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The Moderator Role of Convex Returns in the Geopolitical Risk-Corporate Investment Relationship:
An Applied Study on the Egyptian Construction Sector

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Abstract

This research investigates the moderator role of convex returns in shaping the influence of Geopolitical Risk (GPR) on Corporate Investment decisions. This applied study was conducted on construction firms listed on the Egypt Stock Exchange, EGX 100 during the period from 2018 to 2024. The study was reliant on secondary data that was published in the financial statements and reports of these companies and the GPR_EGY index. Furthermore, the study employed the Data Panel data method, which integrates cross-sectional and time series data. The data were statistically analyzed using STATA 14. The study results showed a significant negative impact of Geopolitical Risk that is represented by the GPR_EGY index, on corporate investment decisions. In addition that a stronger ability to substitute labor for capital, or a higher labor share, leads to a rise in the convexity and weakens the negative impact of the GPR index on corporate investment in the Egyptian construction firms.

Keywords: Geopolitical Risk, GPR Index, Corporate Investment, Convex Returns, Egyptian Construction Sector.

1. Introduction

In 2022, Caldara and Iacoviello devised a proxy for geopolitical risk (GPR) that is only weakly correlated with other widely used uncertainty indices. The monthly index is generated by calculating the prevalence of articles that address critical phrases associated with GPR in eleven prominent international and national newspapers. This methodology is based on newspaper coverage. The U.S. is frequently involved in global geopolitical events, which are documented in these publications. Examples include the Paris assaults of 2015 and the invasion of Iraq in 2003, which resulted in significant increases in the GPR index. As a result, this index can be considered a metric of geopolitical uncertainty that is widely perceived by policymakers, market participants, and the media.

Business, financial market participants, public media, and policymakers are all deeply concerned about geopolitical shocks, including wars, terrorist attacks, military attacks, and diplomatic conflicts throughout the globe. In the aftermath of the 2015 Paris attacks, Joe Kaeser, the CEO of Siemens, issued a warning that corporate investment plans were being influenced by GPR, which was causing apprehension regarding a decline in global development. 75% expressed apprehension regarding the influence of GPR on the American investment climate, of the more than 1,000 U.S. investors who participated in the 2017 Wells Fargo/Gallup survey. As per the International Monetary Fund (2018, 2019), global investment and growth are subject to an additional adverse risk due to GPR. In spite of the public's growing interest in GPR, empirical research on its influence on corporate decisions is relatively scarce (Caldara & Iacoviello, 2022). Using the GPR_EGY index, this paper empirically investigates the influence of GPR on investment for Egyptian construction firms to address this imbalance.

Measuring convex returns by labor share reveals a complex, non-linear connection in terms of corporate investment. Under some circumstances, both low and high labor shares can be favorable for

larger investment returns; moderate labor shares might not provide the same benefits. Policymakers and corporate leaders trying to maximize investment strategies concerning labor compensation structures must first understand this dynamic (Garcia-Macia, 2020).

This research examines the moderating role of convex returns on the relationship between GPR and corporate investment decisions of Egyptian construction firms listed on the Egyptian stock exchange. The research employs both inductive and deductive methodologies. To begin, it employs the deductive approach, reviewing the existing literature on the definition of geopolitical risk, its measurement, and its relationship to corporate investment decisions. Next, the inductive approach is employed to investigate the relationship between GPR and its reflection on corporate investment decisions and how the convex returns affect this relationship.

The subsequent sections of this investigation are structured as follows: Sections 2 and 3 comprise the research problem and research objectives. Literature review and hypotheses formulation are described in Section 4. In Section 5, the research methodology is detailed, including the data description, hypotheses, empirical models, descriptive analysis, and outcomes. Illustrations of the conclusion and recommendations for future research are provided in Section 6.

2. Research Problem

In response to this evident necessity, recent research (Cho, 2023; Jia et al., 2022; Le and Tran, 2021; Nguyen and Thuy, 2023; Salisu et al., 2022; Wang et al., 2024) has initiated an investigation into the impact of GPR on financing and investment decisions. As a result of regional conflicts, and some economic challenges in Egypt, such as the Gaza conflict and its consequences on Suez Canal income, Sudan and Ethiopia's conflict over the Nile River, currency depreciation and high inflation rates in March 2024, the GPR index for Egypt (GPR_EGY) has increased. This risk leads to investor uncertainty and thus leads to discourages long-term investment commitments.

This study aims to find to what degree Egypt's construction industry is impacted by these regional tensions.

Variations in the geopolitical context immediately influence institutional investment decisions, so Egypt's building industry is encountering more difficulties. These effects show themselves in increases in financing costs, capital flow volatility, and investor mistrust (Wang et al., 2024). Notwithstanding these difficulties, it is seen that certain businesses in this industry nevertheless show good returns, suggesting the existence of internal elements that could help to reduce the influence of geopolitical concerns. "Convex returns," which show how well businesses can attain rising returns with more investments, could be one possible determinant of financial flexibility to help one cope with outside swings. Nonetheless, the existing research still leaves open the link between geopolitical risks and institutional investment as well as the function of convex returns as a moderating element in this relationship, particularly in the framework of developing nations like Egypt. In light of this, the research problem can be succinctly stated as follows:

To what extent do geopolitical risks affect corporate investment decisions in the Egyptian construction sector, and what role do convex returns play as a moderating factor in this relationship?

3. Research Objectives

This study helps to offer doable suggestions for businesses, investors, and decision-makers to improve the construction sector's resilience against geopolitical constraints in Egypt. The main goal of this study is to grasp how internal company factors, such as convex returns, interact with geopolitical hazards and affect corporate investment decisions.

4. Literature Review and Hypotheses Development

This section was broken down into six distinct sections. The initial three sections constitute the conceptual framework of the investigation, which encompasses the Geopolitical Risk, Convex Returns, and Corporate Investment. The fourth part is the Impact

of Geopolitical Risk on Corporate Investment. The fifth part is the Impact of Convex Returns on Corporate Investment. The sixth part is the Impact of Convex Returns as a Moderator in the Geopolitical Risk-Corporate Investment Relationship.

4.1 Geopolitical Risk (GPR)

GPR is the risk that is linked to conflicts, terrorist attacks, and tensions between states, which disrupt the normal and peaceful progression of international relations (Caldara & Iacoviello, 2022). This risk that extant tensions will intensify, and that these events will transpire, is captured. GPR distinguishes itself from sources of uncertainty that are specific to either firms or countries. This uncertainty is distinct from uncertainty of the firm level in that firms across a broad spectrum are affected by it, so diversification becomes more difficult in these markets. In addition to policy uncertainty, which is defined as a government's incapacity to credibly commit to protecting property rights on investment due to a lack of checks and balances in the country's policymaking process, is distinct from GPR (Henisz, 2000). It is also distinct from economic uncertainty, which usually indicates a high probability of negative economic events and implies that the national economy's prognosis is uncertain (Drobetz et al., 2018).

