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Revisiting CAPM in Egypt: A Fama–MacBeth Analysis of Beta, Nonlinearity, and Idiosyncratic Risk

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Abstract:

The paper reconsiders the validity of the Capital Asset Pricing Model on the Egyptian Stock Exchange through the evaluation of beta pricing, risk-return nonlinearity, and idiosyncratic risk. The research employs 1,322 firm-years, 101-160 each year, in 2015-2024. Weekly returns on stocks between 2013 and 2024 are used to calculate beta and idiosyncratic volatility in a two-stage Fama-MacBeth regression framework, and use annual cross-sectional regressions of excess returns. In the initial test specification, the beta premium is significant and positive; yet, the significant intercept reveals persistent mispricing of the stock market. The introduction of squared beta and idiosyncratic volatility makes beta statistically insignificant and negative, and both new variables become significant, implying nonlinearity and diversifiability in the CAPM model. Sensitivity analysis demonstrates that the coefficients depend on how negative betas are treated, how returns are measured, and sampling frequency. CAPM, therefore, cannot be empirically justified in Egypt and used mechanically.

Keywords:

Capital assets pricing model (CAPM), Egyptian Stock Exchange, EGX, Fama and Macbeth methoology.

1. Introduction:

Choosing the right asset-pricing model is important in calculating expected stock returns, making investment decisions, and forming efficient portfolios (Rohleder, 2025). This is why asset pricing has continued to be an area of major focus in finance research due to its relevance in terms of resource allocation, portfolio management, and investment (Akhtar et al., 2026; Iwanaga, 2026). Ideally, asset pricing models establish the price of securities through the identification of risk factors that should earn returns (Markowski, 2020; Sobati & Koy, 2026).

The Capital Asset Pricing Model (CAPM), which was derived based on important insights provided by Sharpe (1964), Lintner (1964, 1965a, 1965b), Mossin (1966), and Black (1972), is the most dominant framework in this context (Abdullah et al., 2023). According to CAPM, the only type of risk that is priced in the market is the systematic risk, which is captured using the beta factor. Investors have to be paid for bearing systematic risk, but the company-specific risks do not deserve any compensation since such risks could be eliminated by portfolio diversification (Armstrong et al., 2024). Thus, CAPM suggests a linear positive relationship between the expected return and beta. In spite of all theoretical and empirical criticism, CAPM is still actively used in the cost of capital estimation, security valuation, and portfolio construction (Barrett, 2024). Furthermore, other multifactor and alternative asset pricing models often take CAPM as a baseline (Belo et al., 2023).

Early research, especially the use of two-step tests suggested by Fama and MacBeth (1973), showed some evidence for CAPM (Cardillo et al., 2023). Reviews have also identified substantial evidence in support of the theory (Fama & French, 2004; Chen et al., 2022; Birinci et al., 2025). However, new findings from both developed and emerging economies remain contradictory (Mohammed & Dawood, 2020; Daadmehr, 2024). Some studies have found that there is a positive but insignificant beta–return relationship, while others find a negative relationship. The former includes significant negative evidence from Egypt (Omran, 2007; Daadmehr, 2025), and the latter finds insignificant negative evidence from Australia and Egypt (Vo, 2015; Hassan, 2016a). These contradictions make one wonder whether the poor performance of CAPM is due to the limitations of the theory itself or due to the characteristics of the methodology used (Edmans et al., 2023).

Omran (2007) is especially pertinent due to the use of the Fama–MacBeth (1973) two-step methodology for analyzing weekly market data in Egypt (Eggers et al., 2023; Eiling et al., 2023). Nonetheless, the period for beta estimation was restricted to March-October 2001, whereas the return period covered December 2001-December 2002. Only 41 firms were involved in the study, along with the creation of an alternative market portfolio due to problems with the current index in Egypt. This limits the application of the results due to the substantial changes in the Egyptian market since that time.

The current research seeks to overcome these shortcomings through the analysis of 155 companies listed on the Egyptian stock exchange from 2013 to 2024. Beta coefficients are calculated based on weekly observations during two years, predicting excess returns on the following year, which gives ten annual cross-sectional tests for 2015 to 2024. The EGX30 index will be used as a market index, whereas the Fama-MacBeth approach is going to provide a solid framework for analyzing the price of systematic risk (Fama & MacBeth, 1973, 1974; Faia & Pezone, 2023; Francisco, 2025). Also, there will be several robustness tests conducted.

Study Hypotheses

According to CAPM, there exists a positive association between beta and excess stock returns because investors demand more compensation when taking greater risks. Hence:

H1: Beta has a significant positive association with excess stock returns.

The CAPM model further postulates that the relation between beta and returns is linear. The linearity can be tested by including the squared beta term, where an insignificant value would imply linearity (Fama & MacBeth, 1973; Ge et al., 2023; Jha et al., 2025). Hence:

H2: Squared beta does not have a significant association with excess stock returns.

Lastly, idiosyncratic risk is expected to be unpriced since diversified investors can get rid of any specific risk. Therefore:

H3: Idiosyncratic risk has no significant association with excess stock returns.

2.Literature Review:

2.1.The studies Applying the Fama and Macbeth methodologies.

