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Abstract: The stock market volatility is well correlated with the VUCA (volatility, uncertainty, complexity, and ambiguity) environment, so it's important to understand the best techniques that capture this relationship. The main objective of this work is to analyse the capital asset pricing model (CAPM) to understand the relationship between risk and return. The other objective is to try to understand if the CAPM model is reflected in the Portuguese stock exchange. If there is a direct correlation between risk and expected return, then we are looking at an efficient market. Through the method of observation and bibliographic and documentary research, a practical assessment is made of the relationship between the CAPM model and the Portuguese stock exchange. Analytically, an analysis of 40 companies of the Portuguese stock index (PSI 20) is carried out, where the behaviour of the beta and the rate of return is demonstrated.

Keywords: capital asset pricing model; CAPM model; risk; expected return; stock market; Portuguese.

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1 Introduction

“A large part of the developments that have occurred in financial theory, over the last few decades, start from the hypothesis that the profitability of each financial asset has a normal probability distribution” Fonseca, (2000), p.10]. The portfolio theory elaborated by Markowitz (1952) enables the risk level of an investment to be determined for a given level of return. This model is intended for investors who are risk averse, that is, they prefer to have a lower level of risk for the best level of expected return. This theory intended to develop and diversify investment portfolios and highlight the relationship between portfolio diversification and correlation between assets. To decrease risk (the variance of returns in a portfolio), it is not enough to invest in many financial assets. The intention is not to invest in assets that have a high covariance between them. Thus, there was a need to invest in assets that have a low covariance between them, that there is diversification and that have different characteristics (Ranabhat et al., 2022).

One of the weak points of the Portfolio Theory is the fact that there is the possibility of investors who invest their money in assets with risk and there are other possibilities in the market, without risk, for example, assets proposed by government. The main failures of the CAPM model result from its unrealistic assumptions, such as that investors have diversified portfolios; and that they can borrow and lend at the risk-free rate or that the capital market is perfect (Stănculescu, 2016). For Abbas et al. (2011) the CAPM model despite not being free of controversies, remains extremely useful for the financial analysis of investment in asset portfolios. Assagaf (2015), concluded that the CAPM model has limitations in its ability to predict the risk and return generated.

The research problem is the following: in the present study we intend to study whether: The assumptions of the CAPM model are verified in the different sectors that are listed in the Portuguese stock exchange, in terms of risk and expected return of the shares.

The objective of this analysis is to test the consequences of the model for an efficient market portfolio, knowing the profitability of the shares in the Portuguese market. Thus, we can verify if for an efficient market portfolio, the expected return of the PSI General shares takes into account the risk averse investors in controlling their portfolios with a low level of risk.

2 Literature review

In order to determine the risk and expected return of a particular investment appeared the capital asset pricing model (CAPM model), which is distinguished by being a balance of financial assets and that was formed from various learnings over the years (Markowitz, 1959; Sharpe, 1964; Mossin, 1966; Lintner, 1975; Dionne et al, 2012; Džaja and Aljinović, 2013; Kisman and Restiyanita, 2015; Bao et al., 2018).

Through the foundation of the theories of market efficiency hypotheses, the CAPM Model, formed rules between the expected return and its risks. Being that the one of the risks that impairs the profitability is the existing market risk, being it systematic, represented by the beta (β) of the asset. Beta represents the systematic risk, as previously mentioned, in which ‘it is the result of the division of the covariance between the returns of the market portfolio and the returns of the risky asset by the variance of the market portfolio’ [Teixeira et al., (2013), p.3].

By having an efficient portfolio, when making a certain investment, preferably risk-free, and investing it in risky assets, it means that the value of the return with risk is higher than the value of the return without risk, due to the market risk premium required by investors multiplied by the volatility, systematic risk, of the asset (β). Thus, β indicates different levels of risk of portfolios, so if ($\beta > 1$) it will have a higher risk, lower if ($\beta < 1$) or equal if ($\beta = 0$) to the systematic risk (Frank and Shen, 2012).

However, according to Sharpe (1964), Lintner (1975) and Mossin (1966), risk is divided into two segments, the specific risk, and the systematic risk. Specific risk is defined as being that which is intrinsic to any stock, this being one of the main characteristics of this asset. On the other hand, there is the systematic risk, which differs from the changes (positive or negative) inherent to the market (Netisopakul and Saewong, 2022).

