is determined that the solution to environmental pollution and resource depletion is the development of substitute energy. If developed, substitute energy can eliminate the problem of resource depletion with its availability. By minimizing global warming or carbon dioxide emissions that occur from resource development, security, and consumption, substitute energy can make a significant contribution to environmental purification. In this paper, we conducted research, as well as presented and discussed counterplan research strategies of petroleum firms concerning the continuous expansion of substitute energy. The introduction, literature review, management strategy for successful firm management, global oil market trend, current status of substitute energy for petroleum, research model and methodology, strategy model research results, counterplan research discussion, conclusions, and research limitation are all included in this paper.

2. Literature Review

Analyst forecast biases are positively related to EIA oil forecast biases but only for firms with greater analyst coverage (Wang and Macy, 2021). Oil and gas reserves are clearly the most important assets that oil and gas companies have. Large oil companies are most profitable during periods of moderate gasoline prices (Ford, 2011). Oil price risk is positively impacted by increases in oil production (Sadorsky, 2008).

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The so far implemented enterprise resource planning (ERP) systems have in many cases failed to meet the requirements regarding business process control, decrease of business costs and increase of company profit margin (Gajic et al., 2014). Anecdotal evidence suggests that high oil prices embolden oil-rich states to behave more aggressively (Hendrix, 2015). If we are to revitalize the energy management industry, we need a better sense of what energy management is and what we'd like it to be (Hansen, 2008). Environmental management plays a pivotal role in the financial performance of the energy industry (Xu and Chen, 2019). The integrated practice of strategic management, that is the use of the three components of the strategic management process (formulation, implementation, and evaluation) does matter (Elbanna et al., 2020). In general, optimal corporate strategy has focused on strategic environments and characteristics of business units rather than on managerial flexibility (Chen et al., 2013). Many organizations adopt merger and acquisition (M&A) as a part of their corporate strategy to achieve their business objectives (Chui, 2011). Innovation without clarity in the business model leads to modest or negligible performance outcomes (Gronum and Verreyne, 2015). To achieve positive economic, environmental, and social benefits, many incumbent manufacturing firms attempt to apply circular economy principles to their business practices (Frishammar and Parida, 2018). The emerging growth of the sharing economy demonstrates the need to understand the factors driving this growth and the business models and practices of sharing economy service companies (Apte and Davis, 2019). Although the term 'business model' is widely used in the business world, the academic research on this issue is sparse (Schweizer, 2005). Business model innovation is an emerging hot topic in management research (Filser et al., 2020). Surprisingly, neither empowering leadership nor team creativity was related to business model innovation (Amoroso et al., 2021). Businesses increasingly incorporate the sustainability aspects into their products, services, and processes that drive innovation (Klein et al., 2021). The key elements of a global business model include propositions for adding customer value and capturing a share of that value, methods to control, deploy, and utilize critical resources, and integrated processes that deliver value to target global customers (Tallman et al., 2018). Strategy can be formally interpreted as an idealized path optimizing heterogeneous resource deployment to produce maximum financial gain (Johnson and Foss, 2016). Matrix methods may usefully be deployed to characterise the architecture of resources, costs, and revenues that a business uses to create and deliver value to customers that defines its business model (Johnson, 2017). The earned value project management method integrates three critical elements of project management: scope management, cost management, and time management (Anbari, 2003). The values relate to efficiency, legitimacy, power and control, and stakeholder satisfaction (Eskerod and Riis, 2009).

3. Effective Firm Management Strategy

Management strategy is often defined as a series of actions taken to develop and carry out plans aimed at accomplishing specific goals after determining the company's future path. Two oil shocks made forecasting the economic cycle impossible in the 1970s, thus resulting in scepticism surrounding the strategic plans due to the increasingly recurring highs and lows of the global economy. Meanwhile, American firms, which largely contributed to the global economy, were eventually threatened by Japanese and German firms in the 1950s and 1960s. As a result, CEOs became more interested in developing strategic analysis and thinking skills. The goals of the firm must first be established before developing a management strategy. It is also important to assess the environment of the firm, identify its resources and capabilities, derive strategic alternatives, and use the most efficient strategy. The adopted strategy necessitates internal reorganization of the firm in which the organizational structure and control system are designed. The firm can provide suggestions for future decisions based on the results of strategic practice. The different types of management strategies are cost leadership strategy, differentiation strategy, diversification strategy, niche strategy,

technological strategy, and cooperative strategy. Cost leadership strategy is centered on management, having an advantageous cost leadership over other firms in order to secure within the industry a preemptive position regarding cost. Differentiation strategy differentiates a firm from its competitors by offering clients design, brand image, quality, delivery, flexibility, service, reliability, and high value. Diversification strategy refers to a firm's decision to establish a new business instead of utilizing an existing one. Niche strategy refers to planning based on market analysis and exploring a new market by pioneering one or segmenting the current market. Technological strategy refers to a strategy that involves securing a competitive advantage using technology. Cooperative strategy refers to a strategy that promotes cost reduction, quality improvement, and productivity improvement.

4. Global Oil Market Trend

In December 2019, the whole world was left shaken by the effects of COVID-19, which resulted in a sudden decline in crude oil demand. As a result, the oil industry is trying to cope with the market changes brought about by the global expansion of transition movements under the new climate change system. According to the International Energy Agency (IEA), there is a decline in oil demand. Furthermore, the demand for oil in advanced countries is dwindling, and the rate of growth of oil demand in emerging economies is expected to slow further. The Korean New Deal policy is deemed necessary by South Korea to boost the competitiveness of renewable energy that is gaining traction in the era of global energy conversion resulting from its high dependence on oil and gas. The global oil market is being influenced significantly by the development of shale oil and clean energy, as well as the expansion of electric vehicle supply. As a result of price volatility, oil price forecasts from major energy institutions worldwide are far off, and uncertainties in oil firms are growing. In macroeconomics, oil prices and the unemployment rate are considered as key indicators. When analyzing the oil market, it is important to address this based on supply and demand as oil prices are representative goods that explain the law of supply and demand in pricing. The Middle East, the Commonwealth of Independent States (CIS), South America, and Africa are major oil suppliers of the world. Meanwhile, North America, Europe, and the Asia-Pacific are the world's largest oil consumers. Global oil reserves are increasing as oil exploration in each country improves; however, there is a significant instability with the distribution by region. There is constant volume movement to consumer destination because oil production and consumption by country or region are unbalanced. Oil reserves are readily available. The oil reserves ratio of OECD countries in advanced countries is 15.0%, whereas the reserves ratio of OPEC countries, a group of oil-producing countries, is 70.1%. Table 1 shows the production in thousands of barrels per day.

Table 1: The production in thousands of barrels per day

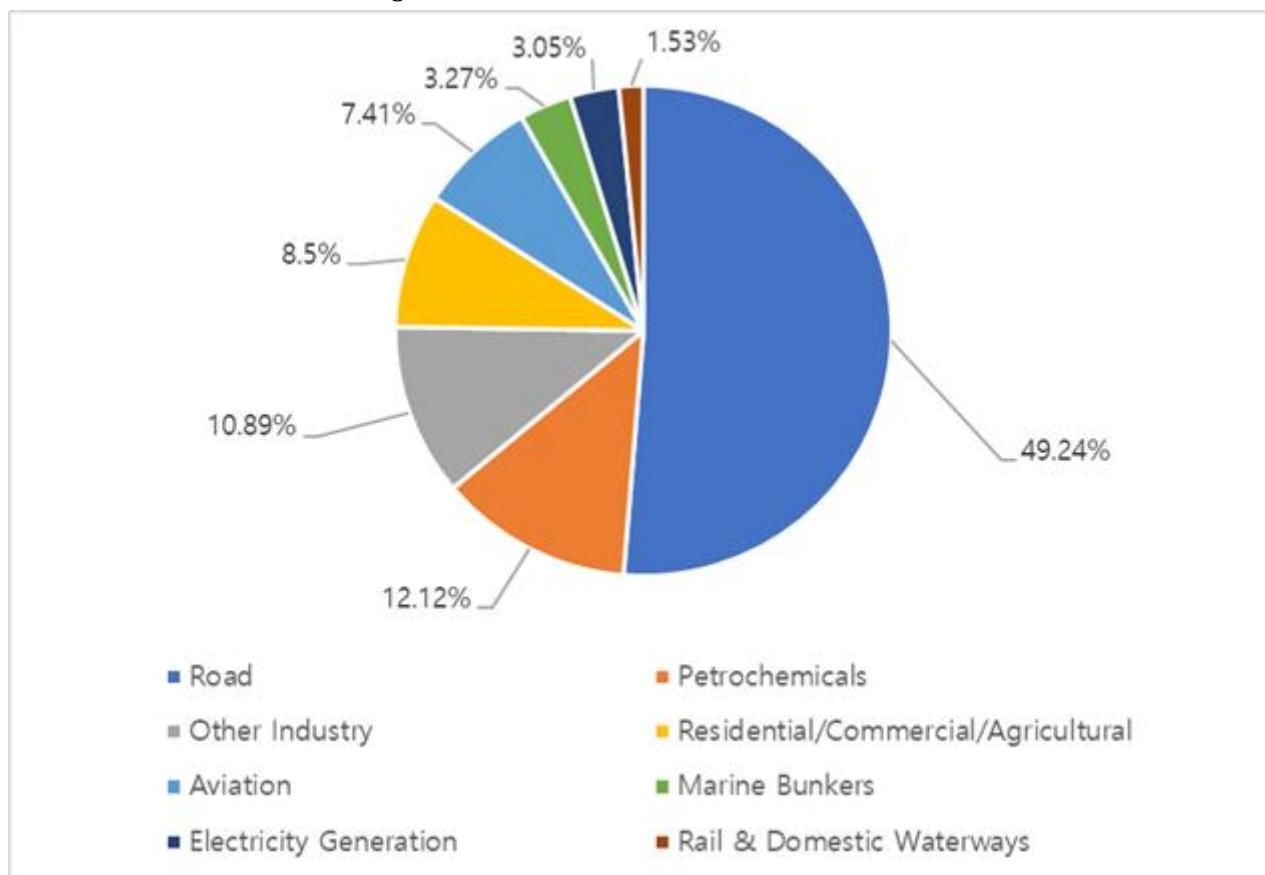
Classification	Groth rate per annum			
	2021	2021	2011-21	Share 2021
OECD	28,405	0.7%	3.8%	31.6%
Non-OECD	61,471	1.9%	-0.5%	68.4%
OPEC	31,745	2.9%	-0.8%	35.3%
Non-OPEC	58,131	0.8%	1.6%	64.7%
European Union	366	-7.0%	-4.8%	0.4%

Data Source: BP Statistical Review (2022)

As oil demand declines, the global oil market is expected to accelerate energy conversion. The decline in oil demand is only temporary, and energy conversion is expected to fall behind the priority as demand

quickly recovers. Subsequently, oil demand determines global oil market trends. Demand for clean energy may increase as a result of declining oil prices and oil demand, whereas demand for gasoline and diesel is expected to decline by 2025 as a result of competition to improve efficiency, CO2 emissions reduction, and recognition of electric vehicles. Fig. 1 shows the distribution of oil demand in the OECD.

Fig. 1: The distribution of oil demand in the OECD



Data Source: Chemical & Resource (2022), Statista

5. Current Status of Substitute Energy for Petroleum

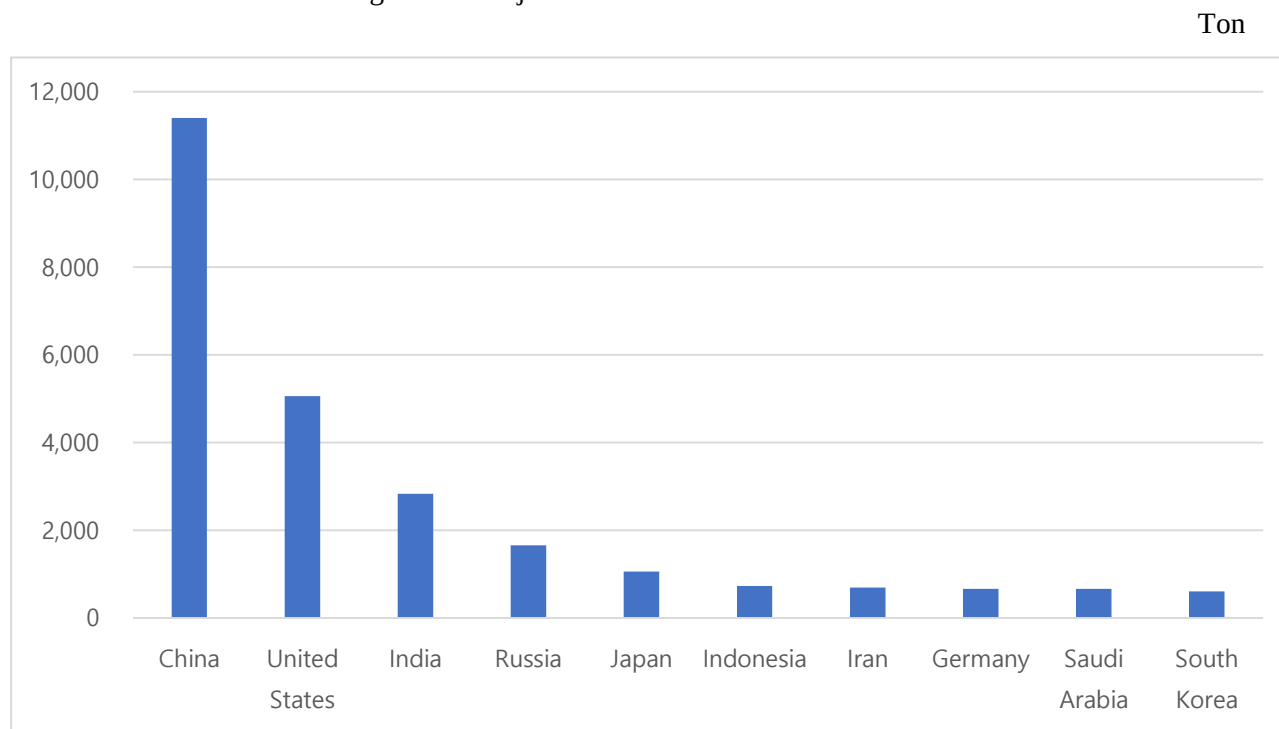
As the world's resource depletion worsens, all countries are attempting to develop and secure resources. Environmental pollution is a serious issue in resource development and security. Mass production and overconsumption of resources are clearly the causes of environmental problems. This pattern will continue as the energy efficiency policy increases the use of fossil fuels, production, and consumption, thus making their disposal difficult to achieve. According to the World Climate Conference (WCC), only sustainable development can improve the quality of life. Reducing environmental pollution to reduce carbon dioxide emissions and stabilize greenhouse gas concentrations in the atmosphere has become an area of importance in the United Nations Framework Convention on Climate Change. Table 2 shows the objective of reducing carbon emissions in major countries. Fig. 2 shows the major countries that emit carbon dioxide.

Table 2. The objective of reducing carbon emissions in major countries

Country	Content
United States	50% ~ 52% reduction compared to 2005 by 2030
China	2020 goal reconfirmation
EU	55% reduction compared to 1990 by 2030
Japan	46% reduction compared to 2013 by 2030
South Korea	24.4% reduction compared to 2017 by 2030 → Raise the reduction goal and resubmit
Canada	40% ~45% reduction compared to 2005 by 2030

Data Source: NDC Registry (2021), United Nations Framework Convention on Climate Change

Fig. 2: The major countries that emit carbon dioxide

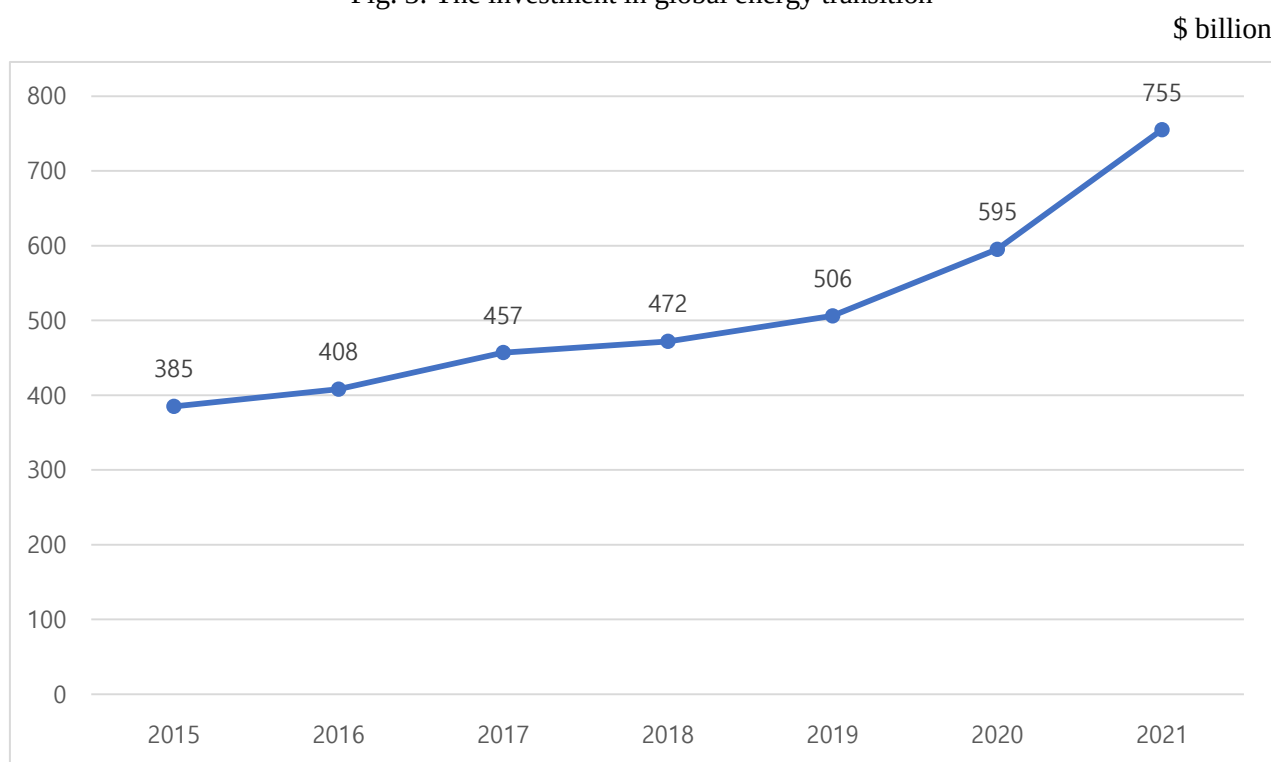


Data Source: Global Carbon Atlas (2022)

Substitute energy development is one of the measures being taken to address the crisis of environmental pollution and resource depletion. Clean energy technology is rapidly evolving, and prices are continuing to fall to ensure economic feasibility. One of the challenges to the existing oil firm's management strategies to generate profits is the rapid diffusion of electric vehicles. Furthermore, de-petroleum nation policies are also having a significant impact worldwide. If developed, substitute energy can be used indefinitely. It has the advantage of greatly contributing to environmental stabilization with carbon dioxide reduction. Substitute energy, also known as renewable energy, is the energy produced by converting fossil fuels or renewable energy (e.g., sunlight, water, geothermal heat, precipitation, and biological organisms). Due to the increasing competition for securing resources, excessive use of resources, and environmental pollution, substitute energy is considered a new solution. Solar energy, wind power energy, hydropower energy, nuclear energy,

bio energy, and thermal energy are the main types of substitute energy. Solar energy refers to the radiant energy from the sun in the form of heat and light that provides support to the living things found on Earth and its climate. Wind power energy is the energy generated by harnessing the power of the wind. Hydropower energy is the energy generated by harnessing the force of water. Nuclear energy is defined as the large amount of energy that is continuously produced by either a fission or fusion reaction. Bio energy, also known as biomass energy, is the energy derived from biomass as fuel. Thermal energy is defined as the energy that causes a change in the temperature or state of an object as heat takes its form. Fig. 3 shows the investment in the global energy transition.

Fig. 3: The investment in global energy transition



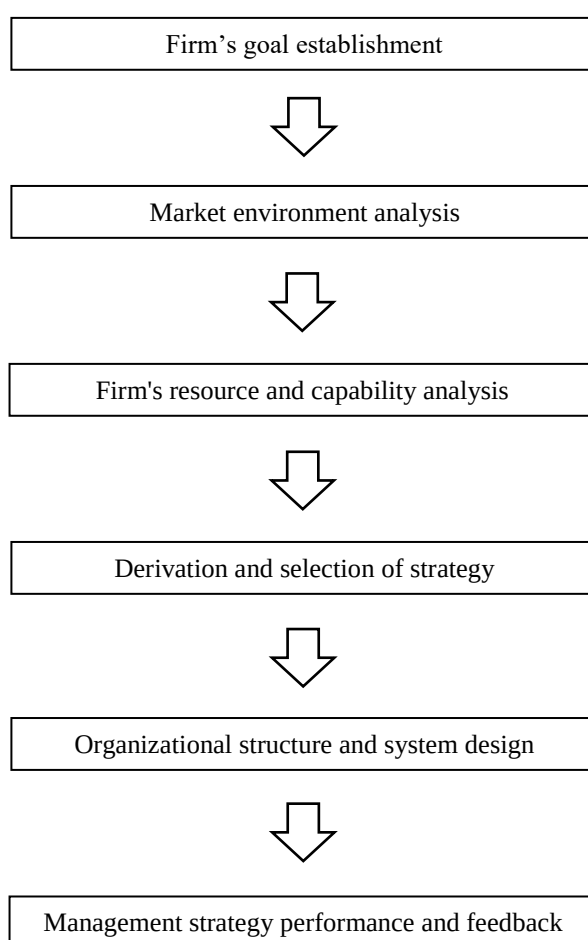
Data Source: Bloomberg NEF (2022)

6. Research Model and Methodology

A management strategy model is discussed in this study for research purposes. Management strategy is analyzed in terms of firm strategy, market strategy, and business strategy. A firm strategy is based on a firm's entry into the business and market. Market strategy is based on the performance of a firm using its strategies to gain an advantage in the market. Business strategy relies on a firm's support of its management, marketing, personnel, finance, production, and R&D. This study focuses on oil firms and their establishment of strategies. Management strategy identifies the objectives of the firm, the allocation of its resources, and the businesses and markets that it enters. The scope of the firm's business and the market in which it competes are based on its strategy. Firm strategies include business areas in which a firm is involved, while focusing on strategies with various environmental characteristics at a competitive level. Market strategy is used to enhance a firm's competitive position in the market. It heavily relies on establishing its edge over its competitors. Furthermore, a competitive advantage strategy is necessary for firms to have a competitive edge

in the market. It is important to have overwhelming competitiveness and a competitive advantage over other firms. To achieve the firm's strategic goals, business strategy is important when allocating internal resources and arranging activities within the firm. Business strategy includes financial management, personnel management, marketing, production operation management, and R&D. It is important for firms to have a systematic management strategy to be able to distribute the resources. For this reason, this study aims to establish management strategies for oil firms. Fig. 4 shows the establishment of management strategy.

Fig. 4: The establishment of management strategy



7. Research Results for Strategy Model

A diversification strategy of oil firms is shown in this study for the expansion of substitute energy for petroleum. In addition, there is a remarkable increase in the demand for shale oil and natural gas worldwide. Due to the availability of coal, it is unlikely to become depleted. Oil firms can introduce strategies for supplying different sources of energy, such as natural gas, coal, other fossil fuels, and biomass. Meanwhile, the diversification strategy considers the significance of natural gas and efforts to reduce energy costs. For an efficient handling of non-liquid fuels (e.g., natural gas and coal), advanced technology and other applicable technologies are necessary. In order to service firms, diversification of power energy transport systems

requires reparation using existing gas station networks and addressing the decrease in oil demand resulting from the increase in the number of electric vehicles that are currently available, such as Tesla. The majority of the transportation energy systems use petroleum fuel. Moreover, electric energy is expected to be the better option concerning to energy efficiency and air pollution. Electrical storage is an important technology in transport energy conversion. The large amount of power consumption by electric charging stations necessitates a large power storage system. As a result, oil firms must improve their technical understanding of power storage. The value of technology will increase as it can efficiently explore, develop, and convert oil and hydrocarbon resources into advanced energy. Firms that provide technology services must enhance their expertise by acquiring key talents. In the near future, oil firms need to invest in substitute energy businesses. Projects involving substitute energy are more important from a policy standpoint than an economic standpoint. Furthermore, these can be promoted through government policies and support. As oil prices increase and international agreement to combat climate change grows, so does the focus on substitute energy. As the market continues to decline and the economic crisis worsens, advanced countries are also pursuing restructuring of the industry. Oil firms are willing to improve their capabilities in the harnessing of substitute energy. A substitute energy business model includes technologies and facilities supplied by technology providers via core technologies and substitute energy facilities handled by operators. From an operator's standpoint, oil firms should be investing in solar and wind power facilities. In addition, the role of corporate suppliers is considered important as they are the providers of core technologies related to biofuels. Venture funds can be used to invest in technologies having future growth capabilities. Oil firms can access the operating sector of oil refining facilities and sell products directly produced offshore by securing a supply chain of firms. Diversification of a refining facility operation project is a viable strategy upon the establishment of the capital and initiatives. Operating refining facilities can help solve the issue of financing for diversification strategies experienced by oil firms. Oil firms need to fortify their businesses by utilizing technology services such as discovery, mining, development, and sales of oil resources to state-owned firms. It is also preferable for oil firms to act as technology suppliers to facilitate a new and substitute energy business. However, there may be a difference based on the specifics of new and substitute energy. Even though the business diversification of oil firms has been evaluated, applying this to all oil firms in a collective manner is found to be difficult. The management strategy of a firm should be reviewed in light of the situation, capability, and specificity of each company.

8. Discussion for Counterplan Research

High technology and large-scale capital goods facilities are required in the oil business. There are fundamental uncertainties involved, such as the absence of oil, and it must be promoted for an extended period. The risk of running the business is higher than that of general manufacturing because it goes through different technical processes. Oil development projects also face various risks in terms of reserves, prices, and development costs, as these are considered factors of interest to stakeholders. Due to the increasing awareness regarding the limitations of oil reserves and the importance of the environment, there is a growing need for a substitute energy for oil. The importance of substitute energy development becomes clear, as well as the concept of sustainable development, keeping the environment in mind. Therefore, oil firms should establish management strategies that are in line with global trends. The concept of sustainable development focuses on harmonizing economic development and environmental protection without compromising the environment. Resource development should be assessed to ensure that it does not impede development. Overproduction and overconsumption are the root causes of the wide development and environmental

disparities; therefore, economic patterns must be changed. It is also necessary to respond to global environmental issues. Regulations affecting development are followed, and cooperation with related organizations is necessary. The national economy should be included in the government's policy support plan for oil firms. Securing economic energy resources will aid in the support of energy projects as well as the discovery of new national economic growth engines. Instead of directly participating in projects, the government's support policy should focus on infrastructure, such as securing manpower and R&D. Oil firms should maintain their competitiveness by enhancing investment efficiency according to the current status of the oil market and the strategies established by the firm. In addition, they need to secure technology and increase investment and profits to improve management efficiency.

9. Conclusions and Research Limitations

In this study, the response strategies of oil firms were shown in terms of substitute energy supply and development expansion. Consumption of energy resources has increased significantly, along with income, mass production, and consumption, due to the advancement in science and technology. For this reason, more energy resources are deemed necessary. In addition, there is a constant need for securing and developing resources resulting from economic growth and resource depletion. Environmental pollution caused by energy resources is also becoming a major concern. Policies and activities regarding the supply and development of substitute energy are actively promoted worldwide to create an eco-friendly environment. The value creation of an oil firm focuses on increasing the net profit by exploring, developing, purchasing assets, and investing in oil. In light of the global trends and changes in the energy market, oil firms need to establish new management strategies and re-establish their roles. Due to the number of variables involved, the oil business is currently difficult to predict. As a result, oil firms need to establish a new management strategy, as well as redefine and diversify their business portfolio. When dealing with global trends and changes in the energy market, efficiency and competitiveness must be increased by the oil market situation and management strategies established by the oil firms. In this study, we looked into the establishment of effective management strategies that oil firms can use for substitute energy supply and development expansion. The research limitations in this study are as follows. There was difficulty in establishing a management strategy for oil firms and substitute energy, and future predictions for the energy market. Due to the prolonged COVID-19 pandemic, oil firms are having a difficult time establishing management strategies. It is also important to forecast prospects for substitute energy. In future studies, we will conduct further research on the matters discussed in the research limitations.

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Deciphering The Interplay of Environmental Trust, Uncertainty, and Herd Behavior Toward Consumer Behavioral Intention: A Meta-analytic Structural Equation Modeling Approach

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Abstract. This study aimed to identify the influence of environmental trust, uncertainty, and herd behavior on predicting consumer behavior intentions. This study also aimed to assess the most appropriate model to describe the relationship between the four variables. The data type was the result of 105 studies that examined the relationship between environmental trust, uncertainty, herd behavior, and consumer behavioral intent. The data source came from the Scopus.com database. PRISMA was used in the selection process using inclusion criteria such as research is carried out according to the theme in the form of journal articles, proceedings, and book chapters published between 2000 – 2024, in the form of quantitative research that provides information on the number of respondents and correlation values, in English and published in reputable international journals. The method used R software to conduct a Meta-Analysis Structural Equation Modeling (Meta-SEM). The results showed that Environmental Trust (ET) has a significant favorable influence on uncertainty (UC) at a rate of 5%. ET also has a more substantial positive influence on herd behavior (HB) and behavioral intention (BI). In addition, UC significantly influences BI, while HB also has a positive influence on BI. Additional findings from gender moderation imply that demographic factors might impact the formation of the association between these variables, particularly regarding herd behavior and environmental trust.

Keywords: environmental trust, uncertainty, herd behavior, consumer behavioral intentions, Meta-SEM

JEL Codes : D81

1. Introduction

In today's digital economy, consumer decisions are increasingly influenced by a complex interplay of rational factors, such as price and quality, alongside psychological and social dimensions, including environmental trust, uncertainty, and herd behavior. This phenomenon was particularly relevant as online transactions proliferate, where consumers often rely on reviews, recommendations, and perceptions shaped by the virtual environment (Pham *et al.*, 2023).

One important aspect of consumer decision-making in the digital economy is the role of trust, especially environmental trust. Trust is a major contributor to purchase intention, indicating that consumers' trust in a brand's environmental practices can significantly influence their purchasing behavior (Shen *et al.*, 2016). This behavior was especially relevant when consumers were increasingly concerned about sustainability and ethical practices. Trust in a brand's commitment to environmental issues can increase consumer loyalty and willingness to pay a premium for products perceived as environmentally friendly (Arasyi and Kusumawati, 2023; Singh and Kunja, 2023).

Uncertainty also plays a significant role in shaping consumer behavior. Trust and attitudes are directly related to consumers' intention to use services, such as post-COVID-19 cruise services, suggesting that health beliefs can predict trust and influence attitudes and intentions (Pan *et al.*, 2021). In digital markets, where consumers often face uncertainty regarding product quality and service reliability, building trust can reduce this uncertainty and facilitate decision-making (Yang *et al.*, 2019).

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Herd behavior further expands the dynamics of decision-making. Consumers often look to the actions of others as a guide to their own choices, especially in online environments where social proof is available through reviews and ratings (Ali and Amir, 2024). This phenomenon can lead to a rattle effect, where individuals are likelier to purchase popular products among their peers, regardless of personal preferences (Su *et al.*, 2023; Zhou *et al.*, 2023). The influence of herd behavior is particularly pronounced in social media, where the visibility of consumer choices can amplify the impact of collective behavior on individual decision-making (Chen *et al.*, 2023; Masuda *et al.*, 2022).

Despite increasing recognition of these factors, the literature often treats them in isolation rather than as interrelated elements of a broader decision-making framework. Previous research has explored the impact of trust on consumer behavior (Ladwein and Sánchez Romero, 2021; Laparojkit and Suttipun, 2022; Lu and Chen, 2021; Shabankareh *et al.*, 2024; Yu *et al.*, 2021), but there is a lack of comprehensive research examining how trust interacts with uncertainty and herd behavior in shaping consumer intentions. Furthermore, integrating these psychological and social dimensions into consumer behavior research is critical to developing effective marketing strategies. As consumers become more aware of the implications of their purchasing decisions, businesses must adapt by cultivating trust (Paravastu and Ramanujan, 2021), overcoming uncertainty (Al-Adwan *et al.*, 2022), and leveraging social influence to increase consumer engagement and satisfaction (Lu and Chen, 2021). However, despite the significance of this issue, there is still a gap in the literature that integrates these factors holistically.

The urgency of this research is based on the reality that uncertainty in consumer decision-making is often a barrier to achieving practical marketing goals. A report from the Global Consumer Insight Survey (2023) showed that more than 65% of consumers are skeptical of the reliability of information available online, especially on e-commerce platforms (www.pwc.com, 2023). This uncertainty often affects their intention to purchase, even if they have already shown initial interest in a particular product or service. In such conditions, trust in the environment, whether related to payment systems, data protection, or user reviews, becomes a key determinant in overcoming this uncertainty (Lu and Chen, 2021).

However, environmental trust alone is not enough. In many cases, consumers are also influenced by herd behavior, where they tend to follow the majority's actions without critical analysis. This phenomenon is increasingly prominent on social media and e-commerce platforms, where high reviews and ratings often determine purchasing decisions. A previous study by Ali and Amir (2024) showed that more than 70% of online purchasing decisions are influenced by most reviews, even though these reviews do not necessarily reflect the actual quality of the product.

A research gap in the literature lies in the need for studies integrating environmental trust, uncertainty, and herd behavior variables into a comprehensive theoretical model. Most previous studies tend to focus on these variables separately. For example, the study by Falahat *et al.* (2019) put more emphasis on environmental trust in the context of e-commerce, while Cakan *et al.* (2019) focused on uncertainty in consumer decision-making. Therefore, a more holistic approach is needed to understand how these three variables interact to influence consumer behavioral intentions.

This study aims to answer the following questions based on the phenomena and background explained.

- RQ1: Do environmental beliefs, uncertainty, and herd behavior generally influence consumer behavioral intentions?
- RQ2: Can uncertainty generally mediate the relationship between environmental trust and behavioral intentions?
- RQ3: Can herd behavior generally mediate the relationship between environmental beliefs and consumer behavioral intentions?

RQ4: Generally, does Gender moderate the relationship between environmental trust, uncertainty, herd behavior, and consumer behavioral intentions?

The meta-analytic structural equation modeling (meta-SEM) approach can analyze aggregate data from previous studies to answer research questions. By integrating environmental trust, uncertainty, and group behavior into one theoretical framework, this study was expected to provide new insights into how these factors can be used more effectively to influence consumer behavioral intentions.

2. Literature Review

2.1. Environmental Trust

Environmental trust, also called external or community trust, is a multifaceted concept encompassing individuals' or groups' trust in their broader social environment, including institutions, communities, and social networks. This trust is critical to fostering social cohesion, enhancing civic engagement, and promoting collective well-being (L'Hermitte and Nair, 2021).

One important aspect of Environmental trust is its correlation with social cohesion within a community. Previous research showed that trust is a foundational element of social cohesion, particularly in educational settings. Higher levels of trust correlate with increased social cohesion among the university community, suggesting that trust is integral to fostering a supportive educational environment (Nesterova *et al.*, 2020). Similarly, social trust is critical in many domains of life, including politics and societal interactions, where a decline in social status can lead to a decline in social trust over time, making it important to maintain trust in society to support social stability and cohesion (Brandt *et al.*, 2015).

Additionally, the implications of Environmental trust extend to health outcomes. A study by Hwang *et al.* (2020) found a significant association between social trust and cardiovascular health among older adults, suggesting that higher levels of trust within a community may lead to better health outcomes. This relationship suggests that trust facilitates social interactions and contributes to community members' overall health and well-being.

Social norms and individual perceptions also influence trust dynamics, as stated by Oyeboade and Nicholls (2023), who discussed how social norms could serve as anchor points for trust, influencing individual trust behavior within a community. This study highlights the role of cultural and social frameworks in shaping trust levels, suggesting that societal trust can be fostered through shared norms and values.

