Journal of
Risk and Financial
Management

MDPI

Article

A New Measure for Idiosyncratic Risk Based on Decomposition Method

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Abstract: This paper introduces an alternate measure of idiosyncratic risk leveraged from the decomposition method to further eliminate the residual systematic risk inherent in the factor asset pricing model. Combining both complementary techniques contributes to a more comprehensive firm-level idiosyncratic risk that is crucial in both portfolio diversification and alpha investing. We focus our result on the idiosyncratic risk estimations and their behaviour on 36 emerging markets covering 39 industries. We show that the new measure exhibits a declining trend across time, consistent with the fact that emerging markets are becoming more integrated with the increased level of common effect across time.

Keywords: systematic risk; idiosyncratic risk; total risk; decomposition; emerging markets

JEL Classification: F21; G11; G15

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Citation: Lee, Meng-Horng, Chee-Wooi Hooy, and Robert Brooks. 2023. A New Measure for Idiosyncratic Risk Based on Decomposition Method. *Journal of Risk and Financial Management* 16: 43. https://doi.org/10.3390/jrfm16010043

Academic Editors: David Allen and Shelton Peiris

Received: 21 November 2022
Revised: 3 January 2023
Accepted: 4 January 2023
Published: 9 January 2023

1. Introduction

The modern portfolio theory is built on the capital asset pricing model (CAPM) where systematic risk is the only risk that is priced in the expected return with the presence of risk-free assets. However, it involves many assumptions that may not hold in the real world such as the mean-variance efficient portfolio which may be difficult to construct in reality due to various constraints such as cost, interest rate, currency, and behavioural factors like rational investors. Hence, the importance of idiosyncratic risk should not be underestimated, as it has large consequences for interpreting asset-pricing models, as claimed by Vidal-García et al. (2019). In fact, it has been proven over time that superior return performance can be attributable to various unsystematic factors such as fund managers' skills and style, timing skill, market inefficiency, etc.

Ever since Merton (1987) uncovered the positive relation between idiosyncratic risk and stock returns, the interest in idiosyncratic risk has never been in vain. Goyal and Santa-Clara (2003) found evidence that aggregate market excess returns can be explained by average idiosyncratic volatility. Recent studies on idiosyncratic risk, such as Bekaert et al. (2012) on G7 and Bley and Saad (2012) on seven frontiers markets, suggest that asset allocation decisions will need to price the idiosyncratic risk for a portfolio that is under-diversified or imperfectly diversified.[1] Using the GARCH model, Fu (2009) found a significant positive relation between the estimated conditional idiosyncratic volatilities and expected returns in the US market.

However, estimating idiosyncratic risk itself is a challenge given the statistical and empirical limitations of various widely used modelling methods such as the Fama and French (1993) factor model, the return-based model in Goyal and Santa-Clara (2003), and the volatility decomposition model of Campbell et al. (2001). The usual approach to measuring idiosyncratic risk is to estimate a CAPM or factors model to disaggregate idiosyncratic risk from stock returns or total risk. However, we argue that there may be further systematic components in the idiosyncratic risk which are not acknowledge in the usual asset pricing model, for example the country and industry factors as highlighted in Heston and Rouwenhorst (1994) (henceforth HR). This is possible, as Bekaert et al. (2012) found that idiosyncratic variances are highly correlated across the G7 countries, and they even concluded there might be a common driving force for idiosyncratic variances across G7 countries. To address the possible issue of a common driving force among idiosyncratic variances, as pointed to earlier, it is critical for us to segregate these common forces from the investigation of idiosyncratic risks to prevent systematic risk being erroneously assumed as idiosyncratic risks.