One of the ways to calculate the return as a function of risk is through the SML (Security Market Line), in other words, the CAPM. According to this model, the investor wants to be remunerated only for the market risk, beta coefficient, and that varies depending on how the asset returns vary in conjunction with the market portfolio returns. Thus, the profitability (expected return) of a stock has a linear relationship with the beta. Therefore, the higher the β , the greater will be the systematic risk and by interference, the greater will be the return expected by the investor (Bhullar et al., 2022).

3 Methodology

The study was developed by the method of observation and experimentation, based on data relative to the profitability indexes (yield) of each sector (materials, industry, consumer goods, communication services, utilities, financial and information technologies) of the Portuguese stock index (PSI 20) general and the respective inherent risks (beta). The data is relative to 40 companies divided by their respective sectors. For each company its beta and Yield (rate of return) were defined to create a joint table, with the calculation of the average values per sector (in terms of betas and yields) so that a comparative study between sectors can be carried out and conclusions drawn.

4 Empirical results

Tables were constructed with the values relative to the different shares of the listed companies, in terms of Beta and yield, relating the risk with the rate of return of each share. Initially, by analysing the 40 companies the acceptance of the CAPM model was empirically contrasted, individually, for the portfolio relative to each of the sectors listed on the Portuguese stock exchange.

4.1 Materials sector

Table 1 refers to the materials sector, analysing the values relative to the different shares of the companies listed in this sector of activity, in terms of beta and yield, relating risk with the rate of return of each share. In terms of risk, the values are between 0.88 and 1.59, with the shares with the highest returns being those of the SEM and RAMA

companies. It is noteworthy that only the CORA company presents a risk lower than the systematic one, with all other stocks presenting a risk higher than the systematic one.

Table 1 Materials sector

<i>Sector</i>	<i>Materials</i>					
	<i>NVGR</i>	<i>SONI</i>	<i>SEM</i>	<i>RAMA</i>	<i>CORA</i>	<i>ALSS</i>
BETA	1.18	1.34	1.14	1.59	0.88	1.53
Yield	0.1	0	0.37	0.43	0.19	0.18

Source: Own source

4.2 Industrial sector

In the industrial sector, where nine companies were taken into account in the analysis, stocks show distinct and dispersed risks, ranging between 0 and 1.5 Table 2, while only two stocks show significant yields (CTT and CDUL). In this sector, most of the companies present risk identical to the systematic risk (seven out of nine of the companies analysed), with the remaining two presenting risk lower than the systematic risk.

Table 2 Industrial sector

<i>Sector</i>	<i>Industry</i>								
	<i>TDSA</i>	<i>SONAC</i>	<i>CTT</i>	<i>MOTA</i>	<i>MARTI</i>	<i>LIFT</i>	<i>LIG</i>	<i>INA</i>	<i>CDUL</i>
BETA	1.26	1.5	0.64	1.5	0.69	0	0.8	0.52	0
Yield	0	0	0.006	0	0	0	0	0	0.4

Source: Own source

4.3 Consumer goods sector

Table 3 looks at the consumer goods sector, where the two companies analysed have distinct risks (1.16 and 0.55) and relatively low yields of 0.03 and 0.21. In the consumer goods sector, one company presents higher risk than systematic risk, and the other presents lower risk relative to systematic risk.

Table 3 Consumption goods sector

<i>Sector</i>	<i>Consumer goods</i>	
	<i>YSO</i>	<i>JMT</i>
BETA	1.16	0.55
Yield	0.03	0.21

Source: Own source

4.4 Technological sector

The technology sector is analysed in terms of risk and return in Table 4. The three companies listed on the stock exchange are analysed in that table, with a risk that varies

between 0.43 and 0.76 (all firms have risk lower than systematic risk), with no relevant yields.

Table 4 Technological sector

<i>Sector</i>	<i>Technology</i>		
	<i>RSGP</i>	<i>NBA</i>	<i>GLINT</i>
BETA	0.76	0.43	0.67
Yield	0	0	0

Source: Own source

4.5 Utility sector

The utilities sector has risks between 0 and 1.07 and returns between 0 and 0.14. In this situation, two companies present risk higher than the systematic risk, one equal and one lower.