Environmental trust is vital in building relationships between consumers and digital platforms. In online marketing, environmental trust refers to consumers' confidence in their systems' integrity, reliability, and security. Environmental trust can cover payment security, personal data protection, and information transparency and is particularly relevant in the digital age, where consumers are often exposed to risks such as online fraud or privacy breaches (Sales *et al.*, 2021).

Environmental trust contributes significantly to consumer behavioral intentions, especially in purchasing decisions in e-commerce. Consumers with high trust in a platform tend to be more committed to making transactions (Al-Adwan *et al.*, 2022). Other research by Chu *et al.* (2021) showed that environmental trust increases consumer loyalty and reduces the perception of risk that may arise during the decision-making process.

Based on the explanation above, the research hypothesis proposed as follows:

H1: Environmental trust has an impact on uncertainty (UC)

H2: Environmental trust has an impact on herd behavior(HB)

H3: Environmental trust has an impact on behavioral intention (BI)

2.2. Uncertainty in Decision Making

Perceived uncertainty in decision-making refers to the subjective assessment of uncertainty associated with the outcome of a choice. This concept is critical in understanding how individuals and organizations navigate complex environments where information is incomplete or ambiguous. Perceived uncertainty can significantly impact the decision-making process, leading to variations in choices and outcomes across contexts (Fjaeran and Aven, 2021).

One of the fundamental aspects of perceived uncertainty is its relationship to confidence in decision-making (Gillman *et al.*, 2023). This idea was supported by the findings of Hong and Cho (2023), which suggested that individuals try to reduce uncertainty based on their existing knowledge before making decisions, especially in high-risk scenarios such as adopting new technologies. Furthermore, perceived uncertainty is not only a cognitive phenomenon but also has an emotional dimension. Perceived environmental uncertainty can have a significant impact on mental health, especially anxiety levels among college students. This anxiety, in turn, can influence their decision-making behavior, illustrating the interaction between emotional responses and cognitive appraisals of uncertainty (Kong and Zeng, 2023).

Uncertainty is one of the most significant barriers to consumer purchasing decisions, primarily online. This uncertainty includes consumers needing to know the product's quality, the seller's reliability, or the outcome of the purchase decision. Kim *et al.* (2021) explained that uncertainty can arise due to a lack of or ambiguous information. In such conditions, consumers are often reluctant to continue the transaction despite showing initial interest in a product.

Uncertainty can also affect environmental trust. Consumers who feel uncertain about the platform's integrity tend to perceive the entire purchasing process negatively. Reducing uncertainty can be done by providing precise and informative reviews or transparent return policies, which can significantly increase consumer behavioral intentions (Lu and Chen, 2021).

Based on the explanation above, the research hypothesis in this study is:

H4: Uncertainty (UC) has an impact on behavioral intention (BI)

2.3. Herd Behavior

Herd behavior plays a significant role in shaping customers' behavioral intentions, especially in environments characterized by social influence and collective decision-making. This phenomenon occurs when individuals within a group imitate the actions or decisions of others, often leading to behavioral convergence that can significantly impact market dynamics and consumer choices (Baddeley, 2013).

One of the primary ways herd behavior influences customer intentions is through social proof, where individuals look to the actions of others as a guide to their behavior. In financial markets, herd behavior manifests when individuals follow the crowd in their investment decisions, leading to increased volatility and potential market crises (Bu *et al.*, 2021). This concept can be extrapolated to consumer behavior, where customers may choose a product or service based on its perceived popularity or acceptance by others, thereby reinforcing collective purchasing decisions. The impact of herd behavior is particularly pronounced during periods of uncertainty or market crises where customers are more likely to purchase a product or service simply because they observe others doing so, regardless of their preferences or needs (Ah Mand *et al.*, 2023).

In social media, herd behavior is reinforced by the rapid spread of information and the visibility of consumer choices. A study by Chen *et al.* (2021) highlighted how customer motivation and engagement

behavior on social media could be influenced by peers' actions, suggesting that a positive feedback loop can emerge where customers are motivated to engage with brands already popular in their social circles. This finding is in line with findings from Xin Jean *et al.* (2017), which emphasized the role of social media influencers in shaping purchase intentions, as consumers often view these numbers as representative of broader social trends.

Based on the explanation above, the research hypothesis in this study is as follows:

H5: Herd behavior (HB) has an impact on behavioral intention (BI)

2.4. The Moderating Role of Gender in the Integration of Trust, Uncertainty, and Herd Behavior

Although each variable has been extensively studied in the integration between trust, uncertainty, and herd behavior, the relationship is sometimes linear. High environmental trust can sometimes reduce consumers' reliance on group behavior because they feel confident enough to make their own decisions. Therefore, further research is needed to understand the complex dynamics between these variables in various contexts.

The moderating role of Gender in integrating trust, uncertainty, and herd behavior is one area of study that examines how Gender influences individual and collective decision-making processes. Gender differences can significantly influence how trust is formed, how uncertainty is perceived, and how individuals behave in groups, especially in consumer behavior, social interactions, and organizational dynamics.

One important aspect of gender moderation is its impact on behavioral intentions, especially regarding technology adoption and consumer choice. Gender differences occur in the adoption of mobile banking services, and men and women may have different motivations and barriers that influence their intentions to use the technology (Glavee-Geo *et al.*, 2017). These findings suggested that Gender not only moderates the relationship between beliefs and behavioral intentions but also suggests that tailored approaches may be needed to address different genders' unique needs and concerns in technology adoption.

In addition, Frank and Seaman (2023) further stated the influence of Gender on group behavior and decision-making. They examined how public brand image affects repurchase intentions differently for male and female customers. Their findings suggest that gender differences strengthen the effects of brand perceptions on customer satisfaction and loyalty, suggesting that marketing strategies should be gender-sensitive to increase effectiveness.

Furthermore, a study by Gruning and Krueger (2023) highlighted the relationship between beliefs about uncertainty and intolerance of uncertainty, noting that Gender can influence how individuals cope with uncertainty in different contexts. Their research suggests that beliefs can shape emotional responses to uncertainty, which may differ across genders, influencing decision-making processes.

Based on the explanation above, the research hypothesis proposed is as follows:

H6: Gender moderates the relationship between environmental beliefs and uncertainty.

H7: Gender moderates the relationship between environmental beliefs and herd behavior.

H8: Gender moderates the relationship between environmental beliefs and behavioral intentions.

H9: Gender moderates the relationship between uncertainty and behavioral intentions.

H10: Gender moderates the relationship between herd behavior and behavioral intentions.

3. Research Elaboration

3.1. Research Approach

This study uses the Meta-Analytic Structural Equation Modeling (Meta-SEM) approach that comprehensively analyses the relationships between these variables based on aggregate data from multiple studies. Meta-SEM is an effective tool for identifying common patterns in the literature and testing complex theoretical hypotheses. This approach can also help overcome methodological limitations in individual studies, such as small samples or contextual bias (Jak *et al.*, 2021).

Meta-SEM also provides deeper insights into the mechanisms underlying the relationships between the variables studied and allows researchers to test more robust and generalizable theoretical models across contexts (Lee and Beretvas, 2022).

3.2. Data Sources and Types

The data sources come from the Scopus.com and Google Scholar databases. The data types are articles, proceedings, and book chapters published between 2000 and 2024 that discuss the relationship between the variables studied. The study used 106 studies from 84 documents.

3.3. Data Collection and Selection

The data collection process is carried out by determining specific keywords so that the articles that are the research objects can be used for research purposes. The data collection process uses keywords like Trust, Uncertainty, Herd behavior, and Behavioral intention. The keyword syntax used in this search is:

“((KEY (trust) AND KEY (uncertainty)) OR ((KEY (trust) AND KEY (herd)) OR ((KEY (uncertainty) AND KEY (herd)) OR ((KEY (trust) AND KEY (uncertainty) AND TITLE-ABS-KEY (intention)) OR (KEY (trust) AND KEY (uncertainty) AND KEY (herd) AND TITLE-ABS-KEY (intention)) AND PUBYEAR > 2001 AND PUBYEAR < 2025”

The inclusion criteria used include articles, proceedings, and book chapters published between 2000 and 2024, using English, published in indexed journals, and providing quantitative data such as the number of respondents and correlation coefficients between the variables studied. The data selection stage was done by applying the Prisma method (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), with the following process description (Figure 1).

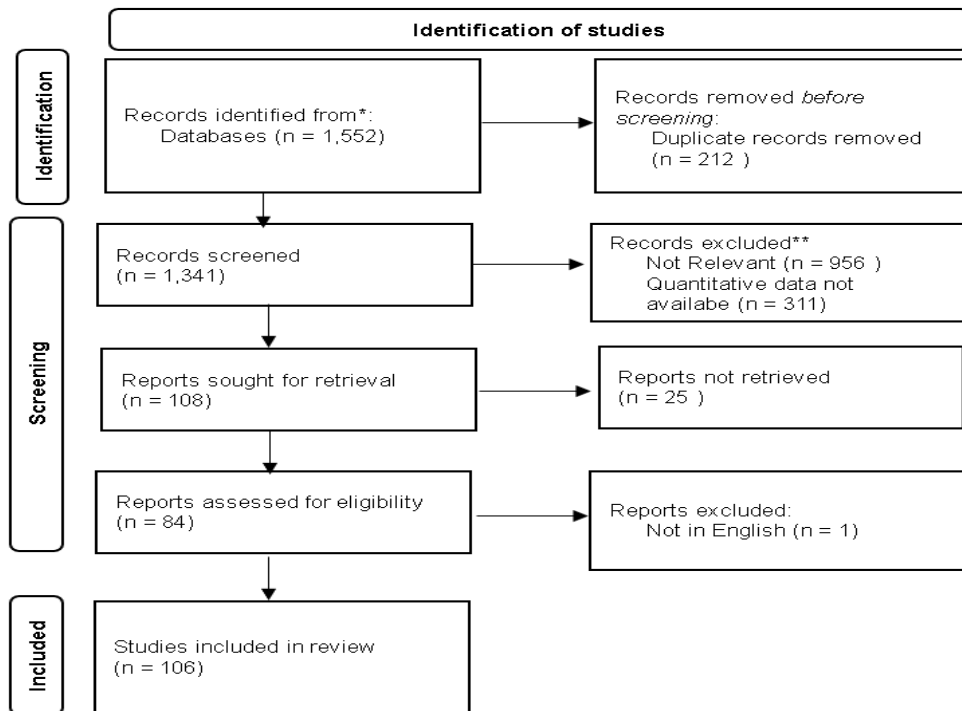


Fig 1: Data Selection Process-PRISMA
 Source: Prepared by Author

3.4. Data Analysis Techniques

Data analysis in this study was in the form of Pairwise Meta-Analysis and Meta-Analysis Structural Equation Model (Meta-SEM). The Pairwise meta-analysis data analysis technique is used to systematically evaluate the relationship between variables based on the results of various studies to obtain an overview of the effects, estimate the overall effect, and identify the level of heterogeneity. At the same time, Meta Analysis-Structural Equation Model (Meta-SEM) is used to evaluate the relationship between variables based on aggregate data from several studies by combining meta-analysis and SEM.

The R program syntax used in this study was adapted and modified to the Meta-Analytic Structural Equation Model script by Jak *et al.* (2021). The syntax modifications made include:

```

## Read in data
data <- read.table("Data_MetaSEM1.txt", header = TRUE, sep = "\t")
head(data)
nvar <- 4
varnames <- c("ET", "UC", "HB", "BI")
labels <- list(varnames, varnames)

## Create list of correlation matrices
cormatrices <- readstack(data[, 3:6], no.var = nvar, var.names = varnames, diag = FALSE)
## Create vector with sample sizes
n <- data$N

# Regression coefficients
UC ~ beta1*ET
  
```

```

HB ~ beta2*ET
BI ~ beta3*ET + beta4*UC + beta5*HB
# Variances
UC ~~ p1*UC
HB ~~ p2*HB
BI ~~ p3*BI
# Fix variances of independent variables
ET ~~ 1*ET
'

RAM1 <- lavaan2RAM(model, obs. variables = varnames)
RAM1

## Add moderator to the dataset
my.df$data <- data.frame(my.df$data, gender = data$gender, check.names = FALSE)
head(my.df$data)
## Create matrix for moderating effects
Ax <- matrix(c(0, 0, 0, 0,
               0, 0, 0, 0,
               "0*data.gender", "0*data.gender", 0, 0,
               "0*data.gender", "0*data.gender", "0*data.gender", 0),
             nrow = nvar, ncol = nvar, byrow = TRUE)
Ax
## Create the model implied correlation structure with moderator
M1 <- create.vechsR(A0 = RAM1$A, S0 = RAM1$S, Ax = Ax)
## Fit model with moderator
mx.fit1 <- osmasem(model.name = "gender as moderator", Mmatrix = M1, Tmatrix = T0, data = my.df)

```

The research model used is shown in Figure 2.

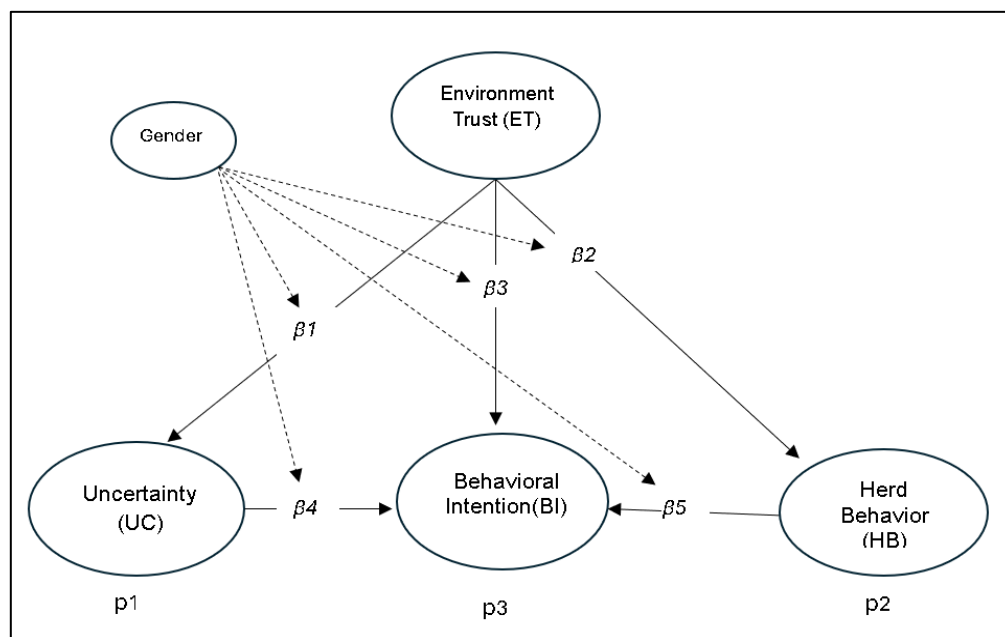


Fig. 2: Research Model
 Source: Prepared by author

4. Results and Discussion

4.1. Pairwise Meta-Analysis

Table 1 presents information about the number of studies, total sample size, effect size, standard error, upper-lower limits, and heterogeneity parameters of the studies used in this study.

Table 1. Pairwise Meta-Analysis

Relationship	k	N	Overall All Effect Size	Lower; Upper Bound	know2	Q Stat	I ²
ET→UC	37	16,779	0.176	[0.020; 0.330]	0.228	9215.5	99,280
ET→HB	8	1,983	0.222	[0.134; 0.310]	0.172	826.4	98,548
ET→BI	13	5,182	0.393	[0.175 ;0.612]	0.159	765.9	98,433
UC→BI	6	1,487	0.203	[0.119 ;0.494]	0.396	558.8	99.105
HB→BI	42	14,116	0.401	[0.233; 0.569]	0.340	6544.2	99.297

Note: k number of studies, N combined sample size,
 Source: Meta-SEM R Output

Based on Table 1. the relationship between Environmental Trust (ET) and Uncertainty (UC) has an overall effect of 0.176, indicating a strong relationship and the confidence interval [0.02; 0.330] does not include zero. The level of heterogeneity is very high ($I^2 = 99.280$), indicating a significant variation among the studies analyzed. Furthermore, the relationship between ET and Herd Behavior (HB) shows an overall effect of 0.222, indicating a strong relationship. The confidence interval [0.134; 0.310] does not include zero, supporting this result. However, heterogeneity remains high ($I^2 = 98.548$), indicating a significant difference between studies.

The relationship between ET and Behavioral Intention (BI) showed a more substantial effect with a value of 0.393. The confidence interval [0.175; 0.612] supports this result, but high heterogeneity ($I^2 = 98.433$) indicates substantial variation between studies. In contrast, the relationship between UC and BI shows a strong effect (0.203) with a confidence interval [0.019; 0.494], not including zero. The high heterogeneity ($I^2 = 99.105$) indicates highly variable results between studies. The relationship between HB and BI shows the most potent positive effect among the relationships analyzed, with a value of 0.401. The confidence interval [0.233; 0.569] strengthens this finding. However, heterogeneity remains high ($I^2 = 99.297$), reflecting substantial variation between studies.

The high level of heterogeneity across all relationships indicated the need for further analysis to understand other factors contributing to the variation in effects and for further moderator analyses to explain this variation. An approach that considers contextual factors, such as demographics, may help improve the interpretation and generalization of research results.

4.2. Meta-Structural Equation Modeling (Meta-SEM)

4.2.1. Beta Coefficient

The results of the Meta-SEM analysis showed a significant causal relationship between the variables in the model (Figure 3 and Table 2).

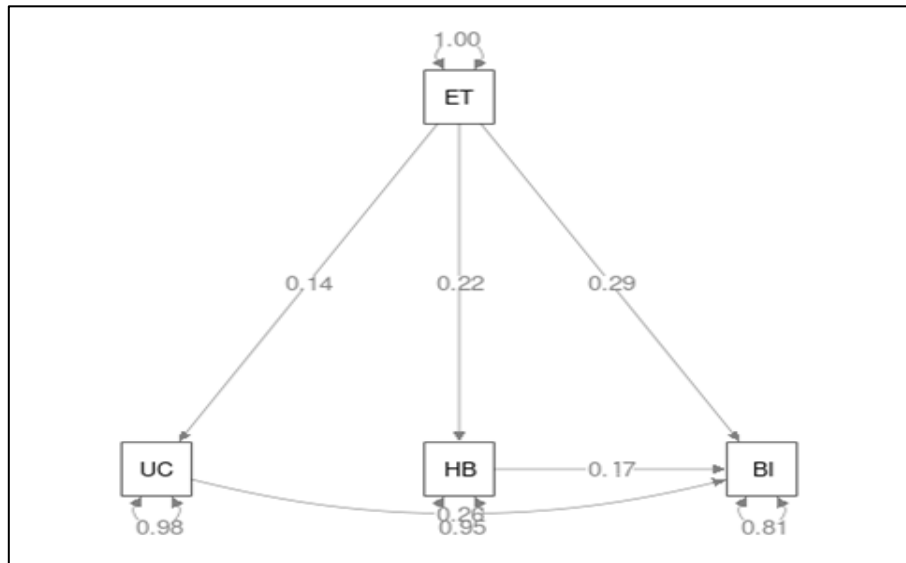


Fig. 3: Meta-SEM Plotting Non-Moderator Models

Source: Processed by researchers via web MASEM (<https://sjak.shinyapps.io/webMASEM/>)

Based on the parameter estimation results, Environmental Trust (ET) has a positive effect on Uncertainty (UC) with a coefficient of 0.143 ($z = 2.217$, $p = 0.026$), which is significant at the 5% level. Et al. so has a more substantial positive effect on Herd Behavior (HB) with a coefficient of 0.218 ($z = 5.139$, $p < 0.001$) and on Behavioral Intention (BI) with a coefficient of 0.288 ($z = 2.991$, $p = 0.003$). In addition, UC significantly affects BI with a coefficient of 0.264 ($z = 5.339$, $p < 0.001$), while HB also has a positive effect on BI with a coefficient of 0.168 ($z = 2.995$, $p = 0.003$). These results indicated that the relationship between variables in the model has strong empirical support, especially on the ET path to BI, both directly and through mediating variables.

Table 2. Beta Coefficient Meta-SEM Model

Hypothesis	Estimate	Std.Error	p-Value	Conclusion
H1:ET→UC	0.143	0.0645	0.026*)	Supported
H2:ET→HB	0.218	0.0424	< 0.001**)	Supported
H3:ET→BI	0.288	0.0963	0.003**)	Supported
H4:UC→BI	0.264	0.0494	< 0.001**)	Supported
H5:HB→BI	0.168	0.0543	0.003**)	Supported

*) Significant at 5% level, **) Significant at 1% level

Source: Meta-SEM R Output

4.2.2. Fit Model

Table 3 shows the level of model fit to the data (model fit). Based on the results of the analysis, the data model was perfect. The chi-square value of 0.003 ($p = 0.957$) indicates that the model almost entirely fits the data. Other indicators, such as RMSEA = 0, with a 95% confidence interval [0; 0.005], CFI = 1.018, and TLI = 1.111, strengthen this finding, indicating that the model is appropriate and may be too perfect. A very small residual (SRMR = 0.004) indicated that the remaining variance not explained by the model is very minimal.

Table 3. Fit Model

Model Statistics:

chi-square: χ^2 (df=1) = 0.002898024, p = 0.957068

Information Criteria:	df Penalty	Penalty Parameters	Sample Size Adjusted
AIC:	-163.4726	124.5274	124.5325
BIC:	-1340.6615	221.8889	186.9307
CFI:	1.018477		
TLI:	1.110864	(also known as NNFI)	
RMSEA:	0	[95% CI (0.004580851)]	
Prob(RMSEA <= 0.05):	1		

Source: Meta-SEM R Output

4.2.3. Residual and Between Studies Variances

Table 4 shows the residual variance of the variables used in Meta-SEM. Based on the residual variance values, the UC (0.9795) and HB (0.9525) variables indicate that there is still variability that the model has not fully explained. However, the residual variance for BI is more minor (0.8103), which means that the model successfully explains most of the variability of BI. On the other hand, the analysis of variance between studies revealed significant heterogeneity, especially in the relationship between UC and ET (0.152) and HB and BI (0.152). This variability indicates that the results between studies are not uniform and need further analysis to understand the specific context that influences the results.

Table 4. Residual Variances and Correlation Coefficients Between Study Variances

	Residual Variance	Correlation Coefficients of Between Study Variances
<i>Residual:</i>		
ET	1,000	
UC.	0.980	
HB	0.953	
BI	0.810	
<i>Relationship:</i>		
UC_ET		0.152
HB_ET		0.000
BI_ET		0.105
HB_UC		0.230
BI_UC		0.086
BI_HB		0.152

Source: Meta-SEM R Output

Table 4 also shows significant variations in correlation between several pairs of variables. The largest correlation was found in the relationship between UC and ET and HB and BI, each with a variance value of 0.152.

4.2.4. Moderator Analysis

The results of the moderation analysis in the form of beta coefficient testing are presented in Table 5 below.

Table 5. Beta Coefficient Of Moderator Analysis

	Estimate	Std.Error	p-Value	Conclusion
Beta1	0.129	0.063	0.0402	Supported*)
Beta2	0.180	0.082	0.0297	Supported*)
Beta3	0.334	0.084	<0.001	Supported**)
Beta4	0.251	0.227	0.0269	Supported*)
Beta5	0.066	0.082	0.0423	Supported*)
H6: Gender *ET_UC	0.085	0.051	0.0096	Supported*)
H7: Gender *ET_HB	-0.128	0.238	0.0591	Not Supported
H8: Gender *ET_BI	0.021	0.388	0.0956	Not Supported
H9: Gender *UC_BI	-0.073	0.733	0.0921	Not Supported
H10: Gender *HB_BI	0.134	0.143	0.0348	Supported*)

*) Significant at 5% level, **) Significant at 1% level

Source: Meta-SEM R Output

Table 5 shows that the gender variable significantly moderates only the relationship between ET and UC and the relationship between HB and BI in this study (H6 and H10 are supported). While hypotheses H7, H8, and H9 cannot be supported because the p-value is <0.05, it can be said that Gender cannot moderate the relationship between ET and HB, ET and BI, and UC and BI.

The highest beta estimate value was found in gender moderation on the relationship between HB and BI (0.1334), which indicated that Gender had a more substantial influence on this relationship than moderation on other relationships.

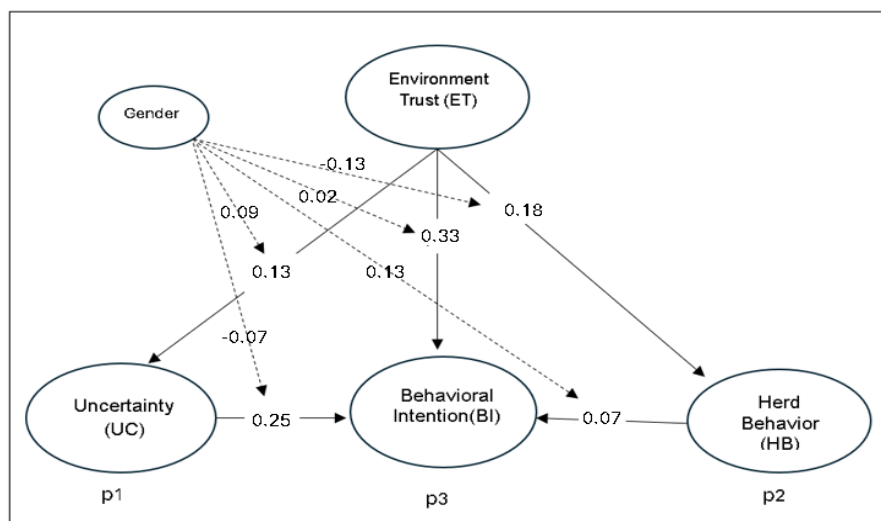


Fig. 4: Plotting Moderator Model

Source: Prepared by author

Based on the model testing results (Table 6), the overall analysis model showed a good fit based on the AIC and BIC criteria, with an adjusted AIC value of 128.9327 and a BIC of 219.6906. Variations between studies in model correlations also reflect the level of heterogeneity of the variable relationships, with the highest variance between HB and UC (0.2257) and UC and ET (0.1412).

Table 6. Fit Model

Information Criteria:	df Penalty	Penalty Parameters	Sample Size Adjusted
AIC:	-159.0779	128.9221	128.9327
BIC:	-1292.0116	270.5388	219.6906

Source: Meta-SEM R Output

Furthermore, the inter-study variation in model correlations also reflects the degree of heterogeneity of the variable relationships, with the highest variance between HB and UC (0.2257) and UC and ET (0.1412). The results in Table 7 indicate that differences between studies, including potentially relevant contextual factors, influence these relationships. The combination of the moderation results and the model fit evaluation supports the conclusion that Gender is an important variable influencing how environmental trust, uncertainty, and herd behavior predict consumer behavioral intentions.

Table 7. Between Studies Variances Of Correlation Coefficients

<i>Between-studies variances of model-implied correlation coefficients</i>	
UC_ET	0.141
HB_ET	0.000
BI_ET	0.105
HB_UC	0.226
BI_UC	0.086
BI_HB	0.141

Source: Meta-SEM R Output

Discussion

Environmental trust significantly affected consumer uncertainty, herd behavior, and behavioral intention. The coefficient of 0.143 ($p = 0.026$) indicates that environmental trust can effectively reduce uncertainty. This result supports previous findings by Huang et al. (2022), which stated that uncertainty reduction is often mediated by the level of trust in the information source or system used. In addition, environmental trust also has a positive effect on herd behavior ($\beta = 0.218$, $p < 0.001$), indicating that consumers who trust a platform are more likely to follow the majority's actions. This finding is in line with the study by Chen et al. (2021), which showed that most reviews on online platforms often influence consumer decisions, especially if consumers feel confident in the platform's credibility.

The effect of environmental trust on consumer behavioral intentions shows a coefficient of 0.288 ($p = 0.003$), strengthening the argument that trust is a key element in driving purchase intentions. A study by Al-Adwan et al. (2022) also supported this finding, finding that high environmental trust in e-commerce platforms increases consumer loyalty and reduces risk perception.

Uncertainty, although having a significant relationship with behavioral intention ($\beta = 0.264$, $p < 0.001$), showed a lower level of influence than other variables and suggests that the influence of uncertainty on behavioral intention is more indirect and is often moderated or mediated by other variables, such as environmental trust and herd behavior. Research by Lu and Chen (2021) supported this by stating that uncertainty can often be minimized through risk mitigation strategies, such as clear return policies or transparent user reviews.

Herd behavior strongly affects consumer behavioral intention ($\beta = 0.168$, $p = 0.003$). This finding supports previous studies by Ah Mand et al. (2023)), which showed that majority reviews or collective actions often influence consumer behavior in online environments. This herd behavior is reinforced by social mechanisms, such as social networks and influencer influence, which make collective actions an indicator of decision validity.

The variation analysis results show that the relationship between the variables is heterogeneous across studies, likely caused by differences in context, method, or sample characteristics in the studies analyzed. In addition, the relationship between BI and ET has a variance of 0.105, which, although smaller than the other relationships, still reflects differences between studies. This variation emphasizes the importance of considering contextual factors that may influence the results, such as culture, demographics, or specific environmental conditions, better to understand the dynamics of the relationships between variables.

The Meta-SEM model used perfectly fit the data, as indicated by the model fit indicators ($\chi^2 = 0.003$, $p = 0.957$; RMSEA = 0; CFI = 1.018). However, the high level of heterogeneity (I^2 above 98% for most relationships) indicates substantial variation between the studies analyzed. This result indicates that context, culture, and sample-specific characteristics influence the relationships between variables.

Furthermore, the results of the moderation analysis show that Gender moderates the relationship between environmental trust and uncertainty as well as between herd behavior and behavioral intention. In the relationship between environmental trust and uncertainty, gender moderation provides a coefficient of 0.085 ($p = 0.009$), indicating that men and women may respond differently to uncertainty based on their level of trust in the environment. Glavee-Geo et al. (2017) stated that demographic factors, including Gender, can influence how consumers process information and make decisions.

The results of the model testing with gender moderation indicate that these relationships may be influenced by differences between studies, including potentially relevant contextual factors. The combination of the moderation results and the evaluation of the model fit supports the conclusion that Gender is a variable that can influence how environmental trust and herd behavior affect consumer uncertainty and behavioral intentions.

5. Conclusion

This study successfully revealed a significant relationship between environmental trust, uncertainty, herd behavior, and consumer behavioral intention in a digital context. The results of the Meta-SEM analysis showed that Environmental Trust (ET) has a positive influence on Uncertainty (UC) with a coefficient of 0.143 ($z = 2.217$, $p = 0.026$), which is significant at the 5% level.

ET also has a more substantial positive influence on Herd Behavior (HB) with a coefficient of 0.218 ($z = 5.139$, $p < 0.001$), as well as on Behavioral Intention (BI) with a coefficient of 0.288 ($z = 2.991$, $p = 0.003$). In addition, UC significantly affects BI with a coefficient of 0.264 ($z = 5.339$, $p < 0.001$), while HB also has a positive influence on BI with a coefficient of 0.168 ($z = 2.995$, $p = 0.003$).

Based on the study's results, environmental trust significantly reduces uncertainty, encourages herd behavior, and increases consumer behavioral intentions. In addition, uncertainty and herd behavior have also been proven to play an important role as mediating variables in the relationship. However, the effect of uncertainty is relatively weaker compared to other variables.

Herd behavior is dominant in influencing consumer behavioral intentions, especially in the digital environment, where reviews, recommendations, and collective action play a significant role in decision-making. Gender moderation provides additional findings suggesting that demographic factors may influence how the relationship between these variables is formed, especially regarding environmental trust and herd behavior.

6. Research Implications

Theoretically, this research contributes to the marketing literature by helping us better understand how the interaction between trust, uncertainty, and collective behavior can predict and influence consumer behavioral intentions, especially in the digital era.

Furthermore, this study's findings are very relevant to modern marketing practices. By understanding the relationship between environmental trust, uncertainty, and herd behavior, marketers can design more effective strategies to increase consumer behavioral intentions. Strategic marketing activities such as increasing consumer trust in the platform through transparency and security can be a significant first step.

This study provides several practical implications for businesses, especially in digital marketing and e-commerce strategy. By highlighting the role of environmental trust, uncertainty, and herd behavior in shaping consumer behavioral intention, our findings can inform how businesses build consumer confidence and drive conversions.

First, the strong influence of environmental trust suggests that companies must enhance transparency, ethical practices, and data security to foster trust. Demonstrating commitment to sustainability or social responsibility can enhance trust, as consumers are increasingly sensitive to environmental issues. Second, addressing perceived uncertainty is critical. Businesses can reduce uncertainty by offering guarantees, clear return policies, and detailed product information. As our study shows, lowering uncertainty positively affects behavioral intentions. Third, leveraging herd behavior—such as showcasing product reviews, ratings, and testimonials can reinforce social proof and guide consumers in decision-making. This is particularly effective in social media environments where visibility and influence are amplified. The integrated model helps businesses understand that consumer intention is not only driven by rational factors but also by psychosocial elements. Tailoring strategies to strengthen trust and reduce uncertainty while utilizing the power of social influence will enable more effective marketing interventions and higher customer engagement.

7. Research Limitations

This study's limitations are its reliance on secondary data from previous studies and its lack of exploration of broader contextual variables. Therefore, further research is recommended to explore the role of contextual factors, such as culture and social norms, in influencing this relationship to gain a more holistic insight into the dynamics of consumer behavior in the evolving digital context.

Another limitation is the high heterogeneity across studies, which indicates that these results are highly contextual and influenced by various factors, such as culture, social norms, and sample characteristics. Therefore, further research is recommended to explore the role of contextual factors and expand the theoretical framework to more comprehensively understand the dynamics of consumer behavior.

8. Conflict Of Interest Statement

The authors declare no conflicts of interest regarding the publication of this article. The research was conducted independently, and no financial, professional, or personal interests were identified to influence the results. All data sources and methodologies used were transparent, and any potential biases were addressed to ensure the integrity of the findings.

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Financial Development and Sectoral Growth In the West African Monetary Zone

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Abstract. *This study adopts a panel estimation technique in evaluating the responsiveness of sectoral growth to financial development in the West African Monetary Zone (WAMZ). Financial development is disaggregated into bank development measured by the ratio of credit to the private sector to gross domestic product, while market development is measured as the quotient of market capitalization to economic growth, and insurance penetration is measured by aggregate premium over economic growth. The results arising from this study hold that financial development positively affects the growth of the agricultural, manufacturing and service sectors in the WAMZ. In line with the supply-leading hypothesis, it is recommended that the financial system development should be pursued to accentuate an all-inclusive growth of a growth-seeking region like WAMZ.*

Keywords: Financial Development; Agricultural Growth; Manufacturing Growth; WAMZ

JEL Codes: G15, E52

1. Introduction and Background

Launched in December 2000 to foster a monetary union for the member nations, the West African Monetary Zone has a membership base made up of Sierra Leone, Liberia, Nigeria, Guinea, Ghana and The Gambia. The West African Monetary Zone is an extremely diverse region with economic dependence and is mostly conflict-prone.

The rationale for WAMZ establishment was to advance intra-regional trade, collaboration of monetary policies, boost economic growth and integration as well as improve the overall economic prospect of the participating nations, adopt a common currency system, reduce transaction costs, exchange rate uncertainty elimination and a smooth flow of investment and trade in the region. However, a divergent economic structure and varying inflation rates have hindered the efforts towards the achievement of the earlier stated West African Monetary Zone objectives.

The region is still grappling with high debt distress risks, hence there is still uneven growth throughout the WAMZ. As of June 2023, some countries were classified as either highly vulnerable to or already experiencing external debt distress, though several factors, including the COVID-19 pandemic, recent poly-crisis, and climate-related problems, contributed to the weight of these debts. To regain financial liberty and sustainability, some effort is being made to start the debt reformation process. Economic planners now must concentrate heavily on financial development on a global scale (World Bank development, 2023).

Financial development is the extent to which people, businesses and private organizations have access to financial services unrestrictedly, in a very low price, and with long-term revenue streams. It is defined as the depth (scale and liquidity of markets) of these markets. It is astonishing to learn that the IMF gave regions as well as West African monetary nations more than \$50 billion between 2020 and 2022 more than twice as much as it has given out in any ten-year span since the 1990s. Additionally, as of March 2023, the IMF had lending agreements with 21 nations, including all of the West African monetary nations, and additional requests were being reviewed (IMF, 2023). Overall, it appears that these nations' economies are still being hampered by the continent's largest nations' below-average performance, particularly in the energy, transportation, and oil sectors, which have long impeded economic activities (Nigeria is a case in point). Their natural resource potentials, however, should offer a chance to strengthen the countries' debt and budgetary sustainability.