Our paper contributes by suggesting an alternate measure of idiosyncratic risk that further segregates these common forces from firm idiosyncratic risks. First, we extend the Heston and Rouwenhorst (1994) decomposition method to derive the firm level idiosyncratic risk by employing a two-step hybrid model to segregate the systematic risk components (derived from the conventional pricing model) from total risks. Leveraging the two models used in this study, an alternate hybrid measure of idiosyncratic risk is introduced to segregate the common force from the investigation of idiosyncratic risks, to prevent certain systematic risks from being erroneously assumed as idiosyncratic risks. Second, as recent research on global uncertainty has gained more attention (Bloom 2009, 2014; Baker et al. 2016), our findings are timely to show that the "real" idiosyncratic risk is not as high as documented in previous studies that measured it via asset pricing models. We show that the level of idiosyncratic risk measured from our approach is consistently lower as compared to the idiosyncratic risk generated from a four-factor model. Higher level of systematic risk means systematic risk is contributing more than expected in a firm dynamic. Last but not least, we also contribute to the literature of the HR decomposition which has been applied to address various returns and risk decompositions, mainly in the context of country and industry diversification issues, including Heston et al. (1999), Serra (2000), Baca et al. (2000), Cavaglia et al. (2000), Lin (2000), Brooks and Del Brooks and Negro (2004, 2005), Ferreira and Ferreira (2006), Campa and Fernandes (2006), Chen et al. (2006), Soriano and Climent (2006), Bai and Green (2010), Menchero and Morozov (2011), Bai and Green (2012), Lee and Hooy (2013), and Lee et al. (2018a, 2018b).

As the issue of idiosyncratic risk is most prevalent in emerging markets given the different characteristics of the developed market such as lower liquidity, a less efficient market, less integration with the world, and (often) displaying a low correlation with developed markets that contribute to the benefit of portfolio diversification. In essence, we focus our scope of a study of 36 emerging countries and across 39 industries within a span of 22 years to better illustrate the dynamic of idiosyncratic risk over time. On average, the new measures are found to show a declining trend over time. This supports the fact that emerging markets have become increasing integrated with the world economy over the last few decades. Convergence between systematic and total risks beginning in 2007 is uncovered.

The remainder of the paper is organised as follows: Section 2 describes the setup of our model and the sources of our data. The empirical results are reported in Section 3 and finally in Section 4 we conclude the paper.

2. Alternate Measure of Idiosyncratic Risk

Under the multifactor model of Fama and French (1993) and Carhart (1997), we can model the excess return of a firm over the risk free rate, $R_t - R_f$, on four factors, namely the market return (MKT), size (SMB), book-to-market (HML), and momentum (MOM) as follows:

$$R_t - R_f = \alpha + \beta_1 MKT_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 MOM_t + \varepsilon_t \quad (1)$$

The total risk σ^2 (TR) of the above excess returns can be divided into a systematic risk factor (SR) and an unsystematic risk or so-called idiosyncratic risk factor (IR), where the systematic factor basically comprises of variance attributable to the volatility of MKT, SMB, HML, MOM, and the covariances between the factors. The total risk thus can be written as:

$$TR = \sigma^2 = SR + IR = \sum \beta^2 \sigma_M^2 + \sigma_\varepsilon^2 \quad (2)$$

The systematic risk is given by the difference between the total risk and the idiosyncratic risk as depicted in Equation (2) or via coefficient of determination, R^2 of the regression, which captures the variation of the return attributed to the four factors, given by the formula below:

$$SR = \sigma^2 R^2 \quad (3)$$

We construct the time series of systematic risks with monthly frequency using a 36 month rolling-window estimation on Equation (1), with a minimum regression of 12 months observation.

In the spirit of the Heston and Rouwenhorst (1994) (henceforth HR) decomposition approach, both systematic and total risk can be re-posited as below:

$$TR_t = \alpha_{TR,t} + \beta_{TR,t} + \gamma_{TR,t} + \varepsilon_{TR,t} \quad (4)$$

$$SR_t = \alpha_{SR,t} + \beta_{SR,t} + \gamma_{SR,t} + \varepsilon_{SR,t} \quad (5)$$

where α is the common base risk, β is the country factor, γ is the industry factor and t denotes the time subscript. From the model construction, IR_t (the idiosyncratic risk) is decomposed into $\varepsilon_{TR,t}$ and $\varepsilon_{SR,t}$. These error terms are uncorrelated across firms and assumed to have zero mean and finite variance for risks in all countries and industries, respectively.