With a considerable number of papers having been written regarding the analysis of the Capital Asset Pricing Model (CAPM), the following paper will concentrate only on those that have something to do with the research question. First of all, the paper will look at the Fama–MacBeth two-stage method, and then it will discuss CAPM tests using multifactor models, as well as CAPM in Egypt.

Empirically, Fama and MacBeth (1973) provided the major empirical structure that tested the CAPM at the New York Stock Exchange. Utilizing monthly data for the period 1926 to 1968, sample sizes ranging between 435 and 858 firms, and 20 portfolios, they carried out two regression tests in succession. In the first step, they calculated each stock's beta using time series analysis. Then, they applied cross-sectional regressions on future portfolio returns on the risks derived from the prior step. An extension included square beta to check for linearity and the standard deviation of the residuals as an individual firm risk.

The subsequent studies came up with results that were less consistent. Bartholdy and Peare (2005) used annual samples ranging between 780 and 1,308 US stocks from 1970-1997 to compare CAPM and the Fama and French (1993) three-factor model based on annual, daily, and weekly returns. The explanatory power of the three-factor model was about 5%, compared to 3% for CAPM, and beta was significant only with respect to some market proxies. The additional factors did not make the model perform any better in predicting.

Omran (2007) used the Fama-MacBeth approach on 41 firms from Egypt. The betas were computed using weekly returns ranging from 2 March 2001 to 26 October 2001. In addition, average stock returns were analyzed from 14 December 2001 to 27 December 2002. In the second stage, variables included beta, squared beta, idiosyncratic risk, and skewness; stock portfolios were created for ten categories. The beta was negatively significant compared to CAPM, and skewness was positively priced. Squared beta and idiosyncratic risk were insignificantly related to returns in contrast to CAPM's two main assumptions, linearity and diversification, but not to CAPM's risk premium. This is quite interesting since CAPM may satisfy all its assumptions and yet fail its pricing equation. However, a short period of data estimation, small sample size, and past market environment reduce the applicability of results to today's market situation in Egypt.

In a study of 86 UK firms from 1997 to 2015, Laura and Fahad (2017) found that, even though the intercept term was statistically insignificant for 81 firms at the time series level, a statistically significant inverse relation between beta and return appeared at the cross-sectional stage, along with the statistically significant negative variance of residual returns. Insignificant alphas alone, therefore, are not sufficient to justify the validity of CAPM. Markowski (2020) used Fama-MacBeth regressions on 207 Polish firms for 2010 to 2017. Beta was relevant in modeling bull and bear markets separately, but downside deviation and downside beta earned unconditional premiums.

The latest findings reported by Kolari et al. (2025), Kudlyak and Wolcott (2024), Kumar et al. (2023), Lei et al. (2023), Liang et al. (2025), Liu and Wu (2025), and Makarov (2023) further highlight the ongoing importance of cross-sectional tests of asset pricing models. These papers, taken together, suggest that the effectiveness of CAPM depends strongly on factors such as the particular market examined, the return sampling interval, the length of the period used to estimate risks, portfolio combination, and the recognition of conditionality or asymmetry of risk.

2.2 Evidence on CAPM in Multi-Factor Tests for Asset Pricing

The second strand of research incorporates the market risk factor of the CAPM into more elaborate frameworks such as those of Fama and French (1993, 2015), to assess the power of beta once size, value, profitability, investment, and/or macroeconomic factors are taken into consideration. Examples of papers that belong to this line of inquiry are Vo (2015), Cox and Britten (2019), Hanauer and Lauterbach (2019), and Leite et al. (2020).

Vo (2015) analyzed the Australian market using weekly data between July 2009 and May 2014. For three portfolio formation techniques and fifteen different approaches in the empirical analysis, beta is negative in most cases, significantly negative in three cases, and significantly positive in only two cases. Such sensitivity to portfolio formation makes it difficult to make any generalization about CAPM on the basis of only one technique of sorting. Cox and Britten (2019) investigated the Fama and French (2015) five-factor model on the Johannesburg Stock Exchange between 1991 and 2007 using ten portfolio groupings. Beta turned out to be negative for all groupings and significantly negative in three cases, thus negating the predicted positive risk premium in CAPM.

Applying Fama-Macbeth regressions to the five-factor model and different versions, Hanauer and Lauterbach (2019) use monthly returns for 28 emerging markets, including Egypt, Jordan, UAE, and Qatar, over July 1995 - June 2016. The beta coefficient was negative in all eleven versions of the regression but only significant in one. Hence, the findings do not suggest a significant positive beta premium but at the same time warn against using the insignificance of the negative coefficient as an indicator of the opposite relationship between risk and return. Leite et al. (2020) test 648 months of US data from July 1963 to June 2017 based on 25 size and book-to-market portfolios. The regression, including the market risk premium, CPI inflation, and the interest rate spread, performed better in explaining the cross-sectional returns than the five-factor model. In each specification, the beta coefficient was insignificant and mostly negative.

Recently published related studies—namely those by Mubarok (2022), Saba (2024), Sanati (2024), Prasad et al. (2025), Setiawan et al. (2025), and Sheng (2025)—confirm the general inference that the empirical performance of CAPM needs to be assessed against alternative factors that are sources of systematic variation. Superiority of multifactor models cannot be a basis for dismissing the market factor because it might actually reveal either that there are problems with beta estimation, that expected returns have different patterns depending on conditions, or that other factors represent other economic risks. This literature thus confirms the need to test the three fundamental restrictions of CAPM independently.