A unique form of uncertainty regarding the future profitability of firms is posed by GPR, which is distinct from traditional sources of country-level uncertainty, including political and economic uncertainty (Julio & Yook, 2012). The Boston Globe, Financial Times, The Daily Telegraph, Chicago Tribune, The Globe and Mail, The New York Times, The Guardian, Los Angeles Times, The Times, The Washington Post and The Wall Street Journal, are among the 11 prominent international newspapers that Caldara and Iacoviello (2022) construct a monthly geopolitical risk index to measure the frequency of articles related to geopolitical tensions (Wang et al., 2024). Articles that contain references to one or more of six categories of terms—geopolitical risk, nuclear threats, war threats, terrorist threats, war acts, and terrorist acts—are specifically targeted by the search. To compute the country-specific geopolitical

risk index, divide the total number of articles mentioning the specific country in the previous year by the number of articles related to both geopolitical risk and the country.

For instance, the GPR for Egypt is assessed by counting the number of articles that include the term "Egypt" in conjunction with terms such as "risk," "tensions," "fear," "violence," "uncertainty," "military," "geopolitical warfare," "war," "army," and "terrorism." Carney et al. (2024) subsequently measure this count by the number of newspaper articles that mention the name of the country (Egypt) for one year.

Whether this geopolitical risk measure is significantly correlated with other political risk measures is a noteworthy concern (Carney et al., 2024). Uncertainty faced by firms can take many forms. Distinguishing the impact of geopolitical risk from the effects of the economic conditions and different categories of uncertainty is a critical challenge in the analysis of the two aforementioned competing predictions.

The Caldara and Iacoviello (2022) index offers numerous benefits for the examination of the GPR-investment relationship. First and foremost, the GPR measure is available on a monthly basis since 1985, in contrast to geopolitical events that occur sporadically in time. With this extensive dataset, this index can investigate the intricate investment dynamics in reaction to fluctuations in GPR. Second, the GPR index does not experience a systemic increase during recessions and financial crises, in contrast to many other uncertainty proxies. However, it does experience a spike during conflicts or terrorist acts. As a result, this index can assist in the differentiation of the impact of geopolitical risk on investment from the effects of other uncertainties and alleviate the endogeneity regarding the relationship between uncertainty and investment. Lastly, the index is divided into the GPT refers to the threats component that includes increased threats from events, and the GPA refers to the acts component that realization of actual events. Also, it determines which is the primary driver.

There is a GPR index related to each country, which enables researchers to study the geopolitical risk in these countries. In this study, the researcher used GPRC_EGY, which refers to the Geopolitical Risk Country-Specific Index for Egypt (Caldara & Iacoviello, 2022).

4.2 Convex Returns

Convex returns are non-linear relationship. Within the framework of this research, it relates to the non-linear link between capital investment and labor expenses. "Convex returns" suggests a U-shaped link between capital investment and labor share. Stated differently, while moderate labor shares may match lower returns, both extremely low and very high labor shares can be linked with higher investment returns. Understanding how changes in labor remuneration affect the investment choices of a company depends on this link (Garcia-Macia, 2020).

According to the Convex Return Theory, projected returns are high and uncertainty is low increases the likelihood of businesses investing. Their marginal cost of avoiding investment under risk lowers when businesses can substitute away from capital, which is more sensitive to risk, thereby matching with the convex return idea. For companies unable to readily substitute, investment will be dropped more drastically (Doshi et al., 2018).

Wang et al. (2024) underlined a varied impact, so not all companies are equally impacted by geopolitical risk. Those who are more flexible in input substitution or labor-intensive find less investment reduction. This empirical result supports the convex return hypothesis, which holds that, especially in cases of limited alternatives, the choice to invest becomes more sensitive under uncertainty.

One can gauge convexity in several ways, including the labor share. In company-level research, labor share is a widely used financial ratio used to gauge the share of economic value generated by a company choosing labor compensation—wages, salaries, and

benefits—rather than capital—profits, interest, etc. This ratio shows you the proportion of the value the business generates via its activities paid for labor. It gauges how labor (workers) and capital (owners/investors) are divided in the economic pie. A high labor share could mean that a company is labor-intensive, maybe with less excess for capital expenditure. A low labor share indicates the company keeps more profit (EBITDA), so maybe boosting debt servicing, dividends, or capacity for investment. More value is kept for capital or profits (Barkai, 2020; Guschinski & Onaran, 2021).

4.3 Corporate Investment

Corporate investment is the distribution of resources by a company (corporation) into assets or initiatives expected to yield returns over time. Usually aiming at expanding the company's operations, increasing efficiency, or acquiring a competitive edge, it is a basic feature of both financial planning and business strategy. Economic development and productivity depend on these expenditures. Capital expenditures, which show how much companies are spending in future productive capacity, generally mirror corporate investment (Jędrzejowicz & Jarecki, 2024).

Macroeconomic expectations, financial conditions, and many other factors shape corporate investment choices (IMF, 2021). In theory, the impact of uncertainty on investment is dubious. In one sense, the real options channel can be used to reduce investment due to uncertainty (Instefjord & Kenç, 2024). Firms may regard their investment decisions as a succession of alternatives. Asymmetric adjustment costs result in a high value of options for delaying investment when uncertainty is high. As a result, firms reduce their investment due to uncertainty. Gulen and Ion (2016) and Kim and Kung (2017) have empirically verified this real options effect. Wars and terrorist assaults are geopolitical shocks that exacerbate economic uncertainty, so fluctuations in GPR affect investment (Wang et al., 2024).

4.4 The Impact of Geopolitical Risk on Corporate Investment

Many recent studies investigated the relationship between GPR and investments. Investments are adversely affected by GPR, as

discovered by Dissanayake et al. (2019). Hu and Xue (2020) also demonstrate that North Korea's nuclear weapon testing harms investments for the sample of Chinese firms. However, the impact of GPR is not significant after controlling for the nuclear test events.

