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# DETERMINANTS OF INVESTMENTS: A CASE STUDY OF COTE D'IVOIRE

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## ABSTRACT

**Purpose-** Based on the importance of investments in supporting the economic growth in the country, the main objective of this study is to investigate the determinants of the investment in Cote d'Ivoire over the period 1980-2020**.** In order to achieve the objective, this study examines the interactive effect of external debt, communication infrastructures, imports and inflation on the investments in Cote d'Ivoire.
**Methodology-** Annual time series data over the period 1980-2020 were employed in this study. The data are obtained from the World Bank. The ADF unit root test, Johansen cointegration test, OLS model, Granger causality test, and CUSUM test were applied to analyze the data. Ordinary Least Squares (OLS) model has been used in this study to estimate the coefficient of the variables, and it has been subjected to a number of statistical diagnostic tests, namely, the normality, serial correlation, and heteroscedasticity tests to ascertain its statistical adequacy.
**Findings-** The ADF unit root test results indicated that all variables in the model are not stationary at the level but became stationary after first differencing. The Cointegration test pointed to a significant long-run relationship among the variables. Besides, the results of OLS model showed that investment is positively and significantly related with communication infrastructures, importing and inflation, but it is related negatively and insignificantly with external debt. Imports have the biggest effect on the investment. The Granger causality test shows that there are no short-run causality relationships between the variables. However, there are bidirectional long-run causality relationships between investment, external debt and importing, and unidirectional long-run causality relationships running from communication infrastructures and inflation to investment. Lastly, CUSUM test indicated that there are no structural changes in the model.
**Conclusion-** The study therefore recommends that the government should use external debt more efficiently, reduce corruption, improve the infrastructure and create an attractive investment climate, as well as reducing most tariff and nontariff barriers, which will support the investment in the country.

**Keywords:** Cote d'Ivoire, Ivory Coast, investments, external debt, VAR
**JEL Codes:** O11, E20, G15

## 1. INTRODUCTION

In the economic growth of any country around the world, investment activities can be classified as one of the most important determinants among many others. Indeed, as one of the most important determinants of economic growth, investment has an important influence over employment and unemployment in a country, because, generally, when the rate of investment activities decline, capital stocks will dwindle and jobs may be lost in the country. Besides, by looking at the future of economic growth in the world, today's investments are the one going to determine the economic activity of tomorrow. In such case, if labour productivity, wages and living standards in a given country fall, then, it means that investment and growth capacity are slow, and therefore growth and employment will suffer a lot. However, if investment is the most volatile component of aggregate demand, then it also has an impact on the business cycle. Therefore, by planning the economic growth of any country, governments should imperatively take into account public and private investment principles (Baddeley, 2003).

Thereby, as in every economy, investment in Côte d'Ivoire plays a vital role by having sustainable support of the country's economic growth. According to the report posted by Deloitte in March 2017, with a title of "Invest in Côte d'Ivoire", the country has the largest economy in the French-speaking West Africa and the third-largest in West Africa after Nigeria and Ghana. Within the last decade, GDP moved up from USD 36694 million in 2011 to USD 61349 million in 2020, as well as the investment increased from USD 6549 million in 2011 to USD 13765 million in 2020 (World Bank, 2021). In fact, in the total growth of the economy, public and private investment have a very important share.

By going through the World Bank full report published in earlier 2021, we can attest, the economic growth of Côte d'Ivoire has indeed encountered some tough periods due to the factors like political instabilities, the fluctuation in the price of its first economy engine and some others factors. However, it still having favourable improvement in the agriculture sector, which has an important percentage in the economic growth of the country. Besides of the sector of agriculture, the country also has some other activity sectors which are not negligible in its economic growth. Among these sectors of activity, we have the area of industry and mining, the energy and petrol sector and the finance and capital market. For the country to avoid the risk of seeing its economy concentrated mainly on agriculture, the government decided to diversify in term of activity. Indeed, industry and mining have an important part in the economy of Côte d'Ivoire. Industry has quickly become a critical component of the Ivorian economy due to an abundance of highly sought-after natural resources. Despite insufficient levels of investment during the recent previous years, the country is gradually trying to reclaim its former position as West Africa manufacturing centre. The creation of the new industrial zone and renovation of the existing ones have boosted the profile of this sector (Oxford Business Group, 2022).

The economy of Côte d'Ivoire is also relying on the Energy and Petrol sector, with a greater involvement from the private energy companies, especially on the production side. As a result, this involvement has led to an increase in electricity production capacity in 2017. However, increasing electricity production capacity is a key part of the government's energy policy, and this has helped the country to be a net exporter of electricity in countries like Benin, Ghana, Burkina-Faso, Mali and Togo (Oxford Business Group, 2018).

In the same alternative of improving living conditions of the population and encourage the economic growth of the country, the government of Cote d'Ivoire is now focusing on investment or setting businesses in the public and private sectors, by creating a favourable investment climate for investors. From the side of Foreign Direct Investment (FDI), since the years 1980s, it has gradually moved up and down due to some factors like political instabilities that affect the country's economy. Indeed, after the end of the political crisis of 2011, the Foreign Direct Investment (FDI) has quickly been incited to boost the economic growth of the country. As a result, the FDI net inflows moved from US$ 302 million in 2011 to US$ 849 million in 2019 (World Bank, 2021). Besides, the government of Côte d'Ivoire has taken some measures to draw the attention of the investor's interest. The Côte d'Ivoire's Investment Promotion Centre (CEPICI) created in June 2012 is now providing information and assistance to local entrepreneurs interested in starting a business or a foreign enterprise interested in setting business in the country. Today, CEPICI provides a "one-stop-shop" for investors, an outreach program to match opportunities with potential investors, and public-private partnership program (CEPICI, 2012).

Hence, given the importance of investment in supporting the economic growth in the country, and based on the Ivorian government's strategy to motivate the investment, it is imperative to investigate the determinants of investment in the country. Thus, the main objective of this study is to determine the factors that affect the investment in Côte d'Ivoire from 1980 to 2020. The organization of this study is as follows. The next section is the literature review and Section 3 provides a brief discussion on the methodology. Section 4 reports the empirical results, and the conclusion and recommendations are presented in Section 5.

## 2. LITERATURE REVIEW

Many studies have investigated the determinants of investment in many countries by using different econometric methods. A number of these studies tested the effect of external debt, inflation, imports, communication facilities and other factors on the investment. Some of these studies will be reviewed in this section.

Adamu (2018) investigated the effect of external debt on public capital investment in Nigeria from 1970 to 2013. By using autoregressive distributed lag (ARDL) bound testing approach, the empirical results revealed that external debt and debt service negatively influence the public capital investment, but the current GDP affect it positively. Onwe and larenwaju (2014) investigated the impact of inflation on corporate investment in the Sub-Saharan African Countries by emphasising on the West-African Monetary Zone (WAMZ). The study aimed at unfolding the short and long-run effect of inflation on corporate investment. Error Correction Mechanism (ECM) was the methodology used to find the eventual influence that inflation has over corporate investment. By following Cobb-Douglas production principles, the result of the analysis revealed that in the long-run, inflation has a positive relationship on corporate investment and in the short-run there exist a negative relationship. Costamagna (2015) tested the relationship between inflation and R&D investment in 15 OECD countries within the period 1981-2008. The result confirmed that the higher inflation rate is related with the lower the R&D investment. However, the study suggested that some features such as monetary stability, regional integration, and currency union could be potential determinants that may increase R&D investment.

Alawneh et al. (2015) investigated the impact of fiscal and quantitative monetary policies on the domestic and foreign direct investment in Jordan during the period of 2000 – 2011. The study used two models such as independent variables monetary policy tools including (re-discount rate) and fiscal tools, which include (taxation and government capital expenditure). The first model was used to assess the effect of fiscal and quantitative monetary policy on the domestic investment. After testing, the study found that the re-discount rate exerts a negative effect over the domestic investment, but it was not statistically

significant, while there is a positive impact with a statistically significant between the mandatory cash reserve and the domestic investment. The study also showed that there exists a negative relationship between taxes and domestic investment, and a positive impact on governmental capital spending and domestic investment. This means that the fiscal impact of the political effectiveness is greater than the monetary policy effects on the domestic investment. Concerning the second model, which tested the effect of fiscal policy and quantitative monetary on foreign investment, the study revealed that there exists a statistically significant negative impact of re-discount rate on foreign investment, while it showed a positive relationship between taxes and foreign investment, because the Jordanian government grants a tax exemption to encourage FDI. Augustine et al. (2019) employed the multiple regression analysis technique and Pearson product-moment correlation to examine the impact of taxation on investment and economic development in Nigeria during the period 2007-2017. The study showed that capital gains tax exerts a positive significant effect on investment and economic development in Nigeria, but the significant level is low.

By using the OLS method of multiple regression analysis, Edame and Okoi (2014) investigated the impact of taxation on investment and economic growth in Nigeria from 1980 to 2010. The result showed that in Nigeria, taxation negatively influences the level of investment and the output of goods and services (GDP), but it has a positive impact on government expenditures. Boahen and Evans (2014) tested the effect of exchange rate volatility on FDI in Ghana by employing a Vector Autoregressive (VAR) model. The study first demonstrates theoretically that nominal interest rate volatility can simultaneously lead exchange rate and affect the foreign investment. It then provides a detailed empirical illustration that looks at the long- and short-run movement of exchange rate volatility, interest rate volatility and foreign direct investment by using the Vector Error Correction model. Here, the study establishes that the stability of the exchange rates and interest rates in the country helps to improve the level of foreign direct investment inflows. On top of that, the study explained that the interest rate indirectly affects the FDI, but it directly has an impact on the exchange rate and the attractiveness of the market, which then affects the FDI in the long-run. Therefore, the study concluded that the exchange rate and interest rate stabilisation policies should be implemented.

Fornah and Yuehua (2017) investigated the influence of interest rates and other determinants on foreign direct investment in Sierra Leone during the period 1990-2016. Adopting the Ordinary Least Square method for the analysis, the results showed that interest rates have a significant impact on FDI inflows and hence can be used for policymaking purposes. Furthermore, the research revealed that trade openness and GDP growth are the major factors that affect FDI in Sierra Leone. Khan et al. (2018) investigated the relationship between FDI, imports and export in Pakistan during the period from 1978 to 2016, by using the annual time series data. For a better understanding of the objective of the study, statistical analysis was first of all conducted to find out the relationship between FDI and its impact on the selected macroeconomic factors (imports and export). For them to analyse the data, the Vector Auto Regression Model (VAR) and (ARDL) was employed for the short- and long-run relationship. However, the study revealed that there is a long-term relationship between FDI and export, while a short-term relationship exists between FDI and imports. To give evidence to the outcome of the VAR model, an additional post diagnostic test was conducted, and they were able to conclude that the regressions have a normal distribution and show a strong correlation between the three variables. Besides, Santi and Wisit (2017) studied the interactions and effects between Imports-exports (international trade) and foreign direct investment in 29 OECD and 6 ASEAN countries from 1980 to 2004, by employing the gravity model approach. They found a positive and statistically significant relationship between international trade and investment, which is consistent with expectations. On top of that, the study detailed that there exists a strong correlation from international trade to FDI inflows, compared to the correlation from FDI inflows to international trade. Therefore, the feedback effect investigation suggested that there is a presence of a bi-directional relationship between the two variables, and the empirical result recommended that if trade creation results from economic integration, regionally or bilaterally, there will be an increase in FDI inflows between trading partners.

Rahman (2011) investigated the relationship between FDI and international trade in Bangladesh during the period from 1972 to 2007. The econometric methods employed are the Johansen LR co-integration test and the multivariate Granger causality. Indeed, the first test found that there is a co-integration between the variables, while the second one revealed that FDI caused import, but causality in other directions between these and another variable is not identified. However, for Bangladesh, FDI does not cause export enhancement and the necessary trade and investment policies are needed to profit such FDI for economic growth in general and trade particularly. To find the reason behind the weak performance of Ethiopian's private investment, Sisay (2010) conducted a study on the performance trend and main constraints of private investment in Ethiopia. Thereby, motivated by the modified version of the Flexible Accelerator Model of Investment, the empirical investigation used the multivariate single equation ECM estimation methodology on integrated of order one, within the period 1950 - 2003. After testing, the study revealed that, the Ethiopian's private investment is positively impacted by domestic market, return to capital, trade openness and liberalization measures, infrastructural facilities and FDI, but it was negatively affected by the government activities, macroeconomic uncertainty and political instability.

Bosede et al. (2013) investigated the impact of transportation infrastructure improvement on the economic growth of Nigeria during the period 1981-2011, by using the Ordinary Least Square Regression (OLS) technique. The study revealed that transport output and investment made on transport infrastructure in Nigeria has a significant positive contribution to growth,

which shows that each impact is statistically significant and strong. Therefore, the study recommended that an economic policy, which will improve the transport infrastructure and investment made in this sector for sustainable economic growth, should be designed. Khurriah and Istifadah (2019) tested the role of infrastructure in Indonesia's economic growth. The study used a growth model derived from aggregate production functions and the generalized method of moment (GMM) estimation techniques to estimate public infrastructure capital as explanatory power in the model. By using infrastructures like roads, energy, water and telecommunication from 34 provinces of Indonesia during the period 2011-2017, the test showed the evidence that water and telecommunication have a positive contribution to economic growth with different values, while road infrastructure is showing a negative effect. Nevertheless, the negative result still means road infrastructure is good. Again, the study showed that the problem could be explained through the U-shaped infrastructure and investment growth relationship which gives a sign of crowding out the effect of private capital if the infrastructure investment is dominant.

Toader et al. (2018) conducted an empirical study about the impact of Information and Communication Technology (ICT) infrastructure on the economic growth of the European Union (EU) countries for 18 years (2000-2017). Using panel data estimation techniques, they investigated how various indicators of ICT infrastructure influence the economic growth. The result indicated that the use of ICT infrastructure exerts a positive and strong impact on the economic growth of EU members states, but the magnitude of the effect depends on the type of technology examined. Qiying (2020) also conducted empirical research on the investment performance of information and communication technology in China. However, by introducing a partial dynamic adjustment model and selecting the panel data of China during the period from 2001 to 2016, the study aimed to study how China's investment in ICT influences its economic growth. The study revealed that such investment has significantly promoted the economic growth of China. Besides, by using Johansen cointegration test, Mohsen (2015) found that investment is positively and significantly related to the trade openness, GDP and population in Syria over the period 1980-2010..

## 3. DATA AND METHODOLOGY

To achieve the objective of this study, the investment model will be developed to test the effect of external debt, infrastructure, imports, and inflation on the investment in Cote d'Ivoire. Annual time series data over the period 1980-2020 will be used in this study. The data are obtained from the World Bank (WB). The investment model is presented as follows:

$$\ln GFCF = \beta_0 + \beta_1 \ln EXD + \beta_2 \ln TL + \beta_3 \ln IMP + \beta_4 \ln INF + \varepsilon_t \quad (1)$$

where $\beta_0$ is the intercept, $\beta_1$, $\beta_2$, $\beta_3$, and $\beta_4$ are the slope coefficients, lnGFCF is the natural log of gross fixed capital formation (USD), lnEXD is the natural log of external debt (USD), lnTL is the natural log of communication facilities as an indicator to the infrastructure (number of telephone lines), lnIMP is the natural log of imports (USD), lnINF is the natural log of GDP deflator as an indicator to the inflation, and $\varepsilon_t$ is the error term.

Because this study involves time series data, it is necessary to begin the analysis with the unit root tests. Augmented Dickey-Fuller (ADF) unit root tests will be conducted on each variable in the model to find out whether the time series data are stationary at the level or first difference. After testing for stationarity and confirming the order of integration of each time series, and if the variables in the model are found to be integrated of the same order, the Johansen cointegration test will be applied to establish whether there is any long-run or equilibrium relationship between the variables in the model. If the variables are cointegrated, then the Granger causality tests will be conducted based on the VECM to determine the long and short run causality relationships among the variables in the model. However, if the Johansen test results indicate no cointegration among the variables in a particular model, then the Granger causality tests will be based on the VAR model. On the other hand, Ordinary Least Squares (OLS) model will be used in this study to estimate the coefficient of the variables, and it will be subjected to a number of statistical diagnostic tests, namely, the normality, serial correlation, and heteroscedasticity tests to ascertain its statistical adequacy. Lastly, stability test based on the cumulative sum (CUSUM) will be applied to determine whether the parameters of the model are stable over the period of the study.

## 4. EMPIRICAL OUTPUTS

In the first step of the analysis, we have carried out the ADF unit root test to determine whether the variables in the model are stationary or non-stationary. Table 1 below shows that all the variables in the model are not stationary at the level, but became stationary after first differencing at the 1% or 5% level of significance. Hence, all the variables in the model are integrated of order one, or I(1).

### 4.1. Johansen Cointegration Test Results

Since all the variables are stationary in the first difference, we can apply the Johansen multivariate cointegration test to determine if there is any cointegration or long-run equilibrium relationship between the variables in the model. However, before running the cointegration test we need to run the VAR model first to determine the optimal lag length, which is 4 based on the minimum AIC.

After having determined the optimal lag length, we then proceeded with the cointegration test for the model. Table 2 indicates that there are at most five cointegration equations based on the trace test and maximum eigenvalue test. In other words, the results reveal that there is more than one long-run relationship among the variables in the system comprising lnGFCF, lnEXD, lnTL, lnIMP, and lnINF.

**Table 1: ADF Unit Root Test Results**

| | Level | | | First Difference | | |
|---|---|---|---|---|---|---|
| | **Intercept** | **Trend and intercept** | **No trend & no intercept** | **Intercept** | **Trend and intercept** | **No trend & no intercept** |
| lnGFCF | 0.026770 | -2.436989 | 0.532757 | -4.342368** | -4.532736** | -3.635942** |
| lnEXD | -2.154991 | -2.533428 | 0.603524 | -2.625712 | -2.8263083 | -2.654163** |
| lnTL | -1.512498 | -0.932021 | 2.771278 | -6.352105** | -6.910282** | -2.735901** |
| lnIMP | -0.164692 | -3.267449 | 1.123346 | -4.734247** | -4.840098** | -4.786207** |
| LnINF | -0.933028 | -2.521013 | 3.236235 | -4.143721** | -4.135062** | -3.337543** |

Note: ** denotes significance at the 1 percent level, and * at the 5 percent level.

**Table 2: Johansen Cointegration Test Results**

| No. of CE(s) | Trace Statistic | 0.05 Critical Value | Max-Eigen Statistic | 0.05 Critical Value |
|---|---|---|---|---|
| r = 0 | 324.7054** | 0.0001 | 182.0366** | 0.0001 |
| r ≤ 1 | 225.6528** | 0.0000 | 75.26038** | 0.0000 |
| r ≤ 2 | 65.9004** | 0.0000 | 32.73595** | 0.0006 |
| r ≤ 3 | 32.00264** | 0.0003 | 16.99606* | 0.0231 |
| r ≤ 4 | 13.20633** | 0.0007 | 14.06943** | 0.0060 |

Note: ** denotes significance at the 1 percent level, and * at the 5 percent level.

### 4.2. Ordinary Least Squares (OLS) Model Results

After having found a cointegration relationships among the variables lnGFCF, lnEXD, lnTL, lnIMP, and lnINF, so now it can estimate the coefficient of the variables using ordinary least square (OLS) model. Table 3 shows that lnGFCF is positively and significantly related to lnTL, lnIMP and lnINF, but it is related negatively and insignificantly with lnEXD. Besides, R-squared, which indicates how much of the total variation of the dependent variable can be explained by the independent variables, is 86.6% which is more than 60%, then the date of this model is fitted strongly. Besides, F-statistic is used to test if the independent variables jointly influence the dependent variable, and we found the probability of F-statistic is 0.000, which is less than 5%. Hence, F-statistic is significant, which means that all independent variables (lnEXD, lnTL, lnIMP and lnINF) jointly affect the dependent variable (lnGFCF).

**Table 3: OLS Model Results**

| **Independent Variables** | **Coefficient** | **Prob.** |
|---|---|---|
| lnEXD | -0.031583 | 0.8675 |
| lnTL | 0.846582** | 0.0004 |
| lnIMP | 1.115300** | 0.0000 |
| lnINF | 0.967688* | 0.0160 |
| c | 3.208524 | 0.5777 |
| **Dependent Variable** | **lnGFCF** | |
| R-squared | 0.866725 | |
| F-statistic | 55.27775 | |
| Prob(F-statistic) | 0.000000** | |

Note: ** denotes significance at the 1 percent level, and * at the 5 percent level.

From Table 3, the long-run lnGFCF equation can be written as:

$$\text{lnGFCF} = 3.208 - 0.031\ \text{lnEXD} + 0.846\ \text{lnTL} + 1.115\ \text{lnIMP} + 0.967\ \text{lnINF} \quad (2)$$

The cointegration equation given by equation (2) above shows a negative and insignificant relationship between external debt and investment in Côte d'Ivoire, which indicates that the borrowed resources were misallocated or wasted in inefficient way. The continued negative and insignificant effect of external debt will reduce the country's ability to service its debt in future. Besides, the expansion in external debt poses significant negative connotations for investment, fiscal sustainability, economic growth and poverty reduction in case of poor debt management capacity. Our finding is in line with the result of Adamu (2018). However, telecommunication infrastructure plays a vital role in the development of the Ivorian investment

activities, in the sense that good infrastructures will enhance the economic growth of the country. If the country has a good economy, this will create an attractive investment environment, and therefore local and foreign direct investment will increase. This result is similar to the results obtained by Khurriah and Istifadah (2019) and Toader et al. (2018). Imports also play an important role in improving the investment in Côte d'Ivoire through supporting the country's needs of investment goods and services such as machinery and new technology, which help in increasing country's productivity and motivating producers to improve and increase their production. Similar results were also borne by Santi and Wisit (2017) and Khan et al. (2018). Besides, inflation has a positive impact on the development of investment activities in Côte d'Ivoire. Indeed, when goods and services are produced, if there are traded at good prices, this will encourage investors to continue investing and even improve the quality and quantity of what they produce. The rise in prices could be more favourable to businesses because they are always seeking for maximising their profit. Our result agrees with Onwe and Iarenwaju (2014).