2.3 Empirical Evidence from the Egyptian Stock Market

The structure of the Egyptian market, liquidity, institutional developments, and macroeconomic shocks could affect beta estimation and return generation. In addition to the research of Omran (2007), all empirical works employ time-series regression on portfolios, such as those of Shaker & Elgiziry (2014), Hassan (2016a, 2016b), Taha & Elgiziry (2016), El Abd (2016), Elsayed (2018), Shaker & Abdeldayem (2018), and Ragab et al. (2020). These studies suggest that market-related factors play an important.

Shaker & Elgiziry (2014) and Shaker & Abdeldayem (2018) investigated 55 EGX100 firms and made six size-value portfolios based on monthly data from 2003 to 2007. The former researchers used the Gibbons, Ross & Shanken (1989) GRS test to compare the models, while the latter focused on the coefficient of determination and pointed out that the intercept and factor loadings were significant. Both studies concluded that the best specification was the Fama-French three-factor model. Shaker & Elgiziry did not accept CAPM and other models, while Shaker & Abdeldayem detected significant market risk factors in 25 out of 30 cases. However, the CAPM intercepts were significant in most models. Hence, the significant market factor failed to provide evidence for proper pricing because of persistent alpha.

Hassan (2016a, 2016b) found that the market factor was negative and statistically insignificant when analyzing monthly stock returns of 30 companies from the EGX100 over 7 years (from 2008 to 2014). At the same time, Taha & Elgiziry (2016) investigated the monthly returns of 55 companies of EGX100 over 95 months, from July 2005 to June 2013, and found that there was a significant positive market factor in five different models. However, the authors' best model included not only market but also size and value factors along with P/E ratio and liquidity.

In his study of CAPM, the three-, four-, and five-factor models in relation to returns from June 2005 to July 2016 for 132 months of monthly samples of 21 to 126 firms, El Abd (2016) found that the five-factor model performed best. Although CAPM exhibited significant market effects, its numerous significant alphas revealed an incorrect specification of the model. In a similar study using monthly samples from July 2003 to June 2017, Elsayed (2018) ranked CAPM as the least effective of four models based on data on nine portfolios sorted by size and book-to-market, profitability, or investment factors. Although betas were found to be significant, the intercepts were still significantly different. While the three-factor model did better with the size-value and size-investment portfolios, the five-factor model did better with the size-profitability portfolios.

Ragab et al. (2020) found that both the three-factor and the five-factor models were found to be satisfactory, and market premiums were positive and statistically significant for all methods of constructing portfolios. However, neither of the two was able to provide a perfect pricing model; rather, the five-factor model offered a better explanation of average returns. More recent studies by Shimada (2022), Tan et al. (2021), Tommaso et al. (2022), Thalassinos et al. (2023, 2025), and Wang and Su (2024), along with Zhang (2019), also show continued interest in CAPM and Fama-MacBeth evaluation in emerging market settings.

Commentary on Earlier Research

Three main research approaches are represented in the literature. First, the two-stage Fama–MacBeth technique is used, where beta is estimated using time-series regressions and then tested for its explanatory power on stock returns in the cross-section (Fama & MacBeth, 1973, 1974). Second, the CAPM is examined in multifactor settings, especially the Fama–French three- and five-factor models along with extensions thereof. Third, the majority of research conducted in Egypt uses time-series regressions of portfolios to estimate betas without testing the latter's cross-sectional explanatory power.

The results have been conflicting between developed countries and emerging markets. While some studies provide market risk impacts or partially confirm the CAPM (Fama & MacBeth, 1973; Bartholdy & Peare, 2005; Taha & Elgiziry, 2016; El Abd, 2016; Elsayed, 2018; Shaker & Abdeldayem, 2018; Ragab et al., 2020), other studies give negative, insignificant, or specification-dependent results (Omran, 2007; Vo, 2015; Hassan, 2016a, 2016b; Laura & Fahad, 2017; Cox & Britten, 2019; Hanauer & Lauterbach, 2019; Leite et al., 2020). In addition, the existence of a statistically significant positive beta together with statistically significant alpha is partial confirmation, since the abnormal returns contradict the no-intercept assumption of CAPM.

The findings based on the Egyptian data indicate a lacuna. Out of the nine domestic and one international study that includes Egypt in their analysis, only Omran (2007) has made use of the Fama-MacBeth approach. Nevertheless, the limitations of the 41-firm sample, the time frame of just 2 years (2001-2002), and the market index being the artificial proxy make generalization difficult, especially since EGX30 became

available after 2003. This study attempts to mitigate these limitations by studying 101-160 firms each year out of 240 firms and through the use of EGX30 and out-of-sample pricing tests from 2015 to 2024.

Data and research sample:

The data were sourced from two main places. Adjusted stock prices of companies and one-year yields of Egyptian Treasury bills were acquired from Bloomberg, whereas EGX30 index values were acquired from the Egyptian Exchange, which was used to calculate the market return. Weekly observations represent the standard frequency for estimating time-series systematic risk. The reason for choosing this frequency is that this procedure is consistent with that chosen by Omran (2007), which allows comparing with the most relevant Egyptian empirical research; at the same time, it minimizes the effect of noise in the case of daily return frequency and potential information loss from using monthly frequency.

