



The end of rational markets: financial econometrics in a behavioural world

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In good times, financial econometrics can seem to work well but they are often found wanting when a financial crisis arises. Here we assess why this happens, and suggest a change in the way risk models are developed.

The development of financial econometrics

In the last few decades, the technological revolution combined with the globalisation of the capital markets has supported the increasing use of quantitative modelling. Economic models combined with sophisticated statistical methods have been used to try to solve many problems in finance. Such modelling has enabled the creation of an ever increasing range of new financial products. Quantitative modelling is used in such diverse areas as trade valuation, portfolio optimisation, hedging, algorithmic trading and risk management.

Many of the popular financial econometrics used nowadays arose from an assumption of efficient rational markets proposed in the 1960s by people such as Fama and Samuelson. Using these assumptions, statistical models commonly based on normal distributions were incorporated into risk measures such as VaR and option trade valuation models like Black-Scholes.

By assuming efficient rational markets, it is possible to infer statistical properties of future market behaviour from quantitative models using historic market data. In other words, such models assume there is stability in the statistics that can be drawn from recent historic data. The ultimate criteria for evaluating a quantitative model has been how well the model has performed in empirical tests

i.e. whether the model gives good estimates of the future market statistics.

Participants in financial markets have become increasingly reliant on quantitative modelling for several reasons

- To create more business through new financial products
- To enable more sophisticated trading methods
- To comply with regulatory requirements
- To comply with internal risk management “best practice”

We are now at a point in time where quantitative modelling is an intrinsic part of the financial markets. Market decisions are increasingly made based on the outputs from quantitative models.

For example, investment managers will trade with a specific risk/return appetite based on the predictions for optimised risk/return from their quantitative models. Recent historical statistics can show a lower than usual volatility for a particular return. In this situation such quantitative models can encourage investment managers to take bigger positions in such low volatility assets even though there are pressures for the volatility to increase significantly. In times of calm, the investment manager gets their bonus from being assessed on taking risk measured on recent calm market volatilities, rather than the real risk that includes the stressed market state.

Quantitative models in such cases have not helped market stability, and in fact accentuate asset price imbalances.

The creation of structured products, only possible with developments in financial econometrics, has a positive benefit to society in creating markets for new areas of risk. But there can also be negative aspects to structured products, as it has also allowed the creation of opaque instruments that have hidden or 'hard to assess' risks.

Basic risk measures such as VaR, supported by the Basel Accord, are now commonly used. Regulatory capital rules are generally seen as a restriction on business, as are other risk controls. This has led to changing patterns of trading to overcome these restrictions. For example, the comparatively low regulatory capital charge for credit risk in the trading book encouraged banks to take on more credit risk in the trading book.

Financial Econometrics in times of crisis

Although there has been a move away from the assumption of efficient rational markets, risk managers are still left with a set of risk metrics based on this assumption and the related inference of stability in the statistics drawn from historical data. As such many risk models incorporate normal probability distributions and stable asset correlations. In times of market calm, such models work reasonably well, but in times of financial stress the statistics used by such models can commonly break down. Even when non-normal

probability distributions and variable correlation are incorporated into the risk model such as for VaR calculated using historic simulation, problems can arise. For example, many banks using historical simulations to calculate VaR in the 2007 crisis found their back-testing exceptions increased dramatically as the crisis developed.

Financial stresses occur regularly and are often accompanied with very large market asset price movements and a big rise in correlations and are therefore not insignificant events as normal probability distributions suggest.

Regulators deal with these limitations in financial econometrics by using stress tests. They expect financial institutions to use stress tests to regularly monitor and be prepared for the effects of market stress. The recent financial crisis triggered a large push by regulators to implement stress tests that incorporated recent market worries like further house price falls. This was with the aim of trying to identify the potential risks at many banks and the capital that was required to cover these risks. This clearly showed the limitations of existing financial econometrics in their inability to be used to identify risk under stressed situations.

There have been developments in quantitative modelling that have moved away from the assumption of rational efficient markets, such as extreme value theory. Although these are progressive, they have not been widely used or accepted. This is because of the rare and inconsistent nature of extreme events, and drawing statistics from them.

Current Debate

Although there has always been criticism of the use of quantitative models in risk management, the importance of the problems was highlighted in the recent financial crisis. Even the regulators have raised criticisms. The *Turner Review*, a regulatory response to the global banking crisis published in March 2009 highlighted misplaced reliance on sophisticated maths as a casual factor in the global crisis. It also questioned the ability to use statistical models based on observed historical markets to infer statistical properties about the future. Such criticisms are reasonable, and are not suggesting the end of the use of quantitative models. They are highlighting clear problems that need to be addressed.