Varying effects have been identified in empirical contexts in recent research on geopolitical risk and business performance. For example, Le and Tran (2021) demonstrate that corporate investment is more significantly affected by geopolitical risks in China and Russia than in India and Turkey, as evidenced by an extensive sample that spans 1995–2018. For firms with a greater degree of investment irreversibility, the adverse effect of geopolitical risk on firm investment is more pronounced. However, firms with greater cash holdings can better mitigate this negative impact. Stock returns in countries with greater geopolitical uncertainty outperform those in countries with less geopolitical uncertainty, according to Zaremba et al. (2022). Stock returns in sophisticated economies are also significantly predicted by geopolitical risk; however, the magnitude of the effect is distinct (Salisu et al., 2022).

Political and geopolitical risks have a profound influence on investment decisions at both the national and corporate levels, as confirmed by the research conducted by Hassan et al. (2019 and 2023). Companies respond to these risks by reducing capital expenditures and increasing financial hedging. Using sophisticated language analysis of earnings calls between firm management and investors, the first study offered a fresh assessment of political risk at the individual corporate level. To gauge the degree of risk businesses incur, the researchers noted words and phrases connected to political uncertainty (such as "tax," "law," "elections"). The second study examined the sources and patterns of the transmission of sovereign and political risks across countries and financial markets. It relies on data analysis from financial analyst reports and measures how risks associated with a specific country transfer to other countries through economic links.

Focusing on non-financial firms from 14 emerging market countries, Pringpong et al. (2023) investigate the influence of geopolitical risk (GPR) on firm value. The negative impact on firm value is primarily driven by the country-specific idiosyncratic GPR, which represents local geopolitical shocks. This is due to the fact that firms reduce internal risk by holding more liquidity and debt during periods of high external uncertainty, resulting in a decrease in firm value. Whereas the global systematic GPR is irrelevant. In addition to that Wang et al. (2024) confirmed a robust negative correlation between GPR and corporate investment. 14% of his sample mean is lost in the next quarter's investment when the GPR index doubles.

The Yilmazkuday (2024) study looks at how global geopolitical concerns affect stock prices in 29 countries over the period 1985 to 2023. Particularly in emerging markets like Latvia (0.80), China (0.71), and the Eurozone (0.62), the findings imply that a single shock in geopolitical risks causes a large drop in stock values. Shen, (2025) looks at how investment decisions are influenced by American corporations' view of geopolitical concerns. The researcher evaluated the effect of geopolitical risk perception on investment decisions using data from earnings calls to U.S. corporations. Particularly in businesses with little cash, the findings revealed that increased awareness of geopolitical concerns results in lower future capital expenditures.

These varied empirical studies have been applied in various countries, with different time frames, highlighting the need to examine geopolitical risk and corporate investment in Egypt, especially after the war in Gaza and its impact on Suez Canal revenues. Accordingly, the study developed the first hypotheses, which can be formulated as follows:

- **H_1: There is a significant negative impact of geopolitical risk on corporate investment.**

4.5The Impact of Convex Returns on Corporate Investment

The body of current research on the correlation between corporate investment and labor share, that is, Convex Returns. This convex relationship emphasizes the difficulty of investment decisions, in which case both undercompensating and overcompensating labor might have different effects on capital spending .

Supported convex return theory, Dao et al. (2017) argued that labor-intensive companies responded more flexibly with investments. This paper investigates how variations in real exchange rates influence corporate investment. Based on firm-level data from France, it is discovered that companies with higher labor shares invest more when the real exchange rate declines.

Although some studies may not specifically model or demonstrate a U-shaped (convex) relationship between labor share and corporate investment, they provide evidence that under some circumstances the link between labor share and investment may show convex properties. Such as Lian (2019) research showing the non-linear influence of industrial activity location on labor share. The interplay of labor share dynamics, offshore, and technical developments points to convex properties in the link between labor share and investment. Garcia-Macia (2020) also looked at how wages—that is, labor costs—impact investment in Italian companies. Under some conditions, such liquidity, this suggests that rises in labor share may drive out business investment.

Examining up to 99 nations and using a cross-country approach, Chortareas and Noikokyris (2021) found, especially in low-income countries, that better capital development is linked to larger labor income share. This link, however, weakens in high-income nations, implying a non-linear dynamic shaped by a nation's revenue throughout the period 2004–2015. Applied to twenty manufacturing branches across the 2012–2019 timeframe, Petreski and Pehkonen (2023) evaluated how minimum wage rules influence the workforce share in manufacturing sectors in North Macedonia. While in capital-intensive sectors the labor share declines, the authors

discover that in labor-intensive sectors rises in minimum wage result in a larger labor share. This implies, under impact of industry factors, a non-linear relationship between labor costs and capital investment decisions. The researcher developed the following hypothesis which can be formulated as follows, with the consistency of the most previous studies,

- **H_2: There is a significant positive impact of convex returns measured by labor share on corporate investment.**

4.6 The Impact of Convex Returns as a Moderator in the Geopolitical Risk-Corporate Investment Relationship

In keeping with the convex return theory, some studies together support the hypothesis that companies with higher labor intensity or more flexibility in substituting labor for capital are more suited to endure the negative effects of geopolitical risks.

Uncertainty can perhaps boost investment via a convexity that called the Oi Hartman-Abel effect (Abel, 1983; Hartman, 1972; Oi 1961; Wang, 2024). When the capital marginal product is a convex function of uncertainty regarding certain underlying variables, Jensen's inequality suggests that higher uncertainty improves the investment marginal value and consequently promotes investment. The literature has evolved this convex return idea even more. For instance, uncertainty can favorably influence investment even with investment irreversibility, provided there a non-decreasing returns in manufacturing and there is a competitive market. Furthermore, Li et al. (2019) discovered that uncertainty greatly motivates investment for companies that have low investment irreversibility or large labor share. Nonetheless, their conclusions are derived from a sample of Chinese manufacturing companies and apply industry-specific currency volatilities as their uncertainty estimate.

The 2019 research by Bekaert and his colleagues emphasizes variation in company reactions to uncertainty. Companies with more flexible manufacturing techniques, such as those able to substitute

labor for capital, tend to show less sensitivity to changes in risk appetite and uncertainty. This is consistent with the convex return theory, according to companies with more flexible input systems have less downside from shocks. The results highlight how under uncertainty investment decisions are shaped by firm-level traits.

Lee and Shin 2000 also asserted on the same concept. For companies with higher labor-to-capital ratios or labor share, the negative impact of uncertainty on investment should be less, as the higher the labor share, the more the convexity in returns. The Oi-Hartman-Abel impact is stronger the higher the labor proportion in manufacturing. On this Oi-Hartman-Abel effect, empirical data on is rare, nonetheless.