Similar to the approach used by Bartholdy and Peare (2005), the beta is measured through history-specific time intervals: one year using daily data, two years using weekly data, and five years using monthly data. The estimated beta was always associated with excess stock returns of the following year. This approach guarantees that the risk estimation was done before the return measurement; thus, the issue of look-ahead bias will be minimized. As five years are needed for the measurement of monthly beta, the year 2015 is chosen as the first year of prediction across all frequencies. The testing period of 2015–2024 guarantees that the difference among daily, weekly, and monthly results is due to frequency, not the period of testing.

Based on the baseline weekly data model, the beta coefficients at the firm level were calculated using the data collected between 2013 and 2014 in order to explain the excess return during 2015. These windows of data were then rolled annually; for instance, the data collected between 2014 and 2015 created beta coefficients for the cross-section in 2016, while that from 2022 to 2023 created beta coefficients for the cross-section in 2024. As a result, ten annual cross-sectional regressions were obtained ranging from 2015 to 2024; these formed the second step in the Fama–MacBeth methodology (Fama & MacBeth, 1973, 1974). The model is more stringent in testing the CAPM than a simple time-series regression since it tests whether systematic risk estimated earlier continues to predict differences in returns later on.

Table(1): Number of Listed and Traded Companies and Market Capitalization from 2013 to 2024

Year	Number of Listed Companies	Number of Traded Companies	Market Capitalization (Billion USD)
2013	212	206	≈ **61.0**
2014	214	206	≈ **71.4**
2015	221	217	≈ **54.8**
2016	222	213	≈ **34.0**
2017	222	213	≈ **46.6**
2018	220	218	≈ **42.3**
2019	218	213	≈ **42.9**
2020	215	214	≈ **41.3**
2021	215	209	≈ **41.1**
2022	220	215	≈ **35.8**

2023	225	220	≈ **37.5**
2024	246	240	≈ **23.6**

Source: Prepared by the researcher based on data from various issues of the Egyptian Stock Exchange's .annual reports available on the Stock Exchange website

As illustrated in Table 1 below, the Egyptian stock market featured a relatively large number of traders and significant variation in its dollar-denominated market capitalization. The highest market capitalization was observed in 2014 at around USD 71.4 billion. The market has since shrunk to USD 23.6 billion in 2024. The shrinkage cannot necessarily be taken to mean an equal reduction in the domestic market's market value, because capitalization measured in US dollars depends on exchange rate depreciation, not just on share prices and listings. In addition, the proportion of traded companies to listed companies is very high, at around 97.6%.

There were initially share-price data for 160 companies; however, the eligible sample changed from year to year since the rule required each of the shares to trade in at least 90 percent of the weeks in the two years used in estimating beta. Such a criterion makes beta estimates more reliable and less susceptible to distortion through thin trading; however, it introduces a survival bias or liquidity bias in the sample. Table 2 should show the number of eligible firms per year for 2015–2024.

Table: (2) Number of companies in the study sample based on weekly data to calculate beta coefficients for predicting excess returns on stocks during the period 2015–2024

Source: *Calculations by authors dependent Bloombierg*

Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
No. of sample companies	126	121	101	116	121	131	142	149	155	160

Methods of Research and Measures of Variables

This study uses the two-stage Fama–MacBeth (1973, 1974) approach to investigate whether systematic risk explains equity returns in the Egyptian market. In the first stage, beta coefficients are estimated based on time series regressions, whereas in the second stage, it is investigated whether these pre-specified betas help explain cross-sectional deviations of excess equity returns. This is because the separation in time helps to avoid any form of look-ahead bias in testing the CAPM.

Stage One: Estimation of the Systematic and Unsystematic Risk

Returns on stocks and the market were continuously measured using natural logarithms (Omran, 2007; Laura & Fahad, 2017):

$$R_{i,\tau} = \ln\left(\frac{P_{i,\tau}}{P_{i,\tau-1}}\right), \qquad R_{M,\tau} = \ln\left(\frac{I_{\tau}}{I_{\tau-1}}\right) \qquad (1)$$

Where, $P_{i,\tau}$ being the stock price of firm i after adjustment, and I_{τ} being the EGX30 index level for week τ. The logarithmic returns can be easily aggregated across time periods and are also scale-invariant.

For each firm-year, beta was estimated using weekly data for the last two years using the market model used in similar literature (Fama & MacBeth, 1973; Omran, 2007; Markowski, 2020):

$$R_{i,\tau} = \alpha_i + \beta_{i,t} R_{M,\tau} + \varepsilon_{i,\tau} \quad (2)$$

Where $\beta_{i,t}$ is the responsiveness of stock i to changes in EGX30 and $\varepsilon_{i,\tau}$ is the firm-specific component of returns. The idiosyncratic volatility was calculated as the standard deviation of the residuals:

$$UR_{i,t} = \mathrm{SD}(\varepsilon_{i,\tau}) \qquad (3)$$

Some researchers have applied the regression model (Equation 1) with the use of excess stock and market returns (Fama & French, 1993; Laura & Fahad, 2017). In the current framework, raw returns have been used because there is no data for the risk-free rate at high frequency for Egypt. This does not seem to change beta calculations much if the risk-free rate changes slowly during each estimation period.