There are primary differences between the conventional asset pricing model and the HR approach from a technical point of view. As mentioned in Fama and French (2005), behaviourists claim that the factor model merely captures the covariance in returns missed by the market return and is not motivated by predictions about state variables of concern to investors. In contrast, the factor decomposition model attributes the systematic risk to three broad factors that cover all the state variables of concern to investors without assuming a market proxy.

Essentially, the basic decomposition model of HR captures the systematic risk that is attributable to common, country, and industry factors. Thus, by construction, the residual systematic risks that were not captured in common, country, and industry factors, for example, regional factors[2] or economic affiliation factors, etc., could then be captured in ε_{TR} in Equation (4). In other words, the error term in the total risk model consists of a firm-specific disturbance and the residual systematic risk, not just the firm-specific disturbance exclusively, as claimed by Heston and Rouwenhorst (1994). As pointed out in Lee et al. (2018a), there are significant differences between the factors in both the total risk and systematic risk models and using total risk decomposition may overstate or understate the benefits of diversification.

We integrate two established models that are widely used in this line of research, namely, the four-factor model and the factor decomposition model, in this study and derive an alternate measure of idiosyncratic risk. This alternate measure of idiosyncratic risk is deemed more extensive as different dimensions of systematic risk can be identified. By construction, ε_{SR} is nothing but the residual systematic risk that could be due to region or economic affiliation factors, where the firm-specific risk is no longer present. Thus, by further segregating the residual systematic risk from $\varepsilon_{TR,t}$, we are able to better identify the individual firm-level idiosyncratic risk, as illustrated in Equation (6) below.

$$IR_t = |\alpha_{TR,t} + \varepsilon_{TR,t}| - |\alpha_{SR,t} + \varepsilon_{SR,t}| \quad (6)$$

Using this hybrid approach further disaggregates the possible systematic risk factor that is not captured by the factor model. The factor model complements the decomposition model by segregating the possible residual systematic factors that are left in the error term. Combining both complementary techniques could potentially mitigate the shortcomings of each model and contributes to the literature by proposing a more comprehensive measure of firm-level idiosyncratic risk using a hybrid model.[3]

For estimation, we employ the monthly data from 1990–2012 from 36 emerging countries in the constituents of Datastream emerging market indices (refer to Table 1), ending up with a final sample of 2045 individual firms with a minimum observation of 12 months after data elimination. We end our sample at the Eurozone crisis, because the post-2012 period is different in terms of risk (Dungey et al. 2019). The asset pricing factors are based on the commonly used Fama and French (1993) and Carhart (1997) from Kenneth French's Data Library. The industry classification is based on ICB Level 4 of 39 industries while the weightings of country and industry factors are based on market capitalizations (in U.S. dollars).

Table 1. List of emerging countries based on the constituents of Datastream Emerging Market Indices.

Sample Countries			
Argentina	Egypt	Morocco	Slovenia
Bahrain	Hungary	Oman	South Africa
Brazil	India	Pakistan	South Korea
Bulgaria	Indonesia	Peru	Sri Lanka
Chile	Israel	Philippines	Taiwan
China	Kuwait	Poland	Thailand
Colombia	Malaysia	Qatar	Turkey
Cyprus	Malta	Romania	UAE
Czech Republic	Mexico	Russian Federation	Venezuela

3. Empirical Results

Due to space constraints, we do not report the estimated detail of the HR method. Instead we focus our result on the idiosyncratic risk estimations and behaviour. We plot the residuals $\varepsilon_{SR,t}$ and $\varepsilon_{TR,t}$ from Equations (4) and (5) in Figure 1. Much to our surprise, a more volatile time series variation of the residual of systematic risk is uncovered. To recap, the $\varepsilon_{SR,t}$ consists of factors that are not captured by common, country-specific and industry-specific factors. Hence, the component in the residual of systematic risk should be a subset of the residual of total risk. One plausible explanation is that the component factors left in the residual of total risk measure have offsetting effects, in which their covariances are rather low, resulting in low volatility. On the other hands, examining the residual of systematic risk, the volatility is much higher than what is depicted in the total risk model. An intuition that can be taken from here is that the total risk model itself may underestimate the remaining unidentified risk. Of course, a counter argument can be raised: because the components factors have offsetting effects, diversification benefits are somewhat achieved in the total risk model. Hence, this suggests that that there are diversification benefits from the firm-level factors in IR or the unidentified factors that are not captured in the Fama and French (1993) three-factor model.