Development of the financial sector and economic growth are essential components of every economy, developed or emerging, which cannot be separated. This is because developed countries must retain the stability they have already established in their financial and growth sectors, whereas developing countries are always working to accomplish both in their economies. (Olaniran & Aderajo, 2018). For any economy to function, the financial system plays a crucial role because it directs resources toward economic actors with favorable investment opportunities. (Schumpeter, 1912). Most of the countries that made up the West African monetary zone have been on the verge of advancing their financial development through several strategic planning processes. For instance, the National Economic Empowerment and Development Strategy (NEEDS), took effect in 2004 in pursuit of economic development. The implementation of Risk Based supervision (RBS) Basel 1 and 11 in 1988 and 2004 respectively, the International Financial Reporting Standard (IFRS) in 2001 (George and Godwin, 2018), and many others were aimed at achieving a certain threshold of the sustainable financial environment, yet challenges like

Macroeconomic Policies, Economic Disparities, Institutional Capacity, Political Instability and External Shocks has made it unattainable. Economic development is also a pursuit of most nations trying to move from underdeveloped to developed countries. Conversely, it can be adduced that the linear association of growth and financial development has made the impact of sectoral growth less significant, whereas policies related to growth are postulated at sectoral levels. More than that, the influence of Industry expansion becomes more acceptable than the overall growth, as diverse sectors have diverse concentrations of funds expectations and also efficiency (Yazidu, Fanta and Ashenafi, 2021).

However, finance thrust to these real sectors of the economy has shown significant variation across economic sectors. Additionally, the agricultural sector is the most adversely affected irrespective of its significant contribution in terms of the provision of food, foreign exchange, employment, market for industrial goods and income. In Nigeria, for example, between 2018 and 2023, budgetary allocation to agriculture oscillated. It increased from 1.70 % in 2017 to a higher figure of 2.00 % in 2018 and later came down to 1.56% in 2019, and a further reduction to 1.34 per cent in 2020. This was followed by a slight increase to 1.37% in 2021, 1.8% in 2022 and 1.5% in 2023. Chukwuezie (2021) observed that Nigeria has been adjudged as a leading agribusiness economy with top exportation of such agricultural produce like palm oil, cotton, groundnut, cocoa, etc. Regrettably, crude oil discovery led to the neglect of not only the agricultural sector but also other productive sectors.

Gambia heavily relies on agriculture but has a limited agricultural base. The Agriculture sector accounts for approximately 30% of GDP. Ghana also accounted for GDP at 18.85%, 19.66% and 19.53 in 2020, 2021 and 2022 respectively. Strategic policies have been made in several ways directed towards repositioning the agricultural sector, like Root and Tuber Expansion Programme (RTEP) of 2021, the National Food Sector Plan (NFSP) of 2007, the National Agricultural Technology and Innovation Policy (NATIP) of 2021 and the Agriculture Transformation Agenda (ATA) of 2013. (Tochukwu and Florence, 2024). In all this, the agricultural sector's contribution to GDP is not discouraging as it contributed 25.1% in 2017, 25.1% in 2018, 25.2% in 2019, 23.69% in 2022 and 23% in 2023 even though it was abandoned for oil dependency that still has not contributed as much as the neglected agricultural sector. Total agriculture credit is not encouraging, the condition is significantly the same across other WAMZ countries, as financial institutions do not treat agriculture as a priority sector. Additionally, the cost of extending credit to the agricultural sector is relatively high due to the presence of multiple low-volume transactions, which increases administrative expenses and operational complexity.

It is also essential to evaluate the performance of the manufacturing sector. According to the Central Bank of Nigeria, the manufacturing sector was the second highest beneficiary of bank loans in 2023 (CBN, 2022) and contributed 10% to the total GDP. For Ghana the contribution for 2018 and 2019 stood at 31.18% respectively, it had a decrease between 2020 and 2021 from 29.88% to 28.4% while in 2022 it went up to 31.99%. This oscillation in growth rate can be blamed on the

difficulties faced by this sector which include a tough operating environment and reduced ease of doing business.

The service sector globally remains competitive and arguably the largest in terms of value addition to any economy whether developed or developing. This is confirmed by Ghana's service sector GDP of 2016, 2017, 2018, 2019, 2000, 2021, and 2022, at 43.92%, 43.48%, 43.68%, 45.14%, 45.19, 45.32 and 31.99 respectively (Ghana Stat., 2022). Also, the Gambia's services sector contribution to GDP accounts for up to 65% of the Gambia's GDP. However, Nigeria is not left behind, showing the highest service sector GDP contribution of 55.8% in the region within the period under investigation.

One of the veritable tools that have been used to engineer economic development is financial development. This thought is supported by Schumpeter (1911) in the explanation of the financial development and economic growth nexus, tagged "supply leading hypothesis". This explains the fact that the supply of financial resources leads the economy, while growth comes as an outcome. Another economist has contrary opinions as Kuznets (1955) proposes that financial markets can develop just like the economy evolves into an intermediate phase of development as the economy becomes more established.

Financial development policies have been put in place in the region over the years by the West African Monetary Institute (WAMI) in cooperation with other sub-regional institutions (the West African Monetary Agency and the ECOWAS Commission), to drive growth through the sectors. WAMI has over the past ten years been able to drive financial development and integration through the zone harmonization of banking supervision procedures and the creation of effective payment system (See Maverick, Chip and Katrina, 2021; Ibrahima, et al. 2017; Reddy, 2003; Mohan, 2005 and Trichet, 2005). Emmanuel (2018) holds that in the mid-'80s, the WAMZ financial sector had a thorough restructuring and market-oriented innovations following the enactment of the liberalization laws. Expanding the financial system, will enhance monetary policy and the way financial intermediation operates. (Ang and McKibbin 2007; George et al. 2018). Norman, Romain and Amine (2018) observed that the engine of economic expansion is finance. But if left unchecked, it might lead to an economic catastrophe. Also, Law and Singh (2014); and Isaac et al. (2022) caution that excessive financial development in developing nations should be reined in when identifying the variables that can shape the sector, as it can cause the economy to heat up and slow down growth.

Financial sector development as a strategy for driving growth is expected to expand investors' access to funds, including their borrowing options (Mihalca, 2007). This is in addition to other functions such as efficient intermediation, reduction in transaction cost and ensuring information symmetry. Poor financial system in an economy only promotes poor economic growth with aggregate poverty and force a large proportion of people to live below the poverty line in the region. Based on the foregoing, the primary question is whether financial development promotes

economic expansion. The debate over whether financial development propels or is driven by economic expansion is the primary question that this study attempts to answer. The importance of the financial system to economic growth is yet to be clearly defined, hence, there are divergent views on the role of financial development in economic growth. There are raging controversies as to which one drives the other. Whichever way, some nations are categorized as developed or developing countries. There is no consensus in the literature on whether the impact of financial development on economic growth is overly negative or positive. Most studies have reported that financial development positively affects economic growth (See Christopoulos and Tsionas; 2004, Sunde, 2013; Adusei, 2012). Earlier in the 20th century, emergent theorist, Schumpeter (1934) noted that financial markets drive economic growth by directing funds to efficient investors and promoting entrepreneurial innovation. The view of Hicks (1969) holds that one of the important roles played by financial organizations is to gather finances for industrialization. Sen (1999) observed that the availability of funds and the ability to gain access to them help the economy to function strongly. In the same line, King and Levine (1993) stated that economic growth activities and performance are the result of financial institution significance. Nevertheless, there are other contrary views. An example of this is Robinson (1952) who argues that demand for financial services can be created by economic development. (cited in Okwo, Eze and Ugwunta, 2012).

Lewis (1956) argues that balanced growth across sectors is essential for sustainable development. The balanced growth path argues that all sectors should expand at a consistent rate. (Yazidu and Ashenafi, 2021). Since the mid-2000s, it is evident in many published works that the positive and negative aspects of finance should be measured mutually (Norman et al., 2018). Lucas (1988) and others considered not financial sector development as a prerequisite for economic growth arguing that its role is being “badly overstressed” by economists. Also, George et al. (2018) supported this by saying that the causality flows from economic growth to finance, and that growth drives financial sector development. This has been a global argument but not many works have brought that down to the WAMZ.

However, most studies on financial development and economic growth nexus have either been country-specific, works like those (Habtamu, 2013; Adusei and Nkrumah, 2013; Emeka and Kelvin, 2013; Igo Lazarus, 2014; Nnanna, 2004; Nzotta and Okereke, 2009; Olofin and Afangideh, 2009; Ebiringa and Duruibe, 2015; Umar, 2010; Adegbite, 2004; Chekwube, Anne, Chibuike and Chukwunonso, 2014) focused on Nigeria, while other like (David, 2012; Nebbio, 2004; Ellene, John and Omar, 2013; Ajayi, 2018; Odhiambo, 2007; Shani, Alhassan, Ibrahim and Mamdouh, 2023; Muazu and Paul, 2017; Yazidu, Ashenafi and Wai, 2020; Mac, Eric, John and Seyram, 2020) and many other on Ghana (George, George and Justice, 2013; China & Liang, 2007). Conversely, studying the contribution of financial development to sectoral growth aggregately will not give us real insight and a picture of how much impact financial development has contributed.

Hence, evaluating the influence of sectoral growth as a diverse industry could have diverse degrees of financial burden including the efficiency level. The way the financial sector drives this sectoral growth is of strong investigative interest. Consequently, trying to find an answer to these questions within the context of the West African monetary zone is the focus of this study.

2. Theoretical foundation of the study

Different schools of thought have different views on the linkage between financial development and economic growth. The key theories in this sense include the Supply-leading hypothesis, Endogenous growth theory, finance-led growth hypothesis, and Demand-following (growth-led) hypothesis.

The supply-leading hypothesis holds that the economy's reaction to real sector growth is driven by financial development. Robinson (1952) presented a different view of the supply-leading hypothesis and stated that the hypothesis predicts growth based on the performance of the financial sector.

Following Endogenous growth theory, in line with De Gregorio and Guidotti (1995); Tekilu, Wondaferahu and Jibril (2018), the linkage between financial sector development and the economy remains a subject of ongoing debate among policymakers and researchers. According to classical growth theorists, economic development emerges from a continuous process of innovation, wherein financial institutions interact with the real economy to stimulate dynamic economic growth. This theoretical framework aligns with the notion that exogenous technological progress serves as the principal basis for long-run economic growth, while the role of financial intermediaries is not regarded as an independent factor influencing long-term growth rates.

Endogenous growth theory contends that growth is a product of internal rather than external factors. This theory posits that sustained economic growth is achievable through investments in human capital. Furthermore, it emphasizes that the overall growth rate of an economy is policy-dependent, which may include the ones that relate to financial development (See Pagano, 1993).

The finance-led growth hypothesis as opined by Schumpeter (1911) contends that a functional financial sector is essential for facilitating the growth of all the sectors, which subsequently drives the growth of the entire economy. In addition, the level of economic growth depends on the degree of financial sector development or deepening. The financial sector grows proportionately with the supply of financial services. The supply-leading hypothesis, also known as the "finance-led growth hypothesis," explains the mechanism through which financial deepening promotes and stimulates economic growth (McKinnon 1973 and Shaw 1973). A developed financial sector facilitates the creation and accessibility of financial services in anticipation of demand from participants in the real sector.

There is also the demand-responsive hypothesis, a widely recognized argument proposed by Robinson (1952), which suggests that increasing economic activity generates increased demand

for financial services especially for the real sector, which also improves the use and access to financial products and services.

Empirically, work has been carried out in this area and more are still ongoing, both within the country and at cross-country levels. However, investigated works centered on West African Monetary Zones (WAMZ) are few.

From the reviewed literature the major gap that this work intends to fill includes the following:

- Disintegrating growth into three sectors, namely, Agricultural, Manufacturing and Service sectors. Showing evidence on West African monetary zone. Most work that studied the nexus between financial development and economic or sectoral growth has either centered on country-specific or only examined a single sector. This work will not only show aggregate impact but also disaggregate the impact of these sections of financial development on the section of economic growth.
- Uncoupling of financial development into three sections, e.g., bank development, stock market and the growth and advancement of the insurance sector. These are the three strategic sectors that drive financial sector development.

3. Methodology

The data for this work is secondary in nature, using annualized and panel data respectively, which will cover a period of 43 years, from 1980 – 2023. The data was drawn from World Development Indicators (WDI). The data employed for this work are panel data sets which are secondary.

The major theoretical consideration for this study is the view proposed by Pagano (1993), which is the endogenous growth model, the simple AK model which is specified thus:

$$Y_t = AK_t \quad (1)$$

Where Y_t reflects output as a function of capital stock:

$$\phi S_t = I_t \quad (2)$$

From equation 1, the growth rate is given as:

$$g_{t+1} = \frac{Y_{t+1}}{Y_t} - 1 = \frac{K_{t+1}}{K_t} - 1 \quad (3)$$

Leaving off the time indices from equation (2), the model is rewritten thus:

$$g = A \frac{I}{Y} - \delta = A\phi s - \delta \quad (4)$$

Following the Yazidu, Ustarz Ashenafi, Beyene and Fanta (2021) we used the understated model:

$$SVA_{it} = \beta SG_{it-1} + \phi FD_{it} + \alpha X_{it} + \varphi_i + e_{it} \quad (5)$$

$$IVA_{it} = \beta IG_{it-1} + \phi FD_{it} + \alpha X_{it} + \varphi_i + e_{it} \quad (6)$$

$$AVA_{it} = \beta AG_{it-1} + \phi FD_{it} + \alpha X_{it} + \varphi_i + e_{it} \quad (7)$$

Where: SVA = Value Addition in Service; IVA = Value Addition in Industry; AVA = Value Addition in Agriculture

The panel estimator for this study follows the ARDL framework presented in an estimable format as follows:

$$SG_{it} = \beta_o + \sum_{n=1}^k \beta_1 SG_{it-1} + \sum_{n=1}^k \beta_2 BDV_{it-1} + \sum_{n=1}^k \beta_3 INP_{it-1} + \sum_{n=1}^k \beta_4 SMD_{it-1} + \delta_1 SG_{it} + \delta_2 BDV_{it} + \delta_3 INP_{it} + \delta_4 SMD_{it} + \varepsilon_{it} \quad (8)$$

$\delta_1 - \delta_4$ = Coefficient of the short-run estimates

$\beta_1 - \beta_4$ = Coefficient of the long-run estimates

ε_{it} = error term (residual term)

The variables for this study are summarized below:

Table 1: Description of Model Variables

S/No	Name of Variable	Notation	Role in the model	Source
1.	Agricultural Sector Growth	ASG	Dependent Variable	World development indicators. (WDI)
2.	Manufacturing Sector Growth	MSG	Dependent Variable	World development indicators. (WDI)
3.	Service Sector Growth	SSG	Dependent Variable	World development indicators. (WDI)
4.	Bank Development	CPSGDP	Independent Variable	World development indicators. (WDI)
5	Stock Development	MCAPGDP	Independent Variable	World development indicators. (WDI)
6	Insurance Penetration	INSP	Independent Variable	Global financial development database (GFDD)

where = (WDI) World development indicators; (GFDD) = Global financial development database.

Source: Authors Compilation

The variables are used in line with their description in the model and form the basis for the determination of the relationship between financial development and growth in the studied region.

Results

The basic descriptive statistics of sectoral growth indicators and financial development indicators are presented in Table 2.

Table 2: Summary of Basic Descriptive Statistics

	Mean	Median	Std. Dev.	Skewness	Kurtosis	CV
AGRVAD	20.81	1.24	4.79	1.844832	5.473696	0.2302
CPSGDP	7.925840	6.815948	5.450897	0.784077	3.437353	0.6876
INSLIFE	0.207919	0.064559	0.123953	1.746219	5.087930	0.5961
MCAPGDP	20.26	8.51	3.09	1.920414	7.128003	0.1525
MVAD	10.809169	2.389552	9.011843	-0.68932	5.343784	0.8337
SVAD	50.131650	3.989819	9.425463	5.319838	54.36918	0.188

Source: Authors' Computation

Apart from the array of statistical averages reported in Table 2, we give specific attention to the coefficient of variation or the relative standard deviation, which is the quotient of the standard deviation over the mean. The relative standard deviations for all the series are all below unity (1). This proves that the financial development and sectoral growth indicators are not widely dispersed and can make good quantitative combinations in a model. This also shows that the panel series are not affected by extreme observations and outliers.

Secondly, a panel correlational matrix is presented in Table 3 to show the extent of linear association among the panel series. This is an important step in showing the possibility of multi-collinear observations and can give information about the statistical comovement of the series.

Table 3: Panel Correlational Matrix

Correlation						
t-Statistic						
Probability	AGRVAD	CPSGDP	INSLIFE	MCAPGDP	MVAD	SVAD
AGRVAD	1.000000					

CPSGDP	0.013574	1.000000				
	0.074352	-----				
	0.9412	-----				
INSLIFE	-0.522072	0.376391	1.000000			
	-3.352679	2.225218	-----			
	0.0022	0.0337	-----			
MCAPGDP	0.778279	0.197463	-0.317608	1.000000		

	6.788791	1.103270	-1.834605	-----		
	0.0000	0.2787	0.0765	-----		
MVAD	0.187028	0.275655	0.176499	0.343361	1.000000	
	1.042795	1.570680	0.982146	2.002402	-----	
	0.3054	0.1267	0.3339	0.0544	-----	
SVAD	-0.012403	0.240022	-0.071008	0.183762	0.280029	1.000000
	-0.067939	1.354240	-0.389910	1.023944	1.597704	-----
	0.9463	0.1858	0.6994	0.3140	0.1206	-----

Source: Authors' Computation

Bank development (CPSGDP) and Market development (MCAPGDP) are found to positively correlate with all the sectoral growth indicators in the West African Monetary Zone. Conversely, insurance penetration shares a negative correlation with most of all the growth indicators except manufacturing value added. This will not be unconnected with the fact that risk and its mitigating approaches can be prejudicial to sectoral growth. Though this is not a test of causation and elasticity, it gives primary evidence of a possible negative impact of insurance on sectoral growth in the West African Monetary Zone.

In addition, the stationarity properties of the variables are assessed using a variety of panel unit root tests for purposes of robustness check. The result is of the form reported in Table 4.

Table 4 – Panel Unit Root Test Results

Variables	LLC	Breitung	IPS	ADF- Fisher	Inferences
AGRVAD	-5.801(0.000)	-4.772(0.000)	-5.283(0.000)	58.452(0.000)	I(0)
CPSGDP	-5.411(0.000)	-5.825(0.000)	-6.747(0.000)	68.101(0.000)	I(1)
GDPGROWTH	-4.514(0.000)	-6.722(0.000)	-5.967(0.000)	60.268(0.000)	I(0)
INSLIFE	-6.713(0.000)	-6.100(0.000)	-5.546(0.000)	32.524(0.000)	I(0)
MCAPGDP	-6.213(0.000)	-4.454(0.000)	-6.149(0.000)	36.611(0.000)	I(0)
MVAD	-5.491(0.000)	-4.419(0.000)	-5.224(0.000)	30.122(0.000)	I(0)
SVAD	-5.305(0.000)	-2.631(0.043)	-5.047(0.000)	28.857(0.000)	I(0)

Source: Authors' Computation

The Levin, Lee and Chu, Breitung, Im, Pesaran and Shin, including the Augmented Dickey Fueler Fisher Panel tests form the basis for determining the stationarity of the variables. All the test statistics are consistent in showing the series to have a combination of I(0) and I(1). This provides sufficient justification for the use of the dynamic panel estimators in the form of Panel-ARDL.

The results of the panel estimation following the autoregressive distributed lag model framework are presented in Table 5.

Table 5: Panel ARDL Estimates

Variables	Model One $AGRVAD = f(CPSGDP, MCAPGDP, INSGDP)$	Model Two $MVAD = f(CPSGDP, MCAPGDP, INSGDP)$	Model Three $SVAD = f(CPSGDP, MCAPGDP, INSGDP)$
CPSGDP	0.82 15.51 0.000	2.72 5.01 0.000	0.21 2.37 0.00
MCAPGDP	4.32 17.19	0.37 5.11	0.38 11.63

	0.000	0.000	0.000
INSLIFE	-1.17 11.21 0.000	1.80 2.25 0.026	1.04 2.66 0.012
ECT ₍₋₁₎	-0.93 51.78 0.000	-0.88 301.7 0.000	-0.99 5.18 0.000

Source: Authors' Computation

The result shows that bank development and stock market development positively and significantly affect the growth of the sectors of the WAMZ's economies. Every unit change in bank development brings about 0.82 units, 2.72 units and 0.21 unit changes in the agricultural, manufacturing and service sectors respectively. For every unit change in stock market development, the agricultural sector responds by 4.32 units, the manufacturing sector by 0.37 units, while the service sector's increase in value-added stands at 0.32 units.

The insurance sector draws a mixed response from the sectors. Agricultural sector value added is found to be a negative and significant function of insurance penetration with a -1.17 unit coefficient of elasticity. The insurance sector contributes positively and significantly to the value-added of the manufacturing and service sector with an elasticity coefficient of 1.80 units for the manufacturing sector and 1.40 units for the service sector.

To measure the speed of adjustment of the value added of the sectors to the shocks and distortions arising from the financial development variables, we present the error correction representations of the three models.

With negatively significant error correction coefficients of 93%, 88% and 99%, the economic value added of the agricultural, manufacturing and service sectors, respectively adjusts to the shocks and dynamics of financial development in the West African Monetary Zone. This means that deviations from equilibrium in the short run are restored fully at 93% (Agriculture), 88% (Manufacturing) and 99% (service) in the long run. This means that the speed of adjustment in time stands at slightly above one year for every one of them. The coefficients, being less than 100%, show the economic predictability of the relationship between the investigated financial development variables and the sectoral economic value added.

4. Conclusion and Policy Implications

This research adopts a panel estimation technique in evaluating the influence of financial development on the growth of the sectors of the economies of countries in the West African Monetary Zone. The results arising from this study support the fact that financial development exerts an increasing effect on the growth of the agricultural, manufacturing and service sectors in the WAMZ. The findings of this study follow the supply-leading hypothesis, which holds that economic growth in the real sector is a response to financial development. The hypothesis which is

consistent with our findings expects that the financial sector's growth and development precede and induces real growth.

This study has a policy implication of driving growth through an intentional pursuit of financial sector development. This is because a well-developed financial system will accentuate an all-inclusive growth of both the real and service sectors of the economy in a growth-seeking region like WAMZ.

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The Monty Hall Problem and High-Frequency Trading: The Value of Information and Speed Combined Together

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Abstract. *The counter-intuitive probabilistic features hidden within the Monty Hall problem display a strong relationship to the dynamics of stock market. Decisions in either system are driven by information and decision-makers may decide whether sticking to their original choice or switching to an alternative one based on their epistemic state. One aspect of this paper deals with the connections between optimal information management suggested by the Monty Hall problem and its application to financial markets. However, in modern markets, mere possession of information superior to most other participants cannot guarantee abnormal returns if it is not supported by low execution latency. This is the second aspect discussed in the paper. The conclusion of the paper is that information and speed combined together create the conditions needed to achieve above average returns. It comes to no surprise that heavy investments go to increasing trading speed, potentially leading to a technological ‘arms race’ that carries high private benefits and high social costs. The main contribution of this paper is the use of simple mathematics to demonstrate how publicly available information, when used at high speed, may ensure abnormal market returns for the few ultra-fast traders, so disrupting the social purpose of stock markets.*

Keywords: Abnormal return, High-Frequency Trading, Monty Hall Problem, Technical Analysis

JEL Codes: _G11, G12, G15

1. Introduction

1.1. The Monty Hall Problem

The Monty Hall problem (MHP or ‘the Problem’) is a TV game show that surged to the honor of academic debate. The Problem is well known. The game host (a male) shows the player (for example, a lady) three closed doors. Two doors conceal no prize and only one conceals a car. The game starts with the player selecting one of the doors. Then, the host knowingly opens an empty door and offers the player a chance to change her mind. She will get whatever is concealed behind the door selected on her second choice. The question is: should the player stick to, or switch, her initial choice? (The right answer is switching, as it increases winning chances from $1/3$ to $2/3$). With a couple of letters to The American Statistician in 1975 (Selvin 1975a; Selvin 1975b), the biostatistician Steve Selvin opened a Pandora Box that has not closed yet. Actually, this apparently simple, yet counterintuitive, problem is so rich in details and subtleties to allow Dr. Jason Rosenhouse to write a whole book on many different aspects of statistics, all springing out from the Monty Hall problem (Rosenhouse 2009).

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1.2. Technical Analysis

Technical Analysis (TA) “refers to the study of the action of the market itself as opposed to the study of the goods in which the market deals” (Edwards et al., 2001, p.4). The theory is summarized by Kirkpatrick and Dahlquist (2011):

- (a) stock prices are determined solely by the interaction of demand and supply;
- (b) stock prices tend to move in trends;
- (c) shifts in demand and supply cause reversals in trends;
- (d) shifts in demand and supply can be detected in charts;
- (e) chart patterns tend to repeat themselves.

A trend is a price movement into a definite direction that continues for a sufficiently long period of time to be identified and taken advantage of. Trends can be identified through statistical tools. Lo (2004) proposed the Adaptive Market Hypothesis, a framework according to which agents adjust their strategies as market conditions change, following a standard competition-adaptation-selection-evolution scheme. More recently, Alonso-Monsalve et al. (2020) focused on neural networks but still making use of TA. TA makes large use of patterns. A pattern is a graphical price profile that has a lower and an upper bound. Within such a band, prices can and do move freely but their movements are controlled by band boundaries. If permanence within a band goes on long enough to allow identification and exploitation, profit probabilities increase. The patterns sought by tech-analysts are the most varied and even though recognizing a pattern ex-post is pretty easy, identifying one ex-ante is not. Bulkowski (2021) indicates, for various types of patterns, the breakout failure rate and the average price rise or decline in case of upward and downward breakout, respectively. The break-even failure rate represents the percentage of days in which returns is negative, that is, the trader loses money and the average price rise/decline represents the average daily price change - a rise in the case of a bull market and a decline in the case of a bear market. The author uses several databases to carry out the analysis, the main one consisting of 500 stocks, with all data referring to the period 1991-2004. The conclusion that the author draws is that all chart patterns analyzed in the research show rather low break-even failure rates. That means that identifying the right patterns and closely following them, ensures consistent above average returns with very few nasty surprises over time. Imagination is not amiss among TA researchers. Some proposed a link between price movements and Fibonacci numbers sequence (Krausz n.d.), psychology-based trading, Bollinger Bands and Relative Strength Index (Thorpe 2000a), Stochastic Oscillators (Thorpe 2000b), Candle Sticks (Bigalow 2002; Nison 1991), and lots of charts, momentums and moving averages.

Aside from Technical Analysis, recent papers suggested some kind of deep learning (a branch of Artificial Intelligence) to identify optimal trading strategies (Abergel, 2020; Briola, 2020). Ferreira et al. (2021, p.30898) revised 2300+ papers to identify techniques based on “portfolio optimization, stock market prediction using AI, financial sentiment analysis, and combinations [thereof]”. Petukhina (2021, p.19) suggests that “it is easily possible to derive sentiment and therefore market reactions from Twitter, Facebook, Stocktwits, or similar”. TA is just one example, albeit perhaps the most widely adopted, but by no means the only technique, to make educated market guesses.

1.3. High-Frequency Trading and the Importance of Speed

While a combination of MHP and Technical Analysis may improve the chances of profitability, High-Frequency Trading (HFT) adds speed to the recipe to ensure abnormal returns. Speed has always been an important factor in financial markets. It is not without reason that financial traders have been early users of technological advancements in communication speed (Markham, 2015). Nowadays, communication speed is

achieved through dedicated submarine cables, fiber optics and microwaves. Beunza et al. (2011) enumerate four lawful categories that trading algorithms can be grouped into: market-making, inter-market arbitrage, statistical arbitrage, and order anticipation strategies. All these strategies benefit from information speed. Hasbrouck and Saar (2013), analyzing publicly-available NASDAQ data, suggest that low-latency trading improves market quality measures: decreases bid-ask spread, increases liquidity, and reduces short-term volatility. To achieve low latencies, HF traders make use of recent technologies, whence it comes the parallel with the notorious arms race of the Cold War in the 1970s and 80s. Leber et al. (2011) explain how any mean is allowed to reduce latencies: Field Programmable Gate Arrays (FPGAs hardware, FAST (FIX Adapted for Streaming) communications protocols, co-location (location of computers within the exchange premises), and efficient software. Bare-bone algorithms allow saving precious microseconds sacrificing the depth of financial analysis. Fiber optics telecommunications that used to take 6.6 milliseconds between the New York Stock Exchange in Mahwah, New Jersey, and the Chicago Mercantile Exchange data center in Aurora, Illinois, have been abandoned in favor of microwave towers, in order to shave off 1.6ms along the trip (MacKenzie et al., 2012; Lewis, 2014). The main contribution of this paper is providing a demonstration of how a combination of information and speed may attain above average return for the few to the detriment of the rest of the trading community.

1.4. Why Is the Monty Hall Problem Relevant to the Stock Market?

The scenario depicted by the MHP is akin to what happens in the stock market. In the beginning, a TA trader evaluates the conditions and decides on a certain strategy but does not implement it. Initially there are many possible choices among patterns and, in the stock market similarity, the market itself ‘opens the doors’ by successively excluding inapplicable patterns. Indeed, Siddiqi (2009) finds a relationship between that cognitive bias that he calls ‘the lure of choice’ at the individual level and the intensity with which it impacts market prices. As fractions of a second go by, the trader acquires more information about price trends and updates her strategy accordingly, until when the final decision is made and she submits the order to the market (Herbranson & Wang 2014). A trader stands facing the market as in the Monty Hall example above. She/he gains higher chances to close their deal profitably as patterns selection based on more, and more recent, information guarantees better outcomes. Similarly, to the MHP, pattern-driven information increases the chances to enter profitable trading. Overall, Kirkpatrick and Dahlquist (2011), consistently report pattern profitability above 80% over the observation period. If we assume N trades during a certain time and the minimum goal is avoiding a loss in that period, with combinatorial calculus it is easy to work out the probabilities of achieving the goal. It can be assumed that all trades involve the same amount of money and therefore the goal becomes getting some losses lesser than the number of wins.

2. Method

The method to verify that a combination of TA and ultra-fast trading is capable of achieving above-average performance is twofold. In the first place, it has been devised a sound technique for ensuring a break-even failure rate of slightly less than 50%. In this case, TA seems a reasonable choice although it is by no means the only one. Nevertheless, mere use of TA does not ensure consistent abnormal return because the technique is very well known and thousands of market traders use it every day. Therefore, to defeat the competition, orders must be executed at very high speed, with HFT. Combinatorial calculus is used to show that the combination of TA and HFT (meaning a very large number of trades per day) results in consistently profitable trading, which converts into above-market returns. The application of MHP to the stock market can be depicted as follows. The HFT algorithmic trader observes the stock market, through data quotation. When the situation seems appropriate, a hypothesis is made about a TA pattern. The trader keeps observing

market movements and verifies whether such movements comply with the chosen pattern. If they do not, the trader selects a different pattern that resembles more to the movements of stock prices. This process repeats until the algorithm evaluates that a sufficient level of confidence in the chosen pattern has been reached. If so, the order executes, otherwise it keeps observing the market and postpones its decision. It must be noted that trading can continue around the clock. Because of HFT, deals may occur several thousand times per day.

3. Results

3.1. How the MHP applies to the stock market: Technical Analysis

Table 1 and Table 2 are derived from Bulkowski (2021), who uses 1991-2004 data from a database containing 500 stocks, most from NYSE, AMEX, and NASDAQ. Although his research displays a large number of statistics, graphs and discussions, Tables 1 and 2 just show the two most fundamental numbers: break-even failure rate and average price rise/decline, in the case of bull and bear markets. The results are varied.

3.1.1. Upward Breakouts

In case of upward breakouts (Table 1), the break-even (B-E) failure rate ranges from 0% with 69% and 42% return in bull and bear markets, respectively (pattern Flags High and Tight) to 22% or 20% (pattern Scallops Descending with 22% or 15% return (patterns: Scallop Descending in a bull market and Right-Angled and Ascending in a bear market). Break-even failures are expected to be lower than 8% at a 95% confidence level if averaged across all patterns in either market, whereas average rise or decline, at the same confidence level, stays above 25% and 35% in the bear or bull market, respectively.

<Table 1 about here>

3.1.2. Downward Breakouts

In the case of downward breakouts (table 2) statistical analysis yields rather bold results, too. B-E failures remain pretty low, between 0% and 2% (Pennants in the bear market and Flags in the bull market) with 23% to 44% return (Head-and-Shoulders Tops Complex and Diamond Bottoms, in bull and bear market, respectively).

<Table 2 about here>

The maximum B-E failures reach 27% (Scallops Ascending) in bull market and 20% (Scallops Descending) in bear market. Minimum returns range between 14% (Scallops Ascending) in bull market and 18% in bear market (Broadening Bottom). At 95% confidence, the average break-even failure is below 12% for a bull market and below 7% for a bear market. The average rise/decline is no less than 17% (bull market) and above 23% (bear market), respectively. The previous analysis provides some indication of the overall value of chart patterns and Technical Analysis when they are being correctly applied. Overall, following TA patterns is, according to Bulkowski (2021), a good choice. As highlighted even by the boldest followers of such a technique, the difficulty is to correctly identify the right pattern without being deceived by other similar, but incorrect, patterns. Actually, in markets populated by a crowd of atomized, uninformed, day-traders (as is the case of modern markets), the very large number of probability judgment error (noise) is

balanced out by the huge number of ultra-fast informed trades launched by a tiny number of high-frequency traders.

3.2. How the MHP applies to the stock market: High-Frequency Trading

An original relationship between the MHP and HFT has been revealed by Seyfert (2016) by highlighting how the same data owned by slow and fast traders leads to different conclusions and therefore to different behaviors in the market. Things must not only be done right; they must also be done fast. Success will only reward those who get there first. This consideration naturally leans toward ultra-fast trading. Indeed, HF traders can make use of very frequent information arriving sequentially (given by price movements) to adapt their strategies to the most suitable TA pattern. Staying ahead of the competition in ultra-fast trading is the goal. This competition, according to several authors, such as Aquilina et al. (2022), and Teall (2023), among others, leads to an arms race where, the subject that could not follow continuous increase of costs just to stand still, admits defeat and surrenders. Indeed, HFT profits started and continued high in the early years of the XXI century (Arnoldi, 2016), only to get flat in the second phase of HFT lifetime (Verousis et al. 2018), to rise again recently with the introduction of Artificial Intelligence techniques (Aït-Sahalia & Saglam, 2024).

3.3. Applying combinatorial calculus

Math somehow supports the hopes of technical traders although theory is not always complied with by the practice. Nevertheless, if the percentages even remotely resemble Bulkowski's figures, abnormal returns will be pocketed. The probability of k success in a binomial experiment is

$$P(k) = P(k \text{ successes}) = {}^nC_r p^k q^{(n-k)} \quad (1)$$

where P is the probability of achieving k successes, ${}^nC_r$ is the combination of k elements from a set of n distinct objects, p is the probability of one success and q (=1-p) is the probability of one failure. In order to maximize chances of success, n, a number of daily trades must go up by increasing the frequency of trades, using HFT. When TA goes hand in hand with ultra-fast trading, things, at least in theory, appear very rosy. Figure 1 shows the increase in return safety for break-even failure rates equal to 49%, 48% and 47% (all much higher than in Kirkpatrick & Dahlquist, 2011) as daily trades increase. Even more explicative are tables 3, table 4 and table 5, showing the number of yearly break-even failure rates in correspondence with the number of daily trades, Failure frequency shows the number of 'losing days' per year (assuming 250 trading days).

<Figure 1 about here>

These tables clearly show that in the presence of even modest return safety levels (i.e. break-even failures rates just below 50%), when the number of trades is low, traders enjoy a relatively low number of expected bad days in a year.

