Feedback on reviewer B’s comments

**1. The authors examine the influence of volatility spill-overs on constructing a portfolio and present an argument for why this additional measure should be used in conjunction with beta to create a diversified portfolio. The authors need to explain why this more computationally expensive process is better than say mean variance optimisation. What is the significance of this method over other “traditional” methods?**

**Reply**

See the following at the end of the first paragraph and the beginning of the second paragraph of the introduction: *In addition, systematic risk still remains even after fully diversifying in accordance with beta. In this regard volatility within and between stocks in a portfolio impacts on the profitability of the portfolio, as well as the portfolio’s overall risk profile. There is a wealth of information that is captured by the price fluctuations of stocks in a portfolio. These price fluctuations also exhibit co-varying properties. Understanding this concept is of utmost importance when a particular economy only offers a limited amount of stocks*.

*Since portfolio managers in smaller economies such as South Africa’s are limited in their choices of stocks, it becomes increasingly difficult to fully diversify a stock portfolio given volatility spill-over effects between stocks listed on the same exchange. In such a setting, using only beta to construct a portfolio that tracks the market or attempts to outperform a market index, may lead to substandard risk weighted portfolio returns, which could have been negated if one considered the impact of volatility spill-over effects during the portfolio construction phase.*

Also note the following under the background section: *Modern portfolio theory (MPT) was developed by Markowitz (1952; 1956; 1959) and various authors in the 1960s, most notably Sharpe (1964), has reshaped the way in which portfolio managers approach portfolio risk (Rubinstein, 2002:1044). In essence MPT started off as a suggestion that portfolio risk is determined by the co-variances of assets included within a portfolio. By the mid-1960s MPT evolved to include the capital asset pricing model (CAPM), which relied on a market related measure of risk, called market beta, to price a portfolio of assets. Empirically, Beta for asset* $i$ *can be expressed as:*

|  |  |  |
| --- | --- | --- |
|  | $$β\_{i}=\left(\frac{σ\_{i}}{σ\_{M}}\right)\left(r\_{i,M}\right)=\frac{Cov(R\_{i},R\_{M})}{σ\_{M}^{2}} ,$$ | *(1)* |

*where* $Cov(R\_{i},R\_{M})$ *is the covariance between the return on asset* $i$ *and the return on the market portfolio. However, CAPM is based on a multitude of underlying assumptions, which includes the efficiency of the market. This market efficiency was presented by Fama (1965; 1970; 1976) as the efficient market hypothesis (EMH), a theory feverously debated in the literature since the early 1970s (Brown & Reilly, 2009). Various studies have indicated that the random walk hypothesis does not accurately hold, because stock prices do exhibit patterns during price development (Jegadeesh & Titman, 1993; Lo & MacKinlay, 1999). This is especially important when considering that stock market anomalies are known to cause serial correlation in returns, providing a different dynamic to portfolio management (Fama, 1965).* *If markets were inefficient to a significant extent, the market measure of risk (beta) could be an ineffective risk measure when constructing an stock portfolio, prompting the use of another measure for such a task.*

*It is therefore not surprising that capital market efficiency have been thoroughly researched, with ample evidence that most developed markets are efficient, but that various anomalies exist. It has been reported for example that markets can never be perfectly informationally efficient (Grossman & Stiglitz, 1980). Information is costly, resulting in prices that do not perfectly reflect the information that is available, therefore leaving some incentive for information-gathering (security analysis) within a market equilibrium model. It is these information asymmetries that cause volatility to be more integrated in the prices and returns of assets. Therefore, in order to effectively price securities, diversify portfolios and hedge portfolio risk, it is important to gain an in-depth understanding of volatility. This understanding should, however, not only be limited to the co-variance in returns (as MPT proposes), but should also encompass the volatility transmission between stocks. It is furthermore important to also look at shorter, and more revealing, intraday returns instead of only focusing on the volatility of daily returns. Since the financial market microstructure reveals so much about the patterns in volatility, it is not surprising that a large body of research has been devoted to understanding it (see Tse & Yang, 2012).*

To my mind this is ample justification to look not only at variance (2nd moment data) on its own, but rather how these data interact when put together in a portfolio. If all stocks were bought and sold in isolation it would be sufficient to consider the variance of each stock in isolation – what mean variance theory suggest. Investors cannot, and do not act in this way. When the investor, or any other market participant, buy stock A, he/she forgoes buying all the other assets in the investment universe. It also happens (very often) that other stock had to be sold in order to buy stock A. It is therefore these intricacies that are better captured by volatility spill-over effects (as seen from the results).