### 4.3. Statistical Diagnostic Tests Results

In order to check the model adequacy, it is essential to subject the model to a number of diagnostic tests, namely, the normality, serial correlation, and heteroskedasticity test. A 5% level of significance will be used in this study. From Table 4, it is clear that the model does not have serial correlation or heteroscedasticity, and the series are normally distributed as well, because the computed P-value is greater than 5% significance level.

**Table 4: Diagnostic Tests Results**

| Normality Test | Serial Correlation LM Test | Heteroskedasticity (ARCH) Test |
|---|---|---|
| 0.551126 | 22.96317 | 13.17225 |
| (0.759145) | (0.1022) | (0.2031) |

Based on the results that we got, we can say that the model is the Best Regression Model because R square value is high, Prob (F-statistic) is significant, residuals are normally distributed, and no serial correlation or Heteroskedasticity in the residual.

### 4.4. Granger Causality Tests Results

Since the variables in the model are cointegrated, the Granger causality tests based on the VECM are used to examine the short- and long-run causality relationships among the variables in the model. The F-test results show the significance of the short-run causal effects, while the significance of the coefficient of the lagged error correction term [ect(-1)] shows the long-run causal effect.

The Granger causality test results based on the VECM are shown in Table 5. It is clear that there are no short-run causality relationships between the variables. However, there are bidirectional long-run causality relationships between lnGFCF, lnEXD and lnIMP, and unidirectional long-run causality relationships running from lnTL and lnINF to lnGFCF.

**Table 5: Granger Causality Test Results**

| Dependent Variables | Independent Variables | | | | | |
|---|---|---|---|---|---|---|
| | **∑Δ lnGFCF** | **∑Δ lnEXD** | **∑Δ lnTL** | **∑Δ lnIMP** | **∑Δ lnINF** | **ect(-1)** |
| Δ lnGFCF | - | 0.372498 | -0.291491 | -0.223254 | 0.660018 | -0.38403** |
| Δ lnEXD | -0.254048 | - | -0.005128 | 0.665610* | 0.496461 | 0.17425* |
| Δ lnTL | -0.203577 | -0.034818 | - | 0.226029 | 0.170135 | 0.07211 |
| Δ lnIMP | 0.165282 | 0.396193** | -0.057996 | - | 0.610669** | -0.35450** |
| Δ lnINF | 0.126221 | -0.041379 | 0.001963 | -0.298196 | - | 0.00161 |

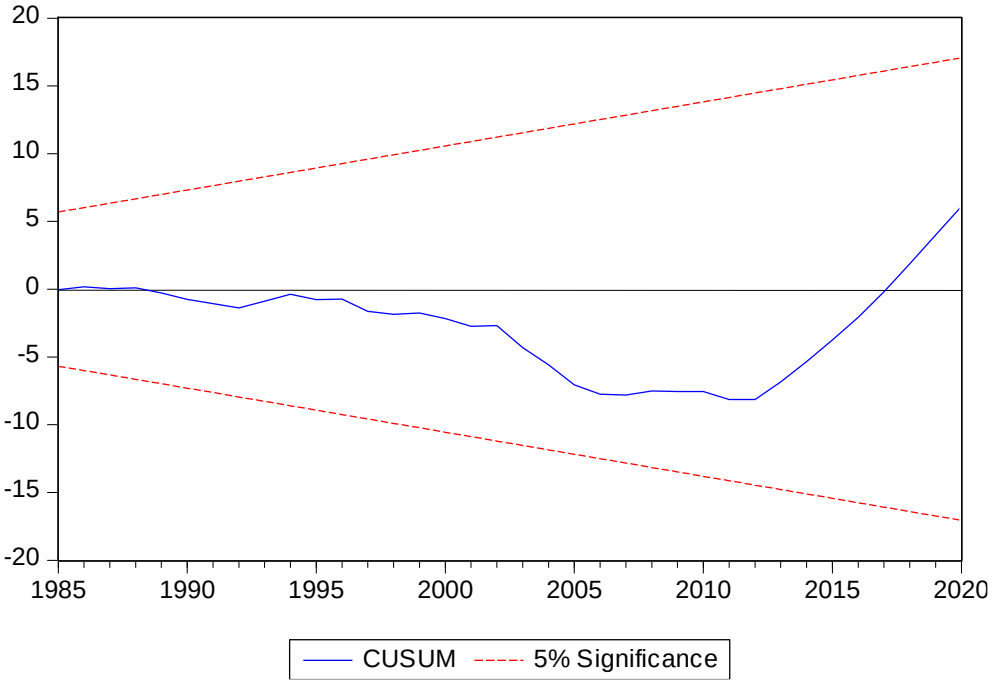
Notes: ** denotes significance at 5 percent level and * at 10 percent level.

Based on the results that we got, we can say that the model is the Best Regression Model because R square value is high, Prob (F-statistic) is significant, residuals are normally distributed, and no serial correlation or Heteroskedasticity in the residual.

### 4.5. The Stability Test Result

CUSUM statistic is used in determining the parameter stability of the model in this study. The decision about parameter stability is based on the position of the plots relative to the 5 % critical bounds. If the plots of the CUSUM statistic stay within the area in the two critical lines, then the parameters of the model are stable throughout the study. Figure 1 indicates that the position of CUSUM plots stay within the area in the two critical lines, which means there are no structural changes in the model.

**Figure 1: CUSUM Test Results**




## 5. CONCLUSION AND IMPLICATIONS

This study investigated the effect of external debt, communication infrastructures, importing and inflation on the investment in Côte d'Ivoire, using annual time series data from 1980 to 2020. The ADF unit root test, Johansen cointegration test, OLS model, Granger causality test based on the VECM, and lastly CUSUM test, were applied in this study.

The ADF unit root test results indicated that all variables in the model are not stationary at the level but became stationary after first differencing. The Cointegration test pointed to a significant long-run relationship among the variables. Besides, the results of OLS model showed that investment is positively and significantly related with communication infrastructures, importing and inflation, but it is related negatively and insignificantly with external debt. The Granger causality test shows that there are no short-run causality relationships between the variables. However, there are bidirectional long-run causality relationships between investment, external debt and importing, and unidirectional long-run causality relationships running from communication infrastructures and inflation to investment. Lastly, CUSUM test indicated that there are no structural changes in the model.

Based on the results of this study, external debt should be using properly by the Ivorian government to support the local economy through improving the infrastructure and creating an attractive investment climate, which motivates the local and foreign investment in the country. Furthermore, based on the vital role of importing as an important source to supply the production activities with machines and new technology, the government should remove or reduce most tariff and nontariff barriers, which will be reflated positively on the investment and economic growth in the country. Government should also promote investment by reducing corruption and encouraging private sector by making funds available for those young entrepreneurs as well as small and medium enterprise to help them in expanding their businesses.

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# OPTION PRICING IN EMERGING MARKETS USING PURE JUMP PROCESSES: EXPLICIT CALIBRATION OF BIST30 EUROPEAN OPTION

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## ABSTRACT

**Purpose-** This study aims to illustrate the efficiency of pure jump processes, more specifically Variance Gamma (VG) and Normal Inverse Gaussian models (NIG), in option pricing by comparing with the Black Scholes (BS) option pricing model for emerging markets.

**Methodology-** This study presents an alternative derivation of option pricing formulas for VG and NIG models. Then, it investigates the VG and NIG models' option pricing performance with the help of new derivation by comparing them with the BS option pricing model for emerging markets for an emerging country, Turkey. The data consists of the BIST30 index daily price and European options written on this index extend from 05 May 2018 to 05 May 2020 for given exercise prices with a maturity of 90 days. In this period, the European call options' strike prices range from 1200 to 1650, and the European put options' strike prices range from 1000 to 1400. To compare the models' efficiency, first, we calibrate the models by minimizing the sum of squared deviations between the observed and theoretical option prices. Second, we compute the option prices and compare the results with the observed option prices.

**Findings-** The significant contribution to the literature is the calibration of the pure jump processes (VG and NIG processes) using the characteristic functions, the continuous BS prices for an emerging market, and the computation of European options prices in BIST. We find that while the NIG process performs better than VG and BS models, the BS model is the worst in option pricing.

**Conclusion-** The pure jump processes (VG and NIG processes) can be calibrated using the characteristic functions, and option price estimations with them are better than the continuous BS prices for an emerging market. Thus, the pure jump processes are more efficient in market modeling than the BS model.

**Keywords:** Variance Gamma Process, Normal Inverse Gaussian Process, Black-Scholes Model, Options Pricing, Calibration
**JEL Codes:** C63, G12, D46

## 1. INTRODUCTION

The 2008 Global Financial Crisis (GFC) fundamental policy response was a sudden noble increase in the money supply, defined as quantitative easing by governments worldwide. Company and even country bailouts have occurred as an immediate consequence of the GFC. Since the GFC, the money supply has been escalating exponentially worldwide, breaking historical records of the money supply. On the other hand, nominal interest rates have been extraordinarily and persistently either negative or almost zero in most developed countries. Such a sustained response and humble policy rate cut are unlikely to feed bubbles rapidly in emerging economies. While financial markets and economic activities have picked up pace and display signs of health, we have anecdotal evidence that both depend crucially on the repeatedly reinforced perception through previous regulatory actions. Hence, policymakers assist endorsement gradually and thoroughly in their economies. However, skeptics, including those with notable influence and visibility, argue that risks are gathering on the horizon for yet another economic and financial crash, which may substantially impact the global financial system as the GFC.

The globalization of economies motivates a rapid increase in the expansion of derivatives and exchange markets. Such markets become extremely attractive to investors since they contain new investment vehicles used for hedging purposes. Furthermore, markets observe information on investors' views on option prices and share prices. In this respect, the options

and shares are also used for speculative investments in the derivatives market in emerging markets (Alp, 2016). Investors are eager to invest in emergent investment vehicles for higher yields in emerging markets.

On the other hand, as previously Alp (2016) indicated, emerging markets are more volatile with superior risk premiums than developed markets. In this respect, the GFC primarily affected the developed economies and increased the investment speed in emerging markets. In particular, options tied to stock exchange indexes are regarded as one of the most charming investment tools for foreign investors since they provide appropriate exposure to local exchange markets.

On the other hand, such options in most emerging markets are comparatively in the early stage compared to those in the developed markets. As Alan et al. (2016) emphasized, previous studies on index options that analyze developed markets show that index options' pricing efficiency and hedging benefits are less efficient than throughout the early trading periods. Hence, derivatives markets and efficient pricing models of options and underlying assets are vital for hedging prospects in emerging markets.

Considering the rise in the flows of capital to the emerging markets following the GFC, this paper concerns the latter, namely the specification of the stochastic processes that underlying assets evolve and the estimation of European put and call option prices for an emerging market, more precisely Turkey's stock Exchange market. The study examines the fitting behaviors of the selected models to the BIST30 index price evolution. In an arbitrage-free market environment, the derivative price is nothing but the discounted value of expectation of the future payoffs under the specified risk-neutral measure. Therefore, such a pricing formula has three fundamental components: The risk-free rate (bank account), the contract specification (for instance, payoff function, etc.), and the stochastic process that the underlying asset evolves from (Eriksson et al., 2009). Hence, we start with identifying of stochastic processes that represent the dynamics of the BIST30 index. The most commonly used model in literature and real-life applications is the Black-Scholes model (BS) developed by Black and Scholes (1973). Hence, we compare the selected models with BS to identify their accuracy.

The implied volatility smile phenomenon reveals that the BS systematically leads to mispricing out-of-the-and-in-the-money options when the implied volatility of the at-the-money option is taken into account. Therefore, many stochastic volatility models, such as Hull&White (Hull & White, 1987), Stein&Stein (Stein & Stein, 1991), and Heston (Heston, 1993), have been designed to mirror the volatility smile phenomenon effect. However, such models still generate mispricing since they lack to capture jumps in the underlying asset price. Hence, Madan and Senata (1990) developed a continuous-time stochastic process called the Variance Gamma (VG) model to predict the uncertainty of the underlying asset return. They provide a practical and empirically relevant alternative to Brownian motion's role as the martingale component of the motion in log prices. Instead of just a distribution for log returns, the importance of introducing a stochastic process is crucial for applications to European option pricing that do not individually compute risk-neutral expectations but account for risk aversion via the identification of an exact change of measure (Harrison & Pliska, 1983). Also, Barndorff (1997) offered a normal-inverse Gaussian distribution (NIG) process, which is a continuous stochastic process. It is given as a normal variance-mean mixture where the mixing density is the inverse Gaussian distribution. Geman et al. (2001) showed that such improvement is motivated by a better fit to the data, improved option pricing and hedging strategies, and theoretical considerations.

The research on some of the fundamental problems of emerging markets needs to be improved, particularly Borsa Istanbul Stock Exchange (BIST). We have recognized a literature gap about the performance of various models for the BIST30 index returns and pricing options tied to this index. While a substantial and expanding body of literature has examined CAPM and FAMA FRENCH models (i.e., Coskun et al. (2017) and references therein), the models based on the stochastic processes are limited for BIST to our best knowledge. In contrast to those studies, this study contains three critical contributions to the literature: First, we fit two Lévy (pure jump) models (VG and NIG) to an emerging market, namely the BIST30 index, and estimate the option prices appealing interpretation and tractability. Hence, throughout our analysis, we calibrate (determine the models' parameters) the pure jump processes and compare their results with the classical BS. Second, we compute the option prices using the calibrated processes and compare their results with the observed options' prices. This analysis shows that the pure jump processes are better than the classical BS in option pricing for the BIST30 index. Therefore, using the VG and NIG models for emerging markets is better. Third, we find delta hedging coefficients corresponding to the models we consider and show that the delta hedging for pure jump processes is superior to the classical BS.

The remainder of the study is outlined as follows. Section 2 summarizes the literature on stochastic models and their usage. Section 3 is dedicated to giving a brief on BIST and related derivatives markets. Section 4 briefly describes the structure of the Lévy processes to be employed and their primary properties and relevance to option pricing theory. In Section 5, we give the details of the data. Section 6 presents the calibration results and estimated option prices, contains the models pricing efficiency, and Section 7 concludes the study.

## 2. LITERATURE REVIEW

Stochastic processes are at the center of option pricing theory. These processes are classified into two broad categories based on their sample paths: i) continuous processes and ii) discontinuous processes. In this study, we are dealing with the pure jump processes, VG, and NIG processes. Hence, this section concentrates on only the literature on the two critical and popular exponential Lévy models.

On a typical underlying asset, for instance, the S&P 500 index, approximately 200 option prices range across twenty strikes and ten maturities at any instant, which is defined by the considered model consistently through the calendar time. From this viewpoint, the BS model's simplicity is unrealistically glaring (Konikov & Madan, 2002) since, generally, log returns show deviations from the normality assumption. Therefore, most research on the jump-diffusion models has emphasized using a diffusion component to describe the relatively large number of small price movements. In contrast, an orthogonal Poisson process with a finite number of sizable moves per unit of time is used to model the large and relatively rarer log return movements (Konikov & Madan, 2002).

More attention has focused on providing the search for special Lévy models to outperform the BS model was initiated since Mandelbrot (1963). Lévy processes and the jump-diffusion models are generally successful at fitting the volatility smile phenomena for a single maturity since these models can incorporate both the skewness and kurtosis properties into the marginal distribution of underlying assets. However, these processes fail to fit in the calibration of multiple maturities. Cont and Fonseca (2002) contributed a considerable model to the literature; contrary to the Lévy processes, Brownian motion has zero skewness and excess kurtosis, which possibly causes the volatility smile phenomena. After Madan and Senata (1987) considered the key findings of Praetz (1972) and issued the prior symmetric edition of the VG process with zero mean, a broader nonnegligible improvement has been adopted to the VG process, a Lévy process (e.g., the hyperbolic/ NIG process in Barndorff-Nielsen (1977) or Eberlein et al. (1995)), as alternatives to the standard BS model.

The literature on the VG process has highlighted two significant parts; theory and application. The univariate case where Madan and Senata (1990) extended the BS model by applying the VG process in the option pricing framework. Madan et al. (1998) concluded that the VG option pricing decreases the bias of option pricing contrary to the BS model, as the VG process controls the excess kurtosis caused by the jumps in the log returns. Daal and Madan (2005) used such a novel assessment for a numerical illustration of the VG option pricing model, the classical BS model, and Merton (1976)'s jump-diffusion model for the options written on foreign currencies. The authors justified Madan and Senata (1990)' conclusions that the VG option pricing model is superior to the other models. For further numerical illustrations of the VG process, interested readers may find more details in Leicht and Rathgeber (2014).

Several VG process variations, like the Carr Geman Madan Yor (CGMY) process introduced by Carr et al. (2002), are introduced to the literature. The multivariate case concerns the integrating correlations and the relation among the Lévy processes. For a general view, see, for instance (Luciano & Semeraro, 2013; Luciano & Schoutens, 2006; Luciano & Semeraro, 2010; Semeraro, 2008). To summarize, the VG process, like the other Lévy processes, suggests many possibilities for asset pricing and modeling risk by decreasing the pricing error or miscalibrations of the models that the underlying assets evolve. Such models help involve jumps, map a realist market behavior compared to the traditional models, and are essential instruments from financial mathematics.

The NIG model introduced in Barndorff (1977) is also one of the most popular Lévy models due to its flexibility. At the same time as its relevance to practice, the NIG process is challenging for mathematical illustrations. However, this modeling family has been widely used in mathematical finance (Eberlein, 2001).

Many computational and statistical procedures are developed for European option pricing in this context. We have three major types of numerical valuation methods: (i) The method of Monte Carlo simulation, (ii) the numerical solution of the partial integration-differential equations related to the model, and (iii) Fourier transformation methods (Eberlein, 2014). Additionally, Ivanov (2013) has given analytical solutions for European Call and digital options under the assumption that the underlying asset price dynamics evolve from the exponential NIG model. The application of the NIG distributions is defined by considering the moments; mean, variance, skewness, and kurtosis. Such moments are essential to many risk management applications. One strength of this class is that authors associate individual derivatives pricing to these risk-neutral distribution moments, which intuitively reviews how the moments can interpret the derivative price behaviors (Eriksson et al., 2009).

For the '*symmetric case'*, a reasonable hypothesis for the price of equities, these models need only one extra parameter given by $\kappa$, compared to the two-parameter the BS model. Such an extra parameter corresponds to the percentage of excess kurtosis connected to the normal distribution. Therefore, $\kappa$ primarily controls the tail thickness of the underlying asset log return distribution. Therefore, it determines the '*excessively*' large positive or negative log return frequency of the underlying asset. Both VG and NIG models are in the family of pure-jump stochastic models with infinite jump activity (i.e., models having infinitely many jumps during survival time $[0, T], T < \infty$ ). Even so, $\sigma$ controls the log returns variability of the underlying

asset. Consequently, $\sigma$ is considered the price process volatility (Viens et al., 2011). Various papers focusing on empirical analysis have confirmed that some parametric exponential Lévy models (ELM), such as VG and NIG models, can fit daily log returns of underlying assets unbelievably well with the classical calibration methods, e.g., maximum likelihood estimators (MLE) or method of moment estimators (MME) (Barndorff, 1997; Behr and Pötter, 2009; Eberlein, 1995; Madan et al., 1998).

## 3.TURKEY'S STOCK EXCHANGE AND DERIVATIVE MARKETS

The Borsa İstanbul Stock Exchange (BIST) is the single exchange market in Turkey. It is organized to supply trading in bills, equities, revenue-sharing certificates, bonds, and international securities. Turkey's securities exchange legal framework was completed in 1982, and started its operation with 40 listed corporations in 1986. Until a manual system was authorized in late 1987, the trade floor activities were limited to licensed brokers, but unlicensed investors could directly execute their orders. In 1989, Turkey's financial system changed to a liberalization system, and then, foreign investors became allowed to invest in portfolios that consisted of stocks traded in BIST. Since November 1994, the number of assets in the market increased drastically by 2003. The daily trading volume of the market has reached an amount of 2.972 billion US dollars. As Bastı et al. (2015) emphasized, BIST has got into the first thirty largest exchange markets among the stock exchanges worldwide and has new memberships in numerous international federations and associations (e.g., the World Federation of Exchanges, Federation of Euro-Asian Stock Exchanges, Federation of European Securities Exchanges, and International Capital Market Association).

There are five sub-markets in BIST that investors can operate. Namely, the equity, futures, and options written on stocks and indexes, the debt securities, the emerging companies, and the precious metals and diamond markets. Additionally, there are eight sub-markets under the equity market: the national, the collective products, the secondary national, the watch-list companies, the primary, the wholesale, the rights coupon markets, and the free trade platform (Bastı et al., (2015).

BIST may be described as regulated by restrictive monetary policy and is led by high-interest rates and large budget deficits. There are limited numbers of studies explaining stock returns and option prices using stochastic processes during the BIST's short history. Even though many studies investigate option pricing for developed and many emerging economies, the studies focusing on option pricing in Turkey's derivatives market are extremely limited. Demir and Tutek (2004) analyzed the applicability of the numerical martingale simulation method for pricing the options tied to the options that are traded in BIST. However, instead of studying real options, the authors hypothetically generate a set of options tied to the BIST Composite Index. In the end, the authors highlighted the method that outputs option prices closer to those driven by the BS model. Later, Akyapı (2014) investigated the differences between real and hypothetical option prices that are again estimated from the BS option pricing formula in the BIST30 index. Akyapı (2014) showed that Turkey's options market permits arbitrage opportunities. The author also observed that the observed option prices are unequal to prices computed by the BS option pricing method.

