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THE LOW BETA PUZZLE

A REPORT PREPARED FOR THE ENA

05 MARCH 2024

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Executive Summary

Frontier has been commissioned by the ENA to provide our view on whether, given how beta estimates may be employed with the UK regulatory approach to populating CAPM, they are likely to lead to emerging forward looking energy network business risk being captured within Cost of Equity (CoE) estimates.

This report is not sector specific.

The low beta puzzle

Following the COVID-19 pandemic, the ongoing Ukraine war and reversal of monetary Quantitative Easing (QE) to tightening, there is a widespread sense that global investment risks have heightened. The same is true of risks faced specifically by energy networks, as in addition to macroeconomic events, tight supply chains and inflationary pressures are bringing heightened cost volatility and delivery risks at a time when these networks are being asked to support the challenge of achieving net zero. In this context in RIIO-3:

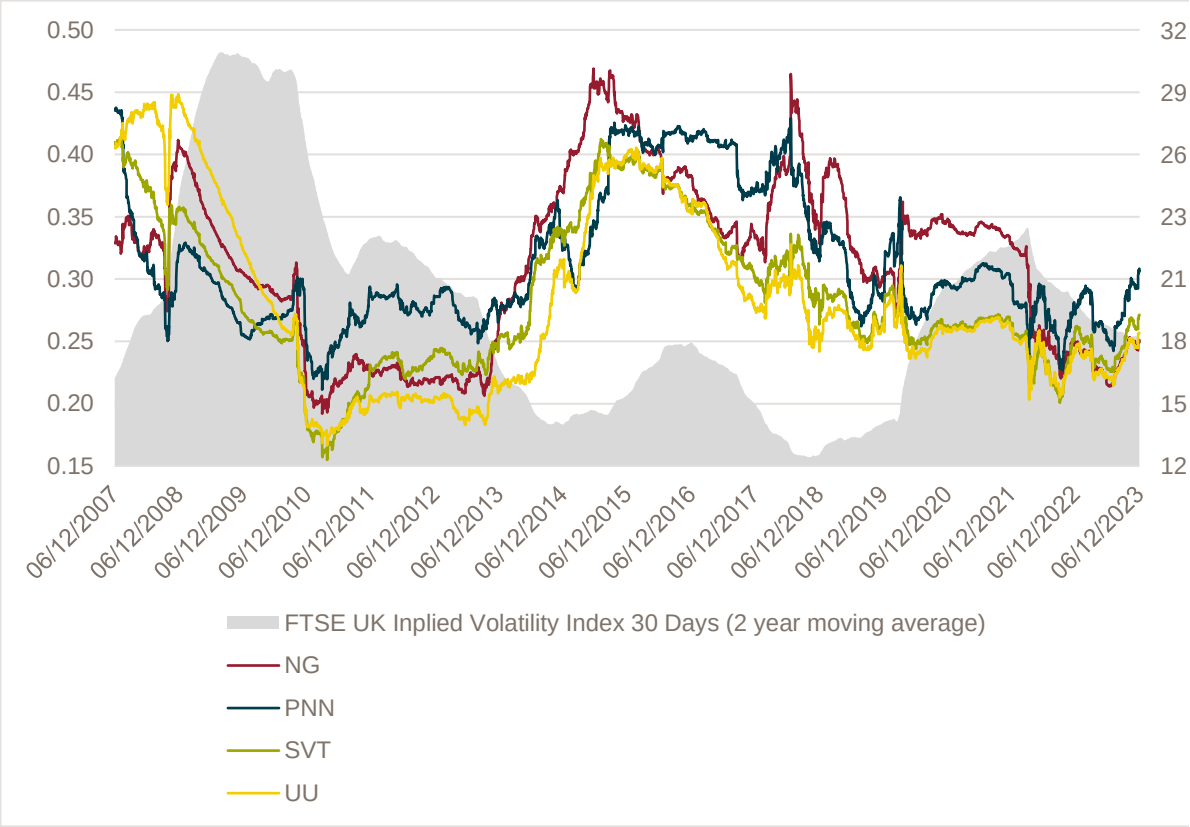
- electricity networks being required to deliver large investments in network capacity and capability to support the path to net zero; and
- gas networks being required to maintain a safe and reliable network while facing the risk of decreased consumption and stranded assets/decommissioning risks, and the potential challenges of transforming their assets to serve future alternative gas/heating vectors over an uncertain proportion of their network.

One would expect these emerging risks – which could crystalise during the RIIO-3 period – would now start to be "priced into" the recent beta estimates of utility stocks, if they prove undiversifiable. Yet, despite this context, empirical estimates show that utility betas have not increased since RIIO-2, which is puzzling to say the least (although betas have begun to rise in recent months). We refer to this as the "low beta puzzle".