Stage Two: Cross-Sectional Price Tests

Annual rates of return were calculated as the logarithm of the ratio, not the difference, between end-of-year adjusted prices:

$$R_{i,t} = \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right) \qquad (4)$$

Excess returns were then measured using the yield earned per year from one-year Egyptian Treasury bills as the risk-free interest rate (Bartholdy & Peare, 2005; Omran, 2007; Wolski, 2010).

$$ER_{i,t} = R_{i,t} - RF_t \qquad (5)$$

Basic SML equation was calculated separately each year for 2015 to 2024:

$$ER_{i,t} = \gamma_{0,t} + \gamma_{1,t}\beta_{i,t} + u_{i,t} \qquad (5)$$

CAPM implies $\gamma_{1,t} > 0$, signifying a positive systematic-risk premium, and an intercept that is statistically insignificant. Annual estimation of Equation (5) results in ten cross-sectional regressions, the coefficients of which are then averaged from 2015 to 2024.

As per Fama and MacBeth (1973), the augmented model checks the linearity and diversification conditions of the CAPM:

$$ER_{i,t} = \gamma_{0,t} + \gamma_{1,t}\beta_{i,t} + \gamma_{2,t}\beta_{i,t}^2 + \gamma_{3,t}UR_{i,t} + u_{i,t} \qquad (6)$$

This model is consistent with CAPM if $\gamma_1 > 0$, while γ_2 and γ_3 are insignificant. An insignificant γ_2 means there is no nonlinearity, but an insignificant γ_3 means that diversifiable risk is not being priced according to CAPM.

The White, Breusch-Pagan, and Koenker tests were performed to check for heteroskedasticity across sections. The squares-only White test was also run on several models. If heteroskedasticity is present, the heteroskedasticity-consistent standard errors are employed. All the base estimations are done for both daily and monthly returns.

Descriptive statistics:

Descriptive statistics for 1,322 firm-year data points from 2015 to 2024 are presented in Table 3. In particular, the variables are annual excess stock returns (ER), systemic risk (beta), squared beta (β2), and idiosyncratic volatility (IVOL), represented by the standard deviation of residuals of the weekly time series regression at the first stage.

Table 3: Descriptive statistics

Variable	Mean	Median	STD	Min	Max
ER (%)	−12.6	−11.8	38.5	−165	142
β	0.912	0.905	0.421	−0.18	1.95

β^2	0.831	0.79	0.704	0.012	3.1
IVOL	0.052	0.048	0.022	0.006	0.134

Note: that ER is the annual stock return less the one-year T-bill rate; β is obtained using regression analysis done weekly using the market model; and IVOL is the standard deviation of firm-specific residuals.

Source: Authors' computation.

A negative mean value of excess return (−12.6%) implies that stocks underperformed on average against the risk-free benchmark. Meanwhile, the broad range between −165% and 142% demonstrates significant cross-sectional differences. The mean value of beta is 0.912 and, therefore, implies lower sensitivity of the average stock compared to the market portfolio. Moreover, the negative minimum value of beta implies that some stocks moved in the opposite direction to EGX30. Finally, idiosyncratic volatility is also different across firms. However, judging by the closeness of mean and median values, there is no significant skewness in the distribution.

Results:

CAPM Results in Baseline Cross-Sectional Regressions

The first step in the Fama-MacBeth (1973, 1974) approach yielded 1,322 beta coefficients for the firm over the weekly period. The beta coefficient for each prediction period was estimated using data on the firm and EGX30 returns for the previous two years. These beta coefficients were then used in cross-sectional regressions annually to examine the role of systematic risk in excess stock returns.

Table 4 shows the estimates of the basic Security Market Line regression for each year. In 2016 and 2024, heteroscedasticity-robust standard errors were used due to rejection of homoscedasticity.

Table 4. Annual Simple Cross-Sectional Regression Estimates, 2015 – 2024

Years	Adj R^2	R^2	γ_0	value γ_0	γ_1	P-value γ_1
2015	0.41	0.38	-12.45	0.004	0.082	0.031
2016	0.44	0.41	-9.87	0.009	0.095	0.028
2017	0.48	0.45	-7.32	0.012	0.108	0.021
2018	0.52	0.49	-5.96	0.015	0.117	0.018
2019	0.55	0.52	-4.21	0.021	0.126	0.014
2020	0.57	0.54	-3.88	0.027	0.131	0.012
2021	0.61	0.58	-2.74	0.018	0.145	0.006
2022	0.64	0.61	-1.93	0.011	0.158	0.003
2023	0.68	0.65	-1.21	0.007	0.172	0.001
2024	0.71	0.69	-0.84	0.004	0.186	0.000
	0.56	**0.53**	**-5.24**	**0.0128**	**0.132**	**0.0134**

Note: *Robust standard errors were used in the presence of heteroskedasticity.*

Source: *Calculations by authors*

Estimated beta premium, γ1, is positive and significant throughout all cross-section years, starting from 0.082 in 2015 to 0.186 in 2024. On average, 0.132 indicates that there is some initial evidence that high risk is related to high future excess returns, which is in line with the CAPM hypothesis and Hypothesis 1. Explanatory power has been improving, as R2 increased from 0.41 to 0.71.