Tokat (2009) searched the volatility of the BIST30 index for January 1990-April 2007. The author perceived unexpected changes in the volatility of the log return and leptokurtic distribution with additional kurtosis. On the other hand, Kayalidere et al. (2012) investigate the effect of GARCH, the tradeoff of risk and return, and the effect of day-of-the-week on the BIST30 future contracts for the 2006-2011 period. They found that the BIST30 index has fat-tailed distribution with negative skewness. Also, Gokgoz and Sezgin-Alp (2014) modeled Turkey's BIST100 market index under the Arbitrage Pricing Theory assumption using the Artificial Neural Networks method. They emphasized that the BIST30 index has a leptokurtic feature. Kayalidere et al. (2012) reflected that the BIST30 futures volatility is affected more by unfavorable news than favorable news. The tradeoff of risk-return is irrational, and the market is not weak-form efficient. Ersoy and Bayraktaroglu (2013) examined the lead-lag link between the spot and future markets utilizing the daily closing prices of the BIST30 index and futures contracts tied to this index. They conclude that there is not a lead-lag association among these markets. Akyapı (2014) investigated the deviations within the real and hypothetical prices derived from the BS option pricing formula in the BIST30 index. He revealed that options markets might be exposed to arbitrage opportunities in BIST. Also, he showed that, generally, the real option prices are unequal to the numerical option prices.

## 4.THE STRUCTURE OF VG AND NIG PROCESSES

### 4.1. Variance Gamma (VG) Process

The VG process considers both the symmetric increase in the left and right tail probabilities of the log return distribution (kurtosis) and the asymmetry of the left and right tails of the log return density (skewness). These properties allow a more accurate representation of stock returns (Rathgeber et al., 2016). Based on Madan et al. (1998), we can write the call option price for a VG process in the BS manner as in the following proposition.

**Proposition 1:** Let the stock price process $S(t)$ be the VG process from which the underlying asset evolves. Then, the European call option price equals to

$$C(S(0),K,r,T,\theta,\nu,\sigma) = S(0)F^S(X,\theta_S,\sigma,T,\nu_S) - Ke^{-rT}F(X,\theta,\sigma,T,\nu),$$

where $X = log\,(S(t)/K\,) + (r - \phi_{VG}(-i))T$ and $\nu_S, \theta_S,\ \sigma$ represent parameters of the VG process, and $\phi$ is the log-characteristic function, respectively.

Proof: The proof is given in Appendix B.

Here, we present an alternative derivation given by Madan et al. (1998) for the VG option pricing formula. However, our new derivation procedure helps write a similar structure for the NIG process in a BS option price formula.

We introduce the CDFs that are used to calculate the VG model option pricing by using the densities that we derive in Appendix B for the VG process,

$$F^S(X,\theta_S,\sigma,T,\nu_S,\nu) = \int_{-\infty}^{X} \frac{2\exp\left(\frac{\theta_S\, x}{\sigma^2}\right)}{\Gamma\left(\frac{T}{\nu}\right)\sqrt{2\pi\nu^{\frac{T}{\nu}-1}}} \left(\frac{x^2}{\frac{2\sigma^2}{\nu_S}+\theta_S^2}\right)^{\frac{T}{2\nu_S}-0.25} \times \frac{K_{\frac{T}{\nu}-0.5}\left(\frac{x^2}{\sigma^2}\left(\frac{2\sigma^2}{\nu_S}+\theta_S^2\right)\right)}{\sqrt{x^2+\frac{T^2}{\nu}}}dx,$$

$$F(X,\theta,\sigma,T,\nu_S,\nu) = \int_{-\infty}^{X} \frac{2\exp\left(\frac{\theta\, x}{\sigma^2}\right)}{\Gamma\left(\frac{T}{\nu}\right)\sqrt{2\pi\nu^{\frac{T}{\nu}-1}}} \left(\frac{x^2}{\frac{2\sigma^2}{\nu}+\theta}\right)^{\frac{T}{2\nu_S}-0.25} \times \frac{K_{\frac{T}{\nu}-0.5}\left(\frac{x^2}{\sigma^2}\left(\frac{2\sigma^2}{\nu}+\theta\right)\right)}{\sqrt{x^2+\frac{T^2}{\nu}}}dx,$$

where $\theta_S$, $\nu_S$, and $\sigma$ are VG parameters under $\mathbb{Q}^S$ measure, and $\theta$, $\nu$, and $\sigma$ are parameters under $\mathbb{Q}^S$ measure and $K_{\frac{T}{\nu}-0.5}$ represents the Modified Bessel function of the second kind (MacDonald's function).

### 2.2. Normal Inverse Gaussian (NIG) Process

As a model of underlying asset return evolution, the NIG process is a particular case of the generalized hyperbolic distributions, primarily introduced by Barndorff (1997). Barndorff (1997) analyzes the NIG process, including the derivation of the Lévy measure of this process, obtaining its properties, and proposing an Ornstein-Uhlenbeck process of the NIG type and an NIG type stochastic volatility model. The distribution of the NIG characterization is done by a normal inverse Gaussian mixing distribution.

**Definition 1:** Let $Y$ be a random variable that follows an inverse Gaussian probability law (IG) given as in Eriksson et al. (2009)

$$\mathcal{L}(Y) = IG(\delta, \sqrt{\alpha^2-\beta^2}).$$

Now, suppose that $X$ is a conditional process on $Y$, and it is normally distributed with mean $\mu + \beta\, Y$ and variance $Y$ $(L(X|Y) = N(\mu + \beta\, Y, Y))$. Then, the conditional density $X$ is an NIG

$$\mathcal{L}(X) = NIG(\alpha,\beta,\mu,\delta).$$

The NIG $X$ has a density function given as in the following theorem.

**Theorem 1:** The $NIG(\alpha,\beta,\mu,\delta)$ distribution, given for the parameters $\alpha,\delta \geq 0$ , $|\beta| \leq \alpha, \mu \in \mathbb{R}$ has a density

$$f(x) = \frac{\alpha\delta}{\pi}\frac{K_1(\alpha\sqrt{\delta^2+(x-\mu)^2})}{\sqrt{\delta^2+(x-\mu)^2}}e^{\delta\gamma+\beta(x-\mu)},$$

where $\gamma = \sqrt{\alpha^2-\beta^2}$ and $K_1$ is the modified Bessel function of the third kind. Then, any process $X_t$ that has a $NIG(\alpha,\beta,\mu\, t,\delta t)$ distribution is called a NIG Lévy process. Such processes are pure jump processes, and their Lévy measure has the following density

$$\nu(x;\alpha,\beta,\delta) = \frac{\delta\alpha}{\pi|x|}e^{\beta\, x}K_1(\alpha|x|).$$

Proof: The proofs may be found in Barndorff (1997). □

**Remark 1:** An $NIG(\alpha,\beta,\delta,\mu)$ distributed random variable has the moments:

- Mean: $\frac{\beta\delta}{\sqrt{\alpha^2-\beta^2}} + \mu$,
- Variance: $\frac{\alpha^2\gamma}{(\alpha^2-\beta^2)^{\frac{3}{2}}}$,

- Skewness: $\frac{3\beta}{\alpha\sqrt{\delta}(\alpha^2-\beta^2)^{\frac{1}{4}}}$,
- Kurtosis: $3(1+\frac{\alpha^{+}4\beta^2}{\delta\alpha^2\sqrt{\delta}(\alpha^2-\beta^2)})$.

Proof: See the detailed proof in Barndorff (1997). □

**Remark 2:** The characteristic exponent of $X$ is given as

$$\kappa(\xi)=\mu\xi+\delta[\sqrt{(\alpha^2\beta^2)}-\sqrt{\alpha^2-(\beta+\xi)\hat{}2}].$$

The NIG class of densities has two key properties:

- Scaling property,

$$L_{NIG}(X)=NIG(\alpha,\beta,\mu,\delta)\Leftrightarrow\mathcal{L}_{NIG}(cX)=NIG(\frac{\alpha}{c},\frac{\beta}{c},\frac{\mu}{c},c\delta).$$

- A closure under convolution property

$$NIG(\alpha,\beta,\mu_1,\delta_1)*NIG(\alpha,\beta,\mu_2,\delta_2)=NIG(\alpha,\beta,\mu_1+\mu_2,\delta_1+\delta_2).$$

The NIG distribution is infinitely divisible and hence generates a Lévy process $(Z_t),t\geq 0$ (i.e., a stochastic process with stationary and independent increments, $Z_0=0$ a.s. and $Z_1$ is NIG-distributed). Now, let $S_t$, for $t\geq 0$, denotes the price of a non-dividend-paying stock at time $t$, and it postulates the following dynamics for the stock price

$$dS_t=S_{t^-}(dZ_t+e^{\Delta Z_t}-1-\Delta Z_t),$$

where $(Z_t),t\geq 0$ denotes the NIG Lévy motion, $Z_{t^-}$ the left-hand limit of the path at time $t$, and $\Delta Z_t=Z_t-Z_{t^-}$ the jump at time $t$. Then, the solution of this stochastic differential equation is $S_t=S_0e^{Z_t}$, and it follows that the log returns, $ln(S_t/S_{t-1})$ are indeed NIG-distributed.

Our objective is the risk-neutral valuation of derivative securities in this model environment. Hence, we must adopt an equivalent martingale measure since the NIG model is incomplete. In this study, we select the method of characteristic functions to determine an equivalent martingale measure. The characteristic function approach is appropriate whenever the stochastic process $(Z_t),\ t\geq 0$, has stationary and independent increments (Eberlein et al., 1995).

**Proposition 2:** Let $S(t)$ be the NIG process that the underlying asset evolves. Then, the European call option price equals to

$$C(S(0),K,r,T,\theta,\theta_S,\kappa,\sigma)=S(0)F^S(X,\theta_S,\sigma,T,\kappa)-Ke^{-rT}F(X,\theta,\sigma,T,\kappa),$$

where $X=log(\frac{S(t)}{K})+(r-\phi_{NIG}(-i))T$.

Proof: We illustrate a detailed proof in Appendix B. □

The CDFs used to calculate the NIG model option price, using the densities derived in Appendix B for NIG process,

$$F^S(X,\theta_S,\sigma,T,\kappa)=\int_{-\infty}^{X}\frac{T}{\pi}exp\left(\frac{T}{\sqrt{k\omega}}+\frac{\theta_S x}{\sigma^2}\right)\times\frac{K_1(\sqrt{\theta_S^2+\frac{\sigma^2}{\omega}},\frac{1}{\sigma^2}\sqrt{x^2+\frac{T^2}{\sigma^2\kappa_S}})}{\sqrt{x^2+\frac{\sigma^2T^2}{\kappa}}}\,dx,$$

$$F(X,\theta,\sigma,T,\kappa)=\int_{-\infty}^{X}\frac{T}{\pi}exp\left(\frac{T}{\sqrt{k\omega}}+\frac{\theta x}{\sigma^2}\right)\times\frac{K_1(\sqrt{\theta^2+\frac{\sigma^2}{\omega}},\frac{1}{\sigma^2}\sqrt{x^2+\frac{T^2}{\sigma^2\kappa}})}{\sqrt{x^2+\frac{\sigma^2T^2}{\kappa}}}\,dx,$$

where $\theta_S,\kappa_S,\sigma$ are NIG parameters under the $\mathbb{Q}^S$ measure and $\theta$, $\kappa$, $\sigma$ are parameters under the $\mathbb{Q}$ measure. Also, $\omega=\frac{1}{1-k(\sigma^2-2\theta}\ as$ noted in Appendix B, and again, $K_1$ represents the Modified Bessel function of the second kind (MacDonald's function).

## 3. DATA

In this study, we analyze the BIST30 index daily prices and its log returns and European call and put options written on it for 05 May 2018 - 05 May 2020. We consider various European put (9 put options) and call (10 call options) options with various

strike prices (1200 to 1650 for call options and 1000 to 1400 for put options) with a 90-day maturity and gather the relevant data from the Bloomberg data stream for the empirical analysis given in this section.

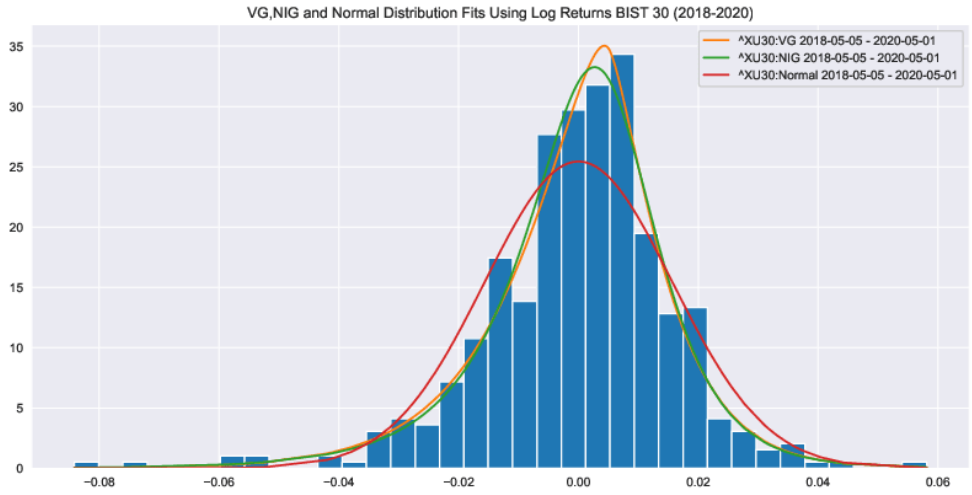
The descriptive statistics of the daily BIST30 index prices and its log return series are depicted in Table 1. The table shows that the average index price and its standard deviation are 99274.371 and 8132.956, respectively. Also, the index price series is highly right-skewed (skewness=1.0013). As a result, the BIST30 index price has a non-normal distribution property. On the other hand, its' log return series' mean and standard deviation are 0.00119 and 0.015090, respectively. Further, the log return series is moderately left-skewed (skewness=-0.7436).

Additionally, the log return series is too peaked and has a heavy-tailed distribution (kurtosis= 3.674>1) compared to the index price series. More importantly, the table shows that the BIST30 index price has negative log returns that may cause swear losses to investors if they do not hedge their positions. The descriptive statistics of the BIST30 price and its' log return series show that both series are not normally distributed and have tail properties. At this stage, we also present the histogram of the log return series in Figure 1. The figure also reveals that the log return series comes from a non-normal distribution family.

**Table 1: Descriptive Statistics of BIST30 and its Log Return Series**

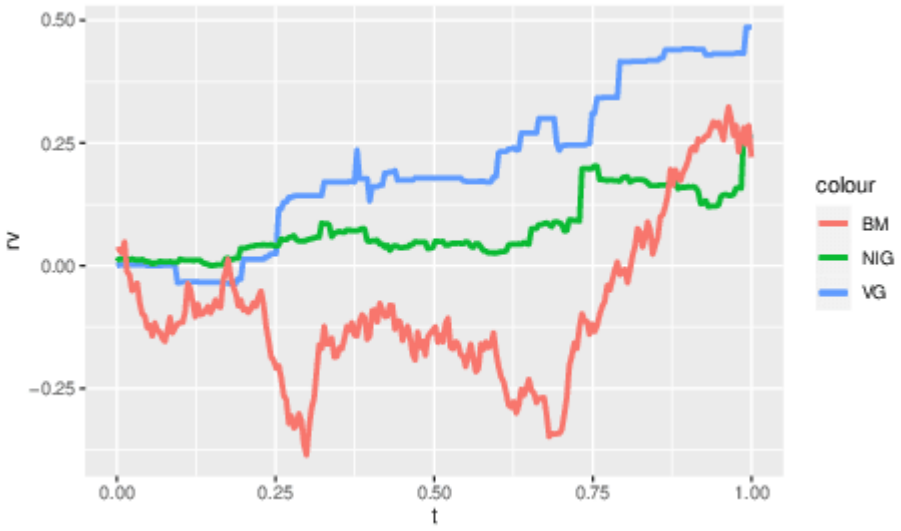
| | BIST30 | Log return |
|---|---|---|
| Std | 8132.956 | 0.015090 |
| skewness | 1.0013 | -0.7436 |
| kurtosis | 0.89194 | 3.674 |
| Mean | 99274.371 | 0.00119 |
| Max | 123556.102 | 0.05983 |
| Min | 83675.296875 | -0.08072 |

**Figure 1: BIST30 Log Return Distribution Characteristic of VG, NIG, and Normal Distributions**




To illustrate all three models' behaviors, we graph their paths that are simulated using the calibrated parameters in Figure 2. Here, it is worth emphasizing that the figure shows that the VG and NIG models show jump behaviors better than the BS and, hence, both are good candidates to capture the jumps, skew, and fat tails properties of the observed data.

**Figure 2: A Simulated Illustration of VG, NIG, and BM Processes with the Fitted Parameters**




## 4. EMPIRICAL ANALYSIS OF OPTION PRICING

As it is well known, instead of working on prices, working on returns is more convenient in financial data analysis due to the stationary problem. Hence, in our empirical analysis, we also used the log return series of the BIST30 index price.

We illustrate the histogram of the BIST30 log return series along with its distribution fitting results of the VG, NIG models, and normal distribution in Figure 1. The figure combines a normalized histogram and density plots of the models to highlight the log return series statistical properties. In this figure, while the orange and green curve illustrates the fitting performance of the pure jump models VG and NIG, the red curve represents the normal distribution (GBM) fitting performance. Due to its Gaussian property, the BS model has a normal distribution. However, as evident from the plot, the BIST30 log return series is slightly left-skewed, with a peak at %0.01. There were also a few tiny peaks seen close to zero. Hence, it is not normally distributed. Therefore, we can conclude that VG and NIG fit better into the log return series than the Normal distribution. This is an expected result since the BIST30 log return series is not normally distributed. The BS model is based on GBM as an asset price process where the returns have Normal distribution.

The parameters and their p-values that we find in the fitting process of the distributions are given in Table 2. The values in parenthesis are the p-values of the parameters. The standard deviation of the NIG and BS models are close to each other ( $\sigma = 0.015$ and $\sigma = 0.01568$, respectively). In contrast, the VG model's standard deviation ($\sigma = 0.011856$) is lower than both NIG and BS models. On the other hand, $\mu$ values of the models vary. The corresponding p-values show that all parameters are statistically significant except the BS mean value $\mu$. Note also that the (-) sign means that the model does not include the corresponding parameter in this and the following tables. For instance, while all models include $\sigma$, only the VG includes $\mu$. The values of these parameters correspond to the distribution parameters we graph in Figure 1. Hence, it is worth emphasizing, to not confuse the readers, that these parameters are not the calibrated parameters. The calibration results are introduced in the following section.

**Table 2: The Distribution Fitted Parameters of the Models (Fitted to Log Returns)**

| | **VG** | **NIG** | **BS** |
|---|---|---|---|
| $\sigma$ | 0.011856 (6.084-13 | 0.015 (0) | 0.01568 (0) |
| $\nu$ | 1.584 (0) | - | - |
| $\kappa$ | - | 0.868 (0.0128) | - |
| $\theta$ | -0.0032 (0.00189) | -0.0045 (0) | - |
| $\mu$ | 0.0051 (4.951-05) | 0.0045 (0) | 0.000005032 (0.10) |
| $L(\mu, \sigma, \theta, \nu)$ | -1364.821 | -1366.754 | - |

Here, it is worth mentioning that our fitting procedure involves the maximum likelihood estimation (MLE) through the optimization of the following log-likelihood function introduced by Loregian and Rroji (V2012),

$$L(\mu,\theta,\sigma,\nu) = \frac{T}{2}log\left(\frac{2}{\pi}\right) + \sum_{t=1}^{T}\frac{(x_t-\mu)\theta}{\sigma^2} - \sum_{t=1}^{T}\log(\Gamma(\nu)\sigma) + \sum_{t=1}^{T}\log\left(K_{\nu-0.5}\left(\frac{\sqrt{2\sigma^2+\theta^2}|x_t-\mu|}{\sigma^2}\right)\right)$$
$$+\sum_{t=1}^{T}(\nu-0.5)\,[log(\,|x_t-\mu| - 0.5log(2\sigma^2+\theta^2))].$$

As it is well-known, the optimization cost is affected significantly (positively) if the initial values of the models' parameters are chosen close to the local/global maximum points. Therefore, a relatively well-specified initial value is crucial in such an optimization procedure. Consequently, we introduce the following analytical formulas for determining the initial values with the help of the method of moments (MM) for both VG and NIG distributions, respectively.

$$\nu = \frac{3}{\mathbb{K}(x)-3}, \qquad \sigma_{VG} = \sqrt{\frac{\mathbb{V}(x)(\mathbb{K}(x)-3)}{3}}, \quad \theta_{VG} = \frac{\mathbb{S}(x)\sqrt{\mathbb{V}(x)}}{3}, \mu_{VG} = \mathbb{E}(x) - \frac{\mathbb{S}(x)\sqrt{\mathbb{V}(x)}}{\mathbb{K}(x)-3},$$

$$k = \frac{\mathbb{K}(x)}{3} - 1, \quad \sigma_{NIG} = \frac{\sqrt{\mathbb{V}(x)}}{\left(1+\left(\frac{\mathbb{S}(x)}{3\mathbb{K}(x)}\right)^2 k\right)}, \theta_{NIG} = \frac{\sigma_{NIG}\mathbb{S}(x)}{3\mathbb{K}(x)}, \qquad \mu_{NIG} = \mathbb{E}(x) - \theta_{NIG},$$

where $\mathbb{E}(x)$, $\mathbb{V}(x)$, $\mathbb{S}(x)$, and $\mathbb{K}(x)$ correspond to the moments: mean, variance, skewness, and kurtosis, respectively. Here, note that we observe significant improvements in log-likelihood convergence after introducing these initial parameters to our optimization procedure. The process takes only three iterations to converge both VG and NIG models.