<Table 3 about here>

<Table 4 about here>

<Table 5 about here>

This is the typical case of professional traders adopting TA tools. Yet, tables 3, 4 and 5 show combinatorial calculations for up to 10,000 trades per day. That is far from an impossible occurrence for HFT during the 27,000 seconds in a typical trading day, 9:00 am to 4:30 pm. As the number of trades increases, break-even failure rates drop dramatically, reaching, in case of break-even failure rate = 47% and 10,000 operations per day, the rather safe probability of closing with a loss one day every nearly four-and-a-half million years.

4. Discussions

4.1. MHP, TA and HFT: Putting All Together

The Monty Hall Problem provides a framework that some authors find suitable for studying the behavior of market traders, highlighting the importance of information and its correct use. Of course, this is not only applicable to TA and HFT but in the environment created by the combination of both, information assumes a special meaning. Although TA patterns may unwind over weeks or months, they may also appear at very short timeframes and consequently make use of information at the sub-second level. Traders can modify their initial decision according to information arrived over the very last few seconds, if they are humans or microseconds, if they are computer algorithms. If a price movement does not follow the pattern initially assumed, the smart trader will switch rather than stick, picking up the one that most closely adapts to the actual profile that unrolls in the market. As in the MHP, the initial technical analyst choice is very likely to be wrong, and the more likely wrong the higher the number of patterns available. Again, switching is the correct strategy. Technical Analysis theory has produced a reasonably large number of profitable patterns and ensures that, if the correct pattern is identified and carefully followed, then fruitful gains will be reaped. Statistical analysis applied over the years on TA patterns (Bulkowski 2021) promises clear chances of success.

4.2. The Social Value of HF, Technical, MHP-driven Trading

The rosy picture drawn in the previous section for High-Frequency-technical traders is certainly not always rosy for all. Traditional, or low-frequency, traders do not enjoy the benefits of ultra-fast transactions but they run into the costs HFT generates. HFT reduces volatility during quiet times but may exacerbate it when markets are under stress, that is, exactly when volatility spikes might turn into disasters (Kirilenko et al. 2017). If trading is a zero-sum game, as Pagnotta and Philippon (2018) suggest, then profitable innovations for one side reveal to be losses for the other(s). According to Farmer and Skouras (2012, p.22) “[t]he private value of more relative speed would remain large even though the social value of more speed is negative”, and Budish et al. (2015) assign social optimal value to slow trading, as compared to HFT, a form of trading in which many suffer and only a few win. In this process, the total technology investment costs may exceed the total benefit. This is a crucial point: despite ensuring abnormal profits for HF traders to the detriment of slow traders, whether total wealth is increased or decreased makes a big theoretical difference. Given a certain amount of extra profit for fast traders, if total wealth increases, some kind of just resource assignment can be thought of via a mechanism such as the Tobin tax. A Tobin tax is a fiscal imposition designed to hit speculative flows of money and since HF transactions would very likely fall within its relevance, much discussion has flourished about it. On the other side, if total wealth were diminishing face to increased profits of ultra-fast traders, social justifications of HFT would fade away. As Farmer and Skouras (2012, p.22) remark: “many individual investors are harmed by market speed, each by a relatively small amount which

however is much larger than the benefits from speed which are extracted by just a few institutions”. Nevertheless, the speed race keeps moving ahead. NASDAQ and Chicago Mercantile Exchange, which in 2014 provided market data with millisecond granularity, after a few years moved to nanosecond granularity: a clear sign of increased care for HF clients’ requests. Menkveld (2014) reports some of the arguments in favor and against HFT. Its defendants claim that the whole market benefits from quicker reflection of news into prices, making markets more efficient. On the other side, the author finds that HF firms overinvest in technology concerning the social optimum and he is sceptical about the social value of timely information efficiency. In this sense, he aligns himself with Paul Krugman, the 2008 Economics Nobel Prize winner, who declared:

“It’s hard to imagine a better illustration (of social uselessness) than high-frequency trading. The stock market is supposed to allocate capital to its most productive uses, for example by helping companies with good ideas raise money. But it’s hard to see how traders who place their orders one-thirtieth of a second faster than anyone else do anything to improve that social function... we’ve become a society in which the big bucks go to bad actors, a society that lavishly rewards those that make us poorer.” P. Krugman, New York Times, 2/8/2009

Joseph Stiglitz, 2001 Economics Nobel Prize winner, refers to “a general theorem (using general results in the theory of statistical decision making) suggesting that the costs of slight improvements in information may outweigh the benefits” (Stiglitz 2014, p.5) and even that, by accessing information before others, “has resulted in an unlevel playing field, allowing [fast traders] to garner rents for themselves at the expense of others” (Stiglitz, 2014, p.13). Hirschey (2021) also finds that HFT impose traditional investors with higher trading costs.

5. Conclusions

The purpose of this paper was to compare the Monty Hall problem to information imbalance in the stock market and demonstrate that speedy information leads to above-average performance. Indeed, the Problem bears a profound resemblance to how modern financial markets work. Its counter-intuitive Bayesian solution adapts easily to the choices made every day, hours, seconds, and fractions thereof by informed, technical, and high-frequency traders. In both situations, a subject makes a decision and, based on market information, she/he can either confirm or change such a decision, much like the MHP. The higher complexity of financial markets with respect to a TV show resides in the very large amount of information that must be taken into account and interaction with a very large number of competitors. Choice in financial markets is given by the rather large number of chart patterns provided by Technical Analysis. Assuming a trader is sufficiently experienced to consistently pick up the pattern that fits the price profile best, she is more or less guaranteed to enjoy a reasonably low break-even failure rate. It means that, over a sufficiently large number of pattern applications, she can hope to make a loss (not breaking even) only a very low number of times compared to the total. That should be enough to avoid overall losses and, quite likely, to make a gain at the end of the day. Even if break-even failure rates were much higher than those shown by Bulkowski (2021), experienced technical traders could expect to close a trading day successfully most of the time. However, information alone is not enough, no matter how good; it needs to be coupled with ultra-high speed. Speed of execution has been a critical success factor ever since in financial markets. Executing trades quickly rather than slowly, presents two advantages: the near guarantee to get first to a profitable deal and the possibility to executing many more deals per time unit. This paper demonstrated that combining information and execution speed enormously increases the chances of profitable trading. Whereas most practitioners recognize the advantages of HFT, academia is not so clear-cut, and some scholars even think HFT provides no advantage at all.

Therefore, a definitive mathematical demonstration, as shown above, could help to settle the matter. The results could be useful to market regulators and policy makers. Indeed, making speedy use of information provided by chart patterns, although a good way to achieve financial success for the few, may not be the most desirable path for the financial community at large, market regulators and the whole economy.

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Table 1: Break-even failure rate and average price movements (rise in bull market and decline in bear market) in case of upward breakouts

	B-E failure rate		Average rise/decline	
	Bull market	Bear market	Bull market	Bear market
Broadening Bottom	10%	9%	27%	21%
Right-Angled and Ascending	11%	11%	29%	15%
Right-Angled and Descending	19%	6%	28%	23%
Broadening Tops	15%	11%	29%	24%
Broadening Wedges Ascending	2%	0%	38%	18%
Broadening Wedges Descending	6%	11%	33%	24%
Bump-and-Run Reversal Bottoms	2%	1%	38%	31%
Cup with Handle	5%	7%	34%	23%
Diamond Bottoms	4%	3%	36%	36%
Diamond Tops	10%	0%	27%	33%
Double Bottoms Adam & Adam	5%	7%	35%	24%
Double Bottoms Adam & Eve	5%	4%	37%	33%
Double Bottoms Eve & Adam	4%	8%	35%	23%
Double Bottoms Eve & Eve	4%	7%	40%	24%
Flags	4%	3%	23%	17%
Flags High and Tight	0%	0%	69%	42%
Head-and-Shoulders Bottoms	3%	4%	38%	30%
Head-and-Shoulders Bottoms Complex	4%	3%	39%	31%
Horn Bottoms	9%	7%	35%	27%
Island Reversals	18%	10%	23%	21%
Islands Long	11%	4%	31%	25%
Pennants	2%	2%	25%	21%
Pipe Bottoms	5%	4%	45%	32%
Rectangles Bottoms	10%	11%	46%	24%
Rectangles Tops	9%	16%	39%	20%
Rounding Bottoms	5%	5%	43%	31%
Rounding Tops	8%	16%	37%	19%
Scallops, Ascending	10%	16%	31%	19%
Scallops Ascending and Inverted	4%	7%	43%	26%
Scallops, Descending	22%	20%	22%	20%
Three Raising Valleys	5%	9%	41%	22%
Triangles, Ascending	13%	12%	35%	30%
Triangles, Descending	7%	9%	47%	27%
Triangles Symmetrical	9%	7%	31%	26%
Triple Bottoms	4%	8%	37%	23%
Wedges, Falling	11%	11%	32%	26%
Wedges, Rising	8%	14%	28%	17%
Average	7.64%	7.65%	35.30%	25.08%
Standard deviation	5.07%	4.92%	8.65%	5.85%

(Source: Bulkowski, 2021)

Table 2. Break-even failure rate and average price movements (rise in bull market and decline in bear market) in case of downward breakouts

	B-E failure rate		Average rise/decline		
	Bull market	Bear market	Bull market	Bear market	
Downward Breakouts	Broadening Bottom	16%	9%	15%	18%
	Right-Angled and Ascending	20%	8%	15%	22%
	Right-Angled and Descending	14%	4%	15%	23%
	Broadening Tops	18%	3%	15%	20%
	Broadening Wedges Ascending	11%	14%	17%	21%
	Broadening Wedges Descending	9%	2%	20%	25%
	Bump-and-Run Reversal Tops	5%	1%	19%	27%
	Cup with Handle Inverted	11%	2%	16%	26%
	Diamond Bottoms	10%	9%	21%	44%
	Diamond Tops	6%	4%	21%	24%
	Double Tops Adam & Adam	8%	11%	19%	19%
	Double Tops Adam & Eve	14%	7%	18%	22%
	Double Tops Eve & Adam	13%	5%	15%	24%
	Double Tops Eve & Eve	11%	2%	18%	25%
	Flags	2%	8%	16%	25%
	Head-and-Shoulders Tops	4%	1%	22%	29%
	Head-and-Shoulders Tops				
	Complex	4%	1%	23%	27%
	Horn Tops	7%	2%	21%	22%
	Island Reversals	17%	5%	17%	23%
	Islands Long	5%	2%	22%	26%
	Pennants	4%	0%	19%	25%
	Pipe Tops	11%	2%	20%	27%
	Rectangles Bottoms	16%	4%	14%	25%
	Rectangles Tops	11%	9%	17%	21%
	Rounding Tops	12%	9%	19%	23%
	Scallops, Ascending	27%	14%	14%	19%
	Scallops, Descending	22%	20%	22%	20%
	Scallops Descending and Inverted	10%	5%	18%	23%
	Three Falling Peaks	12%	4%	17%	24%
	Triangles Ascending	11%	3%	19%	24%
	Triangles Descending	16%	11%	16%	25%
	Triangles Symmetrical	13%	9%	17%	19%
	Triple Tops	10%	5%	19%	24%
	Wedges Falling	15%	6%	15%	24%
	Wedges Rising	24%	15%	14%	20%
	Average	11.97%	6.17%	17.86%	23.86%
	Standard deviation	5.83%	4.71%	2.61%	4.40%

(Source: Bulkowski, 2021)

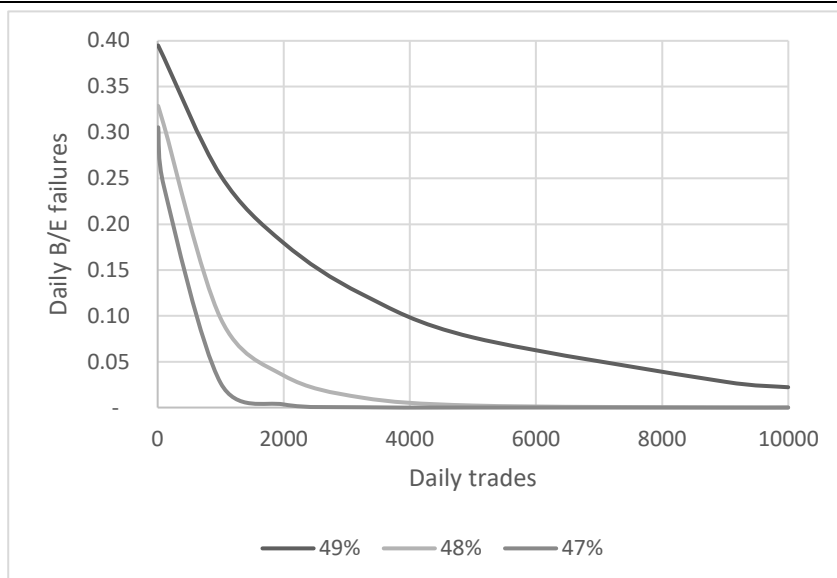


Figure 1 Decrease of daily break-even failures as a function of daily trades (Source: author's elaboration)

Table 3. Failures and failure frequency per number of daily trades with B-E failure rate = 49%

Break-even failure rate = 49%			
Daily trades	Daily failures	Failure frequency	
10	0.353	88.15	per year
100	0.382	95.48	per year
1000	0.253	63.31	per year
10000	0.022	5.55	per year

(Source: author's elaboration)

Table 4. Failures and failure frequency per number of daily trades with B-E failure rate = 48%

Break-even failure rate = 48%			
Daily trades	Daily failures	Failure frequency	
10	0.329	82.21	per year
100	0.308	77.04	per year
1000	0.097	24.31	per year
10000	3.014E-05	1	every 133 years

(Source: author's elaboration)

Table 5. Failures and failure frequency per number of daily trades with B-E failure rate = 47%

Break-even failure rate = 47%			
Daily trades	Daily failures	Failure frequency	
10	0.306	76.42	per year
100	0.241	60.34	per year
1000	0.027	6.68	per year
10000	8.963E-10	1	every 4,450,000 years

(Source: author's elaboration)

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Sustainable marketing and sales performance, an unavoidable synergy for companies: Morocco as a case study

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Abstract. *This article looks at marketing in the light of sustainable development in terms of its theory and practice. It demonstrates how compliance with environmental certification programs, the focus of consumers' needs and wants, and ethical communication shape consumer behavior about responsible consumption. This research will also seek to compare the effects of these practices on business returns, especially customer loyalty, market exposure, and the achievement of a viable competitive advantage. The research methodology uses both quantitative and qualitative data by collecting the performances of companies that respond to sustainable management and using the observations of the marketing managers. The signals offered by the comparative analysis are useful for various economies and sectors where the issue of responsible marketing is important. The findings discussed below support the proposition that marketing responsibility enhances product management realization, growth and satisfying the increasing consumer demand for sustainable products through creating a competitive advantage in "markets sed". Its main focus is on the economic objectives' optimization of sustainable development within sociopotential and ecological responsibilities. Finally, the article provides helpful propositions for enterprises interested in changing their strategic management and incorporating the principles of sustainable development into the framework of corporate strategies and activities that will enhance their position on the market.*

Keywords: Business performance, competitive advantage, consumer behavior, responsible marketing, sustainable development.

JEL Codes: M31, C15

1. Introduction

Today, marketing and corporate social responsibility seems like good bed fellows. However, marketing in particular and the field in general have not always paid much attention to the quality of their links with the market, or more generally, the environment. The exchange relationship between producers and distributors with consumers is increasingly far from fair: the information gap and the imbalance of the power relationship are the focuses created for the company based on its objective to best manage the relationship established with consumers. What's more, there is some confusion: is it right to discuss social marketing or are we more inclined to cause marketing and or just plain 'green' marketing? Moreover, what links such a state with some form of responsibility is not very clear at all. Is marketing then an inherently ethical and responsible endeavor whose chief purpose is to perpetually seek to enhance the quality of the organization's commercial offering and that of its relational and organizational milieu? This question can be quite puzzling, as this discipline is always associated with a bad taste in most instances.

A lot of this is owed to the fact that a number of professionals are involved in practising what can be easily construed as criminal undertakings rather than seeking to meet the otherwise implied or expressed promises to consumers through products marketed. Even though most researchers ignore the theoretical definition and differentiate marketing from selling, marketing can be defined as a “process dedicated to creating, building, and using a series of activities to deliver and communicate customer value to satisfy the customer.” Consequently, applying this definition, marketing is a “responsible” quality tool that is intended to meet customers’ needs. In other words, it means getting the maximum value from the services focused on the target customer and at the same time, the least unfavorable impact on the economic and financial parameters of the organization under study, and on the other hand, its acceptability in the eyes of the larger community. “Responsible marketing is an approach that seeks to balance a company's economic objectives with the social and environmental expectations of consumers and other stakeholders. It is based on transparency, ethics and the creation of shared value, aiming to minimize negative impacts while maximizing benefits for all” (Jean-Marc Lehu, 2008).

The commercial function is rather a delicate function for any company, especially for an industrial one, which prepares a great number of finished products to be sold in the market to continue its existence. Each sales function is supposed to have absolute understanding of managerial and marketing tools, and follow every change that influence the sales volume, while the appearance of the company should represent the work methodical work. For this reason, there is need to develop a management control system in order to consider any environmental changes that may impact on the sales function. It has been observed that the performance of the fourth order logistical managerial work, namely sales function, is specifically influenced by the communication clarity of the mission of the sales personnel. The sales person consequently finds himself/herself in the middle of the many choices which define the business interaction between a company and its customers.

As a result, this article aims at discussing the impact of responsible marketing on the sales performance. This is the central goal in order to identify how responsible marketing could be applied in improving industry players’ operating and financial performance. To this end, this article will delineate the following elements: Various measures used to evaluate responsible marketing sales performance Factors that determine effectiveness or lack of effectiveness of responsible marketing Implementation bottlenecks of responsible marketing Excellence strategy for boosting sales performance.

So how does the implementation of a responsible marketing strategy influence sales performance in an ever-changing economic and social context?

In light of the above, we formulate the following hypotheses for this study:

- **H1:** The adoption of sustainable marketing practices significantly improves customer satisfaction and long-term loyalty.
- **H2:** Corporate responsible marketing practices do not significantly influence customer choices.
- **H3:** Corporate responsible marketing initiatives positively influence customers' perception of the brand.

The first specific part of the work is devoted to the consideration of the theoretical provisions regarding sustainable marketing and its influence on the business outcomes. Finally, an epistemological perspective is taken on the epistemological framework of interviews conducted during the mixed study. Last of all, the problem is in fact examined quantitatively using statistical analysis procedures. The following are the proposals that the paper presents based on the empirical analysis presented above.

2. The Shift in Marketing towards Sustainability and Its Implications for Organizations

2.1. The Evolution of Marketing and the Rise of Sustainable Marketing

Marketing as a discipline has not only been dynamic from time to time but has been in a process of constant adaptation to new conditions that confront consumers in the global business arena. Although marketing originated about the 1930s where its major notion was to distribute the products that were in demand, marketing has greatly evolved. After World War II, in the period of 1950 and 1960, the trend of marketing was changed to consumer orientation from product orientation i.e., from idea of selling products to the idea of satisfying the consumer demands. As Kotler, Dubois, and Manceau pointed out in their work of 2004, this period corresponds to a strategic approach of marketing that enables people to better apprehend the expectations of the consumers and better answer to it rather than forcing consumers to take products they do not need and do not want. It also brought continuity as marketing becomes an essential function for achieving higher market share in a more competitive marketplace.

However, the business world in the 1980s had experienced new challenges such as introducing new technologies and global trade. Strategic marketing emerged as a concept to comprise a more thorough analysis of the market and consumers because of increasing competition. But with a raise of the height of the ecological and social questions in 2000s, the new concept of sustainable marketing arose that included ecological and societal relations into business processes.

Elkington (1998) has described sustainable marketing as the marketing that does not only concerns with financial profitability but also with social and environmental returns which have taken the center-stage of managements' strategic focus of companies who are bothered with long-run implications. This model has gained much importance in the situation where the shift to renewable energy sources and sustainable development is taking place—topics that have recently been raising controversy in public policies and customer preferences. Kantar (2024) has revealed that 90 percent of the marketers are of the view that ministers should get more aggressive in sustainability plans, and 94 percent said that only radical measures would force fundamental changes in their organizations. This trend proves that sustainable marketing is not a niche issue, but a pragmatic solution that would guarantee companies the competitiveness and survival in the global market.

2.2. Core Principles of Sustainable Marketing

Sustainable marketing is based on the integration of three fundamental pillars: economic, social and to an even lesser extent environmental. These three aspects are also known by the “Triple Bottom Line” (TBL) which tries to take business activities beyond the search for revenue to incorporate social and ecological issues. The TBL, as introduced by Elkington (1997), has assisted in the recontextualization of marketing in light of intense global awareness of ethical concerns. Sustainable marketing is the marketing best practice of the current consumer needs met in a way that does not overuse the resources adopted in the marketing procedures in future generations. Thus, waste elimination, use of eco-friendly materials, low carbon exposure and working conditions in the supply chain are considered. This is so because, as noted by Gleim et al., (2023) reveal that ecological, social or ethical marketing communication adjustments impact upon brand image and consumer loyalty and hence a business' economic performance.

2.3. Challenges of Sustainable Marketing and Its Impact on Businesses

Yet, there are some issues that have to be addressed within modern frameworks of sustainable marketing: The first indeed is the belief that practicing sustainability carries a high cost with it as the means to fashion sustainable development. Based on the Kantar's study (2024), in fact, only a quarter of brands

remains in the very early stage of sustainability initiatives, primarily because they lack relevant capabilities and infrastructures and legit reasons for not integrating sustainability strategies into their value systems because the current profitable systems negatively affect the ideas. Secondly, the belief that is characterized by misleading the public stating being environmentally conscious when in fact they are not automatically pose s a challenge for sustainable marketing. This lack of transparency poses a great threat to brand credibility and have a consequential effect of costing the companies the trust of consumers. Hence, there is the need to communicate the intended sustainability strategies in a transparent manner with the intention of making sustainable impacts influenced by the consumer within an organization.

Lack of definite criterion of evaluating environmental and social impacts of a business is also many a hindrance in implementation of sustainable marketing. Those questioned have English problems in identifying performance from operations regarding these areas, which in turn hampers the management of sustainable performance. Furthermore, implementing sustainability into the value chain ranging from purchase to sales means correct and organizational changes on the current business operations. This provides the need for marketing to train their staff and supply chain managers. According to Gérard Mermet (2002), sociologist, companies require both sustainable marketing and establishment of CSR policies in order to thrive in this shift.

2.4. Impact of Sustainable Marketing on Commercial Performance

This goes a long way to prove that in addition to brand image or customer loyalty sustainable marketing has other benefits to producers. It also has a direct implication on the economic performance of the firm. Sustainable marketing can help a firm to achieve a great deal of benefits in terms of cost reduction within a firm due to effective organizational management of systemic processes in production of the goods, and through reducing energy and natural resource utilization. For instance, through adopting sustainable processes that embrace the use of green processing methods, the cost of handling wastes and using natural resources may be avoided this has been emulated by some fashion firms such as Patagonia and Ecoalf by recycling materials.

Sustainable marketing is thus a critical determinant of the marketing efforts aimed improving a firm's brand image due to the rising customer demand for greater environmental and social responsibility. That's why the creation of trust also occurs and the reliability of the firm returns assuming it is ethical. It also aids in establishing customer loyalty since Millennials and Gen Z are more willing to engage with brands that sell real and sustainable products which will in the process compel customers keep on buying products from the said brand. Besides this, sustainable marketing is also a tactical marketing strategy because it affords organizations rivalry benefit and also assists in encouraging the environmentally mindful purchaser behavior. Although it is capital intensive in the short run it assists in developing long term revenues through customers' loyalty, adherence to the law and new markets. Since sustainable marketing assesses elements of the economic-social-environmental context studying, it promotes complete growth and overall business sustainability, making it a strategic approach to current business organizations (Sujanska & Nadanyiova, 2023).

3. Methodology

This section discusses the choice of a post-positivist stance to study the practices of responsible marketing in the North African railway sector and their impacts on commercial performance. This perspective, which integrates both positivism and constructivism, is based on the principle that social phenomena exist in the real world but that their understanding may fluctuate due to the limitations of the researcher. Positivism, developed by Auguste Comte, advocates for a scientific approach based on

observable phenomena and deductive hypotheses, while also considering social and historical elements. In the 20th century, logical positivism, derived from Comte's original positivism, adopted a more modern perspective that influenced constructivism. Despite some modern critiques, positivism remains a key reference in many academic institutions.

The methodology adopted in this analysis integrates elements of both qualitative and quantitative research, constituting a mixed-methods approach. This approach allows for complementing qualitative information with quantitative data and uses both survey questionnaires and interview guides for data collection. Sampling, fundamental to quantitative research, enables the gathering of information from a large population, and the results obtained from samples can be generalized to the entire population (external validity). The quantitative methodology incorporates descriptive statistical analysis, exploratory and confirmatory multivariable analysis, correlations, and linear regression, primarily seeking to analyze causal relationships between dependent and independent variables. The research also relies on an analysis of existing knowledge, explaining the research problem and hypotheses. A preliminary theoretical framework is developed to represent the relationships between variables, which will be empirically tested to validate or reject the research hypothesis.

To analyze the data, we used the programme 'SPSS Statistics 21,' which provided us with the possibility to conduct a comprehensive statistical analysis of the variables and the interactions between them within the examined sample. The tool was used to conduct descriptive and inferential analysis of the results, making the analysis strong and credible. Regarding the analysis of the collected qualitative data, all the responses have been coded and categorized through the use of NVivo software to gain additional insight regarding the variety of themes and patterns detected within the data. Besides, the survey and interview data were analyzed using SPHINX, which allowed using more developed tools for finding important trends and patterns and expand the overall picture of the analysis.

In the context of this study on the impact of responsible marketing on the commercial performance of the railway sector in Morocco, a carefully selected sample of 116 respondents was composed to represent various customer segments of the company. The diversity of this sample, considering characteristics such as frequency of service use, age, gender, and satisfaction level, ensures a faithful representation of customer opinions and behaviors related to responsible marketing. Although modest, the sample size is deemed appropriate for conducting solid statistical analysis and obtaining meaningful insights into the impact of social and environmental responsibility practices on customer loyalty and their propensity to prefer the company's services. Through methodical data collection methods such as online surveys and an interview with a manager in the Moroccan railway sector, this study aims to understand customer motivations and preferences regarding sustainability and social responsibility. The results of this study will be crucial for guiding future responsible marketing strategies in this industry and will contribute to the academic literature on the subject while offering practical suggestions for improving the company's commercial performance.

4. Results

The interview data, analysis and survey outcomes generated substantial evidence on the impact of sustainable marketing initiatives on different customer behavior and firm performances metrics. Worldwide, there is confirmation of the assertion that ethical marketing has a positive impact on customer satisfaction, brand image, and loyalty. Then, both qualitative and quantitative findings are presented, starting with the findings of interview analysis, followed by a series of statistical tables showing the effect and size of such impacts.



Figure 1: Interview analysis

The figure is a word cloud illustrating the terms most used in the interview, highlighting the main themes discussed. The most prominent words are "marketing", "company", "sustainable", "customer", "practices", "responsibility", "safety", "development", "consumers", "satisfaction", "services", and "environmental". These terms show a clear focus on corporate strategy in terms of sustainable marketing, customer loyalty and corporate social responsibility (CSR). It's clear that companies are seeking to incorporate environmentally and socially responsible approaches into their day-to-day actions. The information gathered during this interview is of crucial importance for this study, which aims to analyze CSR strategy and its impact on overall company performance. The manager's perspectives and testimonials will enable us to deepen our analysis and gain an inside understanding of the company's strategic and operational challenges, as well as the concrete actions it is implementing to contribute to sustainable development in Morocco.

Tableau 1: Clean energy for electric traction

Clean energy from electric traction	90 %
GHG reduction	-73,000 Teq CO ₂
GHG gain/Passenger.km	-7.8g CO ₂

Source: Personal interview, April 17, 2024

The table shows that 90% of energy used in electric traction are clean, resulting in a 73,000-ton CO₂ reduction and -7.8g CO₂ saved per passenger-km, confirming strong environmental performance.

Tableau 2: Summary table of energy indicators for the transportation sector

Share of national energy consumption	38%
Share of global CO ₂ emissions	28%
Target to reduce consumption by 2030	24%
Emissions mitigation effort by 2030	7,9%

Source: Personal interview, April 17, 2024

The table highlights that transport consumes 38% of national energy and emits 28% of CO₂. By 2030, a 24% reduction in energy use and 7.9% emissions cut are targeted.

Tableau 3: Summary table of the company energy indicators in 2023

Indicator	Value	Unit
Total energy consumption	503	GWh
Overall share of traction	91%	-
Share of electric traction	64,2%	-
Overall share of renewable energies	34%	-
Energy-related CO ₂ emissions	183000	Tons

Source: Personal interview, April 17, 2024

The table shows total energy use at 503 GWh, 91% for traction, with 64.2% from electric sources and 34% from renewables. CO₂ emissions reached 183,000 tons.

Tableau 4: BARLETT and KMO test

KMO index and Bartlett test		
Kaiser-Meyer-Olkin index for measuring sampling quality		,500
Bartlett's sphericity test	Chi-square approx	33,541
	Ddl	1
	Meaning	<,001

Source: Compiled by authors using SPSS

The KMO index of 0.500 represents the minimum acceptable threshold, indicating a marginal sampling adequacy. Bartlett's test of sphericity is highly significant ($p < 0.001$), confirming that correlations among variables are sufficient to proceed with factor analysis.

Tableau 5: Reliability statistics

Reliability statistics		
Cronbach's Alpha	Cronbach's Alpha based on standardized items	Number of elements
,825	,835	2

Source: Compiled by authors using SPSS

The Cronbach's Alpha value of 0.825 (standardized Alpha = 0.835) indicates a high level of internal consistency between the two items measured. This confirms that the scale used is statistically reliable for further analysis.

Tableau 6: Correlation table

Correlations		CHOICE	FIDELITY
CHOICE	Correlations Pearson	1	,717**
	Sig.(bilateral)		<,001
	N	49	49
FIDELITY	Correlations Pearson	,717**	1
	Sig.(bilateral)	<,001	
	N	49	49
**Correlation is significant at the 0.01 level (two-tailed)			

Source: Compiled by authors using SPSS

Table 6 shows a strong and statistically significant positive correlation ($r = 0.717$, $p < 0.001$) between customers' choice and loyalty. This suggests that a higher alignment with responsible marketing practices positively influences customer fidelity.

Tableau 7: BARLETT and KMO test

KMO index and Bartlett test		
Kaiser-Meyer-Olkin index for measuring sampling quality		,500
Bartlett's sphericity test	Chi-square approx	3,383
	Ddl	1
	Meaning	,066

Source: Compiled by authors using SPSS

The KMO index value of 0.500 is at the acceptable threshold, indicating marginal sampling adequacy. However, Bartlett's test is not statistically significant ($p = 0.066$), suggesting that the correlations between variables may not be strong enough to justify factor analysis in this case.

Tableau 8: Reliability statistics

Reliability statistics		
Cronbach's Alpha	Cronbach's Alpha based on standardized items	Number of elements
,308	,419	2

Source: Compiled by authors using SPSS

The Cronbach's Alpha value of 0.308 (standardized Alpha = 0.419) is below the acceptable threshold of 0.7, indicating low internal consistency between the two items. The scale may require revision or the inclusion of more items for improved reliability.

Tableau 9: Correlation table

Correlations			
		CHOICE	SATISFACTION
CHOICE	Pearson correlations	1	,265
	Sig.(bilateral)		,066
	N	49	49
FIDELITY	Pearson correlations	,265	1
	Sig.(bilateral)	,066	
	N	49	49

Source: Compiled by authors using SPSS

Table 9 indicates a weak positive correlation ($r = 0.265$) between customer choice and satisfaction, which is not statistically significant ($p = 0.066$). This suggests that while there may be a trend, the relationship is not strong enough to confirm a clear effect.

Tableau 10: BARLETT and KMO test

KMO index and Bartlett test		
Kaiser-Meyer-Olkin index for measuring sampling quality		,500
Bartlett's sphericity test	Chi-square approx	26,158
	Ddl	1
	Meaning	<,001

Source: Compiled by authors using SPSS

The KMO value of 0.500 again reflects marginal sampling adequacy, but Bartlett's test is highly significant ($p < 0.001$), confirming that the dataset is suitable for factor analysis.

Tableau 11: Reliability statistics

Reliability statistics		
Cronbach's Alpha	Cronbach's Alpha based on standardized items	Number of elements
,775	,792	2

Source: Compiled by authors using SPSS

The Cronbach's Alpha of 0.775 (standardized Alpha = 0.792) indicates good internal consistency between the two items. This confirms the reliability of the scale used for measuring the construct.

Tableau 12: Correlation table

Correlations			
		CAMPAIGN	TRANSPARENCY
CHOICE	Pearson correlations	1	,656**
	Sig.(bilateral)		<,001
	N	49	49
FIDELITY	Pearson correlations	,656**	1
	Sig.(bilateral)	<,001	

	N	49	49
**Correlation is significant at the 0.01 level (two-tailed)			

Source: Compiled by authors using SPSS

Table 12 shows a strong positive correlation ($r = 0.656$, $p < 0.001$) between campaign effectiveness and perceived transparency. This suggests that well-communicated campaigns are closely linked to customers' perception of the company's honesty and openness.

Tableau 13: Summary table of the status of the Research Hypotheses

	Hypotheses	Status
H1	The adoption of sustainable marketing practices significantly improves customer satisfaction and long-term loyalty	Accepted
H2	Corporate responsible marketing practices do not significantly influence customer choices	Rejected
H3	Corporate responsible marketing initiatives positively influence customers' perception of the brand	Accepted

Source: Personal elaboration

5. Discussions

The data in **Table 1** demonstrates that electric traction systems contribute significantly to clean energy, achieving a 90% clean energy source. This transition supports a notable reduction of 73,000 tons of CO₂ emissions, translating to a reduction of 7.8 grams of CO₂ per passenger kilometer. These figures highlight the effectiveness of electric traction in mitigating green house gas emissions, underscoring its role in sustainable transportation.

Table 2 further contextualizes these findings within the broader transportation sector, which accounts for 38% of national energy consumption and 28% of global CO₂ emissions. The ambitious target to reduce consumption by 24% by 2030 reflects a growing commitment to sustainability. The projected emissions mitigation effort of 7.9% indicates a proactive approach to addressing climate change.

The results in **Table 3** reveal that the company has a remarkable 91% share of electric traction, with 64.2% sourced from renewable. This high percentage not only aligns with national energy goals but also Positions Company as a leader in sustainable transport solutions. However, the energy-related CO₂ emissions of 183,000 tons signal that further improvements are necessary to reduce the carbon footprint of operations.

The results of our empirical study reveal important insights into the relationships among various variables related to marketing practices and customer behavior. The analysis focuses on the reliability of the measurement scales and the correlations between key constructs.

The Kaiser-Meyer-Olkin (KMO) index of 0.500, which is at the threshold of the recommended value, suggests that the data may not be ideally suited for factor analysis. However, the results of Bartlett's sphericity test, with a Chi-square value of 26.158 ($p = 0.000$), indicate that the correlation matrix is significantly different from an identity matrix. This suggests that the variables are sufficiently correlated, validating the feasibility of performing factor analysis despite the KMO index being on the lower end. This

discrepancy highlights the importance of contextualizing KMO results with Bartlett's test, which provides a more nuanced understanding of the data's suitability for factor analysis.

The reliability analysis yielded a Cronbach's alpha of 0.775 for the raw data and 0.792 for the standardized items, both exceeding the recommended threshold of 0.7. These values indicate good internal consistency among the scale items. The high correlation among the items reinforces the reliability of our measurement instrument, suggesting that the constructs measured are coherent and reliable indicators of the underlying theoretical concepts.

A significant Pearson correlation of 0.717 between "CHOICE" and "FIDELITY" ($p < 0.001$) indicates a strong positive relationship between customer choices and loyalty. This relationship suggests that customers who make specific choices are likely to demonstrate higher levels of loyalty, supporting the idea that informed and deliberate choices can foster long-term loyalty. The statistical significance of this correlation at the 99% confidence level underscores its robustness, implying that marketers should focus on strategies that enhance customer choice to build loyalty.