Yu and Wang's (2023) research investigates the influence of geopolitical hazards on foreign direct investment in 41 countries. From 2003 to 2020, the results indicate that on foreign direct investment FDI inflows are highly adversely affected by geopolitical risk. However, the negative effect is mitigated in countries with higher trade dependence, suggesting that firms operating in such environments may have greater flexibility in adjusting to geopolitical uncertainties.

A news-based index of geopolitical risk (GPR) is employed in Wang et al. (2024) study, which establishes a robust negative correlation between firm-level corporate investment and GPR. When the GPR index doubles, next-quarter investment declines by 14% of its sample mean. The convex return theory is bolstered by the fact that the effect is less pronounced for firms with a higher labor-to-capital ratio, a higher labor share, or a stronger capacity to substitute labor for capital. In other words, the impact of a doubling of the GPR index on investment for a firm with labor substitutability at the 75 percentile is 6.4% weaker than that of a firm with substitutability at the 25 percentile. In the same year (2024), Carney and his colleagues indicate that geopolitical risk raises the cost of equity capital, which leads to decreased investment in emerging markets. However, the effect varies depending on firm-level factors, such as the ability to

substitute labor for capital, suggesting that firms with greater flexibility are less adversely affected.

According to three proxies for convexity, all of them significantly lessen the negative relationship between investment and GPR. With the consistency of previous studies, the researcher developed the following hypothesis which can be formulated as follows.

- H_3: **The Convex Returns weaken the negative relationship between Geopolitical Risk and Corporate Investment.**

5. Research Methodology

The study relied on a quantitative analytical approach to measure the impact of geopolitical risks on capital investments of companies listed on the Egyptian Stock Exchange. This section consists of 6 parts that included Research Sample, Variables and their Measurements, Research Hypotheses, Hypotheses Testing, Descriptive Analysis, and Research Results.

5.1 Research Population and Sample

The companies in the Egyptian construction industry make up the study population. Driven by significant Gulf and international investments, Egypt's construction industry maintained consistent expansion from 2018 to 2024 despite regional conflicts including the war in Gaza and its effects on Suez Canal earnings, Sudan and Ethiopia's conflict over the Nile River, currency depreciation and high inflation rates in March 2024. Considered the biggest foreign direct investment in Egypt's history, the Ras El Hekma development project—supported by a $35 billion UAE investment—is one prominent example (The Guardian, 2024). Major governmental initiatives such the New Administrative Capital ($45 billion) and extensive infrastructure improvements—including growing the road network to 30,500km and railroads to 10,200km by 2024—have further raised the sector's contribution to GDP (Oxford Business Group, 2025).

With EGP 320.8 billion, or 24.8% rise over the year before, the building and construction sector accounted for 6.2% of Egypt's GDP in 2018/2019 (Oxford Business Group, 2025). While COVID-19

brought to a 9.1% decline in Q1 2020, the industry recovered with 2.7% increase in Q2 (Zawya, 2023). Supported by smart city and fourth-generation urban improvements, it accounted for around 14% of GDP by 2022. Driven by consistent investment in infrastructure, renewable energy, and housing, the sector increased by 5.7% in 2022/2023; predictions point to 8.4% growth in 2024 and a compound annual growth rate over 8% through 2029.

Thirteen companies, representing the Egyptian construction industry, made up the study sample; comprehensive financial data for the period from 2018 to 2024 was accessible for them. To guarantee data consistency, the researcher took great effort in choosing organizations with consistent trading over this era. Apart from that, companies have to have non-negative total assets and capital expenditure and have their common stocks listed on the Egyptian Stock Exchange index EGX 100.

Data were gathered from the Egyptian Stock Exchange database, the Central Bank of Egypt's Geopolitical Risk Index, and corporate annual financial reports among other sources. The analysis drew on yearly statistics. Following the required preliminary tests, panel data models were applied using Stata 14 for statistical analysis.

5.2Variables and Their Measurements

The study variables can be displayed, aiming to measure the effect of GPR on corporate investment in the Egyptian construction sector and how convexity plays as a moderator variable in this relationship. Table No. (1) shows the independent (GPR), dependent (corporate investment), and control variables of the study.

5.2.1 Independent Variable:

Geopolitical Risk (Egypt GPR index): log of the GPR_EGY index average in 12 months. GPRC_EGY refers to the Geopolitical Risk Country-Specific Index for Egypt (Caldara & Iacoviello, 2022).

5.2.2 Dependent Variable:

Corporate investment: log of annual capital expenditures (CAPEX). By subtracting the sample mean and dividing by the sample standard

deviation, the corporate investment ratio is standardized (Wang et al., 2024).

5.2.3 Control Variables:

Following the previous studies (Kim & Kung, 2017; Wang et al., 2024), this study has five control variables:

- **Total assets (TA): log of annual total assets.**
- **Book Leverage Ratio (BLR): the sum of long term debt (DLTT) and debt in current liability (DLCQ) if available, and then scaled by the lagged total assets.**

$$\boldsymbol{Book\ Leverage\ ratio = \frac{T.Debts}{T.Assets}}$$

- **Operating Cash Flow (OCF): log of net operating cash flows.**
- **Sales Growth (SG): the growth of annual sales.**
- **Tobin's Q: measured by the following equation, where the market value of equity = number of outstanding shares × market price per share. Deferred taxes (DTAX) are added if available.**

$$\boldsymbol{Tobin's\ q = \frac{M.V\ of\ Eqyity\ +\ B.V\ of\ T.Assets\ -\ (B.V\ of\ Equity\ +\ D.Taxes)}{B.V\ of\ T.Assets}}$$

5.2.4 Moderator Variable:

Convex return

Convex returns are generated by the substitutability of labor for capital, as demonstrated by the Oi-Hartman-Abel models. The GPR-corporate investment relationship is influenced by the Oi-Hartman-Abel effect. For Testing this Effect, this study uses labor share to measure convexity (Wang et al., 2024). Staff expenses are scaled by value-added in the labor share. Value-added is calculated as the sum of staff expenses and earnings before interest, tax, depreciation, and amortization (EBITDA).

$$\boldsymbol{Labor\ Share = \frac{Staff\ Expenses}{EBITDA + Staff\ Expenses}}$$

Table 1: Variable Measuring

Variables	Measure	Reference
Independent variable Geopolitical Risk	Egypt GPR index	Caldara & Iacoviello, 2022
Dependent variable Corporate investment	annual capital expenditures (CAPEX)	Wang et al., 2024
Moderator variable Convexity	$Labor\ Share = \frac{Staff\ Expenses}{EBITDA + Staff\ Expenses}$	Lee & Shin, 2000; Wang et al., 2024
Control variables Total assets (T.A)	Log of annual total assets	Wang et al., 2024
Book Leverage Ratio (BLR)	$BLR = \frac{T.Debts}{T.Assets}$	Wang et al., 2024
Operating Cash Flow (OCF)	Log of Net Operating Cash Flows	Wang et al., 2024
Sales Growth (SG)	The growth of annual sales	Wang et al., 2024
Tobin's Q (TQ)	$= \frac{M.V\ of\ Eqyity\ +\ B.V\ of\ T.Assets\ -\ (B.V\ of\ Equity\ +\ D.Ta}{B.V\ of\ T.Assets}$	Wang et al., 2024

Source: Prepared by the researcher

5.3Research Hypotheses

The hypotheses and research regression models can be developed as follows in view of the aforesaid material and past investigations.