Now, we may apply an optimization procedure to calibrate the models. The VG, NIG, and BS model parameters illustrate numerical illustrations of the VG and NIG processes' accuracy in the European put and call options pricing and underlying asset price prediction by comparing their results with the BS and observed option prices.

Using the NIG and VG option price formulas, we calibrate the models from the daily BIST30 index price series log returns, compute European call, and put option prices using data for 05 May 2018 - 05 May 2020. The calibration result of the models is given in Table 3. Afterward, we compute the European Call and Put options for all three models using the parameters in this table. The root means square error (RMSE) shows that the performance of the NIG model is superior to both VG and BS. Also, the RMSE shows that the BS has the worst performance in log return fitting of the BIST30.

**Table 3: The Models' Parameters Obtained from the Calibration**

| Parameter | VG | NIG | BS |
|---|---|---|---|
| $\sigma$ | 0.215342 | 0.460616 | 0.391743 |
| $\nu$ | 0.105535 | - | - |
| $\kappa$ | - | 0.348656 | - |
| $\theta$ | 0.454742 | 0.084060 | - |
| RMSE | 0.00029766 | 0.00003343715 | 0.031066734 |

Figure 3 illustrates European Call (right) and Put (left) options prices with various strikes. The figure shows that the pure jump models, VG and NIG, are superior to the continuous BS model for European Call and Put options. It is clear that both VG and NIG models capture the real option values with the calibrated parameters, summarized in Table 3. It is also important to highlight here that even though the VG model's option price estimation is almost identical to the NIG model option price estimation, the VG is computationally more expensive than the NIG model's (The calibration of the VG model took 0.431 seconds with the error of 0.000298 whereas the former took 0.349 seconds and the latter was 0.0000334 for NIG). Therefore, from the computation cost perspective, we can claim that the NIG process is superior to the VG process.

**Figure 3: BIST30 European Call and Put Option Price Estimations under VG, NIG, and BS Model Assumption**

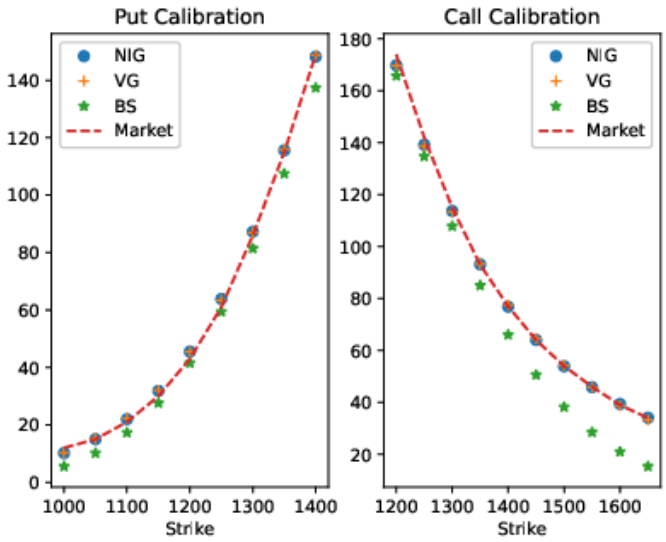



Figure 4 illustrates that both the VG and NIG are successfully capture the volatility smile phenomena of the option pricing since plotting the implied volatility surface as considering the option parameters, strike price, and time to maturity is helpful. Here, we end up with a two-dimensional curved surface graphed in three dimensions. The implied volatility surface of the market (z-axis) of European Call options on the underlying asset is plotted against option prices (y-axis) and time to maturity (x-axis). Such a representation describes the absolute value of the implied volatility surface. By adjusting the coordinates, the option price is returned by delta yields the relative implied volatility surface. More importantly, the implied volatility surface displays both the volatility smile and the volatility term structure simultaneously. Option investors use an implied volatility plot to rapidly select the implied volatility surface's shape and specify any region where the plot's slope (and consequently relative implied volatilities) was out of line. The figure illustrates the implied volatility surface for all European call options on a certain underlying asset price. In the figure, the z-axis corresponds to percent values of implied volatilities while the x-axes and y-axes correspond to the delta of the option and time to maturity. To satisfy the put-call parity, a 20-delta put should be equal to the same implied volatility as an 80-delta call. Given this implied volatility surface, we may conclude that the underlying asset has both volatility skew (a tilt along the delta axis) and a volatility term structure that indicates an anticipated event soon.

**Figure 4: Volatility Surface of VG and NIG Model**

**(a) VG process** **(b) NIG process**

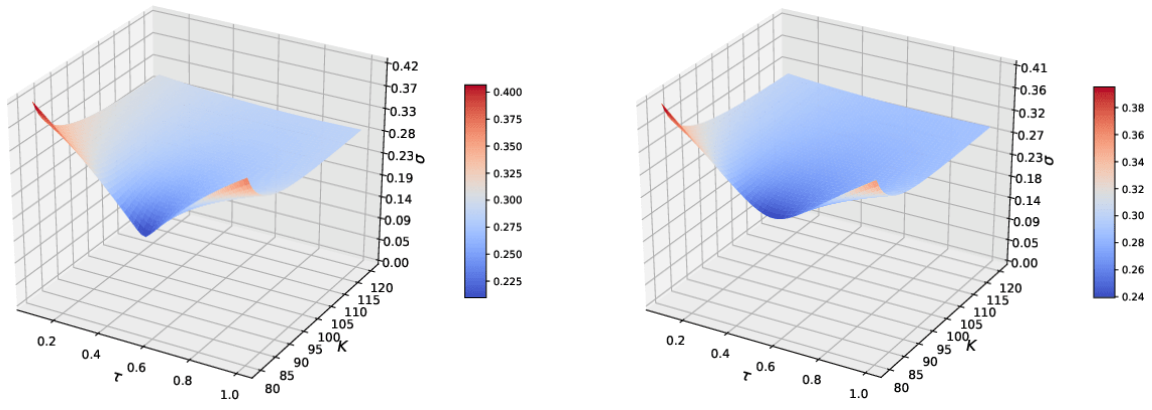
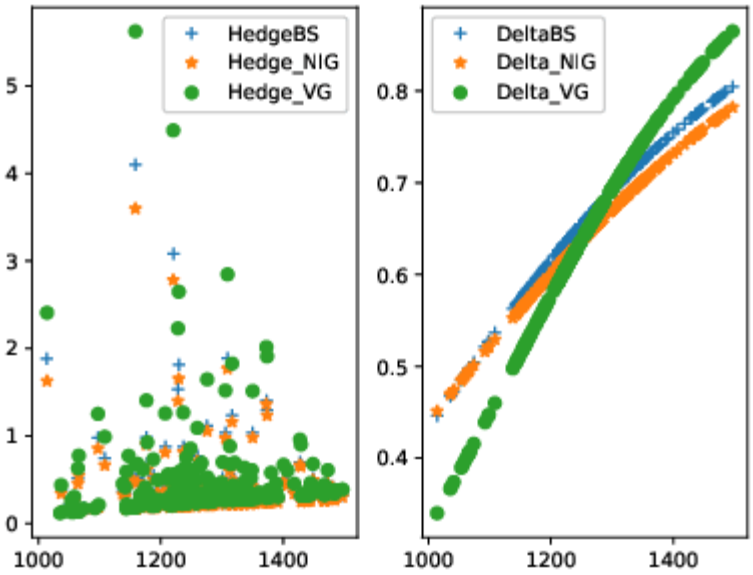



Figure 5 graphs the hedging performance of the models for the options. The first figure (on the left) shows the delta hedging coefficients corresponding to the stochastic models and the European call options. In this figure, the values on the x-axis show the strike price of a European call option, and values on the y-axis indicate the delta hedging coefficients. Here, the critical interpretation is that the NIG and BS models have almost the same hedging coefficient, while the hedging coefficient

corresponding to the VG varies from the BS. The second figure (on the right) shows the stochastic models' dynamic hedging performance and European call options. The figure reveals that the hedging benefit of the VG process increases as the option strike price increases. On the other hand, the NIG model dynamic hedging is almost identical to the BS model.

**Figure 5: Hedging Performance of VG, NIG, and BS Model**




## 5. CONCLUSION AND IMPLICATIONS

The potential hedging benefits of options tied to the BIST30 index provide to investors become even more crucial in emerging markets where the cash markets are more vulnerable and prone to extreme volatility levels. Therefore, an efficient derivative market becomes even more relevant to domestic and foreign investors. There is sufficient literature on the various dynamics of derivatives and their hedging benefits. However, this study's bulk is conducted on emerging markets, particularly the BIST30 index and European options tied to this index.

Our study's significant contribution to the literature is the calibration of the pure jump processes (VG and NIG processes) using the characteristic functions, the continuous BS prices for an emerging market, and the computation of European options prices in this market. Such a study is the first study that investigates the pure jump processes accuracy for BIST. The calibration method can be repeated with other emerging markets by using the derivation we made for the characteristic functions. The essential point is the demonstration that the VG and NIG models can be fitted for emerging markets, and option prices in these markets can be estimated more adequately compared to the classical BS. We conclude that the NIG and VG processes are both attractive and tractable ways to incorporate the phenomenon of option pricing to derive actionable insights and investment decisions from the data. Hence, these pure jump models are becoming imperative for investors and portfolio managers to tackle predicting option prices and hedging in emerging markets.

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**APPENDIX A: ESTIMATED OPTION PRICES**

**Table 4: European Call and Put Option Prices with Various Strike Prices under the VG, NIG, and BS Models Assumptions**

| **Call Option Prices** | | | | |
|---|---|---|---|---|
| **Strike** | **NIG** | **VG** | **BS** | **Market** |
| 1200 | 169.784463 | 169.698553 | 165.800577 | 174.0 |
| 1250 | 139.206130 | 138.710337 | 134.776382 | 142.0 |
| 1300 | 113.717301 | 113.415851 | 107.869369 | 115.0 |
| 1350 | 93.152041 | 93.388213 | 85.032008 | 93.0 |
| 1400 | 76.869700 | 77.422520 | 66.050554 | 77.0 |
| 1450 | 64.051714 | 64.598618 | 50.587017 | 64.0 |
| 1500 | 53.926980 | 54.223663 | 38.226352 | 54.0 |
| 1550 | 45.862685 | 45.772460 | 28.520774 | 46.0 |
| 1600 | 39.371898 | 38.843751 | 21.026090 | 39.0 |
| 1650 | 34.089866 | 33.128667 | 15.327846 | 34.0 |
| **Put Option Prices** | | | | |
| **Strike** | **NIG** | **VG** | **BS** | **Market** |
| 1000 | 10.207271 | 10.241480 | 5.520252 | 12.0 |
| 1050 | 15.041657 | 15.264206 | 10.168876 | 15.0 |
| 1100 | 21.985959 | 22.326443 | 17.328258 | 21.0 |
| 1150 | 31.837063 | 32.099611 | 27.612806 | 30.0 |
| 1200 | 45.512746 | 45.426835 | 41.528859 | 43.0 |
| 1250 | 63.846424 | 63.350630 | 59.416676 | 61.0 |
| 1300 | 87.269606 | 86.968157 | 81.421675 | 86.0 |
| 1350 | 115.616358 | 115.852530 | 107.496326 | 115.0 |
| 1400 | 148.246029 | 148.798849 | 137.426883 | 149.0 |

**APPENDIX B: THE PROOF OF PROPOSITIONS**

Proof: Let us define log discounted stock price, $log(S(T)e^{-rT}) = X(T) - \phi(-i),$ where $X(T)$ denotes a VG process, $\phi$ is the log-characteristic function, and $T$ is a finite maturity ($T < \infty$) as usual. Then, under the risk-neutral probability $\mathbb{Q}^S$, we can obtain the characteristic function of log-discounted stock price,

$$\mathbb{E}^S\left(e^{iuX(T)}\right) = S(0)\mathbb{E}\left[\frac{S(T)}{S(0)e^{rT}}e^{iuX(T)}\right] = \mathbb{E}\left[e^{X(T)(iu+1)}\right]e^{-\phi(-i)T} = \mathbb{E}\left[e^{X(T)i(u-i)}\right]e^{-\phi(-i)T}.$$

Now, by defining $u - i = v$ we obtain

$$\mathbb{E}\left(e^{ivX(T)}\right)e^{-\phi(-i)T} = \frac{\Phi(-i)}{\Phi(v)} = \frac{1-\theta\nu-0.5\sigma^2\nu}{1-i(u-i)\theta\nu+0.5(u-i)\hat{}2\sigma^2\nu} = \frac{1-\theta\nu-0.5\sigma^2\nu}{1-\theta\nu-0.5\sigma^2\nu(1-iu(\sigma^2+\theta)\frac{\nu}{1-\theta\nu-0.5\sigma^2\nu}+0.5\sigma^2u^2\frac{\nu}{1-\theta\nu-0.5\sigma^2\nu})}.$$

At this stage, again by defining $\kappa = (1 - \theta\nu - 0.5\sigma^2\nu)$ we end up with the following four results

$$\frac{\Phi(-i)}{\Phi(\nu)} = \left(\frac{\kappa}{\kappa\left(1 - iu(\sigma^2+\theta)\frac{\nu}{\kappa} + 0.5(\sigma\, u)^2\frac{\nu}{\kappa}\right)}\right)^{\frac{T}{\nu}},$$

$$\Phi_X^S(u,T) = \left(\frac{1}{1 - iu\theta_{s\nu_s} + 0.5(\sigma\, u)^2\nu_s}\right)^{\frac{T}{\nu}}, \qquad (1)$$

$$\theta_s = \theta\ + \sigma^2, \qquad \nu_s = \frac{\nu}{\kappa}.$$

To derive the VG process's probability density function (pdf) of under the $\mathbb{Q}^S$ measure, (1) characteristic function under the $\mathbb{Q}^S$ is needed. After it is derived, we obtain new parameters under the $\mathbb{Q}^S$ measure. This could be obtained using density as well. However, the characteristic function is more straightforward. Then one can first represent the density under this form,

$$g^S(x,\theta_S,k,\sigma,\nu_S,\nu,T) = \int_0^\infty \frac{1}{\sigma\sqrt{2\pi\gamma}}exp\left(-0.5\left(\frac{x-\theta_S\gamma}{\sigma\sqrt{\gamma}}\right)^2\right)\frac{e^{-\frac{\gamma}{\nu_S}}\gamma^{\frac{T}{\nu}-1}\nu_S^{-\frac{T}{\nu}}}{\Gamma(\frac{T}{\nu})}d\gamma.$$

Then, using equation 3.471.9 from Zwillinger and Jeffrey (2007), one can further write the density,

$$g^S(x,\theta_S,k,\sigma,\nu,\nu_S) = \frac{2\exp\left(\frac{\theta_S x}{\sigma^2}\right)}{\Gamma\left(\frac{T}{\nu}\right)\sqrt{2\pi\nu^{\frac{T}{\nu}-1}}}\left(\frac{x^2}{\left(\frac{2\sigma^2}{\nu_S}+\theta_S^2\right)}\right)^{\frac{T}{2\nu}-0.25} \times \frac{K_{\frac{T}{\nu}-0.5}(\frac{x^2}{\sigma^2}(\frac{2\sigma^2}{\nu_S}+\theta_S^2))}{\sqrt{x^2+\frac{\sigma^2T^2}{\nu}}}.$$

Under the risk-neutral measure $\mathbb{Q}^S$, the result coincides with the following density function that was primarily introduced by Tankov (2003)

$$g(x,\theta,k,\sigma,\nu) = \frac{2\exp\left(\frac{\theta x}{\sigma^2}\right)}{\Gamma\left(\frac{T}{\nu}\right)\sqrt{2\pi\nu^{\frac{T}{\nu}-1}}}\left(\frac{x^2}{\left(\frac{2\sigma^2}{\nu}+\theta^2\right)}\right)^{\frac{T}{2\nu}-0.25} \times \frac{K_{\frac{T}{\nu}-0.5}(\frac{x^2}{\sigma^2}(\frac{2\sigma^2}{\nu}+\theta^2))}{\sqrt{x^2+\frac{\sigma^2T^2}{k}}}. \square$$

Proof: Likewise, we conduct derivations for NIG model for similar arguments; let us define log discounted stock price, $log(S(T)e^{-rT}) = Y(T) - \phi(-i)$ where $Y(T)$ is a NIG process as usual. Then, under the risk-neutral probability $\mathbb{Q}^S$, we can obtain the characteristic function of log-discounted stock price,

$$\mathbb{E}^S(e^{iuX(T)}) = S(0)\mathbb{E}[\frac{S(T)}{S(0)e^{rT}}e^{iuY(T)}] = \mathbb{E}\left[e^{Y(T)(iu+1)}\right]e^{-\phi(-i)T} = \mathbb{E}\left[e^{Y(T)i(u-i)}\right]e^{-\phi(-i)T}.$$

Given the characteristic function of NIG and defining $v = u - i$ we have

$$\frac{\Phi_{\mathrm{NIG}}(v)}{\Phi_{NIG}(-i)} = (\sqrt{\frac{1+u^2\sigma^2\ k-2ui\sigma^2k-2iu\theta k}{1-\sigma^2k-2\theta k}}) = (\sqrt{\frac{1+u^2\sigma^2k-2uik\sigma^2+\theta)}{1-\sigma^2k-2\theta\ k}}).$$

Now, by letting $\omega = \frac{k}{\{1-\sigma^2\, k-2\theta\, k}$ and $\theta^S = \theta + \sigma^2$ and following some algebraic manipulations, we finally obtain the characteristic function under the risk-neutral probability, $\mathbb{Q}^S$, measure as follows

$$\Phi^S(u,t) = \frac{t}{\sqrt{k\omega}}\left(1 - \sqrt{1 + u^2\sigma^2\omega - 2ui\theta^S\omega}\right). \qquad (2)$$

To derive the probability distribution function (pdf) of NIG process under $\mathbb{Q}^S$ measure, (2) (characteristic function under $\mathbb{Q}^S$) is needed. Using 3.471.9 from Zwillinger and Jeffrey (2007), we end up with the following density,

$$f^S(x,\theta,k,\sigma) = \frac{T}{\pi} exp\left(\frac{T}{\sqrt{k\omega}} + \frac{\theta x}{\sigma^2}\right) \times \frac{K_1(\sqrt{\theta^2 + \frac{\sigma^2}{k}}\frac{1}{\sigma^2}\sqrt{x^2 + \frac{T^2}{\sigma^2 k}})}{\sqrt{x^2 + \frac{\sigma^2 T^2}{k}}}$$

under risk-neutral probability measure $\mathbb{Q}$, we used the following density function given by Tankov (2003)

$$f(x,\theta,k,\sigma) = \frac{T}{\pi} exp\left(\frac{T}{\sqrt{k}} + \frac{\theta x}{\sigma^2}\right) \times \frac{K_1(\sqrt{\theta^2 + \frac{\sigma^2}{k}}\frac{1}{\sigma^2}\sqrt{x^2 + \frac{T^2}{\sigma^2 k}})}{\sqrt{x^2 + \frac{\sigma^2 T^2}{k}}}$$

Using these densities, we prefer to calculate CDF by numerical integration. Then, it is convenient to arrive following the BS type option price formula,

$$C(S(t),K,r,T-t,\theta,\theta_S,k,\sigma) = S(t)F^S(x,\theta_S,k,\sigma) - Ke^{-r(T-t)}F(x,\theta,k,\sigma),$$

where $x = log(\frac{S(t)}{K} + (r - \phi(-i))(T-t)$. □

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# THE INFLUENCE FACTORS OF CONSUMERS' COMPREHENSIVE CAR INSURANCE DEMAND: EVIDENCE FROM TURKEY

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## ABSTRACT

**Purpose-** Car insurance stands out as the most important line in the individual insurance industry. Even though it is a legal obligation for drivers to have car liability insurance in many countries, there is a coverage gap in comprehensive insurance, especially in emerging countries such as Turkey. Although the comprehensive car insurance penetration rate has slightly increased in the last five years in Turkey, it still has limited coverage. The study investigates the effects of perceived insurance benefit and insurance literacy variables, in addition to socio-economic indicators, as the determinants of comprehensive car insurance demand in Turkey

**Methodology-** The survey method was used for data collection. The survey was prepared digitally and distributed to car owners in Turkey via a social media platform using a simple random method. The total number of usable responses obtained was 261. The binary logistic regression was applied to determine the effect of the socio-economic factors, perceived insurance benefit, and insurance literacy on the comprehensive car insurance demand.

**Findings-** The results showed a significant and strong relationship between comprehensive car insurance demand and having a traffic ticket, driving experience, driver's age, and vehicle age indicators. The other important determinants of comprehensive car insurance demand with a relatively low weight are perceived insurance benefit and insurance literacy. There was no relationship between insurance demand and driving frequency or experiencing a traffic accident.

**Conclusion-** This study has several practical implications for the insurance industry in terms of marketing, product development and the underwriting process. Insurance companies should consider the factors affecting consumers' insurance demand while designing products and services. Furthermore, they should act together with regulatory authorities to organize awareness campaigns and financial literacy courses to better explain the individual and social benefits of insurance products and services.

**Keywords:** Insurance demand, comprehensive car insurance, consumer behavior, insurance literacy, perceived insurance benefit.
**JEL Codes:** G52, G25, D12

## 1. INTRODUCTION

The factors affecting consumers' decision to demand insurance have been the subject of numerous academic research in the field of insurance. Researchers aimed to measure the socio-demographic and behavioral factors that may be effective in making the purchasing decision of consumers with hypothetical and experimental methods (Jaspersen, 2016).