In contrast, the correlation between "CHOICE" and "SATISFACTION" was found to be 0.265 with a p-value of 0.066. This indicates a moderate positive correlation; however, it does not reach statistical significance at the 95% confidence level. This finding suggests that while there is a relationship between customer choices and satisfaction, it is not strong enough to be considered significant in this sample. This raises questions about the factors that influence satisfaction, indicating that other variables may play a more critical role in shaping customer satisfaction than previously assumed.

The findings regarding the KMO index and Bartlett's test results suggest that while factor analysis is feasible, caution is warranted due to the low KMO score in some analyses. In instances where the KMO index was 0.500, the Bartlett test still indicated significant correlations, which supports the idea that further exploration through factor analysis may yield valuable insights despite initial concerns regarding data suitability.

6. Conclusion

This article has shown the importance and influence of sustainable marketing strategies on companies' business performance. The in-depth study of responsible marketing, defined as a set of processes aimed at creating, developing and communicating value to customers in a sustainable way, reveals its significant potential for transforming relationships between companies and their customers. The theoretical framework put in place at the start of this work enables us to understand the principles and roots of responsible marketing and its essential role in sustainable customer satisfaction. Emphasizing the need to overcome simple short-term profit objectives highlights the importance of an ethical and responsible approach to marketing. The aim of this approach is not only to meet customer expectations, but also to protect the environment and consolidate the company's social legitimacy. Through an analysis of the various techniques and sustainable marketing tools, we've found that these practices not only help optimize companies' economic and financial performance, but also enhance their reputation. Companies that incorporate sustainable practices into their marketing strategy benefit from improved public perception of their brand, leading to greater customer loyalty and higher customer satisfaction. The essential role of the sales function in a company, especially an industrial one, was highlighted. The need for this function to make good use of managerial and marketing tools, while remaining vigilant to environmental changes that may affect sales, was underlined. An effective management control mechanism remains essential to predict these changes and maintain optimum sales performance.

Beyond the academic contribution, this research has significant implications for decision makers and managers. Businesses that desire to enhance commercial performance can reap dividends through ethical marketing practice that transcends minimal compliance with regulatory or social expectations towards ultimately establishing long term brand image, customer trust, and loyalty. Green marketing, therefore, can be regarded as a strategic step in a bid to attain competitive advantage while complementing the increasing society demands for environmental and ethical accountability.

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From Vulnerability to The Sustainability of SMEs in the Food and Beverage Sector in the Post-COVID-19 Era, in Surakarta, Indonesia

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Abstract. *SMEs have an important role in the development of the Indonesian economy; however, when there is uncertainty in the external environment, many of them experience high losses and even go bankrupt. This research aims to analyze the vulnerability level of SMEs to the COVID-19 threats, the technical efficiency of SMEs, and successful key variables of SMEs in the post-COVID-19 era. This study employed 3 analyses: business vulnerability, technical efficiency, and structural analysis. Vulnerability analysis is obtained from the index of vulnerability to the threat of COVID-19 compiled from all values of each aspect indicator of SMEs vulnerability. These values consist of exposure, sensitivity, and adaptive capacity. Technical efficiency analysis adopted a non-parametric approach, which was processed using DEAP. Structural analysis was used in determining key variables in SMEs business. The results of the study explain that SMEs are categorized into medium vulnerability, where sensitivity is the highest influence aspect as a determinant of the vulnerability level. The downturn in sales leading to the bankruptcy of small and medium-sized enterprises (SMEs) can be attributed to their inefficient operations, particularly in terms of resource management and achieving desired outputs. Research has identified 11 out of 20 critical factors that significantly impact the success of food and beverage entrepreneurs. These factors include market understanding, leadership and management abilities, optimism, effective marketing strategies, sound decision-making, fostering progress, achievement orientation, risk management, commitment, perseverance, and the presence of supportive partners and businesses.*

Keyword: Dynamic Capability, Efficiency, Sustainability, Vulnerability.

JEL Codes: D24; Q54

1. Introduction

Creative economy is a strategic issue in the national economic development in various developing countries (Purnomo et. Al., 2021; Goel, 2022; Yue, 2022) in the era of business environmental uncertainties. Generally, a food and beverage business is are Micro Small and Medium Enterprise (SMEs) for the creative sub-economy with low resilience (high level of vulnerability) to the threat of external environmental uncertainty (Isa et. al 2021). The food and beverage business plays a vital role in strengthening food security (Hadi, 2020), economic growth (Goel, 2022) and also employment (Purnomo et. Al., 2021). Ninety percent of national food products are provided by SMEs (Hadi, 2020). Small and medium enterprises (SMEs) are firms with less than 100 workers (Tambunan, 2009). In Indonesia, moreover, 99,9% of the industry market was dominated by SMEs, which employed 97% of national employment and contributed to 60% of the national Gross Domestic Product (GDP) (Statistics Indonesia, 2023)

Surakarta serves as a significant hub for the food and beverage sector in Indonesia (Rahadhini et al., 2021). The resilience of this industry in the face of COVID-19 is framed as the performance of small and medium-sized enterprises (SMEs), shaped by various combinations of internal and external factors (Gaffar et al., 2022; Isa and Mangifera, 2019).

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A key concern highlighted in this research is the lack of data regarding the performance of SMEs in the food and beverage sector from non-financial perspectives. This includes aspects such as their vulnerability to external environmental changes, operational efficiency, and the unclear significant impacts on overall business performance. This issue is fascinating for research in an effort to increase productivity and ensure the sustainability of business units.

SMEs in the food and beverage industry pose a formidable challenge e.g., rapid changes of business environment which are full of uncertainties (Gaffar et. Al 2022; Otengei and Ahebwa, 2021). As a result, they need to develop the capacity to endure and enhance their competitiveness (Tatiana and Ritala, 2016). This necessitates a consistent and ongoing response to changes in the external environment, along with a regular assessment of their internal capabilities (Schreyögg and Martina, 2017; Otengei and Ahebwa, 2021). COVID-19 threats have a high risk for SMEs (Otengei and Ahebwa, 2021), that is, 3.33% of SMEs closed their businesses, 11.67% experienced a decrease in turnover of less than 50%, and 75% experienced a decrease in assets of more than 50% (Kuncoro, 2023). Business actors must take notice of business environment uncertainties in the planning, implementation, and evaluation of business strategies (Hamze Moussavi et al., 2020). Not all business units can survive in a business environment of uncertainties (Day and Schoemaker, 2016).

Changes in the business environment alter the critical success factors for small and medium-sized enterprises (SMEs), which in turn necessitate adjustments in their business strategies. These core strategies are fundamentally rooted in essential resources and competencies. As the business environment evolves, it leads to modifications in the resources and capabilities available to SMEs. To navigate these changes effectively, SMEs must develop dynamic capabilities that not only enable them to adapt but also to integrate and reorganize their skills, resources, and competencies (Teece et al., 1997; Purwati et al., 2021). These dynamic capabilities empower organizations to proactively engage with their surroundings, leverage information for internal enhancements, and seize new opportunities efficiently (Wang and Shi, 2011; Otengei and Ahebwa, 2021), thereby influencing both organizational performance and long-term sustainability.

Dynamic capability is the latest approach in building SMEs competitive advantage (Yuniarty et al. 2021; Yuniarty et al. 2022; Otengei and Ahebwa, 2021; Purwati et. al. 2021). Business units must possess three dynamic capabilities: adaptive capability, absorptive capability, and innovative capability (Wang and Shi, 2011; Otengei and Ahebwa, 2021). Adaptive capability refers to the ability of small and medium-sized enterprises (SMEs) to recognize and seize market opportunities. It is assessed by their responsiveness to these opportunities, their capacity to monitor market trends, customer preferences, and competitor actions, as well as their effectiveness in allocating resources for marketing initiatives. On the other hand, absorptive capability is the capacity of SMEs to assess and utilize external knowledge. This capability is measured by the intensity of their research and development efforts. Innovative capability pertains to the ability of SMEs to create new products and explore new market avenues. This capability is evaluated based on the number of innovations in products and services, the processes involved in innovation, and their effectiveness in addressing emerging challenges.

There are two dynamic capabilities (Tatiana and Ritala, 2016; Portillo-Tarragona et. Al 2018): specific domain capability (attached to special organizational ability and becoming short-term superior sources) and generic capability (not attached to certain functions in organization and becoming long-term superior competitive sources). The rationale is that high-level dynamic capabilities not only focus on responsible learning and creativity but also influence low-level dynamic capabilities for the implementation of

more flexible, specific tasks. Generic dynamic capabilities are possessed by all organizations and expressed as organizational change capabilities that are deemed capable of expressing organizational change better than dynamic capabilities with a broader perspective (Tatiana and Ritala, 2016; Otengei and Ahebwa, 2021).

Changes in the strategy of food and beverage SMEs are determined by the leader's decisions by considering many things, as well as the leader's responses to information management (Ambrosini and Bowman. 2009; Brown, et al. 2022). Strengthening organizational quality emphasizes the importance of both the leader's role as the initiator and person in charge of implementing business unit improvements. This indicates the importance of a businessman's dynamic role in improving business unit performance (Otengei and Ahebwa, 2021). Leadership plays a role in directing employees to participate in and be committed to improving business unit performance. SMEs performance entirely depends on the leader's ability to adopt and adapt the improvement program of the business unit. Business owners and/or actors play a crucial role in supporting the performance and sustainability of SMEs in the post-pandemic era. This study has three objectives, namely compiling and analyzing vulnerability indexes of business units, analyzing technical efficiency, and analyzing key success variables for food and beverage SMEs after the COVID-19 pandemic.

2. Research Elaborations

The research was carried out in Surakarta City, Central Java, Indonesia, in 2023. Recognized as a culinary hotspot in Indonesia, Surakarta boasts a diverse array of food and beverage enterprises. The city is home to 727 food and beverage business units, offering a total of 1,729 different types of food and beverages (BPS, 2023). The 727 business units represent the study's population, which will be selected through purposive random sampling, focusing on entities with a minimum of two years of operational experience, prior experience in managing crises such as COVID-19, and excluding street vendors.

Data collection on 215 respondents who were SME owners or managers was carried out through structured interviews supported by a vulnerability index questionnaire. The questionnaire is composed of 3 variables forming a vulnerability index, namely exposure, sensitivity and adaptive capacity (**Table 1**). Exposure consists of 4 indicators, namely the number of infected with COVID-19, COVID-19 depth, COVID-19 duration, and comorbid employees. Sensitivity consists of indicators treatment frequency, availability of raw material, price of raw material, sales and turnover. Adaptive capacity consists of education indicators, a map of COVID-19 spread, information access, distance to health services, COVID-19 awareness, and COVID-19 prevention and socialization training.

Table 1. Vulnerability Variables and Indicators

Variables	Indicators	Definition
Exposure	Number of infected with COVID-19	Number of workers infected with COVID-19
	COVID-19 Depth	Length of time the business has not been operating due to COVID-19 pandemic
	COVID-19 duration	Total time workers infected with Covid-19 are unable to work
	Comorbid Employees	Percentage of workers with comorbid (%)
Sensitivity	Treatment frequency	Number of workers exposed to Covid 19 taking treatment (total)
	Availability of raw material	Availability of raw materials for food and beverage businesses during COVID-19 (%)

	Price of raw material	Increase in raw materials during COVID-19 (%)
	Sale	Decline in sales during COVID-19 (%)
	Turn Over	Workers who resigned and changed jobs (%)
Adaptive Capacity	Education	Percentage of workers' tertiary education (%)
	Map of COVID Spread	Map of COVID spread cases (total)
	Information access	SMEs owner access to COVID-19 information (likert)
	Distance to health services	Distance to nearest hospital (m)
	COVID-19 awareness	Percentage of workers with guarantee (%)
	COVID-19 prevention and socialization training	Number of training and COVID-19 risk socialization attended by SMEs owners (total)

Source: Weis et al. (2016), Kamalipoor et al. (2022), Isa and Mardalis (2022)

After selecting appropriate indicators, researchers utilize them to guide the collection of respondents' answers, which form the dataset. To ensure comparability, this data is normalized, bringing the values of the indicators into a consistent range (Isa et al., 2018). Each observed value is normalized by deducting the mean from it and dividing the result by the standard deviation for each indicator. These indicators are then given weights after that. Then, using a predetermined method, the normalized variables are multiplied by their corresponding weights to provide indices for exposure, sensitivity, and adaptive ability.

$$I_i = \sum_{i=1}^k b_i \left[\frac{a_{ji} - x_i}{s_i} \right]$$

In this context, 'I' represents the index value for each indicator, 'b' denotes the loadings derived from the first principal component analysis (PCA), which are used as weights for the respective indicators. 'a' refers to the value of the indicator, 'x' signifies the mean value of the indicator, and 's' indicates the standard deviation of the indicators.

The formation of a vulnerability index encompasses all dimensions of vulnerability, including exposure, sensitivity, and adaptive capacity, with the assessment results subsequently compiled. A higher index value indicates a reduction in vulnerability levels. The compiled data for each vulnerability aspect is normalized to yield a score ranging from 0 to 1 (Luni et al., 2012; Isa et al., 2021). To represent the vulnerability level, the vulnerability index score is calculated as 1 minus the normalized data result. The findings reveal that a higher score (closer to 1) signifies a greater degree of vulnerability.

The subsequent step involves weighting the aspects of vulnerability. Each variable's weight is determined by assessing its influence on the overall vulnerability dimension; thus, aspects with greater influence receive higher weights. Focus group discussions (FGDs) were used to carry out this weighting process with research area stakeholders. The total score of all indicators is multiplied by the weights given to exposure, sensitivity, and adaptive capacity to determine the vulnerability index (Weis et al., 2016). The following formula is used to present the SMEs vulnerability index (Isa et al., 2021).

Vulnerability = COVID-19 Vulnerability Index

W1 = Exposure weighting

X1 = Exposure score
 W2 = Sensitivity Weight
 X2 = Sensitivity score
 W3 = Adaptive capacity weight
 X4 = Adaptive capacity score

Data collection on 215 respondents who were SME owners or managers was carried out through structured interviews supported by technical efficiency questionnaire. The analysis of technical efficiency employed a non-parametric approach. The inputs considered included business ownership, the educational level of the business owner or operator, the number of employees, and the amount of capital invested. The chosen outputs for the analysis were turnover and gross profit. Efficiency was assessed using data envelopment analysis (DEA) (Planinc, et al. 2022).

The DEA identifies a set of efficient Decision-Making Unit (DMU) and is used as a benchmark for repairing inefficient DMU. DEA also makes it possible to calculate the amount needed for improvements in input and output at the DMU so that it becomes efficient (Planinc, et al. 2022). The basic measure of efficiency used in DEA is the ratio of total output divided by total input. The symbols in the formulation use x and y to represent inputs and outputs, i and j to represent certain inputs and outputs. So that x_i is the i th input and y_j is the j th output on the DMU. The sum of the inputs is represented by I and the sum of the outputs is represented by J , where $I, J > 0$. Mathematically, the input formula is $\text{Input} = \sum_{i=1}^I \mu_i x_i$ μ is the weight of the X_1 units during the accumulation process. The output formula is $\text{Output} = \sum_{j=1}^J v_j y_j$. v_j is the weight of the output y during the accumulation process. From the above model, the efficiency can be formulated as follows.

$$\text{Efficiency} = \frac{\text{Output}}{\text{input}} = \frac{\sum_{j=1}^J v_j y_j}{\sum_{i=1}^I \mu_i x_i}$$

If there are N DMU whose efficiency levels will be compared, the DEA program's linear fractional form is as follows:

$$\text{Max } E_m = \frac{\sum_{j=1}^J v_{jm} y_{jm}}{\sum_{i=1}^I \mu_{im} x_{im}}$$

Subject to

$$0 \leq \frac{\sum_{j=1}^J v_{jm} y_{jm}}{\sum_{i=1}^I \mu_{im} x_{im}} \leq 1; n = 1, 2, \dots, N$$

$$V_{jm}, \mu_{jm} \geq 0; 1, 2 \dots I; j=1, 2, \dots, N$$

E_m is the efficiency of the- m DMU.

y_{jm} is the j th output for the- m DMU.

v_{jm} is the magnitude of the output weight.

x_{im} is the i th input to the m DMU.

μ_{im} is the magnitude of the input weight

Analysis of key variables for the success of SMEs uses structural analysis with the help of MICMAC software (Setiyawan and Isa, 2022). This analysis uses 20 important variables to support the success of SME businesses. Research respondents were representatives of academics, business actors, government and communities (ABGC) and data were collected through focus group discussions (FGD).

Structural analysis was conducted using MICMAC software, which serves as an analytical tool to evaluate the influence and dependence among various variables (Isa et al., 2019; Collewaert et al., 2021). MICMAC analyzes the driving and dependent powers of factors based on the multiplication properties of matrices. This method aims to identify key factors that influence the system across different categories. Factors are classified into four groups—autonomous, linkage, dependent, and independent—based on their driving and dependence powers. MICMAC is utilized to examine the driving forces and dependencies related to the various objectives of stakeholders. The analysis results highlight the key success variables for food and beverage SMEs in the post-COVID-19 context.

C. Result and Discussions

Among the hardest hit during the COVID-19 epidemic were the food and beverage SMEs, which function as regional flagship firms. Kuncoro (2023) reports that the impact was severe: 3.33% of these SMEs were forced to shut down completely, 11.67% had a major decline in turnover of less than 50%, and a startling 75% had a fall in assets of more than 50%. Not only were the direct economic effects of the pandemic detrimental to the performance and sustainability of these SMEs, but their intrinsic susceptibility to such an unprecedented catastrophe also had a significant impact. Key factors that exacerbated their struggles included the level of business vulnerability to the COVID-19 threat, inefficiencies within their operations, and the competence—or lack thereof—of the business actors managing these enterprises. These elements collectively underscore the fragile nature of SMEs in the face of global disruptions and highlight the critical need for resilience, adaptability, and enhanced managerial competence to safeguard their future sustainability.

1. Vulnerability Index of SMEs

The level of vulnerability of SMEs to the threat of COVID-19 affects the resilience of these SMEs (Kamalipoor et al. 2022). This resilience has an impact on the turnover of business actors, which ultimately has an impact on regional economic growth (Isa et al. 2015; Tanaka, 2021). The low resilience of SMEs, which can be seen from the number of SMEs that have experienced a decline in turnover and went bankrupt, indicates an unresolved economic problem, namely inefficiency in business management (Planinc, et al. 2022). Resilience describes the ability of business units to mitigate the threat of COVID-19.

Table 2. Sensitivity Index

Number	Indicator	Vulnerability Value
1	Treatment frequency	0.52
2	Availability of raw material	0.69
3	Price of raw material	0.50
4	Sale	0.73
5	Turn Over	0.29

Source: Authors by SPSS

Sensitivity is a component of vulnerability that shows how well-prepared SMEs are to deal with the COVID-19 threat (Kamalipoor et al., 2022). Table 2 indicates that the five primary components of this sensitivity index are treatment frequency, raw material availability, raw material price, sales, and turnover. The raw material availability and sales indicators are classified as having a high level of vulnerability, meaning that they are very susceptible to disruption from the pandemic. The price of raw materials and the frequency of workers needing medical attention due to COVID-19 are classified as somewhat vulnerable, meaning there is a danger, but not as much as with the other two indicators. Meanwhile, employee turnover is in the low vulnerability category, meaning that its effect on SME sensitivity is relatively smaller. The results of this analysis confirm that the supply chain aspect, especially in terms of raw material availability and sales, has the greatest impact on the level of SME sensitivity, making it the most vulnerable variable and requiring special attention in mitigating risks related to the threat of COVID-19.

Capacity adaptive is the second most vulnerable variable to COVID-19 threats (Table 5). Isa et al. (2015) put forward adaptive capacity as a vulnerability aspect explaining the ability of SMEs to reduce risks (Chasanah, and Hiroyuki, 2021) from the threat of COVID-19. Table 3 shows all aspects of the adaptive capacity of SMEs, namely education, maps of the spread of COVID, access to information, distance to health services, awareness of COVID-19, as well as training and socialization of prevention of COVID-19 are in the moderate vulnerability category.

Table 3: Adaptive Capacity Index

Number	Indicator	Vulnerability Value
1	Education	0.46
2	Map of COVID Spread	0.37
3	Information access	0.54
4	Distance to health services	0.58
5	COVID-19 awareness	0.63
6	COVID-19 prevention and socialization training	0.38

Source: Authors by SPSS

Exposure ranks last as a determining factor for SMES' vulnerability to the threat of COVID-19 (Table 5). Weis et al. (2016) emphasized that exposure is an aspect of vulnerability explaining the extent to which the threat of COVID-19 affects the risk of SMEs related to the amount of exposure, depth, duration and number of comorbid co-workers. Based on Table 4 below, it is explained that the indicators for the amount of exposure, depth, and duration of COVID-19 are in the moderate vulnerability category. The number of Cormobid employees is not very vulnerable at this time. This feature calls for particular consideration of a number of criteria, including the length, depth, and amount of COVID-19 exposure.

Table 4. Exposure Index

Number	Indicator	Vulnerability Value
1	Number exposed to COVID-19	0.37
2	COVID-19 Depth	0.62
3	COVID-19 duration	0.46
4	Comorbid Employees	0.29

Source: Authors by SPSS

The SMES vulnerability index to the threat of COVID-19 was obtained by multiplying the indicator score by the weight of exposure, sensitivity, and adaptive capacity. Vulnerability Index of SMEs is 0,499. This index shows that SMEs are in the moderate level category.

Table 5. Vulnerability Index of SMEs on COVID-19

Description	Exposure		Sensitivity		Adaptive Ability		Vulnerability Index
	Score	Weight	Score	Weight	Score	Weight	
Vulnerability Index	0.43	0.25	0.55	0.4	0.49	0.35	0.499
	0.107		0.220		0.171		

Source: Authors by SPSS

The value between 0.34-0.66 indicates that SMEs in Surakarta City are somewhat vulnerable to COVID-19. Table 5 indicates that sensitivity has the greatest impact on the degree of SMES vulnerability, followed by exposure and adaptive ability. Consequently, this result differs from other research in coastal regions that concluded exposure to be the most sensitive factor. In addition to the level of vulnerability of SMEs to the threat of COVID-19, the level of efficiency in managing SMEs is also a pivotal factor affecting the performance and sustainability of SMEs. The efficiency level of SMEs is obtained based on a comparison between the input variables used and the output obtained (Planinc et. al., 2022). The ownership of the corporate organization, the owner's or executor's educational background, the number of workers, and the amount of capital used are the input variables; turnover and gross profit are the outputs.

Measurement of the efficiency level of SMEs is analyzed using the Data Envelopment Analysis Program (DEAP). The analysis results of using the output maximization approach explained that 80.28% of business actors run their business inefficiently. Therefore, many business units inefficiently achieve their output. Furthermore, 70.42% of business actors are not yet efficient in achieving turnover and 73.24% in achieving gross profit. Based on the results of the efficiency analysis, it is also explained that the input which should be owned by business actors is achieving even greater output. As many as 29.58% of business units have successfully achieved efficiency by having turnover and 26.76% in gaining gross profit. Food and beverage SMEs in Surakarta City, Indonesia have high potential to optimize the output achievement.

The results of the efficiency analysis using the input minimization approach explained that 80.28% of business actors run their business inefficiently. Moreover, the analysis results also explain that 70.42% of business units are inefficient for the aspect of the business owners' and manager's education level, 94.35% are inefficient for the aspect of business entity ownership, 73.24% for the aspect of capital use, and 61.97% for determining the number of employees. These findings suggest that business players should be able to use resources efficiently by producing the current output. Additionally, SMEs may take a variety of actions to reduce the number of resources they allocate.

In Surakarta City, the food and beverage industry typically performs below par, with many business players continuing to operate inefficiently (Setiawan and Isa, 2022). This research shows that the COVID-19 pandemic's direct effects were not the sole factor contributing to the insolvency that food and beverage companies faced. On the other hand, ineffective business management also had an impact on this failure, both in terms of allocating resources and meeting output targets. This demonstrates that even if the pandemic has increased pressure, an important component that exacerbates the situation is the inability to manage the firm. This highlights the significance of improved efficiency and managerial methods to boost the resilience and sustainability of the organization going forward. Moreover, many businesses in this sector

lack the necessary knowledge and skills to implement effective marketing strategies, adapt to changing consumer preferences, and leverage digital tools to enhance their operations. This inefficiency is further compounded by inadequate financial management practices, which limit their ability to sustain operations during economic downturns. Additionally, the absence of innovation and reluctance to adopt new technologies contribute to their struggle in maintaining competitiveness. Addressing these issues requires a comprehensive approach that includes training and support for business owners in areas such as digital marketing, financial planning, and strategic resource management.

The performance and sustainability of the food and beverage business unit is not only influenced by the level of vulnerability to the threat of COVID-19 and the efficiency of business management, it is also influenced by the ownership of business actors in key success variables in business. Determining these variables was carried out using structural analysis, which was processed using MICMAC software. Twenty important determinants for business performance are identified and mapped into four quadrants using this approach, which takes into account each variable's influence and dependence. Risk management abilities, dedication, optimism, decision-making, achievement motivation, perseverance, drive to advance, financial management, workforce management, leadership, networking, efficient marketing, technology use, talent, comprehension of the market and competitors, knowledge of laws and regulations, having government networks, strategic location, and family business background are some of these variables. With the use of this mapping, we hope to shed more light on the various ways that each variable affects the success of the business as well as the ways that dependencies and interactions between variables can impact strategy and overall performance. Understanding where these variables fall inside the quadrants and how they relate to one another can help business actors plan and execute the best possible strategy.

The results of the MICMAC analysis are explained through 4 quadrants as follows (Mafruhah, et al. 2020; Isa, et. al. 2019a). Variables in quadrant I are independent factors, namely variables that have a strong influence and weak dependency. This is a pivotal variable in maintaining business continuity. Quadrant II is a dependent variable, which has a strong influence but is highly dependent. This variable must be studied attentively because the relationship between factors is unstable. The dependent variable in quadrant III has a significant dependency and a mild effect. There is a dependent variable in this region. There is an autonomous variable in quadrant IV. There are variables with weak dependency and influence in this quadrant. Stakeholders cannot prioritize this variable in order to ensure business continuity because it is not closely tied to, and may not even have a correlation with, the key to the success of the food and beverage industry.

Based on Figure 1, it is explained the mapping of key business success variables that support the success of food and beverage businesses in Surakarta City. Quadrant I consist of talent, where talent is a key variable in winning business competition. The talent possessed by business actors is the initial capital for success. Quadrant II is a critical variable for business continuity in the food and beverage business. There are 11 factors in this quadrant: (1) commitment, (2) leadership and management skills, (3) tenacity, (4) encouragement of progress, (5) decision making, (6) effective marketing, (7) achievement oriented, (8) managing risk, (9) ability to understand the market, (10) optimism, and (11) partners and supporting businesses. This supports research (Mangifera and Mawardi, 2022).

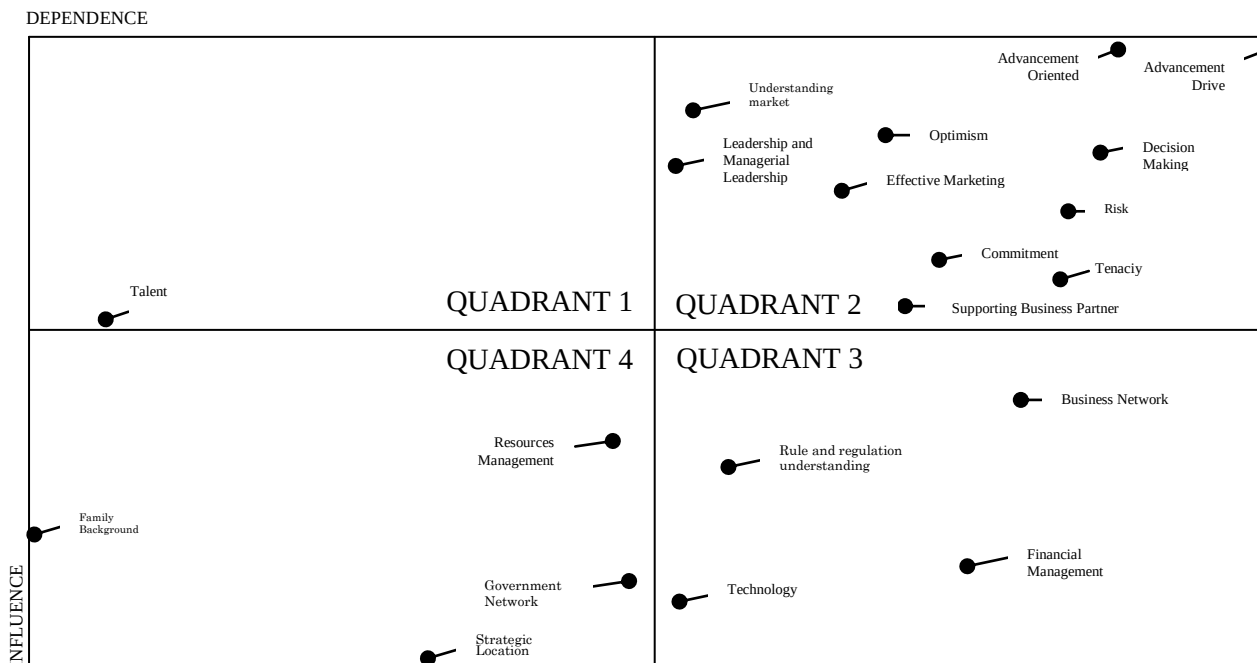


Figure 1. Supporting variables of the success in the food and beverage business.

Source: Authors by Mactor

Quadrant III includes dependent factors. This quadrant's variables are those with significant dependence and weak driving forces. There are 4 factors included in this quadrant, namely (1) business networks, (2) understanding of laws and regulations, (3) technological resources, and (4) financial management. Quadrant 4 is an autonomous factor. This quadrant's variables are those with minimal dependency and influence. Stakeholders seeking to maintain the sustainability of the business cannot give priority to these success characteristics since they are not intimately associated with or correlated with the primary success of the food and beverage industry. The key success factors are (1) family business background, (2) government network, (3) strategic location, and (4) resource management.

D. Conclusions

Food and beverage SMEs are potentially developed for national economic development. Many of them suffered significant losses and even filed for bankruptcy during the COVID-19 pandemic. These SMEs are categorized into moderate vulnerability (0.499) to the threat of COVID-19, and sensitivity is the aspect that has the highest influence on forming the vulnerability level of SMEs, followed by adaptive ability and exposure. The decline in sales and bankruptcy of food and beverage SMEs was also because the majority (80.28%) of SMEs had not operated efficiently, either in resource allocation or output achievement. These findings support the dynamic capabilities hypothesis in SMEs, which states that in order for them to succeed and adapt to dynamic changes in their surroundings, they must possess a specific set of capabilities that allow them to create, integrate, and adjust their resource base.

In maintaining business continuity in the post-COVID-19 era, SME actors must optimize their resources as the main variables to business key success. There are 11 of the 20 main variables that have a major influence on the success of food and beverage entrepreneurs: ability to understand the market, decision making, effective marketing, leadership and management skills, encouragement of progress, commitment, achievement oriented, managing risk, optimism, tenacity, and partners and supporting businesses. In future

research, further identification needs to be carried out apart from the 20 factors that have been analyzed for improvement and a more holistic understanding. Apart from that, further researchers can analyze it using other approaches or other analytical tools.

The implication of this research is that SME owners or managers must be able to increase business efficiency by improving the ratio of input and output, as well as having core organizational resources to maintain business sustainability in the uncertain external environment. These resources are the ability of SMEs to understand the market, effective marketing methods, leadership and management skills, decision-making methods, business partners, risk management, encouragement to progress, achievement orientation, and an optimistic, committed and tenacious attitude in running a business. Apart from that, the Government must support the sustainability of SMEs through regulations, policies and programs that support a conducive business system. Apart from that, the Government must support the sustainability of SMEs through regulations, policies, and programs that support a conducive business system. This includes providing financial assistance, facilitating access to markets, offering training and mentoring programs, and creating a stable economic environment that encourages entrepreneurial activities. Public-private partnerships can also play a significant role in driving the growth and development of SMEs.

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Examining the Determinants of the Demand for Bitcoin: Is Monetary Policy a Significant Factor?

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Abstract. *This study addresses the escalating Bitcoin trading volumes in Egypt, leading to unprecedented price levels. In the absence of prior studies into the determinants of Bitcoin prices in Egypt, the paper evaluates the impact of monetary policies, specifically those related to money supply and interest rates, on Bitcoin prices. The analysis also incorporates determinants of other local investment assets, such as gold and stocks, considering Bitcoin as an alternative investment avenue. Utilizing time series analysis and co-integration models (ARDL, ECM and GARCH) with monthly data from January 2015 to June 2023, the study reveals a positive correlation with money supply (M2), EGX30 index investments, and global Bitcoin prices. Conversely, no statistically significant relationship is observed for the real interest rate and gold pound price. This outcome suggests that Bitcoin usage in Egypt primarily serves portfolio diversification and seeks quick and substantial returns, rather than functioning as an inflation hedge or haven.*

Keywords: Bitcoin Price, Cryptocurrency, Gold, Investment Assets, Monetary Policy.

JEL Codes: G12, E42, E44.

Introduction

The global financial crisis in 2008 is considered a turning point and part of the reason for the development of financial technology into a new paradigm, with the emergence and appearance of Bitcoin in 2009, by an individual or group known under the pseudonym Satoshi Nakamoto (2008). It was the first cryptocurrency, marking the inception of the first decentralized currency. Designed without the oversight of central banks, Bitcoin relies on Blockchain¹. The cryptocurrency trading platform Mt.Gox was launched in July 2010. Notably, from 2011 to 2013, Bitcoin successfully reached parity with the U.S. dollar, and over subsequent years, its value surged, reaching \$60,000 per unit in 2021, and it has continued to hover around this value until 2024 (Coin Market Cap website, 2024).

The pioneer cryptocurrencies, such as Bitcoin and Ethereum, were launched as an alternative medium of exchange to fiat currency. However, over the past years, Bitcoin has been considered as an alternative investment opportunity to traditional investments for some people. Alternative investments, regarded as non-correlated assets, exhibit performance patterns distinct from traditional asset classes like bonds and shares, according to Wilson (2019). Presently, a subset of private investors perceives cryptocurrencies as non-

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¹ Blockchain technology is a distributed ledger technology (DLT) serving as a protocol for peer-to-peer value exchange. Transactions are independently recorded across decentralized computers without the need for a central intermediary. Blockchain also allows for so-called smart contracts, which utilize code to automatically execute contracts between parties such as buyers and sellers (Youssef and Saleh, 2022).

correlated assets, viewing them as an effective means to achieve risk balance within their investment portfolios.

The clear expansion of cryptocurrencies, especially Bitcoin, has emerged recently as a result of monetary policies regarding increasing the money supply and lowering long-term interest rates around the world, especially during and after the COVID-19 pandemic. These policies have caused a decline in asset returns in the economy (safest investments, e.g., money market accounts, Treasuries, and corporate bonds) due to inflationary effects. This prompted many investors to move towards more profitable assets, even if they are riskier. Despite its high risk, Bitcoin also has several benefits, such as being separated from the real economic conditions which makes it less vulnerable to inflationary shocks ((Mert and Timur, 2023); (Zhao et al., 2023)).

As for Egypt, there is also great interest in Bitcoin and trading in it. This is demonstrated by the rise in the demand for Bitcoin and trading volume to reach over 2.2 million L.E in 2020. It is also estimated that over 1.7 million people, 1.8% of Egypt's total population, owned cryptocurrency, especially Bitcoin, in 2021 and increased to over 3.0 million people, 2.95% of Egypt's total population, in 2022². Thus, Egypt had the largest number of cryptocurrency users, ranking first in the Arab world. However, in 2024, it ranked second after Saudi Arabia, with more than 3.4 million cryptocurrency holders, representing approximately 3% of the total population, placing it 36th globally. It is also expected that the number of Bitcoin users in Egypt will rise to 11.30 million people in 2025, and the user penetration rate is expected to be 9.72% by 2025 (Statista website, 2024).