It can be argued that popular short term risk measures such as VaR, encourage investment in assets that have shown recent low volatility and low correlation. The investment in such assets can be accentuated as the whole market uses the same type of risk assessment i.e. volatility and correlation. In this case, such assets can become overvalued, and this leads to a large price fall later. Research has shown (Bolton, 2009) that this behaviour holds in modern day markets i.e. a contrarian trading policy (where users invest in equities not favoured by market sentiment) would be most successful.

One property that has been lacking in popular risk measures is how to identify when a financial asset is under stress. Recent statistical analysis of particular asset returns may show low volatility, and low correlation with other financial assets. Yet if we were able to look into a

crystal ball, in the next few weeks the price may crash along with a whole sector of financial assets. Risk metrics like VaR and Expected Shortfall would not help highlight the oncoming asset price crash in this situation.

Authors such as Sheedy, have countered criticism of quantitative models by apportioning blame to users. The suggestion is that the output from risk models can be used if the assumptions and limitations of the models are included correctly in the trading decision making process. Furthermore, such authors have countered criticism of commonly used risk models, by suggesting the use of models with better empirical results.

The problem of passing responsibility of how models are used to users is that quantitative models are offering a benefit with a fundamental limitation. These models offer statistical predictability that is limited in that the predicted statistics can on occasion be very wrong. In this situation it is not reasonable to judge the user on how they incorporate the risk model outputs into their trading operations. Otherwise the user can be blamed for any failure, regardless of them using or ignoring the risk model outputs i.e. they are being expected to know when the risk model will produce reasonable predictions and when they will not.

Deflecting blame to users seems to be avoiding responsibility rather than facing the problem. Users need to be able to work with the models and have their own inputs in the model so that the prediction is a best combination of user intuition and statistical analysis. Clearly there are issues with commonly used quantitative

models such as VaR. If by definition a risk measure like VaR represents the “value such that the probability that the mark-to-market loss on the portfolio over the given time horizon exceeds this value is the given probability level” then it is a statistical prediction and a prediction which on occasion fails. As users have no input in the VaR model (the figure is completely produced based on statistical analysis), the only choice the user can make in the process is whether the VaR figure produced at the end is reasonable or not. Users should not be blamed for making decisions based on unstable statistical results. Having knowledge of the assumptions and limitations of VaR would not help the user in making a business decision. What would help the user are quantitative models that make supportable statistical assertions.

A new direction

The current problems in risk modelling seem to stem from a fundamental misunderstanding as to the nature of market behaviour. Market behaviour, rather than being rational and totally random, shows trends, cycles and patterns in addition to randomness. The statistical properties of market price changes can change depending on the belief of the market participants. Historic statistical properties of markets such as volatility and correlation may have some stability in peaceful states of the market, but can break down at times of market stress.

Statistical analysis holds for other areas of business such as life and health insurance, because the statistics are based on probability distributions that are reasonably stable. Asset price changes and other related risk drivers such as

interest rates do not have stable probability distributions. They change due to fashions and trends, as such behavioural influences.

For users to have confidence in quantitative models, the assertions for the outputs of these models should be clear and supportable. The fundamental assertion made by the current popular risk models is that they can predict future market statistics, which is not reasonable. To regain confidence, there should be a clear distinction between quantitative models used for modelling the future and models used to analyse historic data. Quantitative models used for analysing historic data should only highlight statistical properties of the historic data. Quantitative models used to model the future should take the form of stress tests, where it is clear there are no statistical assertions about the output of the model. Potential inputs to be stressed can be identified from the historic quantitative models.

Regardless of the existence of quantitative models, all market participants have some kind of model in their mind of how they think the current environment will affect future market prices. These models affect their trading decisions. The use of future looking quantitative models to support this process will enable more inputs to be dealt with.

One aspect of quantitative modelling that is ignored is the effect that the models themselves have on the market. Quantitative models produce outputs that feed back into the market pricing process. In this way, there is a feedback mechanism whereby the historical

statistics used by a model have been affected by the model itself. An implicit assumption of popular quantitative modelling is that the historical statistics are drawn from a closed system. This assumption is fine if the market is efficient and rational but as we have discussed earlier this assumption is becoming increasingly discredited. Asset prices are affected by behavioural processes.

If we assume quantitative models affect market behaviour, then models should be developed that encourage stable behaviour by market participants. In a similar way, government agencies such as the Bank of England are increasingly careful about the type of statistics that are released and the message released with them. This is done in an attempt to have some control over the markets and stabilise market sentiment. Market belief and sentiment are important in determining future market behaviour.