As of 2020, car insurance has reached a premium size of $560 billion and stands out as the most important insurance line in individual insurance, with a market share of 62,1% (Swiss Re, 2022). Car insurance provides financial protection against several risks, such as natural disasters, theft, and fire, in addition to the damage caused by traffic accidents. In many countries, it is a legal obligation for drivers to have car liability insurance against bodily injury and property damage that they may cause to third parties while driving (Hsu et al., 2016). However, there is a coverage gap in comprehensive insurance, which is offered optionally, especially in developing countries where insurance penetration rates are low.

Turkey is one of the countries with the lowest insurance penetration rate of 1.5% among OECD countries (OECD, 2021). Although the comprehensive car insurance coverage rate in the country has increased slightly in the last five years, it is still at the level of 28.2% (TSB 2021; TURKSTAT 2021). The comprehensive car insurance premium size in the country is growing

thanks to economic growth and the increasing number of cars; however, since penetration rates are not increasing significantly, it cannot help the market to deepen. At this point, in order to increase insurance penetration rates in the country, it becomes more important to investigate the factors that affect car owners' decision to demand comprehensive car insurance. Empirical studies on the factors affecting comprehensive car insurance demand in the literature generally attempted to develop a model using socio-demographic indicators (Sherden, 1984; Awunyo-Vitor, 2012; Hsu et al., 2016; Jaspersen, 2016). These studies did not consider behavioral factors in consumers' insurance preferences. However, there are many studies in the literature showing that behavioral and emotional factors have an impact on insurance demand (Browne et al., 2015; Awel et al., 2015; Corcos et al., 2020; Pitthan and Witte, 2021). It is important to conduct empirical studies that focus on the factors determining the demand for comprehensive car insurance from a broader perspective. In this context, the aim of the study is to investigate the factors affecting consumers' comprehensive insurance demand in Turkey. This study differs from its predecessor as it uses perceived benefit and insurance literacy in addition to socio-demographic indicators for developing a model of comprehensive car insurance demand.

## 2. LITERATURE REVIEW

According to the theory of insurance demand in classical economics, individuals would like to maximize their benefits and avoid risk demand insurance in exchange for a reasonable premium over the expected risk. This assumption is based on the Expected Utility Theory. Individuals are protected from future financial difficulties by giving up a small portion of the savings they have today; thus, they maximize their benefits in every situation (Schlesinger, 2013).

Although this approach is successful in providing a general perspective on insurance demand, it is not sufficient to explain consumer behavior for a complex product such as insurance. For example, some individuals prefer to buy insurance against the same risks, while others do not. Moreover, sometimes insurance products with high risk are not demanded by consumers, while insurance products with much lower risk are in demand (Kunreuther et al., 2013).

One of the main reasons why the Expected Utility Theory is unable to provide a precise view of consumers' insurance demand is that individuals cannot always make rational decisions under uncertainty (Jurkovicova, 2016). According to the Prospect Theory developed by Kahneman and Tversky (1979), individuals have different risk appetites when it comes to gains and losses. Individuals make decisions under the influence of a series of cognitive biases when evaluating the probability of an event occurring (Kahneman and Tversky, 1974; Rabin and Thaler, 2001). This brings us to the conclusion that individuals do not always show consistent behaviors regarding their insurance demands. In this respect, it is important to investigate the socio-demographic and behavioral factors that affect the insurance demand of individuals.

### 2.1. Socio-Demographic Factors

When individuals tend to be risk-averse, they will be more likely to demand insurance that provides financial protection against the risks they are faced with. However, the tendency to avoid risk is a subjective phenomenon that varies according to individuals and conditions. There are several empirical studies showing that socio-demographic factors, such as income status, age, gender, and education level, influence the tendency of risk aversion and insurance demand. In different studies, it was observed that when the basic parameters determined as indicators of socio-economic development increased, the demand for insurance was generally higher (Browne and Kim, 1993; Halek and Eisenhauer, 2001; Beck and Webb, 2003; Zweifel and Eisen, 2012; Outreville, 2014).

On the other hand, the effect of indicators on insurance demand is not independent of the socio-economic structure of societies. The results vary according to the data and methods used. For example, in some studies, it was concluded that the age of the consumer was associated with the demand for life insurance. Yet, while some of these indicated the direction of the relationship positively, others indicated it negatively (Zietz, 2003). It is essential to measure the effect of the socio-demographic characteristics of individuals on comprehensive insurance demand, but results may contain biases specific to the data and research method used.

People with a higher risk appetite are expected to tend to demand less insurance (Zweifel and Eisen, 2012). Joseph et al. (2016) showed that individuals' risk appetites, despite certain stability throughout life, varied according to their character traits and domain. Besides, several related studies in the literature found that a number of descriptive variables, such as driving experience and vehicle age, had some effects on risk appetite and insurance demand (Awunyo-Vitor, 2012: Hsu et al., 2016; Shi et al., 2016).

### 2.2. Perceived Insurance Benefit

One of the most valuable contributions of the Prospect Theory to the explanation of individuals' decisions under uncertainty was to reveal that risk preferences changed according to how people classify risk. According to this phenomenon, which is called the framing effect, individuals act more conservatively when it comes to gains and pursue more risks when it comes to losses (Tversky and Kahneman, 1986). Accordingly, individuals' decision to demand insurance would vary depending on

whether they qualify for insurance as a gain or a loss. Weedige et al. (2019) determined that there was a significant relationship between the perceived benefit of insurance products and trust in insurance companies and insurance demand.

Whether individuals qualify insurance as a loss or gain is related to the probability of the risk occurring and the extent of the damage. However, individuals make use of their personal experiences, not actuarial tables, when evaluating loss probabilities (Kunreuther et al., 2013). Individuals would only tend to buy insurance if they think that the probability of a loss is high enough. Hertwig et al. (2004) showed that individuals underestimated the probability of rare events when they made decisions based on their experience and that if a relevant event occurred recently, it would make individuals come up with more accurate predictions. It can be expected that individuals, who have recently been involved in a traffic accident, would be more likely to demand comprehensive insurance.

### 2.3. Insurance Literacy

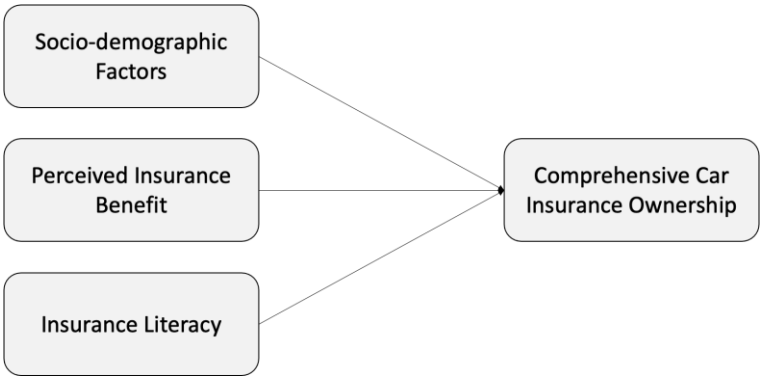
Whether financial literacy has a significant impact on individuals' financial decisions has been the subject of many studies so far (Pitthan and Witte, 2021). Lusardi and Mitchell (2014) found that low financial literacy was associated with poor financial investment decisions and retirement planning. It is a common expectation that financial literacy will have a similar effect on insurance demand. There are many studies showing that the demand for insurance increases as financial literacy increases (Cole et al., 2013; Awel and Azomahou, 2015; Uddin, 2017; Bryan, 2019). However, only a few of those studies specifically attempted to measure the impact of insurance literacy.

According to Tennyson's insurance literacy research, the average consumer did not have enough knowledge about insurance. In addition, the level of knowledge of car and home insurance was lower than in health and life insurance (Tennyson, 2011). Individuals who do not have enough knowledge about insurance products and services may have low awareness of the risks they face, which may reduce their risk aversion level. In addition, it can be expected that the perceived benefit of insurance products for these individuals will be relatively low. In this context, insurance literacy is expected to have a positive impact on individuals' insurance demand.

## 3. METHODOLOGY

We developed the conceptual framework of the study by conducting empirical research in the literature. The dependent variable in the study is comprehensive car insurance ownership, which represents insurance demand. Figure 1 demonstrates the research model of the study used to explain the relationship between the dependent and independent variables.

**Figure 1: Conceptual Framework of the Research**




The study was designed as relational-causal due to cost and time constraints. The research was a cross-sectional study because the data were collected at a specific point in time. We used the survey method for data collection. The survey was prepared digitally and distributed to car owners in Turkey via a social media platform using a simple random method. The total number of usable responses obtained was 261. The survey form contained the perceived insurance benefit scale and the insurance literacy test, in addition to 14 socio-demographic descriptive questions. The survey items were adopted from previous studies in the literature. Specifically, we adopted the perceived insurance benefit scale from Weedige et al. (2019) and the insurance literacy test from Tennyson (2011). The perceived insurance benefit items were measured with a seven-point Likert scale, anchored from strongly disagree to strongly agree. All items were translated into Turkish and adjusted to match the context and the target audience.

In this research, statistical analysis was carried out by using SPSS 17.0 (Statistical Package for Social Sciences). First, we applied descriptive analysis to understand the data set and its characteristics. Then we used Coefficient Alpha to test the reliability of the Likert-type scales in the questionnaire. The test shows the consistency of the statements on the scale with each other. The Coefficient Alpha value is between 0 and 1, and results above 0,7 for social sciences assume that the scale is reliable

(Cronbach, 1958). Next, we applied multiple regression analysis to survey data to determine factors related to the comprehensive car insurance demand. The logistic regression analysis was used to assess the effectiveness of the independent variables since the dependent variable comprehensive car insurance demand, is a binary (King, 2008). Moreover, The Hosmer and Lemeshow test was applied to assess the goodness of model fit. Finally, we used the classification report, confusion matrix, and ROC curve tests to evaluate the performance of the model (Drost, 2011):

- The classification report shows the percentages of correct predictions by accuracy, recall, precision, and F1-score metrics. True Positives, False Positives, True Negatives and False Negatives are used to predict the metrics of a classification report.
- The confusion matrix shows how distributed "actual and predicted" and "false and true" values are in model outputs. In this way, the distribution of predicted values could be determined by observing true and false ones with the matrix indicating density.
- ROC (Receiver Operating Characteristic) curve analysis is a valuable tool for evaluating the accuracy of logistic regression. It's a plot of the sensitivity (true positive) on the vertical axis and the specificity (false positive) on the horizontal axis or several different candidate threshold values between 0 and 1.

### 3.1. The Model Applied

The descriptive statistics used in the study are shown in Table 1. Approximately 71% of the sample had comprehensive car insurance. A typical driver had 13,7 years of driving experience, and 56% of them had a traffic accident recently. The average age of the vehicle was 7,8 years old.

**Table 1: Socio-Demographic Descriptive Statistics**

| | | | | Comprehensive Car Insurance Ownership | |
|---|---|---|---|---|---|
| **Variable** | **Category** | **n** | **%** | **Yes %** | **No %** |
| Age | Below 29 | 49 | 18.77 | 61.22 | 38.78 |
| | 30 - 44 | 169 | 64.75 | 74.56 | 25.44 |
| | Above 45 | 43 | 16.48 | 69.77 | 30.23 |
| Gender | Male | 207 | 79.31 | 71.01 | 28.99 |
| | Female | 54 | 20.69 | 72.22 | 27.78 |
| Marital Status | Single | 66 | 25.29 | 66.67 | 33.33 |
| | Married | 195 | 74.71 | 72.82 | 27.18 |
| Having Children | Yes | 161 | 61.69 | 70.19 | 29.81 |
| | No | 100 | 38.31 | 73.00 | 27.00 |
| Education | High school or below | 15 | 5.75 | 26.67 | 73.33 |
| | Bachelor's degree | 169 | 64.75 | 68.64 | 31.36 |
| | Master's degree or PhD | 77 | 29.50 | 85.71 | 14.29 |
| Family Income | Below 7.500 TL | 23 | 8.81 | 39.13 | 60.87 |
| | 7.501 TL - 15.000 TL | 81 | 31.03 | 61.73 | 38.27 |
| | 15.001 TL - 22.500 TL | 68 | 26.05 | 72.06 | 27.94 |
| | 22.501 TL - 30.000 TL | 36 | 13.79 | 86.11 | 13.89 |
| | Above 30.001 TL | 53 | 20.31 | 88.68 | 11.32 |
| House Ownership | Yes | 161 | 61.69 | 77.02 | 22.98 |
| | No | 100 | 38.31 | 62.00 | 38.00 |
| Vehicle Age | 0 - 2 | 77 | 29.50 | 38.96 | 61.04 |
| | 3 - 6 | 56 | 21.46 | 71.43 | 28.57 |
| | 7 - 10 | 85 | 32.57 | 89.41 | 10.59 |
| | Above 11 | 43 | 16.48 | 93.02 | 6.98 |

| | | | | | |
|---|---|---|---|---|---|
| Driving Experience (years) | 0 - 5 | 68 | 26.05 | 69.12 | 30.88 |
| | 6 - 12 | 60 | 22.99 | 71.67 | 28.33 |
| | 13 - 20 | 75 | 28.74 | 70.67 | 29.33 |
| | Above 21 | 58 | 22.22 | 74.14 | 25.86 |
| Frequency of Driving | Rarely | 41 | 15.71 | 70.73 | 29.27 |
| | Usually | 62 | 23.75 | 77.42 | 22.58 |
| | Always | 158 | 60.54 | 68.99 | 31.01 |
| Having Traffic Ticket | Yes | 125 | 47,89 | 66,40 | 33,60 |
| | No | 126 | 52,11 | 75,74 | 24,26 |
| Having Car Accident | Yes | 146 | 55.94 | 72.60 | 27.40 |
| | No | 115 | 44.06 | 69.57 | 30.43 |
| Having Pension Contract | Yes | 139 | 53.26 | 83.45 | 16.55 |
| | No | 122 | 46.74 | 57.38 | 42.62 |
| Having Healthcare Insurance | Yes | 162 | 62.07 | 85.19 | 14.81 |
| | No | 99 | 37.93 | 48.48 | 51.52 |

The result of the Coefficient Alpha test was used to determine the reliability of the perceived insurance benefit scale. The reliability analysis revealed a coefficient alpha of 0.772, which indicates that the scale is reliable (Cronbach, 1958). Since the dependent variable was binary, we applied binary logistic regression to determine the effect of the independent variable on the dependent variable (King, 2008).

### 3.2. Empirical Results

The results of the logistic regression analysis are shown in Table 2. The Nagelkerke $R^2$ value demonstrates that 70,9% of the variation was explained by the predictive model, which indicates a significantly strong relationship between the independent and dependent variables (Lewis-Beck et al., 2003).

**Tablo 2: Binary Logistic Regression Model Results**

| **Model Fit Statistics** | |
|---|---|
| -2 Log likelihood | 126.796 |
| Cox & Snell $R^2$ | 0.488 |
| Nagelkerke $R^2$ | 0.709 |

| **Hosmer and Lemeshow Test** | |
|---|---|
| Chi-Square | 41.616 |
| Sig. (P) | 0.544 |

| **Variables** | **B** | **S.E.** | **Wald** | **df** | **Sig.** | **Exp(B)** |
|---|---|---|---|---|---|---|
| Age | -0.090 | 0.044 | 4.260 | 1 | 0.039* | 0.914 |
| Education Level | -1.821 | 0.548 | 11.031 | 1 | 0.000*** | 0.162 |
| House Ownership | -1.878 | 0.527 | 12.704 | 1 | 0.000*** | 0.153 |
| Vehicle Age | -0.371 | 0.066 | 31.154 | 1 | 0.000*** | 0.690 |
| Driving Experience | 0.132 | 0.042 | 9.814 | 1 | 0.001** | 1.141 |
| Having A Traffic Ticket | 1.062 | 0.486 | 4.776 | 1 | 0.028* | 2.893 |
| Having Healthcare Insurance | -2.878 | 0.581 | 24.552 | 1 | 0.000*** | 0.056 |
| Having Pension Contract | -1.471 | 0.493 | 8.896 | 1 | 0.002** | 0.230 |
| Income Level | -2.316 | 1.179 | 3.860 | 1 | 0.049* | 0.099 |
| Perceived Insurance Benefit | -1.448 | 0.391 | 13.691 | 1 | 0.000*** | 0.235 |
| Insurance Literacy | -0.760 | 0.334 | 5.174 | 1 | 0.022* | 0.468 |
| Constant | 762.394 | 135.153 | 31.821 | 1 | 0.000*** | |

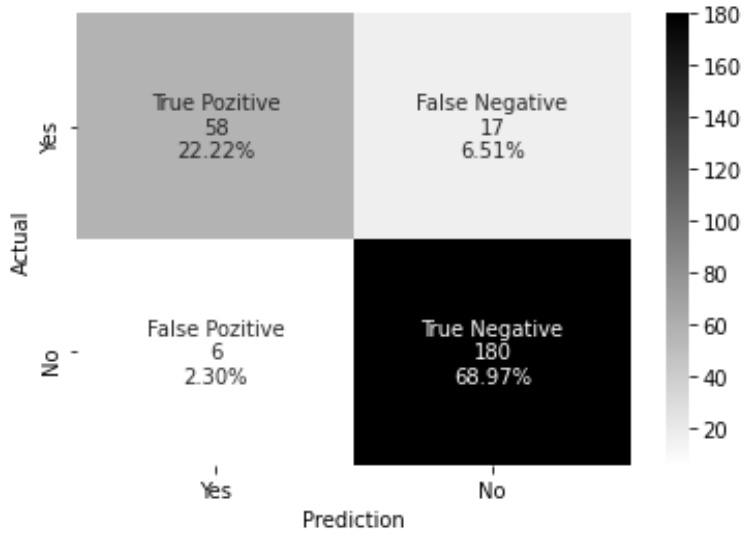
***: p<0.001, **: p<0.005, *: p<0.05

The classification results of the model are presented in Table 3, showing the accuracy of the model. The average classification accuracy score of the model was 91%, and the recall rate and the F-1 Score were obtained as 91%. Out of the sample that the model predicted would have comprehensive car insurance, %91 have it. The model correctly predicted %91 of all comprehensive car insurance owners. The results indicated that the model had high predictive power.

**Table 3: Classification Results of the Model**

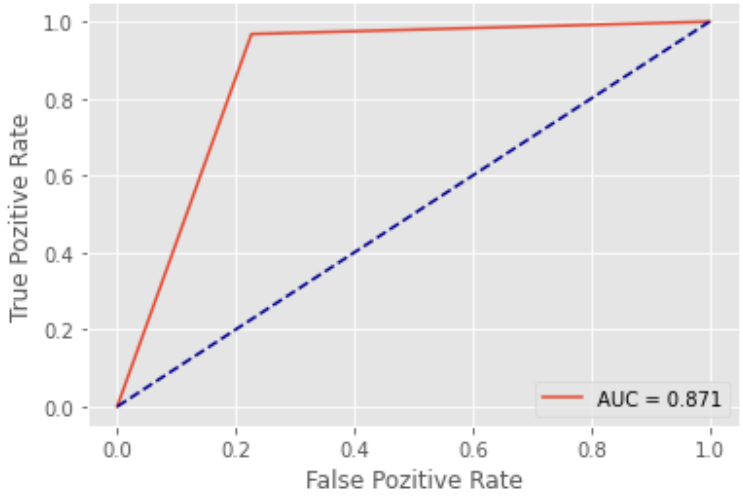
| Comprehensive Car Insurance Ownership | N | Precision | Recall | F1-score | Accuracy |
|---|---|---|---|---|---|
| Yes | 94 | 97% | 91% | 94% | 91% |
| No | 197 | 77% | 91% | 83% | 91% |
| *Avg.* | 261 | 92% | 91% | 91% | 91% |

**Figure 2: Confusion Matrix**




The actual and predicted data of the comprehensive car insurance demand were compared in the confusion matrix (Figure 2). According to the matrix, the correct classification success rate for the True Negative was significantly higher than the others. The True negative in this scheme aligned with the statistical power definition in the statistics literature. The statistical power was 0.68, which is an acceptable level. With a 68% probability, we could detect those individuals who did not have comprehensive car insurance appropriately.

**Figure 3: ROC Curve Graph of the Model**




As seen in Table 3, the ROC curve was positive and the AUC score was 0.979, indicating that the model has high explanatory power. From the ROC curve, it could be easily argued that the model classifies into categories appropriately. There are two indices to consider here: sensitivity and specificity. Sensitivity could be defined as the probability that predicts a positive outcome when an outcome is actually positive. The same could be defined for specificity when observation is predicted as negative when it is actually negative. AUC shows how well our model predicts these two indices, and it is better as it gets closer to 1. Our model is very good in terms of the indices defined above.

## 4. CONCLUSION

The factors affecting the insurance demand of consumers have been the subject of research in many developed and developing countries. This research indicates that socio-demographic indicators, such as age, gender, income, and education level, have significant effects on insurance demand. However, the results obtained differ according to variables such as the data sets used, research method, and insurance type. At this point, it becomes important to re-apply existing research with different data sets, indicators, and insurance types. The results obtained will help make practical contributions to the development of the insurance sector, especially in developing countries where the insurance penetration rate is low.

In the study, we investigated the effects of perceived insurance benefit and insurance literacy variables, in addition to socio-economic indicators, as the determinants of comprehensive car insurance demand in Turkey. The results showed that, besides socio-demographic indicators, perceived insurance benefit and insurance literacy level had an impact on comprehensive car insurance demand. The driver age and vehicle age stood out as the leading descriptive statistics associated with comprehensive insurance demand in the model. In addition, the total years of driving experience had a strong relationship with insurance demand. Having health insurance or private pension contracts also increased consumers' tendency to demand comprehensive car insurance.