It can be noted that this interest may be due to a multitude of factors, encompassing the inclination of individuals to employ it as an investment asset with the objective of attaining substantial returns, and the surge in global prices. In addition to the recent monetary policies implemented by the Central Bank, involving an increase in money supply leading to elevated inflation rates and a negative real interest rate, this has encouraged individuals to explore alternative investments like Bitcoin.

Hence, this paper aims to examine the different determinants of Bitcoin price in Egypt, focusing primarily on whether monetary policies have an impact on changes in those prices.

The significance of this paper comes from the fact that it serves as a reference highlighting the distinctive nature of Bitcoin. Unlike traditional assets, Bitcoin operates independently of any government or central authority, exemplifying a decentralized system where management is open to all. The historical price of Bitcoin emerges as a major factor influencing its value.

Thus, this paper contributes to the relevant literature in two ways. First, testing the relationship between different economic variables, especially monetary policies, and the Bitcoin market. Second, filling a gap by exploring those relationships in Egypt, a context not previously studied, covering the period from January 2015 to June 2023, using monthly data. It can be said that the reason for choosing the period starting from 2015 is due to the initial popularity and spread of Bitcoin in Egypt, along with the increasing demand for trading and using it. In addition to the availability of data for the variables used during this time period.

The main Research question is: "Is there a relationship between the CBE's monetary policy decisions and the demand for Bitcoin in Egypt?" This question includes several sub-questions:

- What is the nature of that relationship if it exists?
- What is the motivation of individuals in Egypt to invest in Bitcoin?
- Is Bitcoin considered a diversification tool for the investment portfolio, a hedging tool, or a safe haven in Egypt?

So, the paper is divided into two main parts, other than the introduction and conclusion. The first section reviews the most important relevant economic theories and previous studies that dealt with the relationship between Bitcoin prices and their various determinants. The second section focuses on the descriptive and econometric methods to analyze the relationship between Bitcoin prices and monetary policies in Egypt

² According to published data by Triple A, a crypto consultancy firm.

using the time series and cointegration methods. The paper ends by explaining the most important results of that measurement and how to benefit to come up with some recommended policies for policymakers and investors in Egypt.

1. Literature Review:

Whether cryptocurrencies are money or financial assets, there is no clear definition for them. The distinctive terminology associated with cryptocurrencies introduces confusion, as certain terms are often used interchangeably, adding complexity to the matter. A universally agreed-upon list of terms is yet to surface, aiming to delineate distinctions among "digital currency," "virtual currency," and "cryptocurrency."

Digital currency is broadly defined as a digital representation of value denominated in legal tender. This term refers to both a digital representation of fiat currency (e-money) and a non-fiat currency. Virtual currencies are "digital representations of value, issued by private developers and denominated in their own unit of account." On the other hand, the term "Cryptocurrency" is more specific, referring to "a math-based, decentralized convertible virtual currency protected by cryptography" (Wilson, 2019). Bitcoin is one of the thousands of cryptocurrencies available globally. It can be used as a store of value, a way to exchange value, or as a speculative investment.

The price of Bitcoin and other cryptocurrencies fluctuates wildly, making them unreliable and highly volatile. Nevertheless, many investors see Bitcoin as an efficient speculative asset to hold over time, rather than make payments with, and it often draws comparisons to gold (Katsiampa et al., 2019). This causes a strong increase in demand for crypto assets and Bitcoin, leading to a substantial rise in prices. Besides, some see Bitcoin as a hedge against inflation because the supply is permanently fixed³, unlike that of fiat currencies, which central banks can expand indefinitely.

In fact, some cryptocurrencies have gained their importance, or have even been developed, specifically for use in Fintech industries. The most famous of these is Yearn. Finance (YFI)⁴. Although the developers implicitly state that this cryptocurrency has no value outside its use in the yearn finance ecosystem, investors and traders have greatly magnified its price in less than a year. This supports the idea that the price of cryptocurrency depends on the behavior of people and their greed to make a quick profit, not on main economic variables or policies (Siripurapu and Berman, 2023).

Hence, it can be said that the determinants of Bitcoin prices stem primarily from within it, in the extent of individuals' confidence or the rates of return achieved over previous periods, in addition to supply and demand, mining costs, capital manipulation, market news, and regulatory policies. Monetary policies, which can affect investors' demand for hedging and diversified investments, may influence Bitcoin prices indirectly through portfolio balance channels (Zhao et al., 2023).

However, despite the expansion and the advantages that Bitcoin may achieve as an asset, there are a significant number of criticisms and disadvantages associated with Bitcoin. The most important of them are: first, Bitcoin has no intrinsic value, its value only depends on market strength and the belief from users (Šurda, 2014). Second, its high volatility is based on the laws of market demand and supply. Third, the lack of regulation raises concerns about fraud, tax evasion, and cybersecurity.

1.1 Theoretical Background:

(Santoni, 1987) examines two theories that aim to elucidate stock prices: the Efficient Market Hypothesis and the Greater Fool theory. The Efficient Market Hypotheses posit that all pertinent information is already reflected in current stock prices, and price adjustments occur solely in response to new information about fundamentals. According to this theory, past price fluctuations do not offer valuable insights into future price

³ Bitcoins are created at a steady but diminishing rate until an arbitrary limit of 21 million has been reached (Grinberg, 2012).

⁴ Yearn Finance is a suite of products in Decentralized Finance (DeFi) that provides lending aggregation, yield generation, and insurance on the Ethereum blockchain. It started out to automate the process of switching capital between lending platforms in search of the best yield offered, as the lending yield is a floating rate rather than fixed rate (Forbes, 2023).

changes. On the other hand, the Greater Fool theory suggests that investors perceive fundamental information as inconsequential. This approach centers around speculation and the anticipation of sustained price increases solely based on historical uptrends. Bitcoin's price is often cited as an example of the greater fool theory.

Momentum in the financial market is an empirically observed phenomenon where rising asset prices tend to continue rising, and declining asset prices tend to further decrease. Momentum theory hinges on short-term market movements rather than fundamental factors. Therefore, the origin of it is attributed to cognitive biases and irrational investor behavior (Kjærland et al., 2018).

Besides, volatility analysis proves beneficial in the processes of price determination, portfolio construction, and risk management, aiding investors in their decision-making. When volatility is high, investors typically aim to divest their assets to mitigate risks. However, elevated volatility indicates that prices are prone to experiencing rapid fluctuations, presenting opportunities for both substantial returns and risks. This phenomenon is commonly referred to in financial terms as "high risk, high return".

In this context, one can differentiate between a diversifier, a hedge, and a safe haven asset, following (Baur and Lucey, 2010) and (Ratner and Chiu, 2013). A diversifier is an asset that has a weak positive correlation with another asset on average. A weak (strong) hedge is an asset that is uncorrelated (negatively correlated) with another asset on average. A weak (strong) safe haven is an asset that is uncorrelated (negatively correlated) with another asset on average during times of stress.

As for technology in financial markets, the theory of innovation diffusion attempts to explain the dynamics through which new ideas and technology spread across a social system. According to this theory, the process of technology adoption fundamentally relies on the level of human capital development (Rogers, 1995). One of the hypotheses from this theory is "Financial Innovation Fragility Hypothesis", which examines financial technology skeptically, i.e., the expansion in the use of cryptocurrencies, may be accompanied by the emergence of financial bubbles that pose a significant risk to financial stability if strong unchecked growth is allowed without institutional and legal restraints (Da-Silva, 2018). As cryptocurrencies become more widespread, the effects may extend globally, affecting the international monetary system as a whole (Georgieva, 2020).

1.2 Empirical Studies:

Previous studies varied in their objectives when measuring the determinants of Bitcoin. Some have focused on macroeconomic determinants, especially inflation and exchange rates. Other studies aim to ascertain whether Bitcoin serves as a diversification tool in investment portfolios, emphasizing the connection between its prices and other assets in the economy. Besides, some studies focus on the impact of monetary variables.

The majority of these studies have been conducted in developed countries, notably the United States, the United Kingdom, and Japan. A limited number of studies have ventured into measuring these relationships in developing countries, such as Indonesia.

In essence, previous studies can be categorized into three groups based on the fundamental variables they focused on studying.

1.2.1 Studies that addressed the relationship between Bitcoin prices and macroeconomic determinants:

(Urquhart and Zhang, 2019) discovered that Bitcoin could be used as a hedge against certain currencies and that Bitcoin functions as a form of investment. Similarly, (Blau et al., 2021) offered strong evidence that a sudden surge in the price of Bitcoin is linked to a large increase in the inflation rate. This supports the idea that Bitcoin can function as a hedge against inflation.

In contrast, (Canh et al., 2019) found that economic factors do not exert significant influences on cryptocurrencies by examining the relationship between the prices of the leading seven cryptocurrencies and economic factors like oil price, gold price, interest rate, US dollar and S&P500 index. The same result was also reached by (Bayramoğlu and Başarır, 2019) using a decision tree method. (Basher and Sadorsky, 2022)

mentioned that inflation is not a strong predictor of the Bitcoin price, suggesting that Bitcoin is not a good hedging asset for inflation. This is also supported by (Srinivasan, et al., 2022) using symmetric and asymmetric versions of ARDL models with structural breaks. The results indicate that Bitcoin cannot be used to hedge against inflation, the Federal funds rate, stock markets and commodity markets. (Wang et al., 2023) Also indicated that economic policy uncertainty negatively impacts the Bitcoin price. Thus, Bitcoin cannot act as a hedge or safe-haven asset.

1.2.2 Studies that focused on the relationship between Bitcoin prices and investment assets:

(Bouri et al., 2018) identified that the Bitcoin price movements can be predicted based on commodity prices and gold prices, using ARDL model (Kjærland et al., 2018) employed ARDL and GARCH approaches, revealing that Bitcoin prices are impacted by S&P 500 returns, historical price performance, optimism, and Google search volume. Moreover, (Kang et al., 2020) explored that there is asymmetric causality between Bitcoin and Treasury bonds, US stock, US dollars, and gold. The results indicate that Bitcoin may strengthen diversification benefits in optimal asset allocation and portfolio risk management.

On the other hand, (Kurka, 2019) acknowledged the connections between cryptocurrencies and traditional assets are negligible. According to (Pirgaip et al., 2019) findings, Bitcoin has no long-term association with any asset and Bitcoin price variation is mostly borne by its prices. (Warsito, 2020) concluded that the volatility of Bitcoin and Ethereum is not influenced by other variables (gold, Dollar Index, and Composite Stock Price Index) but is influenced by past prices of each of them in Indonesia. This shows that the cryptocurrency market is inefficient. Moreover, (Baur et al., 2021) stated that Bitcoin is uncorrelated with other assets, suggesting that while BTC offers great benefits for diversification, it is neither a safe haven nor a reliable hedging instrument.

1.2.3 Studies concerned with measuring the impact of monetary variables on Bitcoin prices:

(Tomás and Ibañez, 2018) mentioned that Bitcoin was not affected by monetary policy news. This result indicates that Bitcoin is a financial asset without any connection to the policies of central banks. (Kusumastuty et al., 2019) indicated that there is no significant influence of monetary variables (inflation, interest rates and the money supply) on the cryptocurrency prices in Indonesia. While the historical price of Bitcoin has become the biggest influence on it.

However, (Ma et al., 2022) found that USA monetary policy shocks contribute to a relatively minor percentage of Bitcoin price volatility. (Mert and Timur, 2023) refers to the causal relationship between Bitcoin prices and central bank money supplies for the Federal Reserve System (FED), European Central Bank (ECB), and Bank of Japan (BOJ). This causal relationship has emerged stronger for the USA, especially after the COVID- 19 pandemic, owing to the rapid increase in the amount of money put into circulation. Besides, (Köse and Ünal, 2023) analyzed the asymmetric effects of the interest rate on the Bitcoin price by using an SVAR model and concluded that negative real interest rates have a positive impact on the Bitcoin price. If this is possible, cryptocurrencies behave like conventional assets, and they can be impacted by conventional economic policies.

From the above, it becomes evident that there isn't a singular nature defining the relationship between various determinants of Bitcoin and its price. It should also be noted that there is an absence of studies estimating these relationships within the context of Egypt.

2. Empirical Analysis

Based on the aim of the study, the paper used the method of time series analysis and cointegration models; the Autoregressive Distributed Lag (ARDL) model and the Error Correction Model (ECM) to examine long-term relationships between variables over time, and also modeling the short-run dynamics of a system, during the period (January 2015: June 2023) monthly data, using the STATA -17 packages.

2.1 Description and Visualization of data:

The study worked on estimating the model to measure the relationship between the Bitcoin price as a dependent variable and several independent variables, namely: money supply (M2), the real interest rate, EGX30 index, the price of the gold pound, and the price of Bitcoin in the United States of America. This is illustrated by the following model:

$$BP_t = \beta_0 + \beta_1 M2_t + \beta_2 RIR_t + \beta_3 EGX30_t + \beta_4 GPP_t + \beta_5 GBP_t + \varepsilon_t \quad (1)$$

Where;

BP_t : Price of Bitcoin variable expressing the demand for Bitcoin in Egypt, estimated in the Egyptian pound.

$M2_t$: Money supply variable expressing the local liquidity in Egypt.⁵

RIR_t : Real interest rate variable as the difference between nominal deposits interest rate (%) and the inflation rate (CPI %).

$EGX30_t$: EGX30 index⁶ variable, as an expression of the demand for stocks and bonds, represents one of the forms of investment assets that is directed by the government.

GPP_t : Gold pound price variable represents one of the safest investment assets in Egypt.

GBP_t : global Bitcoin price variable, which is the price of Bitcoin in the United States of America, given that the USA is the country that trades the most Bitcoin.

ε_t : error term, and t refers to the time varying from January 2015 to June 2023.

All the data are collected from the Central Bank of Egypt website from either time series data or data in monthly statistical bulletins, except the Bitcoin Price data for Egypt and the USA are received from Coinbase and Yahoo Finance, respectively.

The selection of these variables was based on theoretical reasons and applied factors. This can be elucidated by referring to Table 1, accompanied by a graphical representation, Fig.1, of the data for these variables in Egypt throughout the studied timeframe.

Table 1: Reasons behind choosing the model's variables and their expected signs in the case of Egypt:

The variable	The reason for choosing it	Expected sign for the relation
Bitcoin Price	The Bitcoin price variable stands out as the predominant indicator for gauging the demand for Bitcoin, complemented by the constrained supply that establishes a direct and robust correlation between price and demand for this contemporary asset. Moreover, Numerous empirical studies frequently utilize the Bitcoin price variable and explore its associations with diverse determinants.	It is the dependent variable.
Money Supply (M2)	Over the past decade, Bitcoin's price has made significant gains during the fast growth of money supply (M2), owing to a reduction in interest rates and fiscal stimulus. Inflation is commonly linked to an overheated economy following the implementation of expansionary monetary and fiscal policies that amplify aggregate demand. These policies that elevate disposable incomes beyond sustainable levels can stimulate investment, including in high-return assets like cryptocurrencies (Polizu et al., 2023). According to previous literature, M2 is the best estimation of	By calculating the correlation between Bitcoin price and M2, it is about 0.834772; indicating that there is a positive and strong relation between the two variables.

⁵ M2, according to Central Bank of Egypt definition, consists of M1, representing cash in circulation outside the banking system, and non-governmental current deposits in local currency at all units of the banking system. In addition to quasi-money, which consists of non-current, non-governmental deposits in local currency, and non-current deposits in foreign, non-governmental currencies and non-current deposits at all units of the banking system.

⁶ The EGX 30 index is a price index that measures the performance of the top 30 companies in terms of liquidity and activity on the Egyptian Stock Exchange, it is weighted by market capitalization and is adjusted by the ratio of free shares to total shares included in it.

	overall money supply growth, and the supply growth of other major currencies follows a similar trend.	
Real Interest Rate	<p>Interest rate policy can influence investment decisions around the world. Hence, it is assumed that the interest rate can be a significant tool that can change the perception of investors for cryptocurrencies.</p> <p>Policymakers, portfolio managers, and investors consider the real interest rate in the market, as the nominal interest rate and inflation separately cannot create a convincing result for the analysis.</p> <p>when the disparity between the two variables (nominal interest rate and inflation) expands, this may lead to an increased demand for cryptocurrencies until the interest rate begins to rise and align with the inflation rate.</p>	<p>According to previous studies and the known relation between the interest rate of investment assets and the demand for alternative assets, it is expected that this variable to have a negative sign.</p> <p>That expected negative relation appears from panel (C) in Fig.1 and the correlation factor (-0.06084).</p>
EGX30 Index	<p>The stock exchange indices constitute one of the factors influencing fluctuations in Bitcoin's price. These indices, serving as indicators of macroeconomic conditions, are directly overseen by governmental entities. However, their impact on Bitcoin's price change remains minimal due to the absence of direct connections between Bitcoin, the real economy, and governments. However, this lack of connections also contributed to Bitcoin markets not being directly affected by macroeconomic inflationary shocks, which represents an incentive for retail investors to turn to crypto assets to protect their wealth. This helps to explain why adding crypto to a traditional portfolio increases returns, at the cost of also raising volatility (Polizu et al., 2023).</p> <p>Due to the lack of any previous studies applied to Egypt, this paper relies upon EGX 30 index as an indicator to express the demand for shares on the Egyptian Stock Exchange.</p>	<p>The positive relation between the index and Bitcoin price according to the Correlation factor (0.694249) refers to diversification behavior of investors in the local market, which leads to the expectation of a positive sign of that variable.</p>
Gold Pound Price	<p>Analyzing the relationship between the gold price and the Bitcoin price can help understand whether the cryptocurrency can be a safe haven (Wen et al., 2022).</p> <p>Bitcoin has been suggested to have many similar properties to Gold. The scarcity and high “mining” costs of Bitcoin are like those of gold. So, it is often referred to Bitcoin in the media as “digital gold” (Conlon et al., 2021). But the average monthly volatility of Bitcoin price is greater than that of gold price, which makes Bitcoin unsafe enough as a hedging instrument like gold (Dwyer, 2015). So, (Pho et al., 2021) found that gold was a better safe haven and diversifier than Bitcoin.</p>	<p>This fear of huge fluctuations in Bitcoin price makes people in Egypt don't tend to depend on Bitcoin as a hedging or save heaving tool. This appears through the weak correlation between both variables in Egypt, which equals 0.24433. So, we can expect that there is not a strong effect of the gold pound price on the Bitcoin price in Egypt.</p>
USA Bitcoin price	<p>The US is a country that holds a large part of cryptocurrencies. Trading of cryptocurrencies is generally based on the US dollar (Polizu et al., 2023).</p> <p>So, we can use the Bitcoin price in the USA as the global price to determine the impact of changes in the global market for Bitcoin, due to changes in US monetary policy or the trends of global investors, on the domestic market.</p>	<p>From the panel (F) in Fig.1 and correlation coefficient, which equals 0.944077, we can see that local price for Bitcoin moves in sync with global prices, affected by their rises and falls.</p>

(Source: Authors compilation)

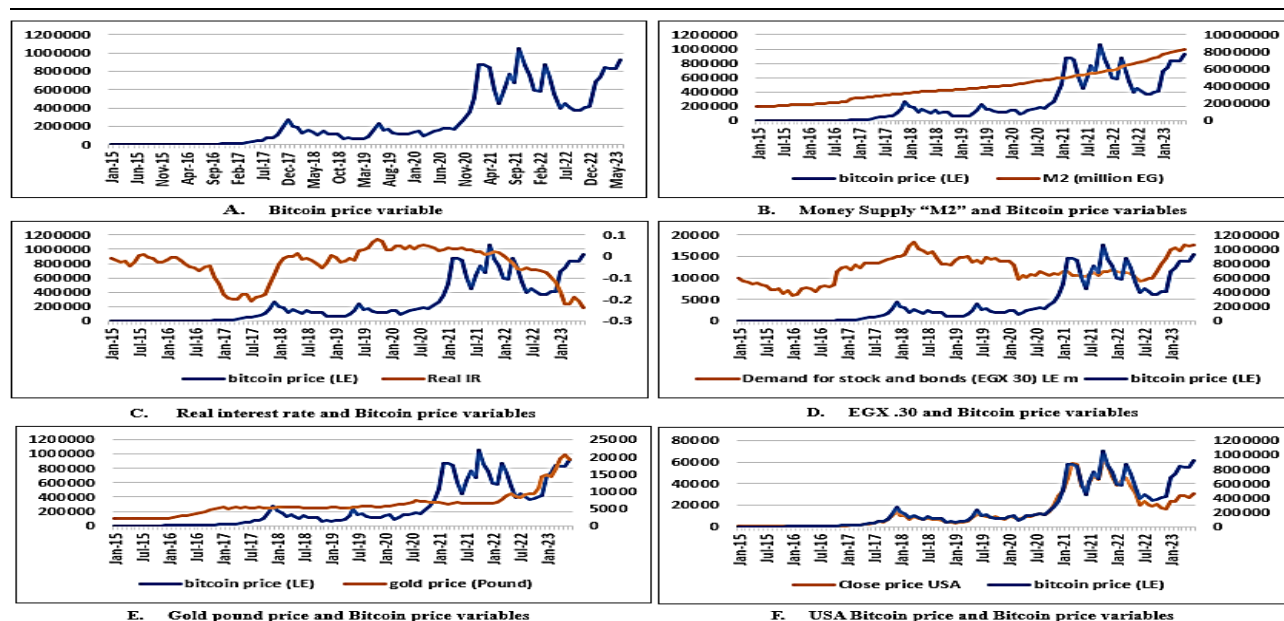


Fig. 1: Changes in the variables during the period (Jan 2015- Jun 2023) in Egypt
 (Source: Authors compilation)

Appearing from panel (A) in Fig.1, there is a general increasing trend in Bitcoin price, especially during the years 2020, 2021, and 2023, which can be explained by some factors such as;

A lot of people are still unbanked, and the stock market has high transaction costs, while cryptocurrency is decentralized, and transaction costs are low. It is also the best way for a large segment of young people who do not have sufficient savings to invest in safer and more stable assets, but rather resort to investing in Bitcoin, that has had huge growth over the last years, to make a decent return back from a smaller amount of money (Barakat, 2022).

Egypt prohibits cryptocurrencies and Bitcoin explicitly, not implicitly, a stance clearly articulated in the recent Central Bank Law, No. 194 of 2020, particularly in Article (206). This prohibition is reinforced, from the Central Bank, by numerous warnings and advisories informing investors about potential risks associated with digital currencies. In addition to the amendments to the Terrorism and Anti-Money Laundering Law, No. 15 of 2020, including provisions on the use of cryptocurrencies in financing illicit activities and the penalties associated with that, which means that it implicitly acknowledges the existence of a significant cryptocurrency traded within the country. Simultaneously, Egypt actively promotes various forms of financial technology and digital banks. Besides, many platforms have also become available, like Coinbase and Binance, that facilitate trading with credit or debit cards and Fawry accounts, allowing the conversion of Egyptian pounds into Bitcoin units stored in digital wallets. It appears that the Central Bank's primary concerns revolve around potential currency instability and the associated risks to the Egyptian economy, in addition to the potential adverse effects on traditional investments like real estate, stocks, or bank deposits, in the event of an expansion in Bitcoin investment.

2.2 Tests and appropriate model validation:

The use of the Autoregressive Distributed Lag (ARDL) Model -developed by (Pesaran et al., 2001)- is based on the advantages that it has compared to other cointegration methods. These advantages are: First, it is suitable for estimating the model in small sample size; Second, it does not require prior information about the order of integration of the variables, whereas this is a prerequisite in Engle-Granger (EG) cointegration analysis; Third, the ARDL method can reduce the error when determining the cointegration order of variables. Finally, ARDL gives unbiased and efficient estimates of variables due to integrating long-run and

short-run dynamics, eliminating problems associated with omitted variables and serial correlation ((Siddiki, 2000); (Motsewakgosi, 2019)).

The ARDL "cointegration equation" version of the model -Equation (1)- can be written as follows:

$$\Delta \ln(BP)_t = \delta_0 + \rho(BP)_{t-1} + \beta_1 \ln(M2)_{t-1} + \beta_2 (RIR)_{t-1} + \beta_3 \ln(EGX30)_{t-1} + \beta_4 \ln(GPP)_{t-1} + \beta_5 \ln(GBP)_{t-1} + \sum_{i=1}^p \delta_{1i} \Delta \ln(BP)_{t-1} + \sum_{i=0}^q \delta_{2i} \Delta \ln(M2)_{t-1} + \sum_{i=0}^m \delta_{3i} \Delta (RIR)_{t-1} + \sum_{i=0}^n \delta_{4i} \Delta \ln(EGX30)_{t-1} + \sum_{i=0}^g \delta_{5i} \Delta \ln(GPP)_{t-1} + \sum_{i=0}^h \delta_{6i} \Delta \ln(GBP)_{t-1} + \varepsilon_t \quad (2)$$

Where;

Table 2: The symbols of cointegration equation no. (2) and the meaning of them:

The symbol	Which refers to
Δ	The first difference for variables
$\ln$	The natural logarithm taken for variables
p, q, m, n, g, h	The number of optimal time lag
δ_0	Constant parameter
$\rho, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5$	Long-run relation parameters
$\delta_{1i}, \delta_{2i}, \delta_{3i}, \delta_{4i}, \delta_{5i}, \delta_{6i}$	Short run relation parameters
ε_t	Error term
t	The time ranges from January 2015 to June 2023

(Source: Authors'work)

The ARDL model also helps to estimate the error correction parameter as well as identify the short-term effects through the Error Correction Model (ECM). This model can be estimated through the following equation:

$$\Delta \ln(BP)_t = \alpha_0 + \sum_{i=1}^{p-1} \alpha_{1i} \Delta \ln(BP)_{t-1} + \sum_{i=0}^{q-1} \alpha_{2i} \Delta \ln(M2)_{t-1} + \sum_{i=0}^{m-1} \alpha_{3i} \Delta (RIR)_{t-1} + \sum_{i=0}^{n-1} \alpha_{4i} \Delta \ln(EGX30)_{t-1} + \sum_{i=0}^{g-1} \alpha_{5i} \Delta \ln(GPP)_{t-1} + \sum_{i=0}^{h-1} \alpha_{6i} \Delta \ln(GBP)_{t-1} + \theta (EC)_{t-1} + \varepsilon_t \quad (3)$$

Where;

$(\alpha_0, \alpha_{1i}, \alpha_{2i}, \alpha_{3i}, \alpha_{4i}, \alpha_{5i}, \alpha_{6i})$: Short run relation parameters.

θ : Short-term error correction parameter to reach a stable equilibrium state.

The study adopted a nonlinear formulation of the Bitcoin price function, aligning with most previous studies like (Kjærland et al., 2018). The use of the logarithm is important in this case because of the high volatility that characterizes most of the economic variables that are used in such models, especially the Bitcoin price variable.

2.2.1 Stationary tests: The stationarity of the model variables must first be verified using unit root tests, where the Augmented Dickey-Fuller test and the Phillips–Perron test, both of which indicated stationarity of all variables after taking the first difference for the natural logarithm ($\ln$) for all variables except the real interest rate (RIR) which exhibit stationarity at first difference without taking the natural logarithm because of its negative values.

2.2.2 Choosing the optimal lag periods for the model variables: To find the appropriate lag length for each of the variables in the ARDL model, we used the Akaike information criterion (AIC), since this criterion is known for having a theoretical advantage over other information criteria (Enders, 2008). Applying this criterion indicates that the optimal model is ARDL (1,0,0,0,0,1).

2.2.3 Short and long-run cointegration tests: To test the cointegration relationship between variables, the ARDL Bounds Test was used (Pesaran et al., 2001), based on the F statistic. The results showed that the calculated F value (=65.927), exceeded the maximum critical value at the highest integration order I(1), at different levels of significance (1%, 5%, and 10%). Therefore, the null hypothesis (H_0) is rejected, meaning

that there is a strong cointegration between the variables that allows the long and short-term relationships to be estimated. Accordingly, to ensure a close approach to long-term equilibrium, the coefficient of the error correction model (ECM term) -which measures the speed of adjusting any imbalance that deviates from the model's path in the short term to reach long-term equilibrium- must be significant and less than zero. This is achieved in the estimated model, where this coefficient takes the value = -0.281, and is highly statistically significant at a 5%. Thus, the coefficient of the error correction model states that Bitcoin price regains long-run equilibrium with an adjustment speed of 28% every month under the influence of the independent variables used.

2.2.4 Diagnostic tests: Based on different Diagnostic tests applied to the estimated model, it can be said that the estimated model is free of standard problems and therefore its results are not spurious, and that any conclusion reached can be considered highly reliable. These tests include Coefficient of determination (adjusted R²), Multicollinearity test “Variance inflation factors for the independent variables (VIF) test”, Heteroscedasticity test “Cameron & Trivedi’s decomposition of IM test and Breusch–Pagan–Godfrey (BPG)”, Normal distribution of the residuals of the estimated model “the Skewness and Kurtosis normality tests”, Autocorrelation test between random error values “the Durbin Watson test and the Breusch–Godfrey LM test for autocorrelation”, Functional Form Misspecification Test “Ramsey’s regression specification error test (RESET)”, and Test to verify the stability of Bitcoin price function “the Cumulative Sum (CUSUM) of Recursive Residuals test”.

The GARCH model was utilized alongside the ARDL model to validate its results. GARCH models are commonly used in analyzing macroeconomic variables, especially those linked to financial markets, due to their ability to handle fluctuations and changes in variance.

It is worth noting here the importance of using GARCH models because of their advantages. The GARCH specification offers a key advantage in efficiently identifying conditional variance. Unlike homoscedastic models, which assume constant volatility and are common in basic Ordinary Least Squares (OLS) analysis aimed at fitting data points to a regression line, GARCH processes acknowledge that asset returns' volatility fluctuates over time and is influenced by past variance. This variability renders a homoscedastic model less effective. GARCH models strive to capture this interplay between present and past variability using a mathematical framework that links them together.

When it comes to GARCH, we aim to address homoscedasticity by examining the unconditional variance of the regression. Deviating from this assumption implies that the Gauss-Markov theorem doesn't hold, and the OLS estimators are no longer Best Linear Unbiased Estimators (BLUE). Even when the unconditional variance remains stable, the conditional variance might vary over time. Engle (1982) introduced the Autoregressive Conditional Heteroskedasticity (ARCH) model, acknowledging the distinction between unconditional and conditional variance, allowing the latter to change based on past error terms. This approach captures volatility clustering but requires a model with an extensive lag structure, posing challenges for estimation. To simplify this task, Bollerslev (1986) proposed the GARCH model, which reduces parameters by imposing nonlinear constraints. The GARCH model forecasts unconditional variance with fewer parameters, placing more weight on recent observations for predicting volatility (Kjærland, et al., 2018).

3. Results and discussion:

After it has been reached that there is a long-term equilibrium relationship between the Bitcoin price and independent variables, the impact of these variables can be shown through Table 3:

Table 3: Long run Cointegration Model results:

ARDL Long Run Estimates, ARDL (1, 0, 0, 0, 0, 1)				
Variables	Coefficient	Std. error	t- statistics	Prob.
$\Delta \ln M2$	2.7845	0.5869	4.74	0.000**
ΔRIR	-0.5168	0.4547	-1.14	0.259

$\Delta \ln \text{EGX30}$	0.3080	0.1337	2.30	0.024*
$\Delta \ln \text{GPP}$	0.0169	0.1738	0.10	0.923
$\Delta \ln \text{GBP}$	1.0428	0.0548	19.02	0.000**
Constant	-0.0462	0.0159	-2.89	0.005**

(Source: Prepared by the researcher depending on the STATA results)

Note: * and ** refer to significance levels at 95% and 99% respectively.

Model results indicate that:

- There is a positive relationship between Bitcoin Price and money supply (M2) as it is expected. This relation means that Bitcoin may be a monetary inflation hedge, and when the money supply starts to expand, we can expect the crypto market cap to follow suit. This relationship has become clear in Egypt recently as a result of the increase in the money supply, which was accompanied by an unprecedented rise in inflation rates. This generated fears among many individuals about saving in the usual form of cash, but rather resorting to other assets that are more profitable like Bitcoin. This led to an increase in demand for Bitcoin in the local market and thus contributed to a significant increase in its prices in light of its finite supply.
- Real Interest Rate does not significantly affect the Bitcoin price. This means that the interest rate policy is not effectively determined for the Bitcoin price in Egypt, which satisfies the decentralized characteristics of the cryptocurrency market. This result is not as assumed but consistent with the correlation coefficient between two variables and findings of previous studies like (Canh et al., 2019), (Kusumastuty et al., 2019), and (Srinivasan et al., 2022).
- There is a positive relationship between Bitcoin Price and the volume of EGX30 index. This reflects the diversification behavior of investors in forming a portfolio of various assets that have high profitability but may be at a high degree of risk. However, the effect is weak because Bitcoin does not have any direct ties to the real economy and/or government yet.
- There is no significant relationship between Bitcoin price and gold pound price, as expected. If there is a connection between them, it can be said that the gold price plays an explanatory role in the Bitcoin price, and that is not applicable to the case of Egypt. The fluctuations in gold prices in Egypt are related to global price changes, in addition to being primarily attributed to individual behavior, driven by a desire to consider gold a secure refuge amidst high inflation rates and diminished purchasing power. However, the same desire does not apply in the case of Bitcoin. The heightened volatility in Bitcoin's prices, coupled with concerns about cyber-attacks and fraud, deters individuals from seeking it as a store of value. Consequently, when individuals seek an asset primarily for its stability and not for potential profitability, they tend to gravitate towards gold rather than Bitcoin.
- Bitcoin price in the USA -as a global price for Bitcoin- positively affects the Bitcoin price in Egypt. This relation is assumed because both prices move together, which means that the local Bitcoin market is highly linked to global prices influenced by global changes.
- Bitcoin price is related to its previous values, meaning that when investors buy Bitcoins, they always look at its historical price, which has tended to increase every year. On the other hand, from the investment side, this dependency suggests that the efficient market hypothesis (past returns should have no correlation with present returns) may not be applicable. Behavioral economists attribute imperfections in financial markets to errors in human reasoning and information processing. Given that many investors likely have limited experience with Bitcoins and the surrounding context can be confusing. In this scenario, it is reasonable to assume that investors are influenced by the momentum effect, reacting to the recent rise in prices. This result is consistent with findings of (Kjærland, et al., 2018) and (Warsito, 2020).

As for the short-term relationship, which is evident from Table 4, it reflects the same results that were reached for the long-term relationship.

Table 4: Error Correction Model results for short run:

ARDL Long Run Estimates, ARDL (1, 0, 0, 0, 0, 1)				
Variables	Coefficient	Std. error	t- statistics	Prob.
$\Delta \ln BP$	-0.2813***	0.7700	-3.65	0.000**
$\Delta \ln M2$	3.5679	0.6987	5.11	0.000**
ΔRIR	-0.6622	0.5912	-1.12	0.266
$\Delta \ln EGX30$	0.3947	0.1664	2.37	0.020*
$\Delta \ln GPP$	0.0216	0.2230	0.10	0.923
$\Delta \ln GBP$	0.9193	0.0532	17.27	0.000**
Constant	-0.0462	0.0159	-2.89	0.005**

(Source: Prepared by the researcher depending on the STATA results)

Note: * and ** refer to significance levels at 95% and 99% respectively, *** refers to the ECM term.

In this context, the results obtained from applying the GARCH model align perfectly with those from the previously mentioned ARDL model. Both models reveal a significant positive impact of variables like money supply (M2), the EGX30 index volume, and global Bitcoin price on the Bitcoin price in Egypt as an indicator of demand. Conversely, real interest rate and gold pound price don't exhibit significant influence, as evident from Table 5. These consistent findings between the ARDL and GARCH models highlight the reliability and robustness of the ARDL model.

Regarding the ARCH and GARCH effects, both had positive values, and their combined total was below 1 as per the required conditions. The coefficient for GARCH(2), at 0.133, was not significantly different from zero individually, but when considered together, the coefficients for ARCH(1) and GARCH(2) were significant (with a p-value of 0.045, below the 0.05 threshold).