Table 2 shows the descriptive statistics for the cross-sectional average of firm-level idiosyncratic risk as proposed in Equations (6) and (1). We also plot the time series of IR_k in Figure 2. Overall, we are seeing a declining trend in this alternate measure of firm-level idiosyncratic risk across time. This is particularly consistent with the fact that emerging markets are becoming more integrated and markets are moving in a more consistent direction than they were 10 years ago, as shown in the increased level of common effect across time due to the higher co-movement among emerging markets, which tend to be susceptible to global shocks and any adverse event. This supports the view that the value in active portfolio management has lost ground over the past decade and coincides with the fund flows into the passive fund, which in turn will spur the co-movement of stocks in different markets.

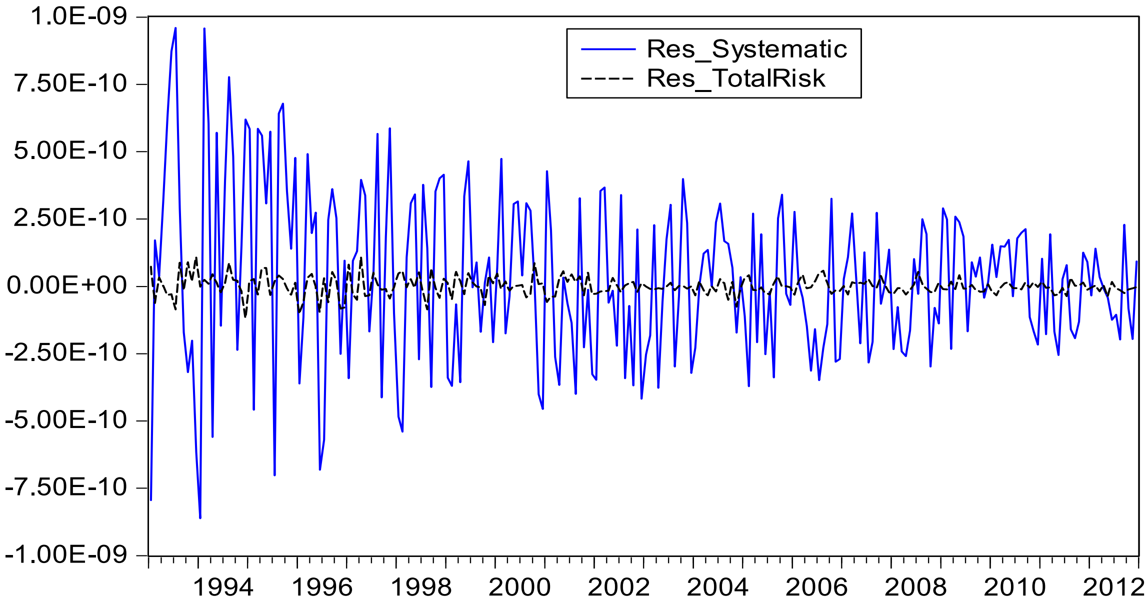

Figure 1. Residuals in Systematic Risk & Total Risk. This figure plots the cross-sectional average variation of the residual in total risks, ε_(*TR*,*t*), and the residual systematic risk, ε_(*SR*,*t*), from Equations (4) and (5), respectively.

Table 2. Descriptive Statistics. This table compares the descriptive statistic for the cross-sectional average of firm-level idiosyncratic risk as proposed in Model (6): $IR_t = |\alpha_{TR,t} + \varepsilon_{TR,t}| - |\alpha_{SR,t} + \varepsilon_{SR,t}|$ and Model (1): $IR_t = \sigma_\varepsilon$.