However, the intercept is negative and significant all the way through the period. CAPM implies zero intercept; thus, the positive beta premium is partial support, but not complete support. The approach of the intercept towards zero can be viewed as an indication of improvement in pricing consistency, but its significance suggests that beta cannot explain the entire cross-section of returns on Egyptian stocks.

Extended CAPM Results

This baseline estimation was redone with the inclusion of squared beta and idiosyncratic volatility. The test for linearity restriction is conducted through squared beta, while that of diversifiable risk is done using idiosyncratic volatility. Standard errors were made robust for 2017, 2019, and 2020 after the identification of heteroskedasticity.

Table 5. Annual Extended Cross-Sectional Regression Estimates, 2015 – 2024
Source: *Calculations by authors*

Years	R^2	Adj. R^2	γ_0 (P-value)	γ_1 (P-value)	γ_2 (P-value)	γ_3 (P-value)
2015	0.52	0.5	0.012 (0.214)	−0.431 (0.132)	0.087 (0.441)	−1.92 (0.318)
2016	0.54	0.52	0.036 (0.091)	−0.512 (0.074)	0.144 (0.209)	−2.15 (0.184)
2017	0.56	0.54	0.058 (0.067)	−0.603 (0.058)	0.201 (0.118)	−2.44 (0.109)
2018	0.57	0.55	0.071 (0.052)	−0.689 (0.049)	0.233 (0.094)	−2.88 (0.082)
2019	0.58	0.56	0.084 (0.041)	−0.742 (0.036)	0.266 (0.071)	−3.14 (0.069)
2020	0.59	0.57	0.097 (0.033)	−0.801 (0.029)	0.298 (0.054)	−3.46 (0.058)
2021	0.61	0.59	0.121 (0.012)	−0.893 (0.008)	0.341 (0.021)	−3.92 (0.017)
2022	0.62	0.6	0.144 (0.009)	−0.957 (0.006)	0.386 (0.018)	−4.31 (0.014)
2023	0.63	0.61	0.168 (0.006)	−1.024 (0.004)	0.422 (0.012)	−4.77 (0.009)
2024	0.64	0.62	0.191 (0.004)	−1.108 (0.003)	0.458 (0.009)	−5.21 (0.006)
	0.58	**0.56**	**0.098 (0045.)**	**−0.776 (0.01)**	**0.283 (0.035)**	**−3.32 (0.01)**

However, the extended regression leads to different results. Beta is found to be significant and negative (γ1=−0.776, p=0.010) after correcting for nonlinearity and idiosyncratic volatility. Besides, beta doesn't affect the stock market in 2015-2017 but becomes significant and negative since 2018. Therefore, the positive correlation

discovered in simple regression is no longer robust, and Hypothesis 1 is refuted by the extended regression.

Squared beta is found to be significant and positive on average ($\gamma 2=0.283$, $p=0.035$), especially during 2021-2024. It means that Hypothesis 2 is rejected by CAPM as $\gamma 2$ is expected to be insignificant. The presence of negative beta and positive squared beta means that there is a nonlinear and probably convex risk-return relationship instead of the linear Security Market Line.

The idiosyncratic volatility is significant and negative on average ($\gamma 3=-3.32$, $p=0.010$) and significant during 2021-2024. Therefore, Hypothesis 3 is rejected according to CAPM because firm-specific risk cannot provide additional information since the investors are diversified. In spite of the fact that the extended regression insignificantly increases the mean explanatory power of the model from $R2 =0.56$ to 0.58, such improvement is made due to inconsistencies.

Interpretation and Relevance to Prior Findings

The inverse relationship between the beta and the premium observed in the extended model aligns with previous findings on both developed and emerging stock markets (Hirshleifer & Jiang, 2010; Vo, 2015; Cox & Britten, 2019; Hanauer & Lauterbach, 2019). This may be because of the low-beta anomaly, whereby stocks with lower betas have higher performance compared to those with high betas, adjusted for standard systematic risk. Hwang et al. (2021) link the anomaly to "adverse beta herding," whereby, as market expectations become less credible, investor behavior becomes disconnected from the expected risk compensation of the security betas in CAPM. Another indication that the anomaly is not an artifact is its persistence after excluding small-cap stocks and increasing the investment holding period (Blitz et al., 2013).

The results have some differences from those of Omran (2007). While both papers indicate problems with the validation of the CAPM in Egypt, the new results suggest that the significance and sign of beta are heavily dependent on the choice of model specification. This suggests issues such as multicollinearity or omitted variables.

In this context, the overall dismissal of CAPM is consistent with the findings from Egypt that support multifactor models. For example, the Fama-French three-factor model was relatively good in Shaker and Elgiziry (2014) and Shaker and Abdeldayem (2018), whereas in Taha and Elgiziry (2016), market, size, value, liquidity, and price-earnings factors were important. El Abd (2016) preferred the five-factor model, and Elsayed (2018) showed CAPM as the least performing one among all alternatives. The investor sentiment had added value in Hashmat and Abdallah (2019). Nonetheless, Hassan (2016a, 2016b) and Ragab et al. (2020) argue that multifactor models are not guaranteed to correct for pricing errors.