Table 5 Utility sector

<i>Sector</i>	<i>Utilities</i>			
	<i>EDPR</i>	<i>GVOLT</i>	<i>RENE</i>	<i>EDP</i>
BETA	1.07	0	0.53	1.03
Yield	0.06	0	0.12	0.14

Source: Own source

4.6 Financial sector

Table 6, looks at the financial sector. This is the sector with the most companies analysed, reflecting the importance of the financial sector in the Portuguese stock market. This analysis includes 10 companies in the financial sector. However, only one presents a risk higher than the systematic risk, with the remaining nine presenting risks similar to the systematic risk, and only two present positive returns (the FLEXD and ENX companies).

Table 6 Financial sector

<i>Sector</i>	<i>Finance</i>				
	<i>MLCVI</i>	<i>ALNOR</i>	<i>MLRSR</i>	<i>FLEXD</i>	<i>MLRZE</i>
BETA	0	0	0	0	0
Yield	0	0	0	0.03	0
<i>Sector</i>	<i>Finance</i>				
	<i>ORE</i>	<i>ALPTR</i>	<i>GFIBI</i>	<i>ENX</i>	<i>BCP</i>
BETA	0	0	0	0	1.93
Yield	0	0	0	1.59	0

Source: Own source

4.7 Communication services sector

Finally, the communications services sector was analysed, counting 6 companies listed on the stock exchange. These companies present risk between 0.19 and 1.39 and yields in two of them Table 7. From the table, it can be seen that two companies have lower risk than systematic risk, with the remaining companies presenting higher risks.

Table 7 Communication services sector

Sector	Communication services					
	SNC	NOS	PHRA	IMPA	MCP	CFN
BETA	0.19	0.68	1.25	1.32	1.3	1.39
Yield	0.07	0.2	0	0	0	0

Source: Own source

4.8 Sector average

Through the observation of the estimated value of the beta of each sector, it is shown that only the portfolios of communication services and materials sectors are aggressive (presenting a beta value above 1), being the remaining portfolios defensive. However, this higher level of risk does not lead to higher yields in these sectors when compared with the other sectors analysed, to remunerate the risk assumed by the investors and attract that same investment as it would be expected. Thus, we can see that the Portuguese stock market does not confirm the assumptions of the CAPM model, not confirming the positive relationship between risk and return.

Table 8 Sector average

Sector	Materials	Industry	Consumer goods	Technology	Utilities	Finance	Communication services
BETA	1,2767	0,7678	0,8550	0,6200	0,6575	0,1930	1,0217
Yield	0,2117	0,0451	0,1200	0,0000	0,0800	0,1620	0,0450

Source: Own source

The literature points to stock returns track market risk (as measured by the beta coefficient) and there is a linear relationship between stock returns and systematic risk (Bhullar et al., 2022). However, the average values of different sectors of activity of companies listed in the Portuguese stock exchange analysed do not reflect this assumption. In fact, both the consumer goods and the financial sectors have average beta values below the systematic risk but have relatively high yields when compared to other sectors. This situation contrasts with the communication services sector where the risk above the systematic risk has one of the lowest yields of the sectors analysed.

5 Conclusions and limitations

Considering the objective of this article, which is to show the applicability of the CAPM model and to test its validity in the Portuguese stock market, we have tried to study how the CAPM model can describe the average expected returns of a sample belonging to the

PSI market index. Thus, throughout this analysis, several theories on the evaluation of non-diversifiable risk (the beta factor) of stocks and portfolios were referred to, the weights of systematic risk and specific risk in total risk were evaluated, the behaviour of systematic risk over time was assessed and a comparison between the estimated betas in relation to portfolios was also carried out. This study sought to show the applicability of this model for a set of companies, verifying its behaviour in relation to the risk and return measured through the model and that which occurred.

Based on the estimation of the beta coefficients of the individual companies and the respective rates of return, of each sector (materials, industry, consumer goods, communication services, utilities, financials, and information technology), it was intended to verify the applicability of the CAPM model in the portfolios of each of the sectors, it was concluded that the model is incompatible. All portfolios are defensive, except for those composed by the return on share prices of companies belonging to the Communication Services and Materials sectors, which are aggressive.

This incompatibility of the CAPM model with the study carried out with companies traded in the Portuguese stock market may result from the low liquidity of the stock market, the low volume of trading on it or the limited number of listed companies. The study should be replicated in a broader and more comprehensive scenario to validate the continued application of the model nowadays or the fact that it has become only a theoretical model due to the evolution and growing complexity of financial markets.

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