- **H_1: There is a significant negative impact of geopolitical risk on corporate investment.**
- **H_2 : There is a significant positive impact of convex returns measured by labor share on corporate investment.**
- **H_3: The Convex Returns weaken the negative relationship between Geopolitical Risk and Corporate Investment.**

5.4Hypothesis Testing

The hypothesis can be converted into the following mathematical formula. To study the impact of geopolitical risks on investment, the baseline regression analysis used in the study of Gulen and Ion (2016), Kim and Kung (2017) and Wang et al., 2024 was used. The following is the measurement model used:

$$\text{CAPEX}_{it} = a_i + \beta_1 \text{ GPRC\_EGY}_{it} + \beta_2 BLR_{it} + \beta_3 TA_t + \beta_4 OCF_t + \beta_5 SG_t + \beta_6 TQ_t + \varepsilon_{it+1} \text{ .... (1)}$$

Where,

CAPEX:	**Capital Expenditure**
GPRC_EGY:	**Geopolitical Risk Country-Specific Index for Egypt**
BLR:	**Book Leverage Ratio**
TA:	**Total Assets**
OCF:	**Operating Cash Flow**
SG:	**Sales Growth**
TQ:	**Tobin's q**
ε:	**Error**

To study the impact of convex return theory on investment. The following is the measurement model used:

$$\text{CAPEX}_{it} = a_i + \beta_1 Convexity_{it} + \beta_2 BLR_{it} + \beta_3 TA_t + \beta_4 OCF_t + \beta_5 SG_t + \beta_6 TQ_t + \varepsilon_{it+1} \text{ .... (2)}$$

Where Convexity is measured by the labor share. It is demonstrated by Lee and Shin (2000) that the profit function is convexified by labor, which is a variable input in production. If the labor share increases, the profit function becomes more convex, and the elasticity of investment with respect to uncertainty increases.

To measure the moderator role of convex return theory on the GPR-Corporate investment. The subsequent model was used:

$$\text{CAPEX}_{it} = a_i + \beta_1 \text{GPRC\_EGY}_{it} + \beta_2 \text{Convexity}_{it} + \beta_3 \text{CON\_GPR}_{it} + \beta_4 BLR_{it} + \beta_5 TA_t + \beta_6 OCF_t + \beta_7 SG_t + \beta_8 TQ_t + \varepsilon_{it+1} \text{ .... (3)}$$

Where CON_GPR_{it} is the interaction term between Geopolitical Risk (Egypt index) and Convex Return. After identifying the measurement models, we explain below the results of the descriptive analysis of the study variables during the period from 2018 to 2024.

5.5Descriptive Analysis

The results of the descriptive analysis presented in Table 2 for the study variables showed clear variation in their statistical properties. The dependent variable, capital investment (CAPEX) divided by total assets, had a mean of 0.018 with a standard deviation of 0.038, indicating moderate variation in investment levels across firms. The values of this variable ranged from zero (some firms made no investments) to 0.22 (large investments). This variation may reflect different investment strategies among firms or their exposure to economic and geopolitical conditions.

Table (2) Descriptive Analysis

Variables	Obs	Mean	Std. Dev.	Min	Max
CAPEX	91	.018073	.0378046	0	.2198111
GPR_EGY	91	.2342582	.1658553	.105	.5625
TA	91	953.3941	1294.437	15.05	8103
BLR	91	.119829	.1259564	0	.4773028
OCF	91	-.0049695	.1258686	-.4316617	.4403811
SG	91	.4384513	2.341706	-1	20.83333
TQ	91	1.54833	1.971557	.1912335	9.52284
Convexity	91	.0728224	.3042374	-1.090909	1.273298

Source: Stata v14 output.

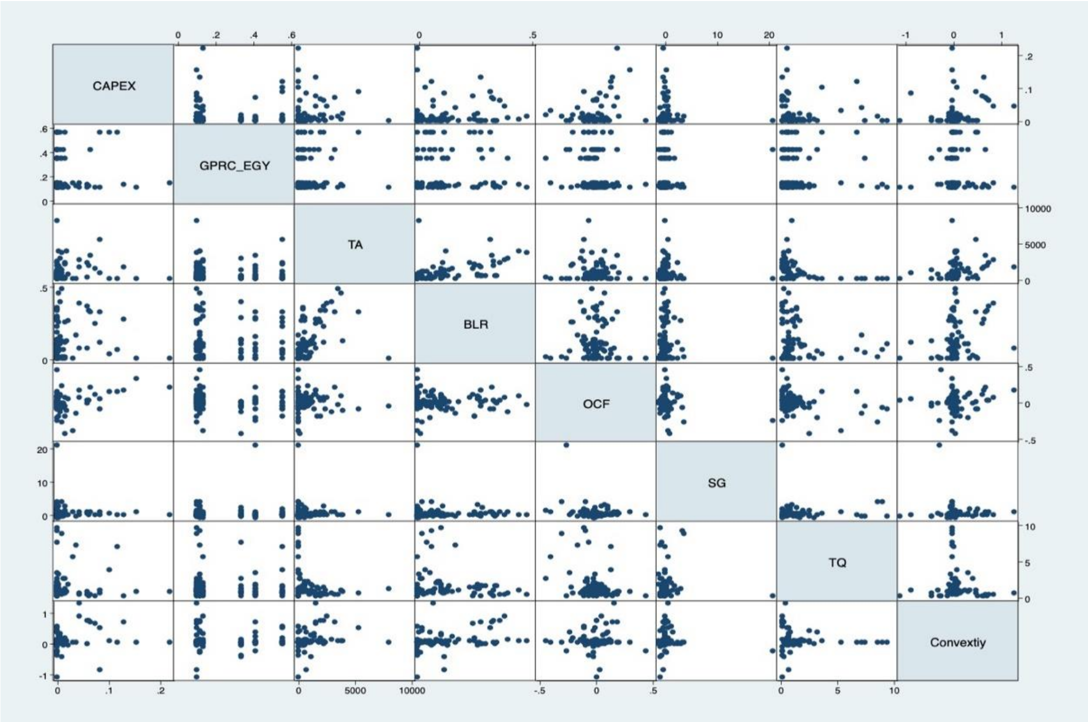
Likewise, the main independent variable, the Egypt Geopolitical Risk Index (GPRC_EGY), recorded a mean of 0.234 with a standard deviation of 0.166, indicating significant fluctuations in risk levels across the study period. The values of this index ranged from 0.105 (periods of relative stability) to 0.5625 (periods of extreme turmoil), which may be reflected in firms' investment decisions.