**2a. The research method needs to be expanded upon to clearly take the reader through the various steps in examining volatility spillover.**

**Reply**

Reviewer B makes a valid point. I attempted to rectify this by including the following paragraph at the end of section 3: *By using the AS model in this way, it is possible to measure what volatility was added to each stock by other stocks. This measurement is important since it allows us to make meaningful diversification choices. Should a specific combination of stocks exhibit fewer volatility spill-overs than another combination of stocks, the first combination would be deemed a more efficient portfolio. The results of these tests also allow us a glimpse of the underlying relationship between the stocks in the portfolio. It is this underlying relationship that eventually determines how portfolio variance will change in future.*

**2b.The authors mention that alternate models can be used instead of the one presented, however, they should mention why their model is considered a better fit to the alternatives.**

**Reply**

In order to address this valid concern, I changed the section under further research to: *These findings are based on randomly generated stocks (for which parameters could be fixed), and is therefore only valid in theory. Further research and implementation will be needed to vindicate the performance of a portfolio which utilises volatility spill-overs as an input in portfolio construction. This might be achieved by using other residual based tests to test the validity of volatility spill-over effects on portfolio variance. These testable frameworks may include (but are not limited to) i) a multivariate E-GARCH (Karolyi, 1995), ii) GARCH-BEKK (Maniya & Magnusson, 2010), or the dynamic conditional correlation (DCC) model (Engle, 2002).*

*The current model was however chosen to test the ‘theory’ that volatility spill-over effects do indeed cause portfolio variance. The AS-model used in this instance was therefore ideal for capturing the spill-over effects from the proxy stocks to the original stocks. Expanding on such volatility spill-over results with actual data may require the use of a volatility spill-over index – as done by Diebold and Yilmaz (2009). Such an index could be expanded beyond the stocks within a portfolio, and may even include all the relevant stocks listed on an exchange.*

*Finally, these results can be tested on other emerging markets, or by using larger data intervals (such as daily stock returns), or when market conditions have significantly improved. However, the overall period of testing in this study did include various two-month-periods in which volatility calmed.*

Further justification for the use of the E-GARCH model is also given in the first paragraph under the methodology section: *The wide-spread use of Engle’s (1982) ARCH-type models is based on their ability to capture several dynamics of financial returns, including time-varying volatility, persistence and clustering of volatility, asymmetric reactions to positive and negative shocks and therefore volatility spill-over effects (McAleer & Veiga, 2008:2). More specifically, the E-GARCH model, proposed by Nelson (1991), provides the basis for testing volatility spill-over effects. This specification improves on the standard ARCH-models since it formulates conditional volatility to be a function of both the magnitude and direction of shocks (Samouilhan, 2006:250).*

The Aggregate Shock model we applied was also used by Lin, Engle & Ito (1994). In this paper the authors mentioned that: “... **reveals some interesting results for the models' performance. In terms of the Schwarz criterion, the SE model is better than the other two models for Tokyo overnight returns except for the post-crash period, whereas the AS model works better for New York overnight returns.**”

Since the main aim of this paper was not to determine the best model for measuring spill-over effects – but rather to prove that spill-over effects influences portfolio variance – we mentioned the possibility of alternative models only as a later test for robustness of the results.

**3. The authors should address the following points:**

**a) Correct the numbering of each equation and make mention of the appendix (or remove entirely).**

**Reply**

We would like to thank reviewer B for pointing this out. The appendix and numbering are relics from a previous version of this paper that should not still be there. It was removed.

**b) In Equation (2), what is the independent variable S? Does this represent the share price? Return?**

**Reply**

Yes, independent variable S is indeed the return series – 1 period back.

**c) Further, the authors need to motivate why the error term in that equation instead of the constant term captures unanticipated factors that influence B's return. This point is crucial to the rest of the methodology. If the error term and constant essentially capture the same effects, then the rest of the methodology needs to be revised.**

**Reply**

Since the Aggregate Shock model is not new (see Lin, Engle & Ito, 1994) we did not think it necessary to dig into the details of the model specification. This was done to save valuable space, and not exceed the maximum length the journal requires. If off course the editor agrees with reviewer B we will be happy to explain how the model works in more detail.

**d) The equations for the EGARCH process need to be revised. The authors have presented an EGARCH(1,1,1) equation yet specify that it is an EGARCH (p,q) model (which in itself is not correct).**

**Reply**

Reviewer B is correct off course. These mistakes slipped in and were fixed.

**e) Conceptually, the authors need to explain why the error term in equation (2), e(t), is normally distributed. This assumption seems at odds with the concept of capturing unexplained factors that influence B's returns.**

**Reply**

Reviewer B is correct. I am so used to apply GARCH models in another context that it slipped my mind to not say that the error term is assumed to be normally distributed. I apologise for this obvious error, and would like to thank reviewer B for pointing this out.