One of the most remarkable findings of the study was that consumers, who had a traffic ticket in the last three years, had a significantly higher demand than others. This result appears to be evidence of adverse selection and moral hazard in comprehensive car insurance. Those, who have recently received traffic tickets, may demand comprehensive car insurance because they drive riskily or may drive riskier since they have insurance. We did not find a relationship between insurance demand and driving frequency or experiencing a traffic accident. Although these two factors increase the consumer's risk of having an accident, there is no meaningful relationship between that and insurance demand.

Perceived insurance benefit and insurance literacy factors also affected consumers' comprehensive insurance demand. However, when compared with the existing literature, the explanatory power of these variables was relatively low. We understand that comprehensive car insurance demand in Turkey is related to tangible indicators, such as vehicle age, rather than intangible indicators, such as perceived insurance benefit.

The findings contain several practical applications for the insurance industry in terms of marketing, product development, and the underwriting process. Since the tendency to demand insurance is higher among consumers, especially those having more driving experience and a newer car, tailor-made insurance products can be developed for these segments. In addition, insurance companies should offer bundled product campaigns to consumers who have a health insurance policy or a private pension contract. On the other hand, it is an important point to consider those risky drivers may attempt to demand more

comprehensive car insurance. The tendency to buy insurance would be higher in this consumer segment, but they would also have a higher loss-premium ratio since the propensity of having a traffic accident is more than others.

Finally, the findings have implications for regulatory authorities and insurance industry associations. If insurance literacy and perceived insurance benefit in society can be increased, the demand for car insurance and, thus, insurance penetration rates will increase. We recommend insurance industry associations act together with regulatory authorities to organize awareness campaigns and financial literacy courses to better explain the individual and social benefits of insurance products and services.

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# DID WALGREENS AND RITE AID BENEFIT FROM THEIR 2017 DEAL?

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## ABSTRACT

**Purpose-** After several attempts that extended over two years, in 2017 the U.S. Federal Trade Commission approved Walgreens' proposal to buy nearly half of Rite Aid stores. The two companies were in the same line of business making the merger fall in the category of horizontal mergers. The main benefits of horizontal mergers are cost savings from improved operational efficiency and superior bargaining power with respect to suppliers. Using annual financial statements, we examined the performance of Walgreens and Rite Aid over the four-year period since the acquisition of Rite Aid stores by Walgreens. The examination is useful because the Federal Trade Commission was not in favor of Walgreens' earlier proposal to merge completely with Rite Aid, but later allowed it to buy almost half of Rite Aid stores. The present study examines whether the revised proposal benefitted both Walgreens and Rite Aid.

**Methodology-** We collected annual financial statement data of the two companies from Mergent database and analyzed the common size statements and the relevant financial ratios.

**Findings-** Analysis of profitability ratios indicate profit margins (gross as well as net) continued to decrease for both companies even after the acquisition. Both companies showed improved operational effeciency as reflected in Inventory turnover and employee productivity, but Walgreens had a superior performance.

**Conclusion-** Only four years have passed since Walgreens acquired Rite Aid stores. Our analysis of the limited data indicates that Walgreen seems to have benefitted more from the deal. Rite Aid, by selling about 46% of its stores to Walgreens in 2017, became a much smaller company. The smaller size did not affect the cost of inventory or financing, but its profitability did not improve.

**Key Words:** Walgreens, Rite Aid, drugstores, pharmacies, mergers
**JEL Codes:** G34, M41, M10

## 1. INTRODUCTION

Drugstores and pharmacies have always been an integral part of the healthcare system. Although most drugstore businesses started as a single store and remained so, a few grew to become regional and national chains. In the U.S., three such large drug store chain companies are Walgreens, CVS, and Rite Aid. The three companies were ranked as the top three drug store chains in the U.S. for several years. Despite competition among themselves and other companies, these three companies retained their positions as major drug store chains in the U.S. through consistent growth. The growth of these companies has been internal as well as through acquisitions. Walgreens was founded in 1901 as a single store in Chicago. It took seven years to start the second Walgreens store. However, by 1926 it grew to become a chain of 100 stores. It crossed the 1,000 mark in 1982, and by the year 2015 it operated at approximately 8,200 locations and became the largest pharmacy chain in the U.S. It gained exposure to the European markets also through its acquisition of Boots Alliance, a large European drug store chain. Walgreens hoped to further increase its operations in the U.S. market and, in 2015, it offered to buy Rite Aid for $9.4 billion.

Rite Aid Corporation also started as a single drug store. It began operations in 1962, opening its first store in Scranton, Pennsylvania. The number of locations it operated grew to 267 by 1972 and to 4,000 by 1996. When Walgreens made its offer to buy Rite Aid in October 2015, Rite Aid had about 4,600 stores. Walgreens and Rite Aid wanted to merge into one company and sought the Federal Trade Commission's approval in 2015. The comission was not in favor of the proposal. Two

years later, in 2017, the commission approved Walgreens' proposal to buy about half of Rite Aid's stores. This study examines whether the two companies benefitted from the transaction.

## 2. LITERATURE REVIEW

In their review of the literature pertaining to the effect of mergers and acquisitions on corporate performance, Ismail, Abdou, and Annis (2011) categorize the studies into the following four groups: (1) Market Measures-Based Studies, (2) Accounting Measures-Based Studies, (3) Mixed Measures-Based Studies, and (4) Qualitative Measures-Based Studies. The first group that uses market measures, generally examines the effect of merger related events and actions on the price of stocks of companies involved in the mergers. The second group of studies examines the changes in the structure and operations of the firms after mergers and acquisitions. These investigations mostly use accounting ratios computed from the financial statements of the companies. The third group of studies [e.g Healy, Palepu, and Ruback (1992)] uses market-based measures (mostly changes in stock price) of the acquirer and the acquired, as well as accounting measures computed from financial statements to investigate whether the changes in market measures were corroborated or not by accounting data and ratios computed from them. The fourth group of studies use qualitative information to investigate the effect of mergers and acquisitions on performance. The most relevant literature for us is the second group of studies that use accounting measures. Some of the studies are briefly mentioned below. Rhoades (1998), in a study of nine bank mergers in the U.S., uses conventional accounting ratios to examine the changes in efficiency of the banks after merger. For example, to quantify operating efficiency, he uses the ratio of expenses to revenue; and to quantify profitability he uses the ratios of net income to total assets and net icome to owners' equity. Avkiran (1999) ivestigates the post merger performance of Australian trading banks in the 1986-1995 period. In that study, he uses the ratio of expenses to operating income to measure operating efficiency and return on assets and return on equity to measure profitability. Ibrahimi and Meghhouar (2019) analyze a sample of ninety French-listed firms to examine value creation and destruction from horizontal mergers using conventional accounting measures.

Studies mentioned above test hypotheses on whether mergers result in improving operating and financial efficiency and thereby increase value to the shareholders. These investigations require samples of companies for analyzing the data and to accept or not to accept the proposed hypotheses. In contrast to examining a sample of mergers or acquisitions for making generalizations, some studies restricted their analysis to case studies of a single acquisition or merger. For example, Cabanda and Pajara-Pascual (2007) examine the financial and operating performance of two shipping companies after merger. Their analysis involves ratios of profitability, leverage, solvency, operating efficiency, and investment spending. Similarly, Agarwal and Mittal (2014) compare the pre-merger and post- merger performance of Reliance Industries Ltd. and IPCL. – companies in the Indian Petrochemical industry. Using company financial data, they compute conventional financial ratios such as Returns on Total Assets, Equity, and Gross and Net profit margins for their analysis. More recently, using accounting measures, Bilbeisi and Narayanaswamy (2018) examine whether the acquisition of Dollar Tree by Family Dollar (the second and third largest U.S. discount variety stores in 2014) resulted in improved performance. The present study is a case-study of the performance of Walgreens and Rite Aid—two large drug store chains in the U.S.—before and after Walgreens bought hundreds of Rite Aid stores. As in the case studies mentioned above, we use conventional accounting measures for the analysis. The acquisition of Rite Aid drug stores by Walgreens extened over two years. In October 2015, when Walgreens and Rite Aid made the announcement to merge, Walgreens was the top ranked drugstore chain and Rite Aid was ranked third. The combination would have made the merged company the largest drug chain store in the U.S. with about 13,000 stores. The merger was expected to be synergic because of its potential to save costs. The proposed merger announcement was well received by the financial markets as evidenced by increase in stock price of both companies. On the day of the announcement Rite Aid's stock price increased by 43% and that of Walgreens by 6.4% [Matitioli, Siconolfi, & Simillucа (2015)]. However, the merger proposal of Walgreens and Rite Aid raised concerns because the combined firm would have become much larger than CVS, the second largest firm in the industry with operations in 7,800 locations at the time. The merged firm was also expected to exercise influence on other pharmaceutical drug related business that handled corporate and government plans [Hufford (2017)]. Because of the potential concentration of market due to the merger, the proposal was expected to attract considerable scrutiny by the Federal Trade Commission (FTC). But Walgreens and Rite Aid were expected to defend the merger proposal by pointing out that there was competition for the business from drugstores located and operated by grocery store chains and clubs such as Costco.

As expected, the 2015 Walgreen-Rite Aid agreement was subjected to intense regulatory scrutiny. Realizing that the proposal was not likely to be approved by the regulators, in January 2017, Walgreens and Rite Aid came up with a plan to reduce their size as a merged firm. Both firms planned on selling more than 1,000 of their stores so that the total number of stores of the merged firm will be smaller than the initial plan and make the industry competitive enough to avoid antitrust concerns. Because of the reduced size of Rite Aid under this proposal, the offer price for Rite Aid was also expected to be lower than the initial $9.4 billion to an amount somewhere between $6.8 billion and $7.4 billion, depending on the number of stores Rite Aid would shed. The financial market's reaction was mixed to the announcement. Rite Aid's shares fell by 17% on the day of the announcement. Walgreens' shares also fell, but by a much smaller amount of 0.1%. In June 2017, in view of the

reluctance of the FTC to approve even the revised deal, Walgreens and Rite Aid abandoned the merger proposal altogether and, instead, came up with a new proposal according to which Walgreens would buy only 2,186 Rite Aid's stores (46% of the total Rite Aid stores) for $5.18 billion in cash and pay a penalty of $325 million for breaking up the initial offer made in October 2015. To ease the concern of Rite Aid's reduced bargaining power, Walgreens gave Rite Aid the option to purchase generic drugs through an affiliate of Walgreens' for a period of ten years following the transaction. But one of the FTC commissioners at the time opined that Rite Aid will be at a disadvantage in buying the generic drugs after the elapse of the ten-year period due to its diminished size [Terrel McSweeny (2017)]. The transaction went through, however. The revised offer by Walgreens was for Rite Aid's stores located mainly in the North East, Mid Atlantic, and South Eastern parts of the U.S. After the purchase, Walgreens planned to close about 600 stores (mostly Rite Aid) that were in close proximity (less than two miles) to Walgreens stores. The day the new offer was announced, Rite Aid's stock price dropped by 26% but Walgreen's stock price went up by 1.7% [Terlep and Kendall (2017)]. The revised offer was approved by the Federal Trade Commission on September 19, 2017. Walgreens bought 1,932 Rite Aid stores for $4.38 billion.

There were three major announcements regarding Walgreens' plans to purchase Rite Aid stores. The first announcement made in 2015 was that Walgreens would buy the entire Rite Aid company, which resulted in the increase in the stock price of both companies. The next two announcements on Walgreens' offer to buy fewer Rite Aid stores resulted in considerable decrease in Rite aid's stock price, but Walgreens' stock price changed very little. Stock price reactions to announcements indicate investors' perception of future performance of the companies. In this case, the steep drop in price of Rite Aid could have portended its future performance. The absence of change in the stock price of Walgreens' stock must have also reflected investors' expectation that there may not be significant change in performance of Walgreens. Using financial statements, we examine the performance of Rite Aid and Walgreens before and after Rite Aid sold its stores to Walgreens in 2017.

## 3. DATA AND METHODOLOGY

Our primary focus of the study is to examine the performance of Walgreen and Rite Aid after Walgreen acquired almost half of Rite Aid stores in 2017. Several stores sold by Rite Aid to Walgreens were located close to Walgreens stores. Walgreen closed many of these Rite Aid stores after the acquisition. By closing the stores, Walgreens could have increased the sales in stores that remained, and thereby, reduced the cost per unit sold. Rite Aid could have also benefitted from the transaction because it did not have to compete with Walgreens in those areas and focus on the remaining stores. Further, with the proceeds of the sale of its stores, it could have reduced its debt and its interest commitments and invested in upgrading its facilities to reduce the cost of its operations.

For our analysis, we mainly use the annual reports published by the companies primarily for the shareholders and the public. The Securities and Exchange Commission requires large, publicly held companies to annually file a 10-K report. This filing is generally a detailed document, which regulators, analysts, and researchers use. Although financial statements are available on a quarterly basis, we use annual data to avoid seasonal fluctuations and focus on annual changes. However, the fiscal year reporting date for the two companies differed somewhat. The reporting dates were August 31$^{st}$ for Walgreens, and end of February or beginning of March for Rite Aid. The maximum gap between the dates was about six months. We used the end of the year closest to the reporting date as the year for which the report was made. For example, we used the report made by Walgreen on August 31, 2021, as the annual report for 2021, whereas the Rite Aid annual data reported in February of 2022 was used as the data for the year 2021. We used Mergent Online as the primary source of data. Mergent, in addition to reporting the financial statements, also publishes several financial ratios. But some ratios we needed were not readily available in the Mergent database. We therefore computed these ratios from the reported income statements and balance sheets. However, to confirm consistency, we compared our estimates with the ratios available in Mergent. We did not find significant difference between the two.

The primary purpose of the paper is to examine whether the transaction between Walgreens and Rite Aid benefitted both companies. We do it by analyzing the performance of the companies using the financial ratios that measure a firm's profitability, activity, costs, etc. Improvements in performance of the company after the reorganization should be reflected in better financial ratios for the post-acquisition period compared to the pre-acquisition period. To obtain a perspective of Walgreens and Rite Aid, we first graph their total assets, sales, and number of employees from 2012-2021. Figure 1 indicates the annual ending book value of the total assets of Walgreens and Rite Aid from 2012 to 2021. During those ten years, as the chart indicates, Walgreens' size grew considerably. The increase in size of Walgreens was mostly through its acquisitions of Alliance Boots and Rite Aid stores. It bought Alliance Boots in two stages: 45% in 2012 for $6.7 billion and the remaining 55% in 2014 for $15.3 billion. After completing the acquisition of Alliance Boots, Walgreens purchased 1,932 stores from Rite Aid for $4.38 billion in 2017. While the total assets of Walgreens increased, the assets of Rite Aid's decreased mainly because of the sale of its stores to Walgreens.

**Figure 1: Total Assets (USD billion)**

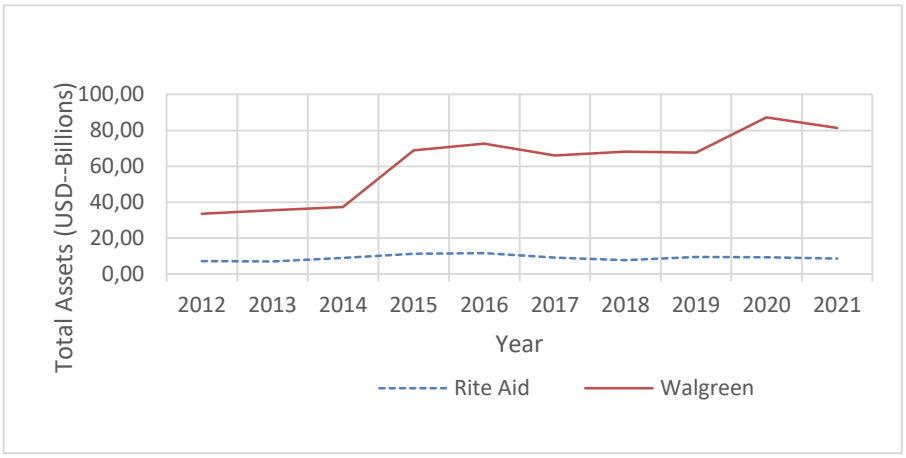



Figure 2 shows the annual sales (revenue) of the companies during the 2012-2021 period. Net annual sales of Walgreens increased from approximately $72 billion in 2012 to $133 billion in 2021. Significant annual increase in sales were in the years Walgreens acquired Alliance Boots and the Rite Aid stores. For Rite Aid, annual sales decreased from $25.53 billion in 2013 to $24.57 in 2021. The year-to-year total sales of Rite Aid increased in most years except in 2017 when it sold its stores to Walgreens. In that year, Rite Aid's sales decreased by $11.32 billion -- to $21.53 billion from its previous year sales of $32.85 billion.

**Figure 2: Net Sales (Billions--USD)**

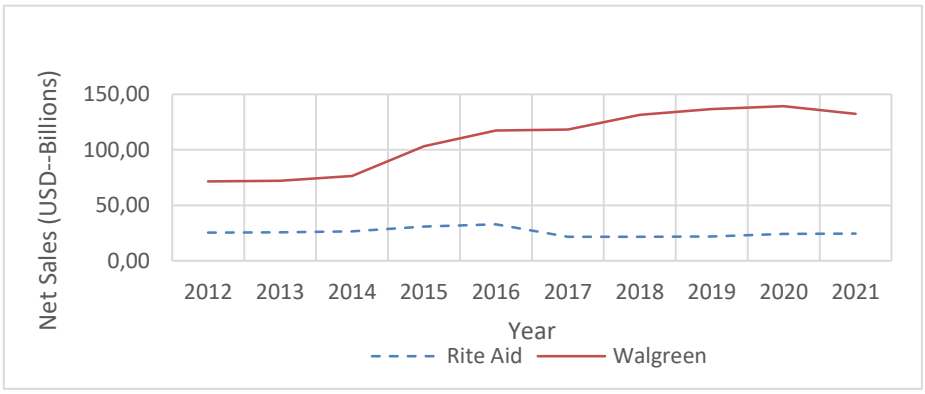
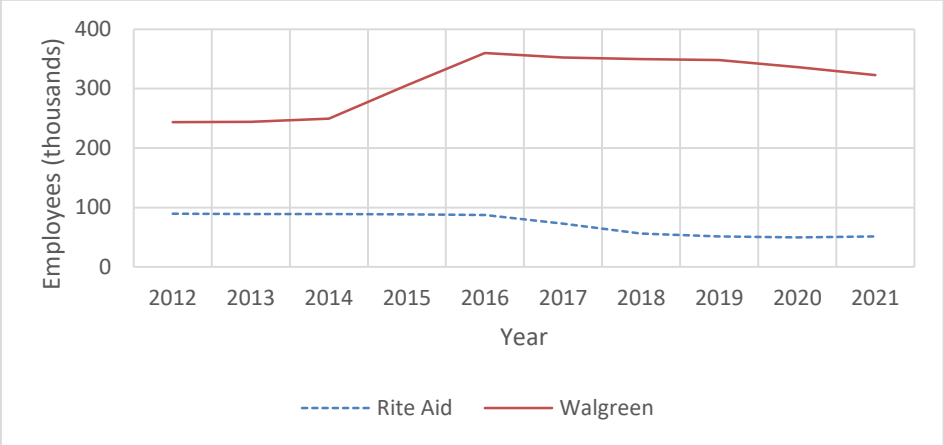



Figure 3 shows the total number of people employed by Rite Aid and Walgreens during the past ten years. The number reported is "total employees", which includes permanent as well as non-permanent employees. It may be noted that, over time, the total number of employees increased for Walgreens. The largest increase was in 2017 when it bought Rite Aid stores. The number started declining somewhat thereafter, probably due to planned store closings. As mentioned earlier, after the acquiring Rite Aid stores in 2017, Walgreens closed most Rite Aid stores if they were within two miles of its branch. On the other hand, the number of employees decreased significantly in 2017 for Rite Aid and remained so after selling its stores to Walgreens.

**Figure 3: Total Employees**




## 4. FINDINGS AND DISCUSSIONS

Four years have passed since the FTC gave its approval to the 2017 proposal that resulted in Walgreens buying almost half of Rite Aid's stores. We use two four-year time segments for comparing performance of the two companies. These are the four-year period before 2017 and the four-year period after 2017. The transaction between Rite Aid and Walgreens reduced the size of Rite Aid significantly. The size of Walgreens increased but was relatively not by as much as Rite Aid lost. Walgreens was a much bigger firm compared to Rite Aid. However, the transaction was expected to affect the performance of both companies.

### 4.1. Profitability and expenses

We begin our analysis of the performance of Rite Aid and Walgreens by first examining the changes in their profitability before and after Walgreens bought Rite Aid stores. Profitability is the key to long term survival of a firm. Shareholders invest in firms with the hope of getting a fair return on their investment. Before the shareholders get the returns, however, the firm must pay for the inventory used for generating the sale, operating expenses it incurred, and the taxes it owed. The amount left from the revenue after each of the above-mentioned expenses are categorized as gross profit, operating profit, and net profit, respectively.

We first compute the gross profit margin for Rite Aid and Walgreens. To compute the gross profit margin, we subtract the cost of goods sold from annual sales and divide it by sales. In order to find out whether Rite Aid's sale of its stores resulted in changes in performance, we compare its gross profit margin before and after it sold its stores to Walgreens in 2017. We do the same for Walgreens also to examine whether its purchase of Rite Aid stores improved its profitability.