Table 5: GARCH Model results

GARCH (1, 2)				
Variables	Coefficient	Std. error	Z value	Prob.
$\Delta \ln M2$	4.375	1.039	4.21	0.000*
ΔRIR	0.3109	0.4875	0.64	0.524
$\Delta \ln EGX30$	0.4307	0.1497	2.88	0.004*
$\Delta \ln GPP$	-0.2923	0.2030	-1.44	0.150
$\Delta \ln GBP$	0.9182	0.0508	18.07	0.000*
Constant	-0.0518	0.0182	-2.84	0.004*
ARCH Effect	0.5956			0.071**
GARCH Effect	0.1336			0.454

(Source: Prepared by the researcher depending on the STATA results)

Note: * refers to significance at 5% significance level

** refers to significance at 10% significance level

4. Conclusion and Policy Recommendations:

The primary objective of this paper is to investigate the influence of monetary policies and government decisions on Bitcoin prices in Egypt. Employing time series analysis and co-integration models, specifically the Autoregressive Distributed Lag model (ARDL), the Autoregressive Conditional Heteroskedasticity (ARCH) model, and the Error Correction Model (ECM), the research concluded that there is a positive

correlation between money supply (M2) and Bitcoin prices. This correlation suggests that the surge in money supply, coupled with escalating inflation rates resulting from restricted production and subsequent currency purchasing power decline, has led some individuals to turn to Bitcoin as an alternative income source. This highlights the indirect relationship between monetary policy decisions and rising Bitcoin prices through the aggregate demand behavior of individuals in the economy.

Conversely, no significant relationship was found between the real interest rate and Bitcoin prices, underscoring the decentralized nature of this market and its vulnerability to influences beyond direct monetary policy decisions and tools.

The weak positive correlation observed between Bitcoin prices and trading volume in stock exchange shares suggests that Bitcoin serves as a tool for diversification and profitability in Egypt. However, the absence of a relationship between Bitcoin and gold negates its role as a hedging tool or a safe haven during crises, as Egyptians do not typically turn to it under such circumstances.

Furthermore, the anticipated alignment between local and global Bitcoin prices reinforces the notion that the Egyptian market is closely interconnected with the global market and its fluctuations. Egypt's cryptocurrency market is experiencing steady growth as more Egyptians embrace digital currencies as an alternative form of investment. Despite its volatility, Bitcoin continues to gain popularity, and its elevated prices remain a primary driver for investors.

According to those results, we can recommend a set of policies for target stakeholders, including policymakers and investors, as follows;

- For Policymakers, it is important to anticipate the significant future implications of monetary decisions on the Bitcoin market, which will, in turn, have repercussions on the overall economy. This will be through focusing on the cryptocurrency market by formulating regulatory guidelines in an acceptable manner that does not violate the nature of this decentralized market. These regulations can safeguard the economy against the potential risks stemming from the hypothesis of financial technology fragility. The government must also benefit as much as possible from this already existing and expanding market by, for example, imposing taxes on transactions. At the same time, it must work on fostering innovation, enhancing regulation, and promoting transparency within traditional financial markets to effectively compete with cryptocurrencies and facilitate investment flows, which will improve the efficiency of these markets.
- For investors, profitability goals should not only be reconsidered, but Bitcoin should be one of the forms of portfolio diversification, but with a lower percentage. Rather, investors should rely mainly on assets with government guarantees, such as stocks, bonds, or real estate, to avoid possible losses of Bitcoin due to fraud or cyber-attacks.

Further Research: There is more interest in measuring Bitcoin and its various determinants that change from one period to another according to the extent of the market's expansion and the changes of countries in dealing with it. It is also possible to study the impact of Central Bank Digital Currency (CBDC) on dealing in the original cryptocurrency markets. Bitcoin can also be added as one of the modern factors, which has an impact on macroeconomic functions and variables, such as the demand for money function or the demand for investment assets function. It may also be possible to do forecasting of Bitcoin prices for the coming periods. Studying the impact of using Bitcoin and its mining on energy consumption and climate change if sufficient data is available, especially for advanced countries.

Research Limitations: One of the key limitations of the paper lies in the limited availability of data, which hinders the ability to measure additional relevant determinants, particularly behavioral and financial factors such as risk perception, inflation-hedging motives, and trust in the financial system. Furthermore, applying the analysis to other cryptocurrencies beyond Bitcoin presents additional challenges due to the shorter time span of available data for these currencies. This discrepancy in data availability may result in a reduced number of observations, potentially affecting the robustness and generalizability of the results.

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The Use of Statistical Process Control in Total Quality Management: A Bibliometric Analysis of Publication Performance and Trends

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Abstract. *Total Quality Management (TQM) has long been a focus of researchers due to its widespread application in enhancing the quality of all organizational processes. This paper conducts an extensive bibliometric analysis to uncover research patterns and trends in the scientific literature on the use of Statistical Process Control (SPC) tools within TQM. The bibliometric techniques employed provide descriptive and performance analyses, as well as mapping of the research field. Data was collected from the Scopus database with source-type journals of as many as 730 documents and analyzed using Bibliometrix on R software and VOSviewer. Statistical Process Control in Total Quality Management spans diverse fields like Medicine, Engineering, Business, Management and Accounting, Decision Sciences, and Nursing. Key publications appear in Pediatrics, Quality Progress, BMJ Open Quality, BMJ Quality and Safety, and TQM Magazine. Influential authors are Kaplan HC, Wang Z, and Wu Z. This field of research has been developed by researchers from countries such as the United States, United Kingdom, Canada, China and Taiwan. Cincinnati Children's Hospital Medical Center, Harvard Medical School, University of Washington, Johns Hopkins University, and McMaster University are the most relevant institutions. Recent studies emphasize quality improvement and statistical process control. This study benefits academics and practitioners investigating Statistical Process Control and offers a comprehensive overview of its role in Total Quality Management spanning the last 34 years. This research identifies the most influential authors, sources, affiliations, and countries in Statistical Process Control within Total Quality Management. Additionally, it illustrates the evolution of research in this field over time.*

Keywords: Quality, Total Quality Management, Statistical Process Control, Bibliometrics.

JEL Codes: E23, L15, M11,

1. Introduction

Total Quality Management (TQM) involves all levels and departments of an organization to improve product and service quality (Putri et al., 2017). Total quality management is a well-known area of study that has engaged numerous researchers in the past and present. The seven tools that can assist include check sheets, scatter diagrams, cause-and-effect diagrams, Pareto charts, flowcharts, histograms, and statistical

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process control with TQM (Heizer et al., 2020). One technique used in total quality management is statistical process control (SPC). SPC analyzes random samples from a process's output to determine if the items fall within a specified range. This method is extensively utilized to monitor and enhance the quality and efficiency both service and production processes. It encompasses various practices such as sample acceptance, statistical control, process monitoring, experimental design, and process capability analysis (Jacobs & Chase, 2018; Veiga et al., 2016).

TQM bibliometrics has been used to analyze the most widely discussed issues related to TQM in the service sector (Zhang et al., 2021), the literature on Industry 4.0, quality management, and TQM (Chiarini, 2020), and examine whether TQM is a fading trend in management and research (Lee & Hew, 2017). This study differs from others because it uses bibliometric analysis terms connected to the use of Statistical Process Control tools in Total Quality Management. Furthermore, the previous research explored by TQM trends was limited to the last 10 years (2006 - 2015), so this research also explores some research published in Scopus database up to now.

Total Quality Management (TQM) involves all company processes and activities to improve product and service quality (Khalil & Muneenam, 2021). TQM techniques are designed to continuously enhance and maintain the quality of products and processes by minimizing variability in production or service delivery and increasing efficiency, reliability, and overall quality (Al-Refaie et al., 2022). Total Quality Management (TQM) encompasses a comprehensive array of quality-centric business processes, including the design, development, control, maintenance, improvement, and assurance of products and services (Kaur et al., 2013). According to Heizer et al. (2020), seven critical TQM tools must be urgently implemented: 1) check sheets, scatter diagrams, and cause-and-effect diagrams for idea generation; 2) Pareto charts and process diagrams/flowcharts for data management; and 3) histograms and statistical process control (SPC) for problem identification. SPC is particularly crucial as it measures and corrects production variables to uphold standards. Veiga et al. (2016) emphasize the importance of SPC in monitoring a process's performance over time to verify compliance with predetermined standards by statistically analyzing variations, identifying "common causes of variation" that impact the process. SPC's graphical representation of changes is essential for determining whether a process is under control. Furthermore, there is a critical distinction between variable-based and attribute-based SPC (Haming & Nurnajamuddin, 2017). Jacobs & Chase (2018) clarify that variables are quality attributes measured in specific units such as weight, volume, or dimensions, while attributes are quality characteristics that either meet or fail to meet requirements. Immediate implementation of these tools and techniques is vital for maintaining and enhancing quality standards.

The publication of this topic is increasing every year, making it an opportunity and important for more comprehensive bibliometric studies to find the latest and address current problems with a large sample of research needed to design identifiable models and trends. Bibliometric analysis aims to (1) determine authors, sources, affiliations, and countries with the highest level of contribution, (2) identify publications with the highest contribution, and (3) determine the main literature on this topic. This research highlights the use and development of Statistical Process Control (SPC) in Total Quality Management (TQM) through a bibliometric study involving 730 research documents published between 1988 and 2022, obtained through searches in the Scopus database using specific keywords. The study will contribute to inform research trends, prioritize relevant topics, and support research policy decisions for SPC in TQM. Furthermore, it is scientifically valuable for evaluating the influence of research over time and predicting the direction and pattern of research in the future.

2. Method

This quantitative descriptive study utilizes bibliometric analysis to uncover trends and research performance in scientific publications on the application of Statistical Process Control topics in Total Quality Management. Bibliometrics is a widely used method for exploring and analyzing extensive scientific data to assess the literature in a field, pinpoint knowledge gaps, generate new research ideas, and position scientists' intended contributions. (Janik et al., 2021).

The data collection required for this bibliometric analysis was taken from the Scopus database on August 8, 2022. This study uses Scopus because Anugerah et al. (2022) emphasize that Scopus stands as the most comprehensive resource for bibliometric analysis, providing extensive content, broad public visibility, and detailed profiles for every author, institution, and publication series. The keywords utilized in the data search were: (TITLE-ABS-KEY ("Total Quality Management" OR "TQM") AND TITLE-ABS-KEY ("Statistical Process Control" OR "SPC")) and produced 951 documents. Then, the data was filtered, namely based on source type. This research only used journals, so 730 documents were obtained that met the search criteria. The data is downloaded in Excel CSV format, which will later be used for bibliometric analysis. The data search strategy can be seen in the following flow diagram:

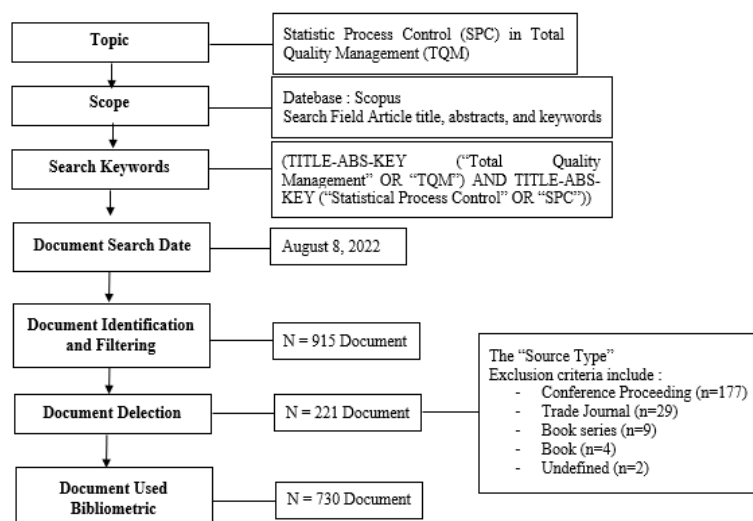


Fig. 1: Search strategy flowchart.

Source: Adopted from Anugerah et al. (2022)

This research utilizes two essential bibliometric analysis techniques to identify trends and evaluate research performance on Statistical Process Control topics in Total Quality Management. Firstly, descriptive and performance analysis examines document types, key subject areas, annual publication and citation counts, prolific authors and sources, affiliations, countries/regions, and highly cited articles. Secondly, network analysis maps research fields through author keyword co-occurrence networks, thematic maps, thematic evolution, and trending topics.

Data analysis in this study utilized VOSviewer software, the RStudio-Bibliometrix Package, and Tableau. The R-package Bibliometrix is a tool for conducting quantitative studies in bibliometrics and scientometrics (Corte et al., 2019). VOSviewer can generate journal, country, and publication maps based on networks (co-citation), keyword maps based on shared networks, and various other types of maps (Effendi et al., 2021). Tableau was used to illustrate publication and citation growth patterns and map the most productive countries.

3. Results and Discussions

3.1. Descriptive Analysis and Bibliometric Performance

The research identified 730 works in the Scopus database on Statistical Process Control within Total Quality Management, including articles (674), conference papers (11), editorials (4), letters (8), notes (3), reviews (28), and short surveys (2). Most publications are in English (714), with others in Chinese (8), German (4), French (2), Danish (1), Hebrew (1), Spanish (1), and Undefined (1). These publications span various fields, primarily Medicine (359), Engineering (257), Business, Management, and Accounting (164), Decision Sciences (132), Nursing (77), and other fields.

The first Scopus publication on Statistical Process Control in Total Quality Management occurred in 1988 and continues to grow. Adams & Gavoor (1988) initial publication on Statistical Process Control in Total Quality Management was titled "Implementing a Company-Wide Quality Strategy," was the first entry found in the Scopus database. The study highlights the challenges, particularly in the US automotive industry, focusing on the balance between long-term and short-term performance measures to adapt to a dynamic market. The research details Rockwell Automotive initiated change by adopting a company-wide Total Quality Control strategy, emphasizing strategic planning, organizational climate, and popular techniques such as QFD, Taguchi Methods, SPC, and the Japanese approach. This research, conducted on Statistical Process Control in Total Quality Management, used document data published in Scopus for 34 years from 1988 to 2022. The annual publication trend can be shown in Figure 2. Growth in the number of publications published related to the use of Statistical Process Control in Total Quality Management in the first 20 years (1988-2007) was 276 publications, almost double the 454 publications in the last 14 years. The growth in publications on Statistical Process Control in Total Quality Management was most significant in 2021, with 62 publications. This shows that in the third quarter of 2022, there has been a slight decrease in the number of research conducted, namely 29 publications. However, let us notice the overall publication with the theme Statistical Process Control in Total Quality Management. The trend is increasing, which illustrates the growing research interest in this field.

Figure 2 also displays the citation impact of studies conducted each year. The bibliometric measure Mean Total Citations per Articles (MTCA) averages research citations from all Scopus-indexed publications (Suwarno et al., 2021). Since 1988-2007, MCTA has shown an increasing trend, while in 2008-2022 it has decreased. Based on the Mean Total Citations per Article (MTCA), the highest occurred in 2007, with an average of 70.75 citations. This shows that publications on Statistical Process Control in Total Quality Management in 2007 were more widely cited than in other years. Overall, the citation trend for Statistical Process Control in Total Quality Management has fluctuated with a decreasing trend. This can happen because research results have not generated many citations in recent years. After all, it takes time for research to have an impact. The number of publications (N) and MCTA in 1988–2022 can be seen in the following figure.

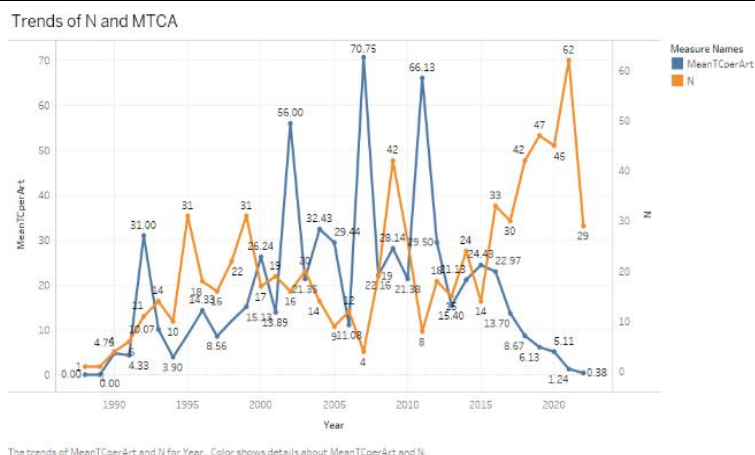


Fig. 2: Trends in Number of Publications (N) and Mean Total Citations per Article (MTCA).

Source: Data processing results (2022)

The number of publications related to Statistical Process Control in Total Quality Management has grown yearly. A total of 58 countries contributed to scientific publications regarding the use of Statistical Process Control in Total Quality Management, where the ten countries with the highest scientific publications are colored blue, as seen in Figure 3. In the blue color, it can be seen that the higher the country's contribution in publications related to Statistical Process Control in Total Quality Management, the darker the blue color produced on the map of that country. Country data is determined based on author affiliation. Based on the data obtained in Figure 3, it can be explained that the United States is the country in the first place, with the most significant contributor accounting for 412 publications (56.44%). The United Kingdom and Canada contributed 70 publications (9.59%) and 43 publications (5.89%), respectively, occupying second and third positions. China and Taiwan accounted for 29 publications (3.97%) and 13 (1.78%), respectively. India and Singapore contributed 11 publications (1.51%), while Australia contributed 10 (1.37%). And in the ninth and tenth place are Germany and Norway, which have the same contribution, namely 9 publications (1.23%).



Fig. 3: Top ten most productive countries.

Source: Data processing results (2022)

The sample used in this research was 730 studies related to Statistical Process Control in Total Quality Management published in 325 journals. The number of research published by each journal based on the level of relevance of the Statistical Process Control theme in Total Quality Management can be seen in Table 1. The top ten journals that received themes related to Statistical Process Control in Total Quality Management, namely 74 documents (10.14%) published in Pediatrics and 49 documents (6.71%) in Quality Progress, and the lowest was Computers and Industrial Engineering with 10 documents (1.37%). Other journals that publish research related to Statistical Process Control in Total Quality Management are BMS Open Quality, BMJ Quality and Safety, and TQM Magazine, each receiving 20 documents, Quality Engineering with 15 documents, International Journal of Production Research as many as 14 documents, as well as Production and Inventory Management Journal and Quality and Reliability Engineering International each with 13 documents. These journals are publication venues that accept research on Statistical Process Control in Total Quality Management. The greater the number of documents published in a journal, the more it can be said that the journal is relevant to the theme discussed, namely Statistical Process Control in Total Quality Management. Meanwhile, the most influential journals based on the total number of citations are Pediatrics, with 517 citations, and Journal of Quality Technology, with 224, while the other journals only have under 200 citations.

Table 1: Most relevant publication sources

Ranking	Publication Source	Article*	Publication Source	Article**
1	Pediatrics	74	Pediatrics	517
2	Quality Progress	49	Journal of Quality Technology	224
3	BMJ Open Quality	20	BMJ Quality and Safety	198
4	BMJ Quality and Safety	20	Quality & Safety in Health Care	167
5	TQM Magazine	20	Technometrics	159
6	Quality Engineering	15	JAMA	145
7	International Journal of Production Research	14	Journal of Pediatrics	136
8	Production and Inventory Management Journal	13	The New England Journal of Medicine	126
9	Quality and Reliability Engineering International	13	International Journal of Production Research	125
10	Computers and Industrial Engineering	10	Quality Progress	86

* Ranking according to the most relevant sources ** Ranking according to locally cited sources

Source: Data processing results (2022)

Our research has pinpointed the top 10 most prolific publications on Statistical Process Control (SPC) in Total Quality Management (TQM) (Table 1) and the 10 most cited articles (Table 2). Key bibliometric indicators, such as Local Citations and Global Citations, have been utilized to spotlight recent groundbreaking research (Suwarno et al., 2021). Global Citations account for the total citations a document has received within the Scopus database, while Local Citations refer to citations from publications specifically addressing SPC in TQM within the same database (Janik et al., 2021). This comprehensive analysis, conducted using Biblioshiny for Bibliometrix, identifies and ranks the most cited articles by both Local and Global Citations, revealing pivotal research within 730 documents.

On the other hand, the most influential publication based on Local Citations is an article by Johan Thor, Jonas Lundberg, Jakob Ask, Jesper Olsson, Cheryl Carli, Karin Pukk Härenstam, and Mats Brommels.

Published in 2007 in Quality and Safety in Health Care, their article, "Application of Statistical Process Control in Healthcare Improvement: A Systematic Review," has received 26 citations. This systematic review highlights the application of control charts, a fundamental SPC tool, in improving healthcare quality. The findings underscore SPC as a versatile tool aiding diverse stakeholders in managing healthcare changes and enhancing patient health outcomes.

Table 2: Most influential articles

Ranking	Local Citations	Global Citations	LC/GC Ratio (%)	Local Citations
1	Critical success factors for the successful implementation of six sigma projects in organisations (Coronado & Antony, 2002)	0	427	0,00
2	The run chart: a simple analytical tool for learning from variation in healthcare processes (Perla et al., 2011)	18	272	6,62
3	Application of statistical process control in healthcare improvement: Systematic review (Thor et al., 2007)	26	253	10,28
4	Behind the learning curve: Linking learning activities to waste reduction (Lapre' et al., 2000)	1	234	0,43
5	Successful change programs begin with results (Schaffer & Thomson, 1992)	0	220	0,00
6	Systematic review of the application of quality improvement methodologies from the manufacturing industry to surgical healthcare (Nicolay et al., 2012)	8	203	3,94
7	Total quality management: an empirical test for mediation effect (Ho et al., 2001)	3	144	2,08
8	Explanation and elaboration of the SQUIRE (Standards for Quality Improvement Reporting Excellence) Guidelines, V.2.0: Examples of SQUIRE elements in the healthcare improvement literature (Goodman et al., 2016)	6	143	4,20
9	An enhanced adaptive CUSUM control chart (Wu et al., 2009)	0	137	0,00
10	Rooming-in to treat neonatal abstinence syndrome: improved family-centered care at lower cost (Holmes et al., 2016)	0	133	0,00

*Ranking based on global citations

Source: Data processing results (2022)

Total Quality Management (TQM) is a management approach that aims to improve the quality of products and services in various industries. Research shows that the successful implementation of TQM depends on several important factors, such as a solid work team, adequate training, linkage to business strategy, understanding customer needs, and management support (Coronado & Antony, 2002). In the healthcare sector, statistical process control (SPC) tools have proven to be highly effective in managing process changes, improving patient outcomes, and detecting variations in infection rates (Thor et al., 2007). Run charts also play an essential role in integrating process variations and improving the quality of care (Perla et al., 2011).

Implementing TQM in manufacturing, service, and health industries shows that quality control is critical to improving operational efficiency and performance (Lapre´ et al., 2000; Schaffer & Thomson, 1992). Lean, Six Sigma, and TQM methodologies in the surgical healthcare sector have reduced errors, infections, and drug costs and improved patient care quality (Nicolay et al., 2012). Core TQM practices are essential in converting the effects of supporting TQM practices into improved quality performance, making quality control crucial to ensure all aspects, from the production process to supplier management, are well managed to achieve optimal quality performance (Ho et al., 2001).

Studies in various industries show that TQM focuses on improving processes and overall quality (Goodman et al., 2016). Using CUSUM control charts in statistical process control helps enhance the quality of products, operational efficiency, and process control in various sectors, including manufacturing and technology (Wu et al., 2009). Implementing rooming-in practices through a Quality Improvement (QI) approach in the health service sector also shows improved quality management in caring for babies with Neonatal Abstinence Syndrome (Holmes et al., 2016). Overall, TQM and statistical process control are essential in improving the quality of products and services in various industries, ensuring operational efficiency, reducing defects, and increasing customer satisfaction.

Figure 4 shows the most relevant institutions in publishing Statistical Process Control research in Total Quality Management. These top ten affiliates are in the United States and Canada. Affiliates originating from the United States are Cincinnati Children's Hospital Medical Center with 53 articles (7.26%), Harvard Medical School with 47 articles (6.44%), University of Washington with 44 articles (6.03%), Johns Hopkins University with 37 articles (5.07%), Dartmouth-Hitchcock Medical Center with 33 articles (4.52%), and Nationwide Children's Hospital with 32 articles (4.38%). Next, affiliates from Canada were carried out by McMaster University with 34 articles (4.66%) and the University of Toronto with 31 articles (4.25%). The rest of the affiliates only contributed under 30 articles. Thus, it can be seen that Cincinnati Children's Hospital Medical Center is an affiliate with the most contributions of research articles using the topic of Statistical Process Control in Total Quality Management compared to other affiliates.

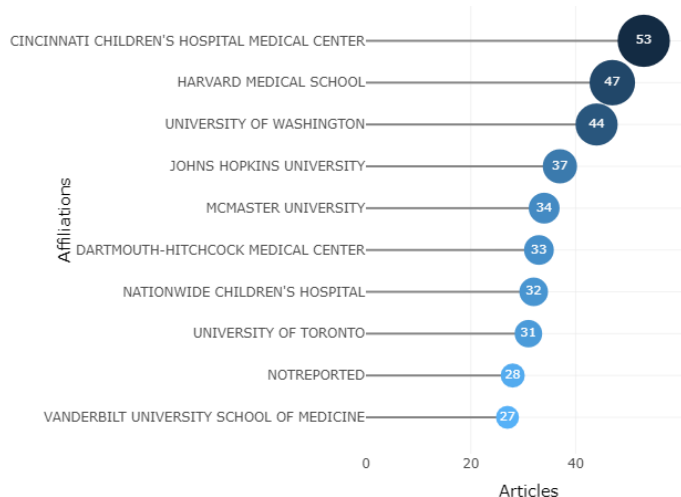


Fig. 4: Top ten most relevant affiliates.

Source: Data processing results (2022)

Authors who have published their writings are sorted according to the resulting impact based on the h-index, where in the top ten authors, this h-index value ranges from 4 to 7. The most significant statistical process control researchers in overall quality management are included in Table 3. Kaplan HC stands out as the most influential, boasting an h-index and g-index of 7, supported by 7 publications and 385 citations,

making him both the most influential and productive writer in this field. Following are Wang Z and Wu Z, ranked second and third with an h-index value of 6 from their 6 publications each. Additionally, Antony J, Guh R-S, Gupta M, Li Z, Poots AJ, and Provost LP hold an h-index of 4 with 4 publications, while JR has an h-index of 4 with 6 publications.

Table 3: Most influential authors

Ranking	Authors	h_index	g_index	m_index	TC	NP	PY_start
1	Kaplan HC	7	7	0,583	385	7	2011
2	Wang Z	6	6	0,429	310	6	2009
3	Wu Z	6	6	0,429	292	6	2009
4	Antony J	4	4	0,167	221	4	1999
5	Guh R-S	4	4	0,167	302	4	1999
6	Gupta M	4	4	0,667	52	4	2017
7	JR	4	6	0,133	100	6	1993
8	Li Z	4	4	0,308	162	4	2010
9	Poots AJ	4	4	0,364	51	4	2012
10	Provost LP	4	4	0,148	356	4	1996

Total Citations (TC), Number of Publications (NP), Initial Year of Publication (PY_start)

Source: Data processing results (2022)

3.2. Literature Research Field Mapping Analysis

Identification of the main research topic on Statistical Process Control in Total Quality Management begins with the analysis of the co-occurrence network structure based on author keywords. A keyword co-occurrence network is a network of author keywords in the same publication that are strongly related and can indicate the core of a research paper (Su & Lee, 2010). Keyword co-occurrence networks study literature keyword connections to understand scientific/technical subject knowledge (Radhakrishnan et al., 2017). Only keywords that appeared at least three times were considered to avoid less important topics and reveal more obvious notions. The author utilized 1234 keywords, but 75 were relevant and formed the network in Figure 5. Circle size shows keyword frequency in Statistical Process Control literature in Total Quality Management. Larger circles indicate authors' frequent keyword selection. Lines linking keywords show their co-occurrences in publications. Significant line widths indicate more co-occurrences (Janik et al., 2021). Word groups are shown by color. The analysis found 12 groupings reflecting the key subtopics of Total Quality Management Statistical Process Control research. Based on the analysis, the words marked with the highest total link strength are statistical process control, quality improvement, quality control, spc, total quality management, quality, TQM, control charts, six sigma, and control chart.

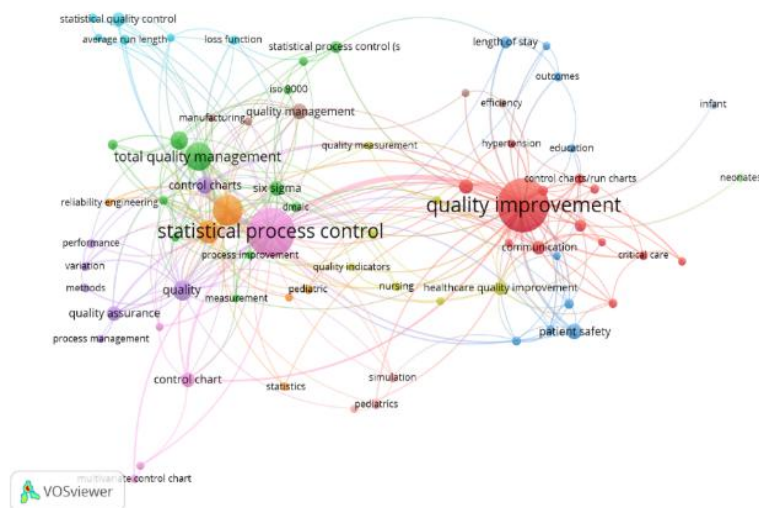


Fig. 5: Co-occurrence network based on author's keywords.

Source: Data processing results (2022)

Groups representing research subtopics in the Statistical Process Control literature in Total Quality Management include: Cluster 1 (13 items): ambulatory care, communication, control charts/run charts, critical care, emergency department, hand-off, hospital medicine, hypertension, pediatrics, patient satisfaction, primary care, quality improvement, sustainability. Cluster 2 (12 items): continuous improvement, dmaic, iso 9000, measurement, process improvement, qfd, six sigma, statistical process control (spc), taguchi methods, total quality management, total quality management (tqm), tqm. Cluster 3 (9 items): education, health services research, implementation science, lean, length of stay, outcomes, patient safety, PDSA, quality improvement methodologies. Cluster 4 (7 items): continuous quality improvement, control charts-run charts, healthcare quality improvement, nursing, quality indicators, quality measurement, statistical process control charts. Cluster 5 (7 items): control charts, methods, performance, process management, quality, quality assurance, variation. Cluster 6 (6 items): average run length, cusum chart, loss function, multivariate quality control, shewhart chart, statistical quality control. Cluster 7 (6 items): pediatric, quality control, reliability engineering, short peripheral catheter, spc, statistics. Cluster 8 (5 items): case study, efficiency, hospitals, manufacturing, quality management. Cluster 9 (5 items): control chart, economic design, multivariate control chart, pattern recognition, statistical process control. Cluster 10 (3 items): cost, pediatrics, simulation. Cluster 11 (1 item): neonates. Cluster 12 (1 item): infant. The above findings demonstrate the variety of keywords authors use, reflecting the multidimensional nature of the Statistical Process Control concept within Total Quality Management.

Figure 6 presents a thematic map constructed using the author's keywords, emphasizing specific clusters and their interconnections. The effectiveness of the cluster design in representing critical research problems increases with the strength of these connections (Yu & Justicia, 2020). This map elucidates the conceptual structure of the topic, classifying themes into four quadrants: Motor themes, Niche themes, Basic themes, and Emerging or Disappearing themes (Cobo et al., 2011). Motor themes, located in the upper right quadrant, exhibit high centrality and density, signifying their advanced development and crucial importance to the research field (Corte et al., 2019). This quadrant includes cluster 2, which encompasses quality improvement, patient safety, and primary care. Niche themes, found in the upper left quadrant, are highly developed internally but have limited external significance, indicating strong internal coherence but minimal impact on the broader field (Corte et al., 2019). This quadrant includes cluster 1 (multivariate control chart), cluster 4 (pediatric), and cluster 6 (process management). Emerging or declining themes occupy the lower left

quadrant, characterized by low centrality and density, reflecting their weak and marginal development (Corte et al., 2019). This quadrant includes cluster 7 (statistical quality control) and cluster 5 (infant). Lastly, fundamental and transversal themes are located in the lower right quadrant, marked by high centrality but low density, indicating their broad relevance and fundamental role across various research areas (Corte et al., 2019). This quadrant includes cluster 3 (statistical process control), which covers statistical process control, quality control, and total quality management.

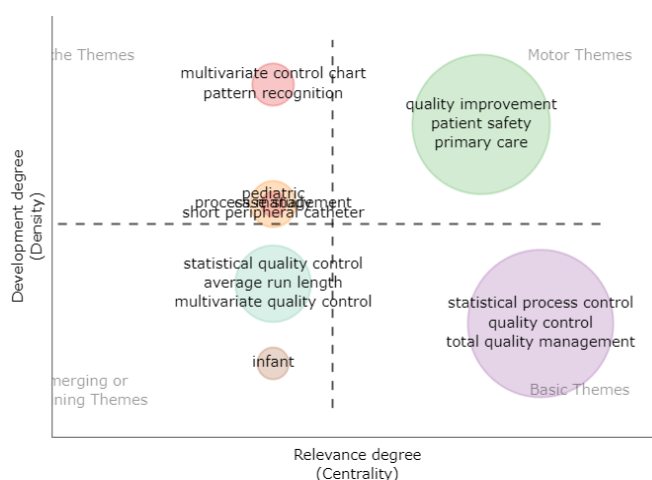


Fig. 6: Thematic map based on the author's keywords.

Source: Data processing results (2022)

Trend topics are also part of this research. Trend topics refer to research topics that are currently popular (Murillo-Vargas et al., 2020). Figure 7 provides a general overview of topic developments over time, categorized by year based on the results of the author's keyword analysis related to the application of Statistical Process Control in Total Quality Management from 2003 to 2022. According to this figure, 19 topics need to be considered over the past 20 years. The image also reveals which topics have been consistently used or have emerged recently. The appearance of these topics is correlated with the frequency of research words related to Statistical Process Control in Total Quality Management. The size of the circle in the image corresponds to the frequency of words used for a particular topic, with the position of the circle indicating the topic's prevalence in research for a specific year. The horizontal line of the circle indicates the period when the topic was extensively researched. Topics that were commonly researched in 2021 include pediatrics and control charts/run charts. On the other hand, quality improvement and statistical process control have been frequently researched over the past 20 years. Quality improvement was the most researched topic from 2016 to 2020 and became the most popular topic with a frequency of 124 in 2019, alongside patient safety and primary care. However, the frequency of these two topics was still lower compared to quality improvement. Statistical process control held the second position, being widely researched from 2007 to 2016 and becoming the most popular topic with a frequency of 106 in 2009, coinciding with quality control and SPC. Nonetheless, the frequencies of these two topics were lower.

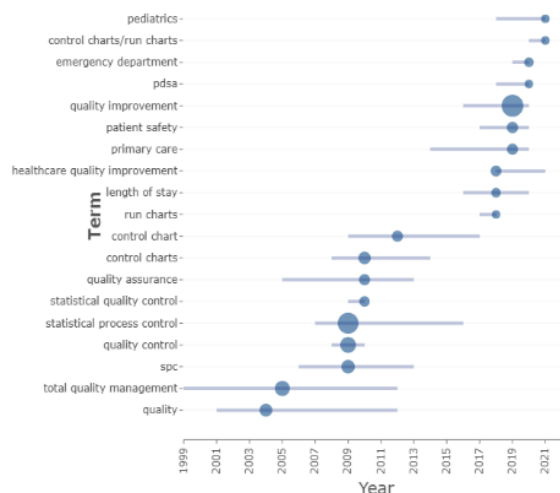


Fig. 7: Topic trends of the last 20 years.

Source: Data processing results (2022)

The next step is a thematic evolution analysis representing research sub-topics in the Statistical Process Control literature in Total Quality Management. Thematic evolution, as generated by R Bibliometrix Biblioshiny, portrays the progression and transformation of keyword clusters across different periods (Hermes & Riedl, 2021). This analysis uses Sankey Diagrams. Sankey diagrams demonstrate related themes that have emerged over time, where each box on the map represents a subject, and its size corresponds to its frequency of appearance (Abhishek & Srivastava, 2021; Aria et al., 2020). The analysis carried out in this research was over 1988-2004, 2005-2017, 2018-2022. The range's years change due to a large rise of publications in recent years. Results are shown in Figure 8.