**f) What is the reasoning behind including the h(b,t) volatility term in Equation (5)? Why is the logarithm of this variable not taken instead?**

**Reply**

I am not sure why reviewer B asks this question. To my mind the following 2 sentences on page 6 (after equation 5) explains why the term was included.. “*The model specification of the variance of stock* $A$ *in equation 5 includes an alternative stock (stock* $B$*) measure,* $h\_{B,t}$*, which allows for explicit testing of the relation between stock* $A$*’s volatility and stock* $B$*’s volatility. The* $κ\_{i}h\_{B,t}$ *term in equation 5 is stock* $B$*’s conditional variance term, and denotes the relation between stock* $A$*’s volatility and stock* $B$*’s volatility.*”

**g) Why is a Monte Carlo simulation conducted? The authors need to motivate what impact this would have on their results. At a cursory glance, I do not see any potential impact of not running this simulation. Further, what are the parameters of the simulation?**

**Reply**

Once more I am not sure why reviewer B asks this question. The first paragraph under section 4.1 explains the reasoning behind the Monte Carlo simulation: “*In order to test whether volatility spill-overs between stocks play a noticeable part in overall portfolio risk, it is necessary to create proxy stocks of each stock within the portfolio during a given period. A Monte Carlo simulation was utilised in generating each of the proxy stock’s returns. This involves a stochastic process that, given the probability,* $p$*, simulates random returns with a given mean,* $μ$*, and standard deviation,* $σ$*. The purpose of the Monte Carlo simulation is to provide a proxy stock with characteristics that exhibit (approximately) identical returns and risk to the actual stock it replaces within the portfolio (during a particular period). In reality it will be difficult to find stocks within a market that replicate another stock’s mean and standard deviation. In order to test whether volatility spill-over effects do play a role in the overall risk of the portfolio, it is imperative that proxy stocks are used that replicate the actual stocks’ mean and specifically their standard deviation*.”

**h) The statement on Page 9 about the volatility of the original stocks being higher than their proxies is somewhat confusing. If the proxy stocks have the same return and standard deviation, how can the volatility be higher?**

**Reply**

Reviewer B is correct, this is confusing. The sentence was changed to: “*The skewness of each of the original stocks are fairly high when compared to their proxies*.” It is the portfolio volatility that is higher when the original stocks are included instead of the proxy counterparts. I apologise for this mistake and thank reviewer B for pointing it out.

**i) How are the portfolios constructed? Are the stocks equally weighted or value weighted? What impact does this have on the results?**

**Reply**

We would like to thank reviewer B for pointing out this shortcoming. For the purpose of testing the impact of volatility spill-over effects we constructed an equally weighted portfolio. I also added this information under section 4.1.

**j) It is recommended that the statement about irrational investor behaviour due to the Haiti earthquake or Greece downgrade be either reworded or removed.**

**Reply**

The references to these two events were removed.

**k) At first glance, it is odd that if the proxy stocks have the same return and standard deviation as their original counterparts, then this results in a portfolio that has a different standard deviation but identical return when they are used instead of their counterparts. The authors highlight this in a statement on page 11. However, this needs to be explained.**

**Reply**

The following was included to clear up any misunderstandings:

“*The reason for this phenomenon lie in the way standard deviation is calculated. In essence, standard deviation is the average of all the deviations from the mean. In mathematical terms it is therefore possible to have two series with identical standard deviations but very different distributions. Because of this anomaly, the various stocks in the original portfolio impacts differently on each other when compared to their proxies*.” – page 11-12

**l) While the authors mention that future research should be aimed at more stocks, it is recommended that a short discussion be included as to the practical interpretation of their results. In other words, why does it (does it not) make sense that Anglo American and Standard Bank stocks have a volatility spillover effect.**

**Reply**

The following was included to enrich the conclusions drawn from this paper: “*The fact that these volatility spill-over effects amongst the original stocks occur so consistently is evidence of the interconnectedness among stocks on small exchanges like the JSE. Many of these stocks are traded together as part of larger portfolios. When market sentiment changes on a global front – such as negativity about developing economies – the returns of these stocks tend to together. This is also visible in the second moment data. As a result, the volatility spill-over effects among these stocks will also be pronounced if the interest in them is similar.*”

**m) Lastly, as this study is heavily based on the EGARCH model, it is recommended that stationarity tests be conducted as well as model diagnostics on the resulting EGARCH models. While the coefficient(s) may be significant, it does not imply that the model form is correct.**

**Reply**

Reviewer B is off course correct. Care was taken to select the appropriate EGARCH models for every set of stocks tested. Please see the explanation on page 12: “*The AS model allows one to formally test the relationship of both returns and volatility on the stocks within each five-stock portfolio. As is custom in the finance literature, various lag specifications were estimated for each stock within each portfolio, with the appropriate lag specification for the E-GARCH(*$p,q$*) term chosen where the Akaike information criterion (AIC) and* *Schwarz criterion (SC) values are minimised. These criteria allow for choosing the appropriate aggregate shock model for each one estimated*.”