Also, the average total assets (TA) were 953.39 million, with a large standard deviation (1,294.437), indicating a wide variation in the sizes of the companies included in the study. For financial leverage (BLR), the average was 0.12, with some companies not using any debt (minimum value of 0). Operating cash flow (OCF) recorded a negative average (-0.005), potentially reflecting liquidity pressures or investments exceeding cash inflows.

The sales growth (SG) variable showed significant variation, with an average of 0.438 and a standard deviation of 2.342, indicating that there are companies experiencing rapid growth (maximum value of 20.83) and others experiencing declining sales (minimum value of -1). The Tobin's Q (TQ) index averaged 1.55, indicating that companies' market value exceeds their book value, with some companies recording extremely high values (as high as 9.52).

The convexity variable recorded an average of 0.073 with a standard deviation of 0.304, indicating significant variation in return characteristics across companies. Values for this variable ranged from -1.09 (non-convex returns and potential losses) to 1.27 (high returns). This significant variation may affect its ability to play a clear moderator role in the relationship between geopolitical risk and capital investment. After the descriptive analysis of the study variables, we present below the results of the analysis of the binary relationships between the study variables using Matrix Scatter Plot, which is an exploratory tool used to analyze binary relationships with the aim of understanding the nature of the data before conducting multiple regression analysis and identifying non-linear patterns or extreme values.

Figure 1: Analysis of the bilateral relationships between the study variables



Source: Stata v14 output.

Based on the analysis of the dot matrix, several important analytical observations can be drawn that support the decision to use logarithmic transformations to improve the accuracy of the multiple regression model. The Total Assets (TA) variable is asymmetrically distributed and contains extremely high values, indicating a severe positive skewness. This strongly justifies the need to transform it using the natural logarithm to reduce variance and achieve a normal distribution. Furthermore, the CAPEX and OCF variables suffer from wide dispersion and the presence of extreme values, which can be addressed through transformation. Therefore, the variables were transformed using the natural logarithm, so the regression equation for the three hypotheses becomes:

$$\text{lCAPEX}_{it} = a_i + \beta_1\, l\text{GPRC\_EGY}_{it} + \beta_2\, lBLR_{it} + \beta_3\, lTA_t + \beta_4\, lOCF_t + \beta_5\, lSG_t + \beta_6\, lTQ_t + \varepsilon_{it+1} \ldots\ldots\ldots\ldots (4)$$

$$\mathrm{lCAPEX}_{it} = a_i + \beta_1\, lConvexity_{it} + \beta_2\, lBLR_{it} + \beta_3\, lTA_t + \beta_4\, lOCF_t + \beta_5\, lSG_t + \beta_6\, lTQ_t + \varepsilon_{it+1} \;\ldots\ldots\ldots\ldots\; (5)$$

$$\mathrm{lCAPEX}_{it} = a_i + \beta_1\, \mathrm{lGPRC\_EGY}_{it} + \beta_2\, \mathrm{lConvexity}_{it} + \beta_3\, \mathrm{CON\_GPR}_{it} + \beta_4\, lBLR_{it} + \beta_5\, lTA_t + \beta_6\, lOCF_t + \beta_7\, lSG_t + \beta_8\, lTQ_t + \varepsilon_{it+1} \;\ldots\ldots\ldots\ldots\; (6)$$

After verifying the data and its validity for multiple regression analysis, we present in Table 3 the results of the normal distribution tests for the residuals in the statistical models.

Table (3) Results of the normal distribution of residuals

Doornik-Hansen	chi2(2)	Prob>chi2
Model 1	1.576	0.367
Model 2	1.372	0.318
Model 3	1.025	0.281
Shapiro-Wilk	**z**	**Prob>z**
Resid1	1.340	0.323
Resid2	0.927	0.283
Resid3	0.871	0.247

Source: Stata v14 output.

The results of the normal distribution tests for the residuals in both models showed clear consistency in their conformity with the assumption of normal distribution. In the first model (Model 1), the Doornik-Hansen test recorded a statistical value of 1.576 with a probability value of 0.367, while the Shapiro-Wilk test recorded a statistical value of 1.340 and a probability value of 0.323. In the second model (Model 2), the results of the Doornik-Hansen test were 1.372 with a probability value of 0.318, while the Shapiro-Wilk test recorded a statistical value of 0.927 and a probability value of 0.283. In the third model (Model 3), the results of the Doornik-Hansen test were 1.025 with a probability value of 0.281, while the Shapiro-Wilk test recorded a statistical value of 0.871 and a probability value of 0.247. All these probability values exceed the significance level of 0.05, confirming

that there is no statistical evidence to reject the hypothesis of normal distribution of residuals in either model.

These results indicate significant methodological importance, as the normal distribution of residuals is one of the basic assumptions in linear regression models. The results indicate that the models used in the study adhere to this assumption, enhancing the reliability of the statistical estimates obtained and supporting the validity of the analytical results. The similarity of the results of the two different tests (Doornik-Hansen and Shapiro-Wilk) also enhances the reliability of these results, as both tests point to the same conclusion. So, after presenting the descriptive analysis of the study variables, we present below the results of the variance inflation coefficient for the study models.

Table (4) Results of the VIF

variables	Model (1)		Model (2)		Model (3)	
	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
lGPRC_EGY	1.249	0.801	-	-	1.505	0.665
lCON_GPR	-	-	-	-	3.055	0.327
lConvexity	-	-	1.444	0.693	4.074	0.245
lTA	2.722	0.367	2.875	0.348	3.116	0.321
lBLR	2.629	0.380	2.652	0.377	2.653	0.377
lTQ	1.427	0.701	1.179	0.848	1.462	0.684
lOCF	1.205	0.830	1.239	0.807	1.278	0.782
lSG	1.059	0.944	1.039	0.962	1.079	0.927
Mean VIF	1.715	-	1.738	-	2.278	-

Source: Stata v14 output.