Consequently, the findings in this study cannot be taken to be conclusive proof that an alternative model is superior in all cases. On the contrary, what the findings suggest is that the beta factor is inadequate and that the results obtained through CAPM are highly dependent on the presence of nonlinearity and firm-specific variance. Consequently, robustness tests ought to consider negative beta values, return skewness, annual returns calculations, and the year 2020.

Robustness Tests

Five further analyses have been carried out to determine the sensitivity of the basic results to the handling of negative betas, skewness of returns, measurement of annual returns, the COVID-19 shock, and estimation frequency of betas. These tests measure the robustness of the results instead of justifying their statistical significance through other models.

Treatment of Negative Beta Coefficients

Negative beta coefficients can suggest returns lower than the risk-free rate in the classical version of CAPM theory or a V-shaped risk-return trade-off when risk is assessed through beta values (Cloninger et al., 2004; Wolski, 2010). Robustness of the results was, thus, considered by employing absolute values of negative beta coefficients or omitting them altogether. There were only 13 negative beta coefficients out of 1,322 firm-year observations, meaning that the effect on results was likely to be small. The use of absolute beta coefficients resulted in $\gamma 1 = 0.113$ ($p=0.0234$), while omitting the negative beta observations provided $\gamma 1 = -2.014$ ($p=0.0250$). Both estimations are statistically significant, yet they have different signs and, hence, are not directionally robust.

Return Skewness Control

As stock returns can deviate from normality, skewness was included in the extended cross-sectional regression model following Omran (2007) and Markowski (2020). The average coefficient on this variable was statistically significant and negative (-0.498, $p=0.035$), suggesting that those stocks with greater positive skewness generated lower future excess returns. Beta, squared beta, and idiosyncratic volatility have been claimed to still be statistically significant. Hence, the core findings are not completely driven by the excluded distribution asymmetry, yet skewness includes additional pricing information beyond CAPM.

Alternative Measure of Annual Returns

The annual returns were recomputed using weekly average returns based on Fama and MacBeth (1973) and Omran (2007) instead of using year-end price change. The beta estimates were estimated as 0.237 ($p=0.0121$) and 0.124 ($p=0.0142$) for the simple and extended models, respectively. These values are positive and statistically significant, while the sign of beta square and idiosyncratic risk also differs. Thus, the results are still statistically significant, but the coefficient signs vary depending on how the returns are measured.

Without the COVID-19 Shock

The shock of COVID-19 may have affected risk assessment and return pricing due to unprecedented uncertainty and trading disruption in Egypt in 2020. In accordance with the rolling methodology, the robustness test should omit the 2020 return dataset and the 2021-2022 data sets because the two-year period for beta estimation includes 2020 for each of them. Nonetheless, 2023-2024 should be retained because their estimation periods do not include 2020 observations. Tables 4 and 5 suggest that the rejection of CAPM is not solely caused by the pandemic. While the simple model finds positive beta premiums significant even outside 2020-2022, intercepts still differ significantly from zero. Nevertheless, the extended model shows negative beta coefficients even when squared beta and idiosyncratic volatility are significant after the pandemic.

Different Data Frequencies

In accordance with Bartholdy and Peare (2005), while maintaining the standard 2015–2024 forecast horizon, betas were recalculated using one year of daily, two years of weekly, and five years of monthly data. In the simple model, daily estimations yielded $\gamma 1 = -8.856$ ($p=0.131$) and in the extended model, -1.275 ($p=0.046$). The monthly estimates were $\gamma 1 = -2.727$ ($p=0.026$) and 18.379 ($p=0.035$). Frequency sensitivity is seen in the monthly extended model's shift from negative to positive.

Taken together, the tests do not show complete robustness: significance is generally maintained, but there are mixed signals regarding a negative-beta treatment, return measurement, and sampling frequency. The valid conclusion is that CAPM is not

consistently supported in Egypt. The beta premium is not directionally stable, and large squared-beta and idiosyncratic-risk coefficients reject the linearity and diversification restrictions of the CAPM. Thus, Hypotheses 1-3 are not consistently supported, and the results favor model instability over unconditional CAPM validation.

Results Interpretation and Discussion of Study Findings

The benchmark model detects a significant positive beta risk premium, partly supported by CAPM and the original findings of Fama and MacBeth (1973), along with results of Taha and Elgiziry (2016), El Abd (2016), Shaker and Abdeldayem (2018), and Ragab et al. (2020). However, persistent significant intercepts indicate systematic mispricings and prevent CAPM validation, as indicated by Bartholdy and Peare (2005) and Elsayed (2018). Recent evidence also suggests that static models may fail to describe the conditional behavior of returns and market anomalies (Nettayanun, 2023; Fletcher, 2024; Zhou et al., 2025). Thus, beta is an appropriate aspect of stock risk in Egypt; however, it does not provide an explanation of expected returns without consideration of the impact of market conditions and other factors.

With the inclusion of squared beta and idiosyncratic volatility, beta turns out to be significantly negative, while the two extra risk factors are priced, thereby rejecting the assumptions of linearity and diversification in CAPM. This specification sensitivity is consistent with the negative or reverse beta premiums reported in Omran (2007), Hirshleifer & Jiang (2010), Vo (2015), Cox & Britten (2019), Hanauer & Lauterbach (2019), and Leite et al. (2020). Recent studies also show that low-beta stocks can beat high-beta stocks in terms of performance and that the anomaly depends on the quality of firms, behavior of investors, sentiments, and market imperfections (Traut, 2023; Bradrania et al., 2023; Vayanos, 2023; Zhang et al., 2023; Bouteska et al., 2024; Zhou et al., 2025). Thus, the risk-return relationship in Egypt seems to be nonlinear and dependent upon certain conditions.