**Table 1: Gross Profit Margin (%)**

| Year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|
| Rite Aid | 28.69 | 28.56 | 25.46 | 23.67 | 22.20 | 21.61 | 21.56 | 19.57 | 20.78 |
| Walgreens | 29.24 | 28.23 | 26.03 | 25.46 | 24.67 | 23.41 | 21.97 | 20.08 | 21.18 |
| Rite Aid - Walgreens | -0.55 | 0.33 | -0.57 | -1.79 | -2.47 | -1.80 | -0.42 | -0.51 | -0.40 |

Table 1 contains the gross profit margin for the two companies for the period 2013-2021. Figures in the table indicate that the gross profit margin of both Rite Aid and Walgreens decreased in the post-2017 period compared to the pre-2017 period. For Rite Aid, the average annual gross profit margin during the years 2013-2016 was 26.60% and for the 2018-2021 period it was 20.88% -- a decrease of 5.72%. For Walgreens, the average annual gross profit margin fell from 27.24% to 21.66%, a decrease of 5.58%, for the same four-year periods. For both companies the gross profit margin fell by almost the same amount.

We can also note that the year-by-year difference in gross profit margin between the two companies also did not change much in most of the years. Subtracting the gross profit margin for Walgreens from Rite Aid for each year, as shown in the last row of Table 1, we note that the difference was about 0.5% for most of the years. The largest differences were in 2016, 2017, and 2018, the years surrounding 2017 when the transaction between the two companies was approved. The figures indicate that Rite Aid and Walgreens generated about the same gross profit per dollar sold before and after Rite Aid's sale of its stores

to Walgreens in 2017. Based on this data, it appears that Rite Aid, despite its reduced size after 2017, was not disadvantaged in procuring its inventory.

**Table 2: Net Income / Sales (%)**

| Year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|
| Rite Aid | 0.98 | 7.95 | 0.54 | 0.01 | 4.38 | -1.95 | -2.06 | -0.38 | -2.19 |
| Walgreens | 3.53 | 2.66 | 4.14 | 3.57 | 3.47 | 3.82 | 2.89 | 0.30 | 1.90 |
| RAD-WG | -2.55 | 5.29 | -3.60 | -3.56 | 0.91 | -5.78 | -4.96 | -0.68 | -4.09 |

Table 2 shows the Net Profit margin for the two companies from 2013 to 2021. The net profit margin for Rite Aid was considerably lower than Walgreens' in all the years except 2014 and 2017. This was despite both companies having had almost the same gross profit margin. The average net income margin for Rite Aid during the pre-2017 four-year period was 2.37%. The margin was also positive in all the four years. In the post-2017 period, however, the average was negative 1.65%. It was not positive in any one those years. The decline in average net income margin for Rite Aid from the pre-2017 to post-2017 period was 4.02%. For Walgreens also there was a decline in average net income between the two periods, but the difference was much smaller. The decline in average net income for Walgreens was only 1.24%. Further, Walgreens did not have negative net income in any year. Comparison of year-by-year net income margin of the two companies also reveal that the net income of Rite Aid was less than Walgreen's in all the years except 2017. To gain understanding of this, we examine the components of expenses and associated activities that could have contributed to it. After the cost of inventory is accounted for in the gross profit margin, the largest component of expenses is attributed to selling, general and administrative expenses (SG&A).

**Table 3: SG&A / Sales (%)**

| Year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|
| Rite Aid | 25.70 | 25.24 | 22.82 | 22.05 | 21.60 | 21.22 | 20.92 | 19.37 | 20.49 |
| Walgreens | 24.29 | 23.55 | 21.82 | 20.37 | 20.08 | 18.68 | 18.44 | 19.38 | 18.55 |
| RAD-WG | 1.41 | 1.69 | 1.00 | 1.68 | 1.52 | 2.54 | 2.48 | -0.01 | 1.94 |

Table 3 contains the annual Selling, General & Administrative (SG&A) expenses as percentage of net sales, from 2013 to 2021. For the pre-2017 years, the averages were 23.95% for Rite Aid and 22.51% for Walgreens. For the post-2017 period, the average of this expense category was 20.50% for Rite Aid and 18.76% for Walgreens. For both companies, the SG&A expenses (as a proportion of net sales) fell by almost the same amount (3.45% for Rite Aid and 3.75% for Walgreens). But Walgreens had significantly lower SG&A expenses compared to Rite Aid every year except 2020. On average, Walgreens' SG&A (as a proportion of sales) was about 1.44% lower than Rite Aid's in the pre-2107 years and about 1.74% in the post-2017 years. It indicates that Walgreens has been more efficient in its operations compared to Rite Aid. We next investigated the possibility that the extent of debt financing could have affected the net income. Table 4 contains the data on net interest payments made by the two companies, expressed as percentage of sales. The table indicates that, Rite Aid performed well with respect to debt since 2017. After selling many of its stores to Walgreens for $4.38 billion in 2017, Rite Aid reduced its debt by about $3.92 billion. The annual interest paid on debt by Rite Aid (expressed as a percentage of sales), although higher than Walgreens' in the post-2017 period, the gap has been narrowing quickly.

**Table 4: Interest / Sales (%)**

| Year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|
| Rite Aid | 1.66 | 1.50 | 1.46 | 1.32 | 0.94 | 1.05 | 1.05 | 0.84 | 0.78 |
| Walgreens | 0.23 | 0.20 | 0.58 | 0.51 | 0.59 | 0.47 | 0.51 | 0.46 | 0.68 |
| RAD-WG | 1.43 | 1.29 | 0.88 | 0.81 | 0.36 | 0.58 | 0.53 | 0.38 | 0.10 |

### 4.2 Activity Ratios: Asset Management Efficiency, Asset Liquidity, and Employee Productivity

Examination of financial statements indicate that the two companies, Rite Aid and Walgreens, differed significantly in their Net Income margin since 2017. The poorer performance of Rite Aid could not be due to inefficiency in procurement or costs related to inventory because the cost of goods sold were almost the same for the two companies. The difference in performance could not be due to higher levels of debt commitments either. Rite Aid in fact fared well by reducing its debt level after 2017 from the proceeds of the sale of its stores to Walgreens. The low net income of Rite Aid was likely due to its higher operating expenses. To investigate it we next examine their activity ratios.

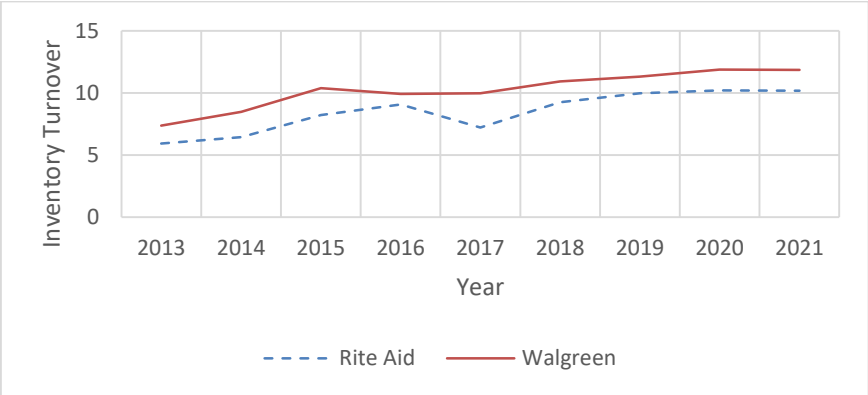
### 4.2.1 Inventory Turnover

Inventory turnover measures the efficiency of the firm in managing and selling inventory. It measures the number of times average inventory was sold during the accounting period. It is a gauge of the liquidity of a firm's inventory. The ratio is calculated by dividing the annual Cost of Goods Sold by average inventory for the corresponding year. As shown in Table 5, both firms increased their inventory turnover after 2017. However, Walgreens' inventory turnover ratio was higher than Rite Aid's every year, before and after 2017. For the post-2017 period, Walgreens' average inventory turnover ratio was about 1.81 higher than Rite Aid's. The higher measures for Walgreen indicate its inventory was being sold and replenished more frequently than for Rite Aid.

**Table 5: Inventory Turnover**

| Year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|
| Rite Aid | 5.92 | 6.45 | 8.21 | 9.06 | 7.22 | 9.24 | 9.07 | 10.21 | 10.18 |
| Walgreen | 7.36 | 8.48 | 10.37 | 9.92 | 9.98 | 10.91 | 11.3 | 11.87 | 11.86 |

**Figure 4: Inventory Turnover**




### 4.2.2 Short-Term Solvency (Current Ratio)

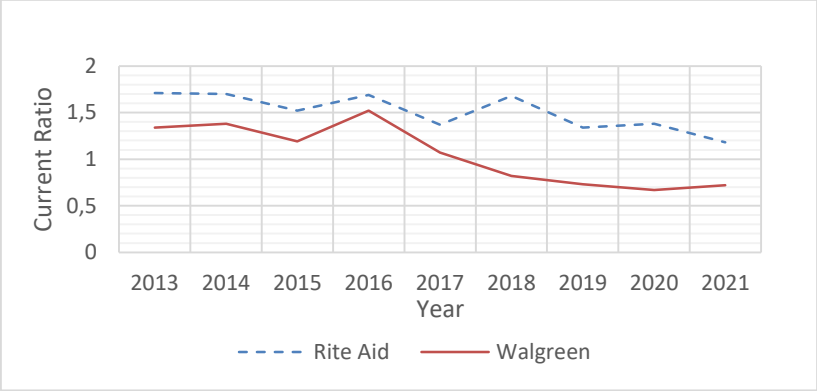
Current Ratio is a commonly used measure of short-term solvency, the ability of a firm to meet its debt requirements as they come due. Current Liabilities are used as the denominator of the ratio because they are considered to represent the most urgent debt, requiring retirement within one year or one operating cycle. The available cash resources to satisfy these obligations must come primarily from cash or conversions to cash of other current assets.

**Table 6: Current Ratio**

| Year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|
| Rite Aid | 1.71 | 1.7 | 1.52 | 1.69 | 1.37 | 1.68 | 1.34 | 1.38 | 1.18 |
| Walgreen | 1.34 | 1.38 | 1.19 | 1.52 | 1.07 | 0.82 | 0.73 | 0.67 | 0.72 |

Table 6 shows the annual Current Ratio of Rite Aid and Walgreens for ten years from 2013 to 2021. Current ratio declined for both Rite Aid and Walgreen since 2018. The decline has been substantially greater for Rite Aid compared to Walgreen. The current ratio for Walgreen decreased from 0.82 in 2018 to 0.72 in 2021, whereas for Rite Aid the decrease was from 1.68 to 1.18. Although the ratio declined for both companies, the current ratio for Rite Aid has been significantly higher compared to Walgreens'. The high value of this ratio for Rite Aid could be indicative of carrying higher inventory compared to Walgreens. It could partly be the reason for Rite Aid's lower inventory turnover ratio discussed earlier.

**Figure 5: Current Ratio**



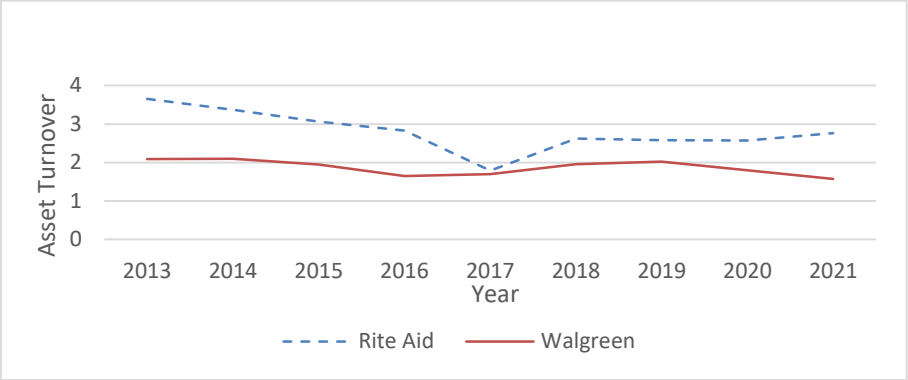

### 4.2.3 Asset Turnover

The efficiency with which assets were utilized in the business can also be measured by Total Asset Turnover Ratio. It is computed by dividing net sales by average total assets for the period. The resulting number shows the dollars of net sales produced by each dollar invested in assets. Table 7 shows the total asset turnover for Rite Aid has been higher than Walgreens', every year, before and after 2017. Rite Aids assets turnover was higher averaging 2.63 compared with Walgreens' which averaged 1.84, for the four post-2017 years. These figures indicate that Rite Aid likely made better use of its non-current (fixed) assets.

**Table 7: Total Asset Turnover**

| Year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|
| Rite Aid | 3.65 | 3.37 | 3.06 | 2.83 | 1.79 | 2.62 | 2.58 | 2.57 | 2.76 |
| Walgreen | 2.09 | 2.1 | 1.95 | 1.65 | 1.70 | 1.96 | 2.02 | 1.8 | 1.57 |

**Figure 6: Total Asset Turnover**




### 4.2.4. Employee Productivity

Turnover ratio measures the effectiveness with which physical assets were used to generate sales. But sales are also generated by employees. A popular measure of employee productivity reported annually is the revenue generated per employee. Like other items on the balance sheet, the number of employees reported in the annual financial statements are year ending figures. To get the annual sales per employee, therefore, we divide the annual sales by the average of the reported year ending employment figures. Table 8 shows the revenue generated per employee for the two firms during the years 2013-2021. To investigate employee productivity, we express the annual revenue per employee as a product of two components, namely "Total assets per employee" and "Sales per dollar of Total Assets". The second ratio is the same as "Total Assets Turnover Ratio" which we have already discussed. Revenue generated per employee can be written as a product of the two ratios.

$$\text{Revenue per employee} = \left(\frac{\text{Total Assets}}{\text{Employees}}\right) \times \left(\frac{\text{Sales}}{\text{Total Assets}}\right)$$

The decomposition of the "Revenue per employee" ratio, as shown above, implies that changes in revenue generated per employee, an important measure of the utilization of employees, can be due to the two factors that interact in a multiplicative fashion. Table 8 shows revenue per employee, total assets per employee, and total asset turnover for Rite Aid and Walgreens from 2013 to 2021. The table is divided into three panels, one for each of the three ratios. It can be noted that Rite Aid exceeded Walgreens in revenues generated per employee every year since 2017. It achieved higher revenue generation despite having, on average, lower amount of assets per employee compared to Walgreens. The higher annual revenue per employee, with lower assets per employee, indicates that Rite Aid's employee productivity was better than that of Walgreens during the four years since 2017.

**Table 8: Employee Productivity**

| Year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|
| **Sales per Employee** | | | | | | | | | |
| Rite Aid | 287 | 298 | 347 | 375 | 295 | 386 | 425 | 481 | 477 |
| Walgreen | 296 | 306 | 339 | 326 | 335 | 376 | 393 | 415 | 410 |
| **Assets per Employee** | | | | | | | | | |
| Rite Aid | 79 | 89 | 114 | 131 | 141 | 148 | 165 | 188 | 173 |
| Walgreen | 141 | 146 | 174 | 196 | 197 | 192 | 195 | 230 | 261 |
| **Total Asset Turnover** | | | | | | | | | |
| Rite Aid | 3.65 | 3.37 | 3.06 | 2.83 | 1.79 | 2.62 | 2.58 | 2.57 | 2.76 |
| Walgreen | 2.09 | 2.1 | 1.95 | 1.65 | 1.7 | 1.96 | 2.02 | 1.8 | 1.57 |

## 5. CONCLUSION AND IMPLICATIONS

Analysis of financial statements is an important, even necessary for making right decisions. Information obtained from financial analysis are the basis for making decisions, both internally and externally. The main objective of our analysis was to examine if both Rite Aid and Walgreens benefitted from the deal that was approved by the Federal Trade Commission in 2017. Rite Aid sold 1,932 of its stores to Walgreens in return for $4.38 billion. Our analysis indicates that Walgreens and Rite Aid both had comparable performances in managing the costs of inventory. The cost of goods sold for both companies was not significantly different from each other. On the financing side, Rite Aid narrowed its debt financing cost (as a proportion of sales) since selling its stores to Walgreens. The main difference in the two company's performance was in the operating expenses. The sales, general, and administrative expenses per dollar sales was significantly and consistently lower for Walgreens compared to Rite Aid. We attempted to find the underlying reasons for this difference in efficiency. Analysis of activity indicate that, Rite Aid had lower inventory turnover compared to Walgreens in all the years, before and after 2017. The lower inventory turnover ratio is also substantiated by higher Current Ratio of Rite Aid, indicating that Rite Aid might have been carrying more inventory relative to Walgreens. However, on another important measure of activity, namely "Revenue Generated per Employee," Rite Aid did significantly better than Walgreens. Rite Aid's employees achieved it although they had, on average, lower total assets per employee. A likely reason for Rite Aid's lower net income margin compared to Walgreens seems to be its higher Sales, General, and Administrative expense. For a more detailed analysis, we need information on the components of the SG&A that are not currently available in published statements such as 10-K reports. One may note that, Rite Aid, after the sale of its stores to Walgreens, became a much smaller firm than it used to be prior to the 2017 deal with Walgreens. It was also subjected to competition from several drugstores located in grocery stores and clubs such as Costco and Walmart, in addition to the traditional drug store chains. As these changes in the landscape of drug store industry were anticipated, the Federal Trade Commission could have favorably considered the merger of the entire Rite Aid Corporation with Walgreens when the proposal was first made in 2015.

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# THE IMPACT OF FINANCIAL LITERACY ON RISK PROPENSITY MEDIATED BY ACCESS TO FINANCE

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## ABSTRACT

**Purpose** – Financial literacy has become an important area of research in recent years. Its significance in making wise financial choices has also been documented in recent studies. In developing economies, business sustainability is a major issue as has been identified in many prior studies. Most SMEs are unable to survive 3 years after establishment. Prior researchers have mostly attributed this to a lack of access to finance. Recently, it has been discovered that financial literacy tends to assist SMEs with the needed skills and knowledge such as understanding the various sources of finance and analyzing different financial choices accurately, in order to be able to make the right financial choices. This study hence examines the impact of financial literacy on risk propensity mediated by access to finance.

**Methodology** – Data for the study was collected from SME owners/managers through structured questionnaires. The questionnaires were administered to 432 SME owners/managers. Descriptive statistics was used in describing the demographic statistics of the respondents. PLS Structural Equation Modeling (SEM) was used for the data analysis.

**Findings** – The study's hypotheses were confirmed. The findings showed that access to finance partially mediates the association between financial literacy and risk propensity. The relationship between financial literacy and risk propensity was likewise strongly favorable, and it was further established that access to finance significantly impacts on risk propensity.

**Conclusion** – Financial literacy and access to finance both remain a significant aspect of SME sustainability, both have a positive and significant implication for risk propensity. SMEs should hence include financial literacy programs such as workshops and seminars in their annual programs to help improve their financial knowledge since financial literacy impacts both access to finance and risk propensity. Policymakers should also put in more effort in making policies such as financial literacy training compulsory to help improve the financial knowledge of SMEs.

**Keywords:** SMEs, financial literacy, risk propensity, access to finance, mediation
**JEL Codes:** D91, G11, G53

## 1. INTRODUCTION

Financial literacy has recently become a very important research area, with many emerging research in the area. Policymakers worldwide are also increasingly according the needed attention to the area in both developed and developing nations. One of the main objectives of financial literacy is to assist individuals in making sound monetary judgements when dealing with financial issues. SMEs are essential to economic development, mainly due to their contributions to employment and economic growth, as has been documented in prior studies (Aphu,2018; Khan et al.,2020). However, SMEs are burdened with many challenges which limit their contribution to economic development (Ackah and Vuvor,2011; Wang,2016).

These challenges include lack of access to finance, poor financial decision-making, poor record keeping, among others. Prior literature has established that financial literacy is a significant variable for quality decision-making. One essential attribute of

entrepreneurs is their risk propensity. Risk propensity measures the attitude of individuals towards risk. Risk attitude has been identified to have major implications for business performance and sustainability (Ye and Kulathunga,2019). This study, therefore, examines the impact of financial literacy on the risk propensity of SME owners/managers mediated by access to finance. The study on the relationship between financial literacy and risk propensity has not been accorded the needed importance in developing economies, we therefore conduct this study in a developing economy, Ghana and introduce access to finance as a mediating variable between the two variables.

The findings of the study are significant for SMEs as it throws further light on the need for SMEs to acquire financial skills and knowledge relevant for running their business. Policymakers can also add financial literacy training as a policy requirement for SMEs to help improve their financial knowledge. The introduction of access to finance as a mediating variable introduces a new link through which financial literacy can impact on risk propensity. The study makes contributions to the knowledge base theory and the perking order theory. SMEs with financial literacy are able to consider different sources of finance when considering access to finance. Financial literacy is also considered a strategically significant resource relevant in obtaining competitive advantage. This study will be a significant guide in risk assessment for SME businesses since a comprehensive review has been done on financial literacy, risk propensity and access to finance. The rest of the study is structured as follows, section 2 includes the literature review and conceptual framework for the study, section 3 has the methodology and analysis for the study and sections 4 contains the conclusion for the study.

## 2. LITERATURE REVIEW

### 2.1. SMEs

Small and Medium Enterprises are businesses which maintain their assets, revenue and employees below a certain threshold. Even though definitions differ from country to country, the denominator for the purpose remains asset, turnover and employee. The International Monetary Fund describes enterprises employing between 10 and 249 employees as SMEs. The definition of SMEs in Ghana by the Ghana Statistical Service is enterprises employing between 6 and 100 employees. The contribution of SMEs to development has been documented in prior literature in both developed and developing economies (Khan,2022). Beck et al. (2005) found that SMEs play essential roles in the revolution process of transition economies. A study by Asare (2014) revealed that SMEs in Ghana contribute massively to employment and Gross Domestic Product (GDP), especially in the manufacturing sector. Despite all these contributions, the many challenges the sector face makes sustainability difficult (Asare,2014), hence this study's motivation.