Behavioural Modelling

The allure of modelling based on rational efficient market behaviour is understandable. The beauty and complexity of quantitative models that have been developed based on this assumption have been appealing. As is the idea that it is possible to get some hold on the statistical properties of future market behaviour. But as the belief in rational efficient markets declines, the use of such models should also decline. In their place, there will probably be more pragmatic and less idealistic models. These will give better insight into the behavioural processes at play in the market.

One of the aims of a quantitative model is that it gives a good representation of how the economic factor in question, such as asset price, performs in different market scenarios. As such, empirical testing of quantitative models is still important. This is especially important for use in future looking modelling through stress testing. Even though empirical testing is still important, a distinction should be made that success in such tests does not support the assertion that the output from the model is predictive. Responsibility for a prediction should still lie with the user, not the model itself. Authors such as Taleb have highlighted the problems of using empirical testing to assert predictive power. Empirical tests are prone to use of selective data, and miss 'black swan' scenarios.

By relaxing the assumption of rational efficient markets, risk models can incorporate any parameters that affect market behaviour. One outcome of this is that it opens up an area of investigation into the assessment of intrinsic asset value. This would highlight when market behaviour is causing asset prices to deviate from intrinsic value. Such models could include inputs such as accounting ratios, but may also be any quantitative or qualitative data affecting market sentiment.

Another area of analysis that was previously closed in a rational market world, was the investigation into patterns or trends in behaviour within and across markets. Contagion modelling highlights recurring patterns in the movement of asset correlation changes due to particular asset price stresses (McWilliam N, Loh K, 2009). These models encourage users to change cyclical

behaviour, thus smoothing out such patterns. Market behaviour has clearly shown trends that have appeared and faded away again (Marquering, Nisser and Valla, 2006).

There has been research (Lo A, MacKinlay A, 2001) that showed that people tend to see more patterns in data than actually exist i.e. there is more randomness than expected. This shows quantitative analysis can be helpful in distinguishing between random and non random patterns in market data.

There has been much recent talk about regulators introducing pro-cyclical capital charges. The set of metrics used to identify an asset price cycle or economic cycle will have to be determined for this to happen. These key parameters will be helpful in developing risk models that support market stability.

The move to focus on behavioural modelling also opens up the issue of diversity in behaviour. The current trend in increasing globalisation has led to decreasing diversity in the behaviour of market participants. This means there is a trend for market participants to react in increasingly similar ways across global markets. The possibilities of diversifying risk by finding markets that act more independently are diminishing. As diversifying risk is important, it may in the future be an aim for regulators to encourage diversity through the use of different quantitative models.

Another possibility is the increased use of financial econometrics in price setting. Behaviourally, it is usual in price setting to take into consideration a subset of the actual factors affecting price, those

factors that are currently in fashion in the market at that moment. This is reasonable as human processing can only consider a limited number of factors at a time. Over the course of time, the importance of each factor in relation to affecting the price changes. Some factors drop out of consciousness, other factors appear again. Quantitative modelling of prices can help overcome the limitations of human price setting by including a wider set of factors than can be dealt with personally. In addition, statistical analysis can be used to give more realistic weights to the effects of risk factors on asset price at a particular time.

Conclusion

The use of quantitative models has proliferated over the last few decades, driven by the revolution in computing technology and globalisation of the capital markets. This trend has stalled with the onset of the recent financial crisis. There is now more debate about the use of quantitative models in risk management. It is doubtful the recent emphasis on short term risk measures can continue, as these exacerbated the current financial crisis. Most of the economic models used have assumed the efficient rational behaviour of market participants. Based on these assumptions, statistical methods used to implement these models asserted future statistical properties. In practice statistical predictions from quantitative models are unstable, especially in times of stress.

Future financial econometrics may move away from the limitations of modelling financial behaviour based on rational efficient markets. Rather than conforming to statistical analysis, financial behaviour

is in an ever changing state. Statistical analysis is still useful though, as techniques such as contagion modelling can be used to highlight stresses, patterns and randomness in historic market data. This information can be fed into future looking quantitative models running stress tests. These practices should help highlight actions that need to be taken and dampen extreme behaviour. Instead of empirical verification being the most important test of a financial model, the ultimate test is its use in analysing historical behaviour and initiating action to control extreme behaviour.

References

Turner A, 2009

The Turner Review: A regulatory response to the global banking crisis
FSA

Sheedy E, 2009

It's NOT the econometrics, stupid
Risk September 2009, pages 106-109

Bolton A, 2009

Investing Against The Tide
FT Prentice Hall

Marquering W, Nisser T, Valla T, 2006

Disappearing anomalies: a dynamic analysis of the persistence of anomalies
Applied Financial Economics, 2006

Lo A, MacKinlay A, 2001

A Non-random Walk Down Wall Street
Applied Financial Economics, 2006

McWilliam N, Loh K, 2009

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Dependencies in the Valuation of Credit
Derivatives*

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