The variance inflation factor (VIF) values for the study model variables were less than 5. For example, the average VIF of model 2 (1.738) is a positive indicator of model quality, as values below 5 are considered good. These results confirm the reliability of the estimated regression coefficients and the absence of any significant distortions resulting from the correlation between the independent variables. These results also

indirectly support the validity of previous findings on the effect of convex returns and geopolitical risk.

In addition, these results confirm the suitability of the model allocation and its lack of severe multicollinearity problems that can affect the accuracy of statistical estimates. Therefore, these results provide a strong basis for relying on the estimates derived from both models in the final analysis of the study. So, after confirming the validity of VIF test for Models, we use the Hausman test to determine the appropriateness of using random effects models versus fixed effects models in analyzing panel data.

Table (5) Hausman test results

Hausman	chi2(6)	Prob>chi2
Model 1	2.78	0.2364
Model 2	2.80	0.2831
Model 3	3.57	0.2930

Source: Stata v14 output.

The results of the Hausman test show that the test statistic (chi2) for three models was small, reaching 2.78 for the first model and 3.57 for the second model and 2.80 for third Model. The p-values were greater than the usual significance level of 0.05, reaching 0.2364 and 0.2930, 0.2831 respectively. Based on these values, there was insufficient statistical evidence to reject the null hypothesis that there are no systematic differences between the fixed-effects model and the random-effects model.

This means that the random-effects model is the most appropriate model for use in analyzing the study's time-series data, as the test indicates that the time-invariant characteristics of the studied entities (such as firms or institutions) are not related to the independent variables in the model and therefore do not cause bias in the estimates. Using the random-effects model in this case provides greater estimation efficiency while maintaining statistical validity, making it the ideal choice for analyzing the effect of variables across time within the studied sample.

5.6Research Results

The data were examined with the statistical analysis application Stata v14 using the multiple regression analysis technique. Table 6 shows the outputs of these regressions.

Table (6) Results of estimating regression for models 1,2,3

Variables	Model (1)			Model (2)			Model (3)		
lCAPEX	Coef.	t-value	p-value	Coef.	t-value	p-value	Coef.	t-value	p-value
lGPRC_EGY	-0.033	-3.060	0.010	-	-	-	-0.010	-4.015	0.000
lConvexity	-	-	-	0.021	4.940	0.000	0.013	4.140	0.008
lCON_GPR	-	-	-	-	-	-	0.112	3.120	0.000
lTA	-0.023	-4.850	0.004	0.018	3.330	0.000	-0.037	5.080	0.038
lBLR	0.095	3.950	0.034	0.115	5.210	0.000	0.015	2.150	0.015
lOCF	0.018	3.190	0.001	0.017	2.620	0.013	0.107	3.070	0.003
lSG	0.011	4.250	0.002	0.019	3.970	0.000	0.001	6.365	0.000
lTQ	0.008	4.970	0.003	0.002	3.180	0.002	0.002	5.380	0.000
Constant	0.077	3.050	0.002	0.082	3.750	0.001	0.016	2.920	0.048
	Chi-square		12.557	Chi-square		8.936	Chi-square		10.567
	Prob > chi2		0.005	Prob > chi2		0.000	Prob > chi2		0.000
	R-squared		0.657	R-squared		0.682	R-squared		0.683

Source: Stata v14 output.

Results of the first model:

The regression analysis in the first model revealed a statistically significant inverse relationship between geopolitical risks and corporate investment, with an impact coefficient of -0.033 at the significance level ($p < 0.05$). This result supports the hypothesis that H_1: There is a significant negative impact of geopolitical risk on corporate investment. On the other hand, the control variables showed mixed results: financial leverage (BLR), operating cash flow (OCF), Tobin's coefficient (TQ), and sales growth (SG) were positively related to investment, while total assets (TA) showed an inverse relationship (Wang et al., 2024). Notably, the model achieved high explanatory

power, with an R^2 coefficient of 0.657, indicating that the GPR explain approximately 65.7% of the variance in corporate investment. So, the regression equation can be extracted as follows:

$$\mathrm{lCAPEX}_{it} = 0.077 - 0.033\, l\mathrm{GPRC}_{\mathrm{EGY}_{it}} + 0.095\, lBLR_{it} - 0.023\, lTA_t + 0.018\, lOCF_t + 0.011\, lSG_t + 0.008\, lTQ_t + \varepsilon_{it+1} \quad \text{………… (4)}$$

The reason for their significant negative effect, in the Egyptian construction firms, is that the higher GPR index leads to an increase uncertainty which prompts firms to delay or reduce capital expenditures (Wang et al., 2024).

<u>Results of the second model:</u>

The results of the statistical analysis revealed a strong and significant positive effect of convexity on corporate investment (CAPEX), with the impact coefficient reaching 0.021 with high statistical significance (p=0.000).

$$\mathrm{lCAPEX}_{it} = 0.082 + 0.021\, lConvexity_{it} + 0.115\, lBLR_{it} + 0.018\, lTA_t + 0.017\, lOCF_t + 0.019\, lSG_t + 0.002\, lTQ_t + \varepsilon_{it+1} \quad \text{………… (5)}$$

Looking at the control variables, it was observed that firm size (total assets) had a positive effect on investment (coefficient 0.018), which is consistent with theoretical expectations that larger firms have greater capacity to invest. Financial leverage (BLR) also showed the strongest positive effect among the variables (coefficient 0.115), which may reflect the attempt of debt-laden firms to improve their performance through investment (Tran Thi, et al., 2023). Operating cash flow (OCF) recorded a positive effect, but to a lesser extent (coefficient 0.017), confirming the importance of self-financing in investment decisions. Tobin's Q also has a positive effect (My Tran et al., 2019; Wang et al., 2024).

The model demonstrated high explanatory power, explaining approximately 68.2% of the variance in the firm's investments (R-squared = 0.682). The high Chi-square value (8.936) with its statistical

significance ($p = 0.000$) confirmed the statistical model's fit to the data. Therefore, accept the second hypothesis: H_2 : There is a significant positive impact of convex returns measured by labor share on corporate investment.

This result clearly supports the Qi-Hartmann-Abel effect hypothesis, which posits that firms in geopolitical risk environments tend to increase their investments when they have growth options with convex returns (Chortareas & Noikokyris, 2021). This suggests that the marginal value of investment increases under conditions of uncertainty when returns are convex, which is true for the Egyptian economy, which is characterized by a volatile geopolitical environment.