### 2.2. Financial Literacy and Risk Propensity

A person's current inclination to take or avoid risks is their risk propensity (Sitkin and Pablo, 1992; Sitkin and Weingart, 1995). It can be characterized as the risk-seeking or risk-averse attitudes of the decision-maker. Risk propensity, therefore, can be seen as the extent to which a person is willing to pursue risky opportunities with unknown outcomes. SME owners/managers make many important decisions in the day-to-day running of their business, which has serious repercussions on the performance of their business. It is therefore necessary to have a wide range of knowledge in finance to enable them to make efficient and effective decisions. According to Hasan et al. (2021), knowledge of various financial services significantly impacts financial choices. De Mel (2011) found that financial literacy training obtained from financial knowledge, assists SMEs in making the right financial decisions for business growth.

Adomako (2015) discovered that lack of financial literacy has resulted in poor financial judgments causing business failures in many parts of the world. Other studies also found the quality of entrepreneurs' decision-making have similarities with financial literacy (Eniola and Etenbang,2017). According to Ye and Kulathunga (2019), risk attitude and the management of risk depends partly on attitude towards uncertainties. Kim (2011) described risk attitude as a competitive characteristic in the construction industry since a contractor's risk-taking attitude is an essential element of the construction business. Ye and Kulathunga (2019) found a direct positive effect of risk attitude on business sustainability. Caliendo and Fossen (2010) posits that the level of risk has a significant effect on entrepreneurial survival. The study by Wall and Dyer (1996) found risk-taking attitude substantially impacts the economic performance of petroleum firms. Implying that the attitudes exhibited in business can impact positively or negatively on the performance of the business, and having financial literacy has been found to impact significantly on the decision-making ability of SMEs (Adomako,2015; Ye and Kulathuga,2019; Buchdadi et al.2020). Thus, financial literacy has the tendency to influence SME owners/managers to exhibit the right attitude towards risk in business. We hypothesize that:

H1: Financial literacy has a significant effect on the risk propensity of SMEs

### 2.3. Financial Literacy and Access to Finance

Among the many challenges SMEs face, access to finance remains the major among them (Cressy, 2006; Beck et al., 2006). The findings from prior studies, have found access to finance as a significant determinant of firm growth (Beck et al., 2006; Malo and Norus,2009; Adomako, 2015; Bongomin, 2017). However, the challenge of most SMEs being unable to acquire finance for business is well documented (Beck et al., 2006; Bongomin, 2017). Recent studies have found that access to finance can be enhanced with financial literacy. Wachira and Kihiu (2012), discovered that the possibility of financial illiterates remaining financially excluded is significantly very high. According to Hasan et al. (2021), the knowledge of various financial service factors, like interest rate and different sources of finance substantially impacts on access to finance.

Hussain et al. (2018) found evidence suggesting that financial literacy enhances access to finance and has growth potential in business. According to Fatoki (2021), a significant relationship exists between access to finance and financial literacy. The findings of Adomako (2015) suggests that financial literacy has a positive significant effect on access to finance. Ye and Kulathunga (2019) also found financial literacy to significantly impact on access to finance. Measurement for the variables of access to finance in the study were adopted from Buchdadi (2020). The items measured SMEs' ability to access finance and utilize various financial services. Therefore, we state:

H2: Financial literacy significantly impacts on access to finance

### 2.4. The Impact of Access to Finance on Risk Propensity

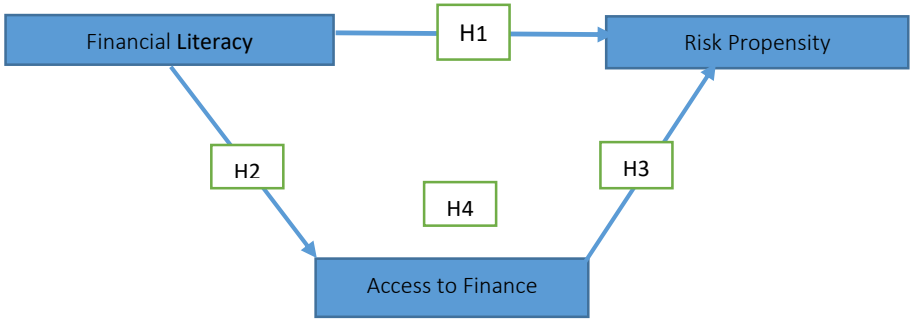
Risk propensity measures the tendency of a decision-maker to take or avoid risk. The impact of access to finance on risk propensity assesses the likelihood of a decision maker to take or avoid risk when access to finance has been obtained. Gaisie (2020) posits that being risk-averse has no significant effect on using debt financing in business. There are a few studies that examine the implications of financial literacy on risk attitude (Kim, 2011; Ye and Kulathunga, 2019; Buchdadi,2020). Others have also studied the impact of risk attitude on access to finance (Han et al., 2019; Ye and Kulathunga, 2019; Buchdadi et al., 2020). There have also been several studies on the effect of risk attitude on SME performance (Buchdadi,2020; Ajemunigbohun et al.,2020; Bandara and Ekanayake,2020). Researchers like Ye and Kulathunga (2019), assessed the effect of risk attitude on the sustainability of SME businesses. However, studies examining the effect of access to finance on risk propensity are scarce and have not been accorded much consideration. Both access to finance and risk attitude according to prior studies have significant effect on SME performance (Ye and Kulathunga, 2019), and risk propensity examines a decision makers' tendency to make or avoid risk (Sitkin and Pablo, 1992; Sitkin and Weingart, 1995), thus a decision maker's tendency to take or avoid risk after finance has been obtained has significant implication for the performance of the business. The study on the impact on access to finance on risk propensity must therefore be given enough attention by researchers. This study hence examines the effects of access to finance on the risk propensity of SME owners/managers.

Access to finance has been used as a mediating variable in various studies in recent times. Khyareh (2020) examined access to finance as a mediating variable in entrepreneurship and economic growth, while (Ye and Kulathunga,2019; Buchdadi et al.,2020) recorded a significant partial mediation between financial literacy and SME performance. Syahdan et al. (2020) found substantial mediation of access to finance in the link among market orientation, entrepreneur orientation, technological orientation, learning orientation and SME performance. Twumasi et al. (2022) recorded a significant result after examining access to finance in the relationship between financial literacy and household income. Even with all these studies, studies examining access to finance as a mediator between financial literacy and risk propensity remain vague. Access to finance is examined in this study as a mediating variable in the relationship between financial literacy and risk propensity. We therefore state:

H3: Access to finance significantly impacts on risk propensity

H4: Access to finance significantly mediates the relationship between financial literacy and risk propensity

**Figure 1: The Hypothesized Relationships**




## 3. DATA AND METHODOLOGY

Data for the study was collected from 432 SMEs with employees ranking from 6 to 100 per the definition of SMEs by the Ghana Statistical Service (GSS). Structured questionnaires were administered to SME owners/managers across the country. The respondents included members of the Ghana Enterprise Agency. We recorded 14 incomplete questionnaires and 18 questionnaires with errors. PLS- Structural Equation Modeling (SEM) was the primary analytical tool used for the study, while descriptive statistics was employed for the demographic description of the SMEs.

**Financial literacy:** The tool used to assess financial literacy were adapted from Adomako (2015). The following questions were asked to test the financial literacy of the respondents: (a) I prepare monthly financial statements, (b) I review monthly financial reports, (c) I analyze monthly financial statements, (d) I have an understanding of the company's gross profit margin. The last question was adapted from (Chen and Volpe,1998), (e) I am aware of the requirement for a bank loan. A seven-point Likert scale, from strongly agree to strongly disagree, was presented to the respondents.

**Access to finance:** Access to finance implies using accessible financial services. Respondents were asked to rate how satisfied they were with access to finance provided by their banks (Buchdadi et al., 2020). The questions were adapted from Buchdadi et al. (2020) and included questions such as whether the bank's financial services have increased business in our industry; whether our company is formally insured; whether the fee charged on the account opened is reasonable. The loan products offered are as needed for the business. The terms and conditions of the loans provided are good for us. The savings products offered are safe for business. These were evaluated on a seven-point Likert scale, from strongly satisfied to strongly dissatisfied.

**Risk propensity:** A few changes were made to the instrument of risk propensity used by Ye and Kulathunga (2019). On a Likert scale from 1 to 7, respondents were asked to indicate how likely they were to take the following actions. Invest 10% of revenue annually for business development, invest 10% of your annual income to buy stocks / mutual funds, put 10% of monthly revenue into a business emergency fund and bet a day's revenue in a high-risk game.

### 3.1. Descriptive Statistics

For sectorial distribution, the service sector had a maximum frequency of 220, accounting for 55% of the population, the industrial sector with 116, accounting for 29%, and the agricultural sector had 64, accounting for 16% of the population. Enterprises with employees ranging from 61 to 100 were 104, accounting for 26% of the population, and those from 6 to 30 had 111, which is 27.8% of the population. Enterprises with employees from 31 to 60 recorded the highest population of 185 accounting 46.3%. We recorded 32.8% of the businesses with a frequency of 131 had been in existence for less than three (3) years, companies above ten (10) years had a frequency of 113 accounting for 28.2%, companies in existence for seven (7) to ten (10) years were 108 accounting for 27%, and those in existence between three (3) and six (6) years were 48 representing 12% of the population. (See Table 1 below).

**Table 1: The Profile of the Sample**

| Sector | Frequency | Percentage |
|---|---|---|
| Agriculture | 64 | 16% |
| Industrial | 116 | 29% |
| Service | 220 | 55% |
| Company Size | | |
| 6 – 30 employees | 111 | 27.8% |
| 31 – 60 employees | 185 | 46.3% |
| 61- 100 employees | 104 | 26% |
| Age of the Company | | |
| Below 3 years | 131 | 32.8% |
| 3 – 6 years | 48 | 12% |
| 7 – 10 years | 108 | 27% |
| Above 10 | 113 | 28.2% |

## 4. FINDINGS AND DISCUSSIONS

The chapter on data analysis and results presents the findings in great depth. Basic statistics were performed, and PLS-SEM analysis comprising the assessment of measurement and structural model was performed. The measurement model establishes the reliability and validity of the construct. The structural model ascertains the significance of hypothesized relationships. Different hypotheses were proposed to evaluate the association of predictors with the outcome.

H1: Financial Literacy has a significant effect on the risk propensity of SMEs

H2: Financial Literacy significantly impacts on Access to Finance

H3: Access to Finance significantly impacts on Risk Propensity

H4: Access to Financial significantly mediates the relationship between Financial Literacy and Risk Propensity

**Measurement Model -** Based on the model's evaluation, the study's constructs are rated for quality. The quality criteria assessment starts with factors loadings and establishes the construct reliability and construct validity.

**Factor Loading -** Factor loading refers to the extent to which each item in the correlation matrix correlates with the given principal component. According to Pett et al. (2003), factor loading can range from -1.0 to + 1.0, with higher absolute values indicating a higher correlation of the item with the underlying factor. The factor loading is presented in table 2.

**Table 2: Factor Loading**

| | AF | FL | RP |
|---|---|---|---|
| AF1 | 0.764 | | |
| AF2 | 0.831 | | |
| AF3 | 0.866 | | |
| AF4 | 0.865 | | |
| AF5 | 0.853 | | |
| AF6 | 0.801 | | |
| AF7 | 0.639 | | |
| FL1 | | 0.881 | |
| FL2 | | 0.902 | |

| | | | |
|---|---|---|---|
| FL3 | | 0.902 | |
| FL4 | | 0.897 | |
| FL5 | | 0.876 | |
| RP1 | | | 0.834 |
| RP2 | | | 0.854 |
| RP3 | | | 0.869 |
| RP4 | | | 0.837 |

**Reliability -** The degree of a measuring instrument's stability and consistency is measured by its reliability. Cronbach alpha and composite reliability are mostly used in determining the stability and consistency of an instrument. According to Hair et al. (2011), a criterion of 0.70 or higher is considered acceptable. Reliability was therefore established since both Cronbach alpha and composite reliability results in the table below were above 0.7.

**Table 3: Cronbach's Alpha Evaluation Results and Composite Reliability**

| Variables | Cronbach's Alpha | Composite Reliability |
|---|---|---|
| Access to Finance | 0.908 | 0.928 |
| Financial Literacy | 0.936 | 0.951 |
| Risk Propensity | 0.870 | 0.911 |

**Convergent validity -** The degree to which various attempts to measure the same concepts are in agreement is referred to as convergent validity. The average variance extracted (AVE) indicates that items converge to measure the underlying construct and demonstrate convergent validity when AVE is greater than or equal to 0.50 (Fornell and Larcker, 1981). The AVE in table 4 below indicates that items converge to measure the underlying construct.

**Table 4: Construct Convergent Validity (AVE)**

| Variables | Average Variance Extracted (AVE) |
|---|---|
| Access to Finance | 0.650 |
| Financial Literacy | 0.795 |
| Risk Propensity | 0.720 |

**Discriminant Validity -** Following Fornell and Larcker's (1981) criterion, discriminant validity is established when the square root of AVE for a construct is greater than its correlation with all other constructs. In this study, the square root of AVE (in Bold Italic) for each construct was found greater than its correlation with other constructs (Table 5), hence discriminant validity was established.

**Table 5: Discriminant Validity – Fornell and Larcker Criterion**

| | Access to Finance | Financial Literacy | Risk Propensity |
|---|---|---|---|
| Access to Finance | ***0.806*** | | |
| Financial Literacy | 0.800 | ***0.892*** | |
| Risk Propensity | 0.804 | 0.779 | ***0.849*** |

*Note: Bold and Italics represent the square of AVE*

**Indicator Multicollinearity -** The Variance Inflation Factor (VIF) statistic is used to assess multicollinearity in the indicators (Fornell and Bookstein, 1982). According to Hair et al. (2011), multicollinearity is not a severe issue if VIF values are below 5. Table 6 presents the VIF values for the indicators in the study and reveals that the VIF for each indicator is within the recommended threshold.

**Table 6: VIF**

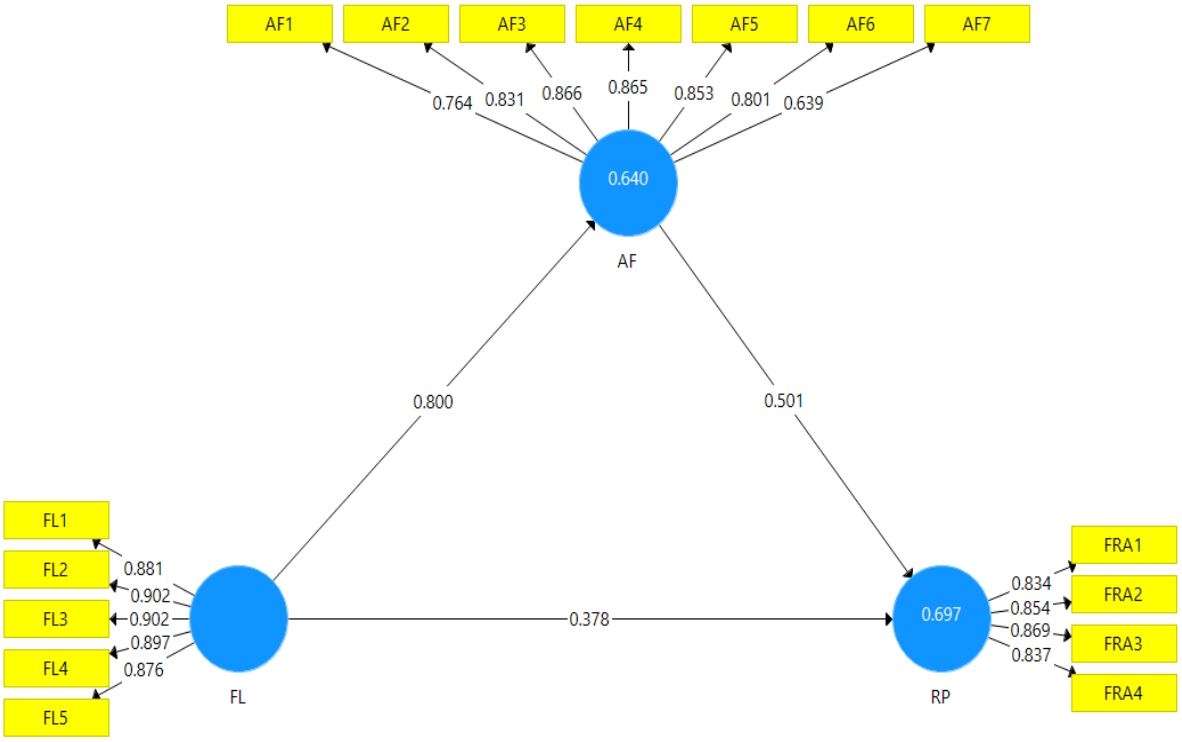
| | VIF |
|---|---|
| AF1 | 2.Şub |
| AF2 | 2.743 |
| AF3 | 3.089 |
| AF4 | 3.118 |
| AF5 | 2.863 |
| AF6 | 2.209 |
| AF7 | 1.531 |
| FL1 | 3.115 |
| FL2 | 3.594 |
| FL3 | 3.417 |
| FL4 | 3.325 |
| FL5 | 2.916 |
| RP1 | 2.063 |
| RP2 | Şub.16 |
| RP3 | 2.445 |
| RP4 | 2.215 |

**The Goodness of Fit (Model's Predictive) -** The results disclosed an R2 value of 0.640 for access to finance and 0.697 for risk propensity indicating that 64% variation in access to finance can be attributed to financial literacy. In comparison, the 69.7% variation in risk propensity can be credited to both financial literacy and access to finance. These results indicate that other predictive variables contribute to access to finance and risk propensity.

**Table 7: Goodness Fits**

| | R Square |
|---|---|
| AF | 0.640 |
| RP | 0.697 |

**Figure 2: Path Coefficients of Structural Model**




**Structural Model -** The next step in structural modelling is assessing the hypothesized relationship to substantiate the proposed hypotheses.

**Hypothesis Testing -** H1: Financial Literacy significantly impacts Risk Propensity. The result revealed a significant positive impact of financial literacy on risk propensity (β = 0.378 t = 6.839, p = 0.000), indicating that the hypothesis was accepted. H2: Financial Literacy significantly impacts Access to Finance. The result also revealed a positive and significant impact of financial literacy on access to finance (β = 0.800, t = 34.689, p = 0.000) indicating that the hypothesis was accepted. Finally, H3: Access to Finance significantly impacts Risk Propensity. The result showed that access to finance has a positive significant impact on risk propensity (β = 0.501, t = 9.932, p = 0.000) indicating that the hypothesis was accepted. Table 8 shows the direct relationship results:

**Table 8: Direct Relationship Result**

| | Beta Coefficient | T Statistics | P Values |
|---|---|---|---|
| FL -> RP | 0.378 | 6.839 | 0.000 |
| FL -> AF | 0.800 | 34.689 | 0.000 |
| AF -> RP | 0.501 | 9.932 | 0.000 |

**Mediation Relationship -** H4: Access to Finance significantly mediates the relationship between Financial Literacy and Risk Propensity. The result for H4 was positive and significant, indicating that access to finance mediates the relationship between financial literacy and risk propensity. Therefore, the hypothesis was accepted (β = 0.401, t = 9.231, p = 0.000).

**Table 9. Indirect Relationship Result**

| | Beta Coefficient | T Statistics | P Values |
|---|---|---|---|
| FL -> AF -> RP | 0.401 | 9.231 | 0.000 |

## 4. DISCUSSION AND CONCLUSION

The study examined the effect of financial literacy on the risk propensity of small and medium enterprises (SMEs) mediated by access to finance. SMEs are essential for the growth of every nation's economy, and leaders of both developed and developing nations over the years have made issues that concern SMEs top priority. De Mel (2011), stated that financial literacy is helpful when making financial decisions and each financial decision in business comes with risk (Adomako,2015). SME owners/managers are usually responsible for decision-making in business; hence they must have the necessary financial knowledge that will assist them to make the right choices while considering risk. This study hence examined financial literacy's effect on the risk propensity of SME owners/managers mediated by access to finance. The main analytical tool used was PLS-Structural Equation Modelling (SEM). The findings of H1 indicated that financial literacy has a positive significant impact on risk propensity. This implies that SME owners/managers with financial literacy can determine and analyze all risky impacts likely to affect their business before making decisions. This confirms the knowledge base view theory that businesses centered on knowledge acquisition have strategically significant strategy for attaining competitive advantage.

The findings of H2 also shows that financial literacy positively and significantly impacts access to finance, this finding is in line with prior findings (Adomako,2016; Ye and Kulathunga, 2019; Buchdadi et al.,2020) indicating that SMEs with financial literacy can consider different sources of finance and requirements for access to finance, hence, have a better chance of obtaining finance as compared to those without financial literacy. This also confirms the pecking order theory that businesses consider different levels and sources of finance when making decisions for acquiring finance. H3 also indicated a positive and significant result, showing that access to finance has a positive and significant effect on risk propensity. This finding proves that when SMEs have access to finance, their risk-taking attitude is impacted positively. Risky situations are therefore well assessed before choices are made. This result has a significant policy implication, in the sense that, with the right policies in place to assist SMEs to have easy access to finance, owners/managers will be more careful when making risky choices for businesses, thus, leading to growth and sustainability.

Finally, the result for H4 was significantly positive indicating that access to finance partially mediates the relationship between financial literacy and risk propensity, this is because the direct relationship between financial literacy and risk propensity is positive. However, access to finance still mediates the relationship between financial literacy and risk propensity. The hypothesis is therefore confirmed, this shows that even though financial literacy significantly impacts on risk propensity, some elements of financial literacy still go through access to finance to impact on risk propensity. Policymakers must therefore not relent on their effort to make access to finance for SMEs more accessible. Access to finance as a mediating variable also introduces a new link through which financial literacy can impacts on risk propensity. The study's mediator, access to finance, partially mediates the relationship between financial literacy and risk propensity. This implies that other variables may be able to link the relationship between the two variables fully. Future researchers can extend and test other mediation variables such as risk perception and manager's negotiation skills.

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