	Model (6)	**Model (1)**
Mean	9.1002	11.9738
Median	9.1273	11.8909
Maximum	12.3166	15.1349
Minimum	6.2588	8.6604
Std. Dev.	1.9302	1.8423
Skewness	0.0178	0.0235
Kurtosis	1.4326	1.6832
Jarque–Bera	24.5797	17.3610
Probability	0.00001	0.0002
Sum	2184.052	2873.7170
Sum Sq. Dev.	890.4743	811.2139
Observations	240	240

We compare the results of the proposed alternate idiosyncratic risk using the hybrid model as shown to the traditional measure of idiosyncratic risk using the Fama and French multifactor model in Figure 3. We show that the traditional measure of idiosyncratic risk is consistently higher than our alternate idiosyncratic risk, which supports our argument that there are residual systematic factors that are left in the error term in the multifactor model. This supports our thesis that taking the hybrid approach is more comprehensive in estimating the firm-level idiosyncratic risk, as the multifactor model may not fully capture various systematic risk factors that can be complemented by using a hybrid approach with the decomposition model.

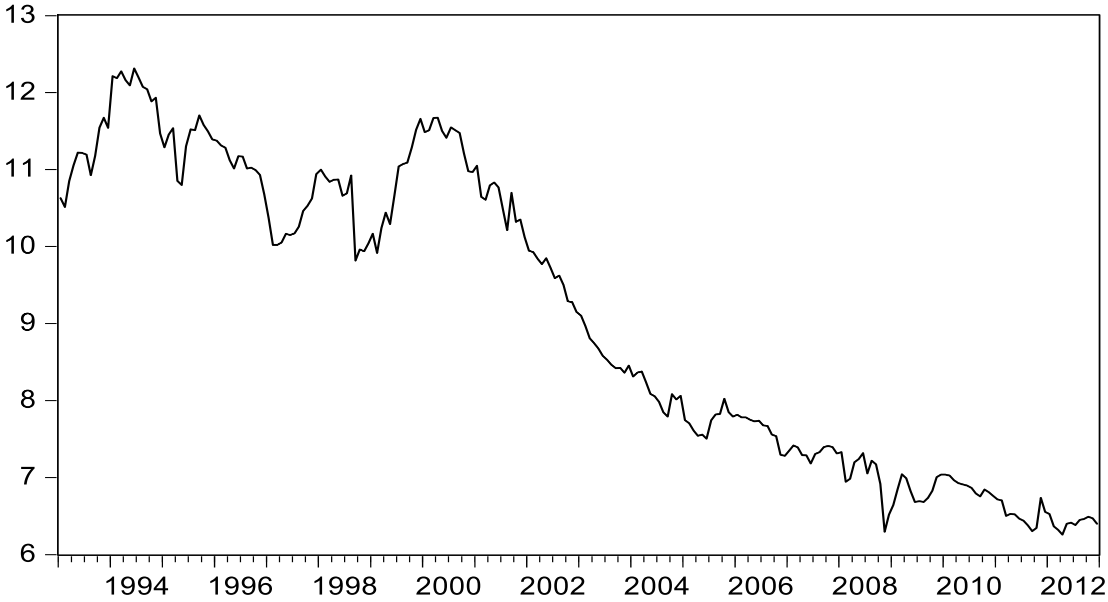

Figure 2. Alternate Measure of Idiosyncratic Risk. This figure plots the cross-sectional average of firm level idiosyncratic risk as proposed in Equation (6): where $\alpha_{TR,t}$ and $\alpha_{SR,t}$ and are the common base risks for total risk and systematic risk extracted from Equations (4) and (5), respectively; $\varepsilon_{TR,t}$ and $\varepsilon_{SR,t}$ are the residual risk from the decomposition model as depicted in Equations (4) and (5), respectively.