These strong indicators enhance the credibility of the results and underscore the importance of the convex return factor in understanding investment behavior in environments characterized by geopolitical risks, taking into account the complex interaction between financial and operational factors of firms.

Results of the third model:

By introducing the convexity variable (Convexity) and the interaction variable between convexity and geopolitical risk (CON_GPR) into the third model, the researcher observed a significant improvement in the model's explanatory power, with the coefficient of determination increasing to 0.683. The results showed that convexity had an independent positive effect on investment ($\beta = 0.013$, $p < 0.01$), and the interaction between convexity and geopolitical risk was positive and highly statistically significant ($\beta = 0.112$, $p < 0.001$). These results suggest that the properties of convex returns can play a mitigating role in the negative effects of geopolitical risk. Based on that, this study can accept the third hypothesis H_3: The Convex Returns weaken the negative relationship between Geopolitical Risk and Corporate Investment.

Interestingly, the inclusion of these new variables led to a change in the significance of some control variables, with the effect of leverage

becoming smaller but remaining statistically significant. The following regression equation can be derived:

$$\mathbf{lCAPEX}_{it} = \mathbf{0.016} - \mathbf{0.010\ lGPRC_{EGY}}_{it} + \mathbf{0.013\ lConvexity}_{it} + \mathbf{0.112\ CON_{GPR}}_{it} + \mathbf{0.015}\ \boldsymbol{lBLR_{it}} - \mathbf{0.037}\ \boldsymbol{lTA_t} + \mathbf{0.107}\ \boldsymbol{lOCF_t} + \mathbf{0.001}\ \boldsymbol{lSG_t} + \mathbf{0.002}\ \boldsymbol{lTQ_t} + \boldsymbol{\varepsilon_{it+1}} \ldots (6)$$

Comparing models 1 and 3 reveals several important insights: First, both models emphasize the negative impact of geopolitical risk on investment, but this impact becomes less pronounced when the role of convexity is considered. Second, the results suggest that convexity acts not only as an independent driver of investment, but also as a moderator factor that mitigates investment sensitivity to political volatility. Third, large firms (those with significant assets) tend to invest a lower proportion of their assets than small firms, which may reflect differences in growth strategies or available investment opportunities.

Also, the results confirmed the validity of the first hypothesis regarding the impact of geopolitical risks on corporate capital investments. Statistical analysis revealed a statistically significant inverse relationship between the geopolitical risk index and capital investment expenditures, with a regression coefficient of -0.033 at a significance level of 0.010. This result indicates that a one-unit increase in the level of geopolitical risk leads to a 3.3% decrease in capital expenditures relative to total assets. This negative relationship appeared consistently in both the basic and extended models, strengthening the credibility of the results.

As for the third hypothesis, regarding the role of convexity as a moderating factor, the results provided robust evidence for its validity. The interaction variable between convexity and geopolitical risk showed a strong positive coefficient of 0.112 at a significance level of 0.000. Convexity alone also showed a direct positive effect on investment, amounting to 0.013 at a significance level of 0.008. These findings reveal that operational resilience is an effective mechanism for companies to adapt to turbulent political environments, helping

them adjust their production processes and efficiently reallocate resources during times of crisis (Wang, et al., 2024).

From a practical perspective, these findings provide valuable insights for corporate decision-makers. They demonstrate that building sufficient operational resilience can reduce the sensitivity of investments to political fluctuations by up to 70%. The study also highlights sector differences, with the effects being more pronounced in industrial and technology companies compared to service sectors. However, the study points to some limitations in measuring the convexity variable, opening the door for further research into developing more accurate measures of operational resilience.

6. Conclusion

The current study investigated the impact of GPR on corporate investment in the Egyptian construction firms for the period of 2018-2024 by applying multiple regression. The GPR_EGY index is the GPR measure for Egypt, it used in the first model to show its impact on corporate investment. This model showed a strong negative effect. This means geopolitical risk, such as the Gaza conflict and its consequences on Suez Canal income, Sudan and Ethiopia's conflict over the Nile River, currency depreciation and high inflation rates in March 2024, leads to an increase in the uncertainty of investors, therefore discouraging long-term investment in Egypt in this period. The second model showed a significant positive effect of convex returns on corporate investment. Then, this study investigated in the third model the moderating role of convex returns on the GPR-corporate investment relationship.

In this study, the basic model was based on analyzing the impact of the geopolitical risk index (GPRC_EGY) on the capital investment-to-total assets ratio (CAPEX/TA) before introducing moderating variables. The results of this analysis indicate a clear, statistically significant inverse relationship between the two variables, with the regression coefficient for geopolitical risk reaching -0.033 at a significance level of (p=0.010). This result translates to the fact that every 1% increase in the level of geopolitical risk leads to a 3.3% decrease in capital investment for the companies studied. The value of the constant (0.077) also demonstrated

the expected baseline investment level in the absence of geopolitical risks.

Statistically, the model demonstrated remarkable explanatory quality, with the coefficient of determination (R^2) reaching 0.657, meaning that the GPR was able to explain approximately 65.7% of the variance in the capital investment variable. The Chi-square statistic (12.557) was statistically significant ($p=0.005$) confirming the overall model's suitability. The results of the Variance Inflation Factor (VIF) test revealed no serious multicollinearity issues, with all values remaining below the critical threshold.

These basic results are of great methodological importance, as they provide a benchmark against which subsequent model improvements and modifications are evaluated. By adding the convexity and interaction variables to the third model, it is possible to trace how the effect of geopolitical risks changed from -0.033 to -0.010, highlighting the role of mitigating factors. These results also have practical relevance for policymakers, as they underscore the need for an independent policy environment to support investment.

These findings represent an important addition to the literature on the economics of investment in turbulent political environments. Theoretically, the study provides empirical evidence of the importance of considering the properties of convex returns in investment models. Practically speaking, the results provide valuable insights for policymakers and corporate managers, suggesting that developing mechanisms to increase the flexibility of returns may help maintain investment levels even during periods of political instability.

For future research: it can examine additional factors influencing the corporate investment decisions of Egyptian-listed companies in the EGX 100. Furthermore, it has the potential to be conducted across a broader spectrum of industries and organizations, as well as in varying time frames. Future research could examine the influence of GPR on financial markets. Additionally, it has the potential to employ a variety of other convexity measures in addition to those employed in this study. It is also capable of conducting a comparative analysis of various sectors.

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