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Idiosyncratic risk in the Dow Jones Eurostoxx50 Index

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Abstract

Recent evidence by Campbell et al. [J.Y. Campbell, M. Lettau B.G. Malkiel, Y. Xu, Have individual stocks become more volatile? An empirical exploration of idiosyncratic risk, The Journal of Finance (February) (2001)] shows an increase in firm-level volatility and a decline of the correlation among stock returns in the US. In relation to the Euro-Area stock markets, we find that both aggregate firm-level volatility and average stock market correlation have trended upwards.

We estimate a linear model of the market risk–return relationship nested in an EGARCH(1, 1)-M model for conditional second moments. We then show that traditional estimates of the conditional risk–return relationship, that use ex-post excess-returns as the conditioning information set, lead to joint tests of the theoretical model (usually the ICAPM) and of the Efficient Market Hypothesis in its strong form.

To overcome this problem we propose alternative measures of expected market risk based on implied volatility extracted from traded option prices and we discuss the conditions under which implied volatility depends solely on expected risk. We then regress market excess-returns on lagged market implied variance computed from implied market volatility to estimate the relationship between expected market excess-returns and expected market risk.We investigate whether, as predicted by the ICAPM, the expected market risk is the main factor in explaining the market risk premium and the latter is independent of aggregate idiosyncratic risk.

Keywords: Idiosyncratic risk; Intemporal capital asset pricing model (ICAPM); Dow Jones Eurostoxx50 Index; Efficient market hypothesis (EMH)

1. Introduction

It is widely accepted that volatility is not stable over time. Both aggregate market volatility and single stock volatility generally exhibit time-varying behaviour. Schwert [13] points out, "large changes in the ex-ante volatility of market returns have significant effects on risk averse-investors. Moreover changes in the level of market volatility can have important effects on capital investment, consumption, and other business cycle variables". Previous empirical studies that focused on stock market volatility include those of Bollersev et al. [3], Hentschel [11], Ghysel et al. [9], Campbell et al. [4].[1] More recent literature has examined the role played by total risk, including idiosyncratic risk, in explaining stock market returns; in particular Goyal and Santa-Clara [10] find a significant positive relation between average stock market variance and the returns to the market. Campbell et al. [6] present evidence from three US stock

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[1] See for a review Cambpell et al. [6].

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markets (NYSE, NASDAQ, AMEX), all indicating that average correlations among stock returns have declined over the last two decades. Furthermore the decline in US stock market correlations has been accompanied by a parallel increase in average firm-level volatility.[2]

This study focuses on the relationship between stock market and firm-level volatility in the Dow Jones Eurostoxx50 Index (the leading stock market in the Euro Area). To analyse this relationship we require a decomposition of the variance of the Dow Jones Eurostoxx50 Index. This involves splitting average total variance of the returns on the Eurostoxx50 Index into market variance and aggregate firm-level variance. This in turn enables us to study, model and test the relationship between risk and return with regard to a portfolio represented by the stocks included in the Dow Jones Eurostoxx50 Index.

Variance decomposition is carried out in a manner similar to the methodology used by Campbell et al. [6]. The weighed average variance of excess-returns on all the stocks in the Eurostoxx50 Index is then decomposed into market variance and average firm-level variance. Various tests are performed on the relationship between risk and return; in particular, we test the Intemporal Capital Asset Pricing Model (ICAPM) which claims that a positive relationship exists between the market risk-premium and the expected market variance. Here, an EGARCH-M model will be used to estimate the conditional first and second moments of the market excess-returns. We also employ implied market variance to proxy market risk-premium, computed from the implied volatility of traded options prices on the DJ Eurostoxx50 Index. Market excess-return is then regressed against conditional[3] average firm-level volatility to test the CAPM and ICAPM claim that market volatility is unrelated to idiosyncratic risk. We find consistently with the results reported by Campbell et al. [6] that average firm-level variance for the Eurostoxx50 index trended upwards over our sample, however contrary to Campbell et al. [6], we find that the Eurostoxx50 stock market correlations do not trend downwards.

2. Methodology

The representation of the expected risk-premium prevalent in financial theory relies on a linear relationship between excess-return and some explanatory factor. In particular, asset returns usually depend in a linear fashion on one or more *pervasive*[4] explanatory factors.

After studying the decomposition of the variance of the excess-return on the stocks included in Dow Jones Eurostoxx50 Index (our proxy for the market portfolio), we will examine the relationship between excess-returns on the market portfolio and both systematic and average idiosyncratic risk. In particular, we will check whether the same puzzling results obtained by Goyal and Santa Clara [10] with regard to the relationship between excess-return and average idiosyncratic risk are valid for our market portfolio of European stocks.

This paper proposes a formal derivation of the relationship between the expected risk-premium and the expected risk consistent with Merton's ICAPM. In particular, we show that traditional tests of asset pricing models ultimately derive expected risk using ex-post returns as the conditioning information set. This in turn requires the assumption that market prices incorporate all the relevant information. Any test of the risk–return relationship that uses ex-post returns as the conditioning information set is therefore a joint test of the theoretical asset-pricing model and of the efficient market hypothesis (EMH) in its strong form. In the early 1970s, Black and Scholes [2] made a major breakthrough by deriving a differential equation that must be satisfied by the price of any derivative security dependent on a non-dividend-paying stock. One parameter that cannot be observed directly in the above model is the volatility (the σ term) of the stock price. On the other hand it is possible to solve the Black and Scholes (BS) differential equation for σ,[5] given knowledge of all the other variables and of the option market (traded) price. This value is called *implied*

[2] According to Campbell [6] there has been a "noticeable increase in firm-level volatility relative to market volatility".

[3] Lagged volatility measures will be used as proxy variables for conditional/expected volatility, relying on the usual persistence of volatility time-series, as suggested by Goyal and Santa-Clara [10].

[4] Probably under the influence of the earlier State-preference Theory, asset pricing is mainly related to the risk of common, undiversifiable variations of aggregate wealth in the economy.

[5] Unfortunately, it is not possible to solve analytically the BS differential equation for σ. Implied volatility must therefore be calculated by searching with an iterative procedure for the value that, given all other parameters, the appropriate boundary conditions and the option price, satisfies the BS differential equation. A formal iterative procedure would be the Newton–Raphson method, which is designed to solve any equation of the form $f(x) = 0$. It starts with a guess of the solution $x = x_0$ and then produces successively better estimates $x = x_0, x = x_1, \ldots, x = x_n$ of the true solution using the formula $x = x_{i+1} = x_i - f(x_i)/f'(x_i)$.