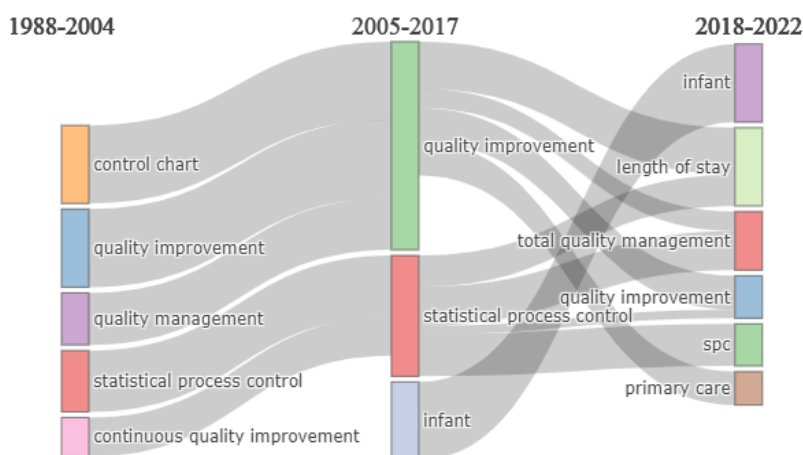


Fig. 8: Thematic evolution based on the author's keywords.

Source: Data processing results (2022)

Figure 8 illustrates that during the initial phase of exploring the Statistical Process Control concept in Total Quality Management, research concentrated on various sub-topics: control charts, quality improvement, quality management, statistical process control, and continuous quality improvement. In the subsequent period (2005-2017), several topics evolved. Control charts, quality improvement, and quality

management merged into quality improvement; statistical process control and continuous quality improvement merged into statistical process control. A new topic, infants, emerged during this period. The present research is centered on infants, length of stay, total quality management, quality improvement, SPC, and primary care. The evolution of the Statistical Process Control topic in Total Quality Management indicates a growing interest from researchers across different fields. Statistical process control emerged between 1988-2004 and gained popularity from 2005-2017, aligning with the quality improvement topic.

4. Conclusions

The research findings suggest that the Statistical Process Control literature in Total Quality Management spans various fields, predominantly Medicine, Engineering, Business, Management, Accounting, Decision Sciences, and Nursing. Key publications include Pediatrics, Quality Progress, BMJ Open Quality, BMJ Quality and Safety, and TQM Magazine. Over time, there has been a rise in publications on this topic, but its citation structure has experienced fluctuations, indicating a decreasing trend. The most globally cited article is "Critical Success Factors for the Successful Implementation of Six Sigma Projects in Organizations", while the locally cited article is "Application of Statistical Process Control in Healthcare Improvement: Systematic Review". Influential authors include Kaplan HC, Wang Z, and Wu Z. Researchers from the United States, United Kingdom, Canada, China, and Taiwan have significantly contributed to this field. Noteworthy institutions include Cincinnati Children's Hospital Medical Center, Harvard Medical School, University of Washington, Johns Hopkins University, and McMaster University.

This study explores research findings through field mapping analysis. Co-occurrence network analysis highlights prevalent themes such as statistical process control, quality improvement, SPC, total quality management, TQM, control charts, six sigma, and quality in the literature. Over the past two decades, quality improvement and statistical process control have been popular research areas. Thematic evolution analysis shows an early focus on control charts, quality improvement, quality management, statistical process control, and continuous quality improvement in exploring Statistical Process Control in Total Quality Management. In subsequent years, these themes merged and transformed, with 'infant' emerging as a new area of interest.

This study utilizes bibliometric methods to present academics and professionals with a comprehensive overview of Statistical Process Control in Total Quality Management over the past 34 years. It lays the groundwork for future research in this area. Despite offering a thorough analysis, the study has its constraints. It exclusively depends on the Scopus database and concentrates on articles for bibliometric analysis within the Statistical Process Control literature in Total Quality Management. It is recommended that future research considers databases like WoS and Google Scholar for further exploration. Moreover, upcoming studies could delve into various document types beyond articles, such as conference papers, reviews, and other forms of documentation.

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The Differential Role of Consumer Emotions and Brand Attachment: The Creation of Brand Love and Premium Price for Hedonic Customers

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Abstract. Hedonic value creates positive emotions, fostering brand attachment and love, as well as perceive premium price. The objectives of this study are: (1) to explore the antecedents of premium pricing and brand love arising from the hedonic value of a product/service, consumer emotions, and brand attachment, and (2) to investigate the role of consumer emotions and brand attachment in strengthening the relationship between hedonic value and brand love and premium pricing. A total of 155 respondents who participated using purposive sampling with the criteria for the sample were consumers who have consumed hedonic products more than once. Hypothesis testing was conducted using Smart-PLS after the prerequisites of discriminant validity (Fornell-Lecker), convergent validity, reliability, and AVE were met. The results of hypothesis testing show that premium pricing and brand love are influenced by hedonic value and consumer emotions. However, brand attachment is not predicted by hedonic value. Additional findings indicate that consumer emotions mediate the relationship between hedonic value and brand love and premium pricing, while brand attachment does not demonstrate the same role. Therefore, businesses must pay attention to consumer emotions when making pricing decisions and instilling consumer love for the brand.

Keywords: brand attachment, brand love, consumer emotions, hedonic value, premium price

JEL Codes: M31

1. Introduction

Consumers are motivated by both hedonistic and utilitarian factors while making decisions. Utilitarian motivation is based on functionality and benefits, where rationality plays a role in decision-making. In contrast, hedonic value is based on symbolism and status, where consumers' emotions play a role in decision-making. Hedonic value serves the purpose of fulfilling affective or sensory goals. Unlike utilitarian products, hedonic products are considered capable of satisfying greater passion, pleasure, and involvement (Bettiga et al., 2020).

Hedonic value and customer emotion are strongly correlated, with hedonic value evoking happy, exciting, and satisfied feelings. Customer emotion arises due to past experiences with the same product. According to (Peshkova et al., 2016), customer emotions have an impact on attitudes and behaviors; therefore, they should be leveraged by businesses to strengthen customer loyalty. This is supported by (Bettiga et al., 2020), who state that the emotional aspect is one of the drivers behind their decision-making. Therefore, it is not wrong to consider consumer emotions as a construct in this research to compare consumer emotional responses to the use of hedonic products, especially since many have been focused on luxury goods and retail products so far (Kim et al., 2016).

Hedonic value reinforces brand attachment by building positive emotional connections through delightful and memorable consumer experiences. These positive experiences contribute to a stronger emotional bond with the brand, making the brand a preferred choice over competitors, remaining loyal,

creating a unique identity for its customers, and seeing the brand as an extension of itself. Self-congruence, extrinsic value, self-expression, and prestige are constructs that shape brand attachments (Lee & Workman, 2015). According to them, psychologically, the bond between the brand and the consumer will influence decisions that lead to the formation of repeat purchase patterns and brand loyalty. Furthermore, this bond will drive motivation and behavioral implications to maintain the existing relationship.

Ultimately, emotions and brand attachments will strengthen the consumer's love for a brand. Brand love becomes an essential construct because it can retain existing customers and attract potential new consumers, starting with the ability to identify the brand, past experiences, and satisfaction (Pandowo, 2015). Unsurprisingly, consumer affection for a brand will lead them to loyalty and a willingness to recommend it to others. Furthermore, the existence of love and loyalty to a brand creates the ability to set a premium pricing policy. This policy can only be achieved if a business entity has loyal customers and low customer churn rates. According to some previous studies, premium pricing policies can be influenced by past brand experiences, brand credibility, and the perceived uniqueness of the product by customers (Dwivedi et al., 2018). In the context of the current research, premium pricing policy represents the effect of the hedonic value of a product, consumer emotions, the bond between consumers and the brand, and customer affection for a brand.

As a real-world example to highlight the relationship between hedonic value, consumer emotion, brand attachment, brand love, and premium price, is the existence of Apple iPhone products. As a product that represents a hedonic value commodity, the Apple iPhone provides not only functionality but also symbols. Apple iPhone products can evoke positive emotions such as inner satisfaction, joy, gratitude, and environmental acceptance in users. Furthermore, users become loyal to the brand and feel that they are an important part of the community built by the Apple iPhone (Constantin & Stenescu, 2014). This can happen because the Apple iPhone uses exclusive apps that are only accessible to that user. The experience of using Apple iPhone products reflects high quality and value encouraging users to try or use other Apple products (iPad, Macbook, Smartwatch). This is in line with the findings of (Sheinin, 2020) who investigated user experience in terms of the tendency to explore the same product (parent brand) due to familiarity with the brand. People who love a brand tend to use by-products of the same brand. Although the price of Apple products has historically been higher than competitors in the same market, people are willing to sacrifice higher costs to obtain Apple products. Of course, the issue of their emotional role and brand attachment cannot be ruled out. To love a brand and pay a premium price, the product must have functional benefits and status symbols, be emotionally binding, and provide pleasure and comfort when used.

Based on these considerations, this research explores the determinant factors that shape the constructs of brand love and premium pricing and seeks to uncover any hidden roles of these constructs. The results of this research can contribute to the elaboration of consumer emotions and brand attachment as well as the extent to which determinant factors play a role in business entity policies. By focusing on the cognitive aspect, this article can address the unanswered gaps in the relationships between constructs up to this point.

2. Research Elaboration

2.1. Hedonic Value

Consumer motives in making purchase decisions consist of hedonic and utilitarian values. Utilitarianism is the consumer motive related to purchases based on a product or service's value, utility, and benefits (Huber et al., 2018). On the other hand, hedonic value is the consumer motivation related to the feelings associated with a product or service (Huber et al., 2018). In a common consensus, it is believed that hedonic products have a richer impact compared to utilitarian products (Baghi & Antonetti, 2017). This serves as the foundation in the current research context.

Hedonic value typically targets consumers with irrational, affective processing. The forms of reactions from users of hedonic values include feelings of joy and happiness stemming from their emotional side. The goal is to actualize their freedom, fantasies, and emotional passion. Therefore, multisensory experience becomes a primary aspect in shaping hedonic value.

When measuring consumer responses to hedonic products, various findings show different results. Essentially, hedonic products generate greater passion, pleasure, and engagement than utilitarian products (Bettiga & Lamberti, 2017). However, even though the emotional aspect of consumers proves to be more effective for hedonic products compared to utilitarian products, this effect may only apply to specific segments or specific modes of interaction (Liao et al., 2016), or it may not differ significantly between hedonic and utilitarian products (Vila-López & Küster-Boluda, 2018). In this study, hedonic products are believed to be able to predict consumer emotions. Therefore:

H1: There is an influence of hedonic value on consumer emotions.

The hedonic value represents the emotional side of consumers in shopping, generally having a prestige effect. Hence, consumers must associate themselves with products or brands with this value. This, in turn, creates a strong bond between consumers and the brand. The higher the product quality and the happiness derived, the stronger the brand attachment. The hedonic value attached to a product or brand contributes to this bond (Liu et al., 2016). This opinion is further supported by findings from different industries (Liu et al., 2020). Even (Y. et al., 2021) believe consumers are emotionally attached due to hedonic value. Therefore:

H2: There is an influence of hedonic value on brand attachment.

Hedonic value and brand love are related (Huber et al., 2015). According to them, hedonic value in eliciting brand love tends to be stable and does not diminish even over a long period. This is because hedonic products serve as a means for individuals to express themselves and signify their social status. Affection for a brand is easier to develop for products with symbolic (hedonic) value than for functional (utilitarian) products. This has been confirmed in previous research (Karjaluoto et al., 2016), which describes the emotions of female consumers in loving ready-to-wear clothing brands due to the influence of hedonic value as part of the brand's self-expression (Siddique & Rajput, 2022). Therefore, the following hypothesis is proposed:

H3: There is an influence of hedonic value on brand love.

The hedonic value associated with a product tends to be related to using emotions as decision-making stimuli, especially when offered at a higher price level compared to similar products in the market. In an investigation conducted by (Abrate & Viglia, 2016) in the luxury hotel industry, consumers' willingness to pay a higher price signals quality and the balance of intangible aspects and service provision. This indicates that consumers' perception of fulfilling hedonic motivation can increase prices. Some literature, however, presents different findings. Wei et al. (2023), who studied users of utilitarian green products, are willing to pay a higher price for these products compared to hedonic products. Convenience and functionality are the reasons for their willingness to acquire these products. This supports the findings of (Palazon and Delgado-Ballester, 2013), who believe that the inclination toward instrumental products is much easier to accept than hedonic products. Nonetheless, hedonic products in certain industries are believed to be associated with premium prices offered.

H4: Hedonic value influences premium pricing.

2.2. Consumer Emotions

As a vital element in the shopping experience, consumer emotions have both cognitive and affective impacts. Feelings such as joy, happiness, or satisfaction represent forms of cognitive perception. Emotions themselves depict the readiness of one's mental state in terms of (a) influencing core changes in other dimensions, (b) cognitive processing, (c) physiological expressions, and (d) the ability to produce actions in response to these emotions (Kranzbühler et al., 2020).

Conceptually, in this research, emotions focus on the manifestation of consumer feelings and their relationship with brands. This is noteworthy to pursue because emotions, as one of the elements of psychology, influence an individual's decision-making. This is because emotions differ in valence, and these differences impact behaviour in decision-making. Furthermore, emotions are distinct from moods, conceptualized as a low-intensity, long-lasting core state (Kranzbühler et al., 2020).

Past experiences lay the foundation for consumer reactions in the form of moods and emotions and their relationship with the use of a brand. The role of emotions in past experiences and their dynamics is a focus of several researchers (Mathieu et al., 2020), including how emotions crucially predict future behaviours (Gaur et al., 2014) and whether they are positive or negative. However, it is important to note that consumer emotions can change over time.

So far, brand love is a positive feeling that reflects an emotional attachment to the object of affection. Carroll and Ahuvia suggest that brand love is formed due to the emotional bond with satisfied consumers over a brand's performance and is built on intimacy and trust (Sheets, 2014). Similarly, (Bairrada et al., 2019) justify brand love as a positive overflow, encompassing feelings, emotions, and attitudes that drive consumer behaviour. Meanwhile, (Kohli et al., 2015) believe that brand love results from consumers' emotional manifestations in their relationship with the brand. Therefore:

H5: There is an influence of consumer emotions on brand love.

For brand users, the emotions embedded in their minds enhance their appreciation of performance and shape their attitudes regarding transactions related to a brand. Research indicates that in pre-offer and during offer periods, consumer emotions play a decisive role in an individual's willingness to pay a premium price (Xu et al., 2020). This particularly holds true for male respondents compared to females. These findings also validate the findings of (Grappi et al., 2015), where an individual's emotions can enhance their willingness to pay. Therefore:

H6: Consumer emotions influence premium pricing.

2.3. Brand Attachment

Brand attachment is a relationship built on strong and positive emotions, reflecting enthusiasm and feelings between consumers and a brand. First formulated in 2005 by Thomson et al., brand attachment encompasses emotional and cognitive bonds that reflect the brand and self-connection (Japutra et al., 2014). Furthermore, the affective aspect complements the existence of brand attachment after (Bahri-Ammari et al., 2016) linked it to consumers' psychological closeness and consumption entities. In essence, brand attachment results from the accumulation of consumer interactions with the brand over time.

The attachment between a brand and consumers ultimately can influence behaviour, leading to a company's profitability and customer lifetime value (Theng et al., 2015). Moreover, brand attachment strengthens brand trust (Japutra et al., 2018), credibility, and satisfaction (Dwivedi et al., 2018), as well as brand equity (Dwivedi et al., 2019). Another important role it plays is that of a mediator in the relationship between the brand and consumers (Li et al., 2020; Loureiro & Lopes, 2019).

As the intensity of the relationship continues over time, satisfied consumers develop not only rational preferences but also emotional attachments to the brand. This attachment can then give rise to concern when negative sentiments occur (price increases, withdrawal, operational closures) or add excitement when they experience other positive effects. A strong, positive attachment over time then evolves into brand love (Fetscherin & Heinrich, 2014). The findings (Ghorbanzadeh & Rahehagh, 2021) convincingly confirm brand attachment as a predictor of brand love. Therefore:

H7: There is an influence of brand attachment on brand love.

Psychological attachment to a brand determines consumer behaviour, including the willingness to spend resources to acquire that brand (S. et al., 2015). Consumer attachment to a brand tends to make them willing to pay more due to the emotional closeness they have with the brand (Bahri-Ammari et al., 2016),

provided that the brand is easily remembered and can evoke positive thoughts. To extend these findings, the following hypothesis is proposed:

H8: Brand attachment influences premium pricing.

2.4. Brand Love

Brand love grows from the strong connection between consumers and a brand. There are three components of brand love: commitment, passion, and intimacy (Stenberg). Intimacy refers to the emotional attachment in an interpersonal relationship; passion relates to the motivation to maintain the interpersonal relationship, while commitment reflects the tendency to continue the long-term relationship that has been established. Unlike satisfaction, which is more cognitive in nature, brand love tends to be more affective. Therefore, brand love is defined as the extent of emotional attachment created in satisfied customers towards a brand. The concept of brand love is based on attitudes, subjective norms, and control factors. Meanwhile, (Vernuccio et al., 2015) initiate the concept of brand love as a plural psychological aspect consisting of brand awareness, emotional response to the brand, positive brand evaluation, brand passion, and declaring love for the brand.

The concept of brand love has become embedded in the consumer's identity (Karjaluoto et al., 2016) as a means of self-expression. This presents a challenge for modern marketers in formulating the concept of brand love for their business entities. Consequently, brand love has become a new phenomenon in brand management and a tool for building sustainable brand-consumer relationships. According to (Kohli et al., 2015), brand love is a manifestation of a positive brand-consumer relationship. As evidence, brand love tends to be associated with self-concept (Sirgy, 2015), self-image, and personality (Khare, 2014).

Various findings have validated brand love as a positive stimulus in predicting consequential variables. Several variables that have been studied include loyalty (Sarkar & Sreejesh, 2014), word of mouth (Wallace et al., 2014), and even building long-term brand-consumer relationships (Kohli et al., 2015; Vernuccio et al., 2015). Conversely, a strong sense of love can lead to negative energy, resulting in brand jealousy (Sarkar & Sreejesh, 2014) due to perceived injustice.

2.5. Premium Price

Premium pricing refers to the additional amount of money consumers are willing to pay as a cost for the added benefits of desired product or service features. Premium pricing is a characteristic of customer commitment to the desired product or brand (Trivedi et al., 2015). The extra cost is compared to the value the consumer will receive. The willingness to pay more for additional value can be due to social or health considerations (Molinillo et al., 2020) or social and sociodemographic status (Knaggs et al., 2022). Another surprising finding is that younger consumers are willing to pay a premium price (Zhang et al., 2020) because they have stronger beliefs and more open-minded thinking than older consumers.

The willingness to pay a premium price is often found in consumer motivations that prioritize hedonism (Abrate & Viglia, 2016), aiming to make life easier, more valuable, and stable in the long term. Additionally, consumers gain value and experiences that are not attainable at regular prices, such as convenience, social class, and lifestyle (Pandowo & Pandowo, 2019). In the era of sustainable marketing that emphasizes environmentally friendly practices, several studies indicate consumers' willingness to pay more to align with their lifestyle concepts (Namkung & Jang, 2017). In the context of online sales, (Xu et al., 2020) identified seller reputation as a driving factor, in addition to the integrated cognitive and emotional values of consumers. In the hospitality sector, (González-Rodríguez et al., 2020) investigated environment, company image, and consumer environmental considerations factors as determinants in consumer willingness to spend more. Meanwhile, (Zhang et al., 2020) demonstrated that consumer attitudes driven by perceived value, environment, and personal factors, as well as regulations and publications, influence the desire to pay a premium price.

In addition to its role as an outcome, premium pricing is also known to act as an antecedent for other constructs. (Molinillo et al., 2020) identified premium pricing as an active predictor for repeat purchases of organic food products through cross-cultural research conducted in Spain and Brazil.

2.6. Research Method

This research utilizes a quantitative approach, where primary data is collected through survey distribution to respondents. The research employs purposive sampling, with the following criteria for respondents: (1) aged 18 or above and (2) regular users of hedonic products. Using estimation guidelines (Hair et al., 2019) that suggest the number of respondents should be at least five times the number of parameters, the minimum required sample size is 115 individuals.

The questionnaire consists of two parts. The first part collects demographic data about the respondents, including age, gender, profession, and shopping location. The second part includes the parameters of the constructs to be tested in this study. The construct of hedonic value comprises five parameters; consumer emotions comprise six parameters, brand attachment comprises seven parameters, brand love comprises four parameters, and premium pricing comprises three parameters. All parameters use a 7-Likert-like scale.

Using the Smart-PLS 4 software, the testing process consists of examining both the outer model and the inner model. The outer model testing, as a prerequisite for the model, includes assessing convergent validity and discriminant validity, Cronbach's alpha, Average Extracted Variance, Rsquare, Fsquare, and Qsquare. Subsequently, the inner model testing is conducted to examine the hypotheses.

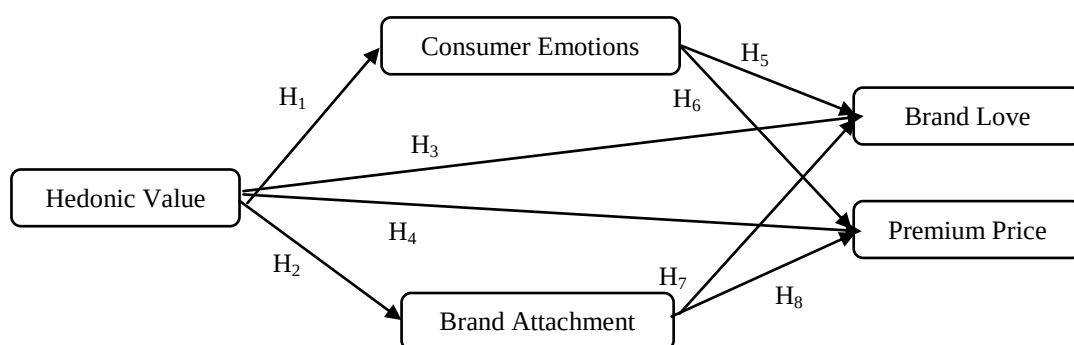


Figure 1. Research Model

3. Results and Discussions

3.1. Data Characteristics

To facilitate the categorization of respondent characteristics, they are classified into four categories: age, gender, profession, and shopping location. For more details, please refer to Table 1.

Table 1. Respondent Demography

	Number of Respondents (N=155)	Percentage
Age		
< 20	36	23.2
21-30	46	29.7
31-40	43	27.7
41-50	25	16.1
> 50	5	0.3
Gender		
Male	63	40.6
Female	92	59.4

Occupation		
Student	43	27.7
Civil Servant	45	29.0
Employee	53	34.2
Housewife	14	9.1
Brand		
H&M	50	32.3
Uniqlo	32	20.6
Executive	15	9.7
Wakai	9	5.8
Planet Surf	14	9.1
Erigo	12	7.7
Others	23	14.8

Source: Processed Data (2023)

Based on Table 1, a total of 155 respondents were grouped according to their age, gender, profession, and shopping location characteristics. In terms of age groups, the largest group of respondents falls in the 21-30 years old range (29.7%), followed by the 31-40 years age group (27.7%). The age group of >50 years represents the smallest group of respondents (0.3%), followed by the 41-50 years age group (16.1%). Regarding gender, the most respondents are women (69%), followed by men (40.6%). In terms of professions, the largest group comes from employees (34.2%), followed by civil servants (29%). The smallest professional group is made up of housewives (9.1%) and students (27.7%). When it comes to shopping locations, the most significant contributors are H&M (32.3%) and Uniqlo (20.6%). Wakai (5.8%) and Erigo (7.7%) are the least significant contributors.

3.2. Inner & Outer Model Test

Table 2. Inner Model Test

Construct		Loading Factor	Cronbach Alpha	Composite Reliability	AVE	F ²	R ²	Q ²
Hedonic Value	H1	0.916	0.889	0.899	0.695	0.056		
	H2	0.880						
	H3	0.738						
	H4	0.869						
	H5	0.750						
Consumer Emotions	E2	0.745	0.842	0.859	0.686	0.104	0.713	0.704
	E4	0.896						
	E5	0.714						
	E6	0.936						
Brand Attachment	I1	0.698	0.888	0.950	0.665	0.067	0.005	0.009
	I2	0.850						
	I5	0.838						
	I6	0.891						
	I7	0.786						
Brand Love	BL2	0.931	0.702	0.810	0.762		0.347	0.011
	BL3	0.811						
Premium Pricing	PP1	0.864	0.832	0.842	0.752		0.511	0.418
	PP2	0.945						
	PP3	0.785						

Source: Processed Data (2023)

Based on Table 2, the factor loading values for all constructs are above 0.7 (Hair et al., 2019), which falls into the category of "very satisfactory." Even though one parameter has a value of 0.698, it is considered acceptable because its removal does not significantly affect the composite reliability (Garson, 2016). It is recorded that at least five parameters were removed (E1, E3, I3, I4, and BL1). The lowest Cronbach's Alpha value is recorded for brand love (0.702), and the highest is for hedonic value (0.889). Meanwhile, the lowest composite reliability is for brand love (0.810), and the highest one is for brand attachment (0.950). The Average Extracted Variance values are all above 0.6, surpassing the 0.5 threshold, with brand love at the lowest (0.665) and brand attachment at the highest (0.762). The R-square value of about 0.511 indicates that premium pricing can be explained by hedonic value, consumer emotions, and brand attachment, with the remainder being contributed by other unexamined factors. A Q-square value above 0 indicates sufficient predictive relevance (Hair et al., 2019). The GoF test shows a value of 0.529, indicating a moderate fit. Table 3 displays the results of the discriminant validity test using the Fornell-Lecker method, where the square of the AVE is greater than the correlations for each construct.

Table 3. Fornell-Lecker (Discriminant Validity)

	Brand Attachment	Brand Love	Consumer Emotions	Hedonic Value	Premium Pricing
Brand Attachment	0.815				
Brand Love	0.547	0.873			
Consumer Emotions	0.038	0.027	0.828		
Hedonic Value	0.073	0.162	0.824	0.834	
Premium Pricing	0.143	0.006	0.675	0.651	0.867

Source: Processed Data (2023)

3.3. Hypothesis Test

Since all values are eligible, hypothesis testing can proceed to the next stage. Table 4 presents the results of the hypothesis testing.

Table 4. Hypothesis Test

Variable	Direct Path Coefficient	t Statistic	Indirect Path Coefficient	t Statistic	Indirect Path Coefficient	t Statistic	Total Path Coefficient	t Statistic
			Via Consumer Emotions		Via Brand Attachment			
HV – CE	0.844	40.196					0.844	40.196
HV – BA	-0.073	0.691					-0.073	0.691
HV – BL	-0.408	3.656	0.284	2.433	-0.039	0.685	-0.162	1.974
HV – PP	0.308	3.730	0.356	5.424	-0.013	0.695	0.651	15.302
CE – BL	0.337	2.548					0.337	2.548
CE – PP	0.421	5.495					0.421	5.495
BA -BL	0.530	8.851					0.530	8.851
BA – PP	0.181	4.344					0.181	4.344

Note: HV = Hedonic Value, CE = Consumer Emotion, BA = Brand Attachment, BL = Brand Love, PP = Premium Pricing

Source: Processed Data (2023)

The results of the hypothesis testing indicate that hedonic value has a significant influence on consumer emotions ($\beta=0.844$; $t=40.196$), brand love ($\beta=-0.408$; $t=3.656$), and premium pricing ($\beta=0.308$; $t=3.730$). However, the effect of hedonic value on brand attachment is not significant ($\beta=-0.073$; $t=0.691$). Therefore, H1, H3, and H4 are accepted, while H2 is rejected. Furthermore, the testing of consumer emotions on brand love ($\beta=0.337$; $t=2.548$) and premium pricing ($\beta=0.421$; $t=5.495$) shows positive

significance. Meanwhile, brand attachment is able to predict brand love ($\beta=0.530$; $t=8.851$) and premium pricing ($\beta=0.181$; $t=4.344$). Thus, H5, H6, H7, and H8 are accepted.

Beyond hypothesis testing, this study explores the potential mediating role of consumer emotions and brand attachment. Therefore, hypothesis testing continues with mediation testing. The results of the mediation testing show that consumer emotions play a role in strengthening the relationship between hedonic value and brand love ($\beta=0.24$; $t=2.433$) and the relationship between hedonic value and premium pricing ($\beta=0.356$; $t=5.424$). On the other hand, brand attachment fails to mediate the relationship between hedonic value and brand love ($\beta=-0.039$; $t=0.685$) and premium pricing ($\beta=-0.013$; $t=0.695$).

3.4. Discussions

Hypothesis testing results show that hedonic value can predict consumer emotions, brand love, and premium pricing, except for brand attachment. In the first hypothesis, the testing of hedonic value on consumer emotions suggests that purchasing hedonic products can enhance consumers' enthusiasm, engagement, and happiness. This finding also confirms previous research by (Bettiga et al., 2020), which found emotional responses from consumers when consuming hedonic products that align with their typology. It can be concluded that consumer emotions increase due to the presence of hedonic value in a product, even if consumer engagement is relatively low (Liao et al., 2016).

The results of the second hypothesis indicate that hedonic value does not affect brand attachment. This suggests that purchasing hedonic products does not strengthen the bond between consumers and the brand. One possible reason is that consumers purchase hedonic products for intrinsic value alone, disregarding extrinsic value, which may need to be stronger to foster a connection between consumers and the brand. According to (Leroi-Werelds et al., 2014), intrinsic value brings joy, satisfaction, and happiness but may not be sufficient to foster attachment between both parties.

In the testing of the third hypothesis, it was found that hedonic value influences brand love. This finding aligns with previous research (Siddique & Rajput, 2022b). It suggests that the positive value of hedonic products motivates consumers to love the brand. For consumers, both extrinsic and intrinsic values of hedonic products can fulfill their needs and provide benefits, forming the basis for consumer emotions to love the brand. The findings presented by Ahn, Ekinci, and Li (2013), as well as Lambert and Desmond (2013), support this notion, indicating that brands are approached not because of their superior performance or functionality but because of the symbolic value or status associated with them.

To test the fourth hypothesis, the research findings indicate that hedonic value can predict premium pricing. This suggests that if a product can demonstrate hedonic value and is directly perceived by consumers, they are willing to sacrifice more to obtain the product or service. Because purchasing hedonic products is more emotionally oriented than rational, purchases tend to be driven by feelings rather than common sense. This is why buying more expensive hedonic products often occurs, even when cheaper competing products are available in the market. The purchase of hedonic value products leading to impulsive buying behaviour has been discussed by (Liao et al., 2016).

The results of the fifth hypothesis testing show that consumer emotions influence consumer love for a brand. In general, a person's feeling of love always begins due to emotional factors. In marketing, a person's love for a brand is driven by positive experiences created and promoted by strong emotional responses, transforming into love. This is echoed by Ahn, Ekinci, and Li (2013), who state that love begins with an emotional bond arising from the value provided by the product. This finding is also in line with the statements of Lambert and Desmond (2013), who agree that emotional factors are the basis for the formation of love in consumers.

The results of the sixth hypothesis testing show the significant predictive ability of consumer emotions on premium pricing. Thus, customers' willingness to sacrifice more in payment for a product or service is driven more by emotional factors than rational ones. This is in line with previous findings, such as (Okoe et al., 2014), who suggest that customers may feel a sense of pride when using a product at a higher price. Similarly, (Zhang et al., 2020) believe that decision-making is done to satisfy pleasure and enhance consumer preferences in line with consumer emotions and adoption behaviour.

The findings of the seventh hypothesis testing state that the ability of brand attachment to predict the love for a brand is significant. This proves that for customers who have established consumer-brand relationships, these relationships become deeper over time, eventually turning into love for the brand to some extent. The stronger the attachment, the greater the love. This finding also supports research presented by (Kaufmann et al., 2016), who identified brand attachment as an antecedent of brand love.

In the eighth hypothesis, the significance of brand attachment to premium pricing was found. This finding confirms the customers' ability to pay a higher price due to the positive emotional connection established in the past, making them willing to obtain a product with a greater sacrifice. Consistent with the findings of (Sreejesh et al., 2016), customer attachment to a brand encourages them to use the product more frequently and resist switching even if a higher price is offered. Emotionally, the decision to purchase at a higher price is preferred over breaking the established attachment.

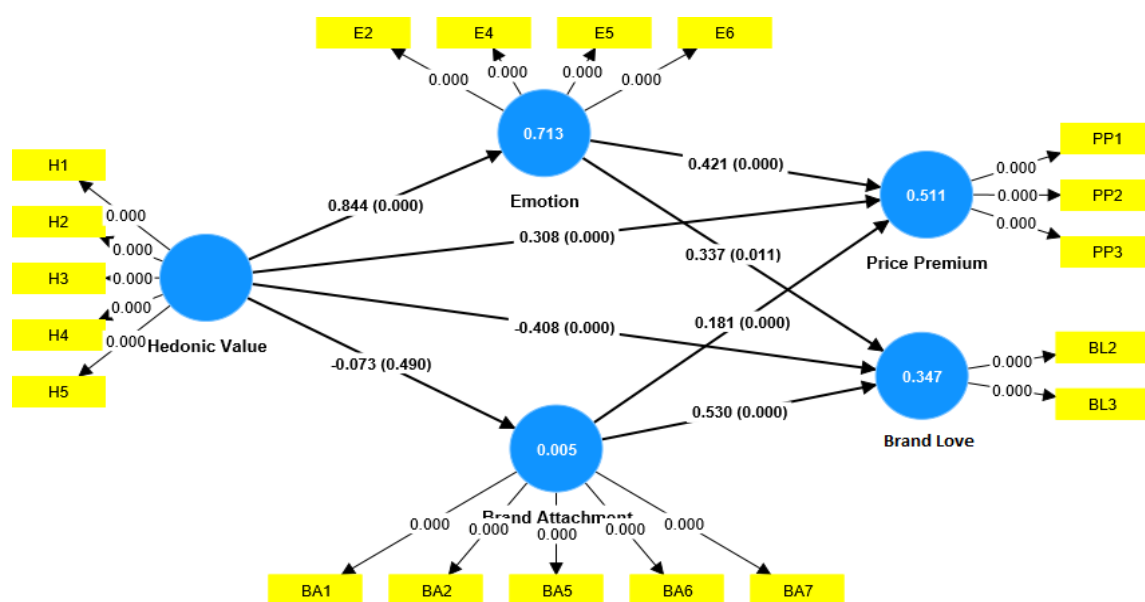


Figure 2. Final Research Model

In this study, there are two constructs, such as consumer emotions and brand attachment, which are suspected to have hidden roles. Therefore, even though not hypothesized, we have included the testing of their roles. Based on the results of the mediation testing, the construct of consumer emotions has been proven to strengthen the influence of hedonic value on both premium pricing and brand love. Thus, customers' emotional aspects serve as the starting point for a brand-consumer relationship that can benefit companies by fostering customer love for the brand and their willingness to make greater sacrifices to obtain the product or service.

On the other hand, the test showed that the mediating role of the brand attachment construct did not demonstrate its ability to predict the influence of hedonic value on either brand love or premium pricing. This suggests that the love for the brand and the willingness to pay a higher price are primarily driven by the emotional aspects of consumers.

4. Conclusions

Based on the findings, it can be concluded that (1) both premium pricing and brand love are influenced by hedonic value, consumer emotions, and brand attachment; (2) the specific influence of hedonic value on brand attachment is not significant; and (3) additional findings show that there is a mediating role of consumer emotions in strengthening the influence of hedonic value on brand love and premium pricing. At the same time, the brand attachment construct does not play the same role.

Based on the results obtained in this study, businesses should pay attention to consumer emotions in building relationships with consumers. The research findings indicate that consumer emotions play a significant role in the decision-making process to establish a deep relationship with the brand and to continue making purchases even in premium pricing conditions. This also ensures that hedonic products will continue to fulfill their functions and benefits in providing emotional satisfaction to users.

As a recommendation for future research, it would be beneficial to include comparative products that focus on the utilitarian, more rational aspect of the decision-making process, where the products are evaluated based on their functional benefits. To create a more comprehensive study, consider incorporating additional constructs related to affective behaviour, such as impulsive or compulsive buying, word of mouth, loyalty, and past experiences. This would provide a more holistic understanding of the factors influencing consumer behaviour and brand relationships.

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