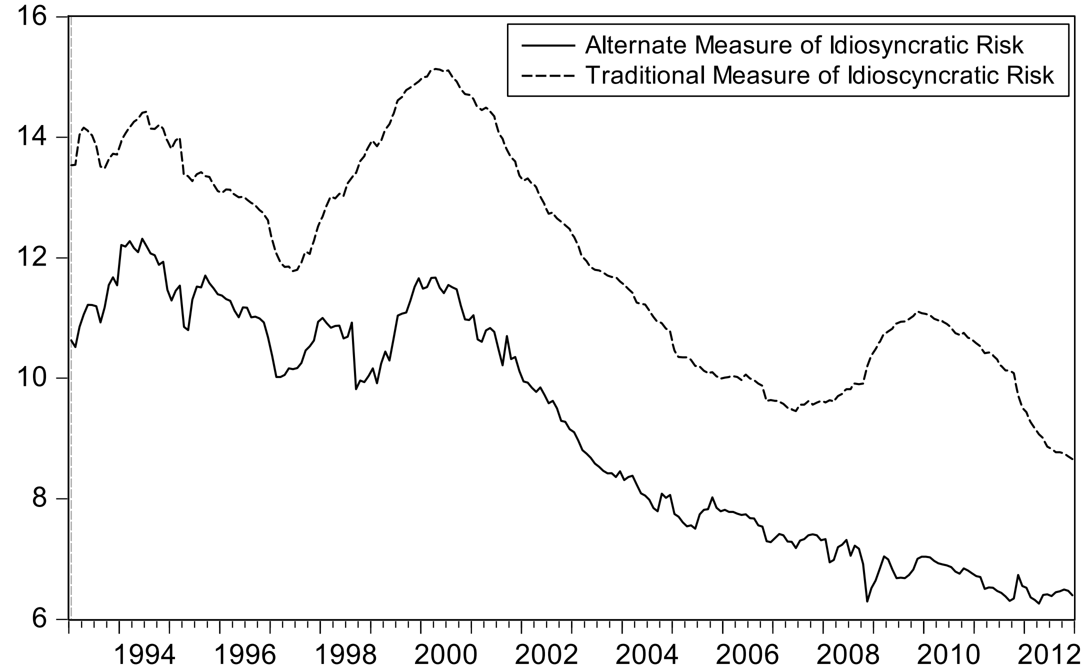

Figure 3. Alternate Measure of Idiosyncratic Risk. This figure plots the time series of cross-sectional average of firm level idiosyncratic risk as proposed in Equations (1) and (6).

4. Conclusions

Drawing from the Heston and Rouwenhorst (1994) decomposition method, this paper uncovers an alternate measure of idiosyncratic risk that is more comprehensive relative to other approaches in the literature. This hybrid approach complements the shortcomings in each model whereby the possible systematic risk factors that are not captured by both models can then be further disaggregated. Doing so will possibly segregate the common force inherited from the conventional measure of idiosyncratic risks to prevent systematic risk from being erroneously assumed as part of idiosyncratic risk, and the findings contribute to the literature in proposing a more exhaustive measure of idiosyncratic risk.

We also uncover the trend of decreasing trend of idiosyncratic risk or increasing trend of co-movement among the emerging markets, spurred by global integration and pointing to the diminishing value of active investment style as there is less alpha to be explore. Further study can focus on inferring the behaviour of this new idiosyncratic risk measure with firm specific factors for the purpose of investment and diversification.

Author Contributions: Conceptualization, methodology, validation formal analysis, writing, M.-H.L., C.-W.H. and R.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Fundamental Research Grant Scheme (FRGS) grant number 203/PMGT/6711253 from The Ministry of Higher Education, Malaysia.

Acknowledgments: The authors acknowledge financial support of Fundamental Research Grant Scheme (FRGS) no. 203/PMGT/6711253 from The Ministry of Higher Education, Malaysia.

Conflicts of Interest: The authors declare no conflict of interest.

Notes

1. Fedenia et al. (2013) also concurs with the theory of under-diversification due to information cost and investors' specialization.
2. The region factor was first found in Brooks and Del Brooks and Negro (2005) by extending the Heston and Rouwenhorst (1994) model. A more recent paper on diversification using an extreme value approach by Chollete et al. (2012) noted that the downside risk differs depending on the region.
3. However, because the variations of residuals are so small compared to the respective factors, it is negligible when coming to a decision in portfolio diversification, and further study can be carried out on the other factors.

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