Conclusion and Recommendations

Asset-pricing models provide estimates of equity costs, discount rates, investment feasibility, and security valuation. The CAPM continues to be a useful benchmark despite continued criticism (Sharpe, 1964; Lintner, 1965; Mossin, 1966; Black, 1972; Yamagata, 2025). The validity requires joint support for a positive beta premium, zero intercept, linearity in beta, and no compensation for diversifiable risk (Fama & MacBeth, 1973, 1974). Thus, just testing the significance of the beta is not sufficient.

This study used 1,322 firm-year regressions of 101 to 160 Egyptian companies, applying weekly time-series regressions for 2013–2024 and ten annual cross-sectional regressions for 2015–2024. The design extends the work of Omran (2007), whose Egyptian evidence was based on 41 firms and a short 2001–2002 horizon. In the baseline specification, beta was positive and significant, suggesting that systematic exposure initially appeared to command a return premium. However, the intercept was still statistically different from zero, showing persistent pricing errors. When squared beta and idiosyncratic volatility were included, beta was found to be significantly negative, and both additional variables were priced. Therefore, beta still has explanatory power, but the joint restrictions of CAPM are not satisfied.

This sensitivity indicates that Egypt's beta–return relationship is conditional upon nonlinearity, firm-specific volatility, and omitted conditioning information. The result is consistent with evidence that low-beta stocks can outperform CAPM predictions (Traut, 2023), the anomaly varies with firm quality (Bradrania et al., 2023), and higher-order risk moments may be priced (Altay et al., 2024). Investor sentiment and dynamic information may also enhance conditional models (Bouteska et al., 2024;

Zhou et al., 2025). Hence, rejection of CAPM does not imply that market risk is irrelevant; beta is not a sufficient, unconditional risk measure.

Robustness tests varied treatment of negative betas, return skewness, annual-return construction, pandemic-affected observations, and estimation frequencies of daily, weekly, and monthly data. Statistical significance often remained, but the signs of the coefficients were not invariant. Thus, the robust conclusion is model instability, not a universally negative beta premium. This is consistent with Fletcher (2024), who shows that the assessment of factor models varies substantially when the conditioning information and dynamic trading are taken into account. Furthermore, it cautions against using the claim of higher explanatory power as evidence of correct pricing when the theoretically required restrictions are still violated.

The practitioners must note that CAPM should not be used in a mechanical way as the only approach to calculating the cost of equity of the firms in Egypt, valuing securities, or portfolio construction. Beta estimation should be complemented by other risk measurement approaches and discounted rates based on scenarios, as well as multi-factor models. The selection of the model will depend on the goal of valuation, investment period, liquidity, and current market environment. The latest research, which incorporates CAPM with a dividend-based approach to valuation, shows another example of the synergy (Yamagata, 2025).

Future research must consider alternatives to the market proxy because the EGX30 index construction and weighting may fail to reflect the investable market of Egypt (Simmet & Pohlmeier, 2020). The second recommendation is that time-series standard errors should be used for the analysis of Fama-MacBeth inferences, especially average annual risk premiums, which can be corrected using Newey-West and Shanken approaches if necessary. In addition, individual stock results should be compared with portfolio results to minimize measurement error for betas. Alternative estimation periods, Dimson adjustments for thin trading markets, and GARCH models for measuring idiosyncratic volatility need to be considered (Chok & Sun, 2007; Algebaly, 2016).

Finally, it is necessary to differentiate between bull and bear markets in the conditional version of CAPM (Markowski, 2020), while taking into account factors of liquidity, sentiment, and macroeconomic conditions. It would be appropriate to compare the model with the three- and five-factor Fama-French models and their modifications (Fama & French, 1993, 2015). At the same time, the recent rejection of a few linear multifactor models shows that simply adding factors is not enough to resolve the issue of misspecification (Fletcher, 2024). Thus, future research should test models in terms of pricing errors, out-of-sample forecasting, and economic value.

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Declarations

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Compliance with Ethical Standards

This study relied exclusively on secondary financial and market data and did not involve human participants, personal data, animals, clinical interventions, or experimental procedures. Therefore, institutional ethics approval was not required.

Data Availability

The cleaned and processed datasets, variable definitions, data-transformation procedures, statistical code, and supporting documentation required to reproduce the reported results are provided as supplementary materials for peer-review purposes. EGX30 data are publicly available from the Egyptian Exchange. The underlying share-price and Treasury-bill data obtained from Bloomberg are subject to licensing restrictions and therefore cannot be publicly redistributed. However, authorised Bloomberg subscribers may retrieve these data using the sources and identifiers documented in the supplementary materials.

Conflict of Interest

The authors declare that they have no financial or non-financial interests that could have influenced the research reported in this article.

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Consent for Publication

Not applicable.

Consent to Participate

Not applicable.

Clinical Trial Declaration

Not applicable. This study did not involve a clinical trial.

Supplementary Files

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- DataFamaandMackBath2025.xlsx