High market volatility and beta

Formulaically, the level of utilities' beta is inversely related to market volatility, i.e. the higher the market volatility, the lower the beta. Unless the volatility of an individual stock increases at a greater rate than the level of market – which will not be the case for defensive stocks including utilities – measured betas will fall when market volatility rises. Figure 1 shows estimated betas over a rolling 2-year estimation window alongside market volatility derived from a 2-year moving average of the implied volatility index derived from options.

Figure 1 30d implied market volatility and (unlevered) utility betas estimated using a 2-year estimation window



Source: Frontier Economics based on Bloomberg data

Note: [Insert Notes]Daily frequency of the underlying data for beta estimation. We consider a 2-year moving average of the VIX index as the VIX index is inherently forward-looking, while betas are inherently backward looking. Using a 2-year moving average attempts to 'match' the appropriate time period of market volatility to the beta estimation windows.

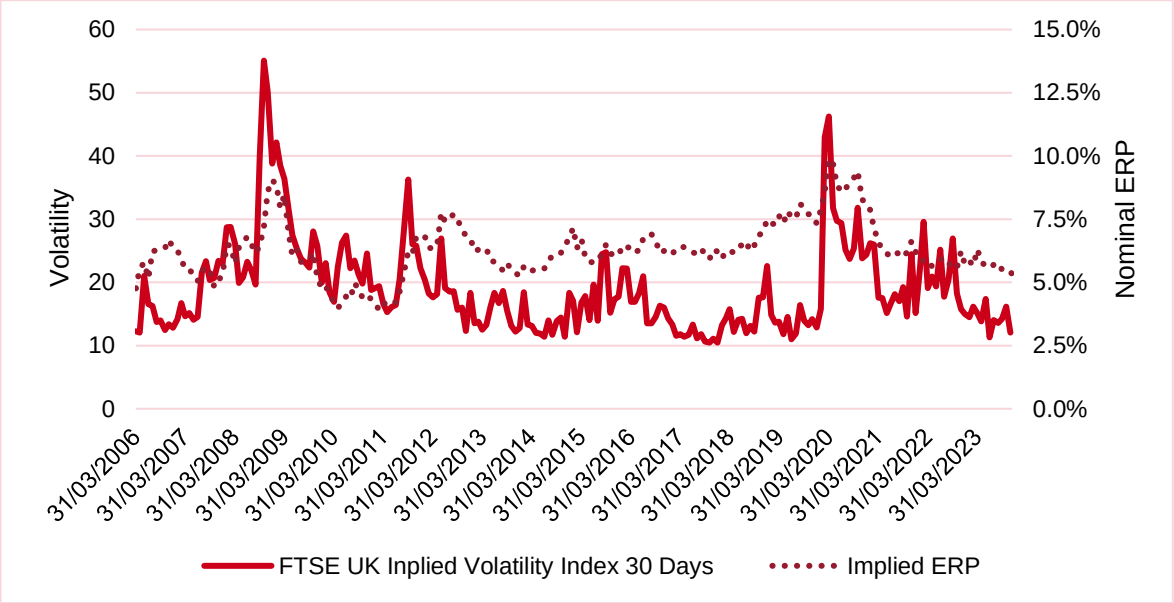
The effect of volatility is clear. In periods where market volatility has been high, betas of the four UK listed utility stocks are low. Based on the figure, we observe that there have been two such periods of notably high volatility during the period of analysis, during the Global Financial Crisis (GFC), and during the period affected by the Covid-19 pandemic and Russia's invasion of Ukraine.

High market volatility and Equity Risk Premium (ERP)

In times of high market volatility, it would be logical to expect the required equity risk premium to be higher than normal. Typically, markets are more volatile than usual precisely because of higher uncertainty than usual, i.e. high market volatility is typically a symptom of heightened risk. This relationship can be confirmed empirically, as show in the chart below, which shows implied volatility alongside the implied ERP estimated using a Dividend Discount Model with

market data. This relationship has also been observed by the Bank of England in a study conducted in 2017.[1]

Figure 2 Relationship between ERP and volatility



Source: *Frontier DDM analysis, Bloomberg, Bank of England*

Note: *The implied ERP shown in the figure above is derived from a market-wide DGM approach. We first estimate the forward-looking required total market return using a market-wide DGM model. Then, we estimate the implied ERP by subtracting the yield on a nominal gilt with a 20-year maturity.*

The danger of a mismatch

For the reasons set out above, during periods of high volatility, utility betas will tend to fall, while ERP will tend to rise. If both effects are captured in an assessment of the applicable CoE, then arguably it would be at least internally consistent to combine these in a short-term forward-looking estimation of cost of equity during periods of high volatility.

However, in the context of the prevailing approach to setting allowed returns in the UK, this could present a problem. When setting the allowed equity returns, regulators have preferred to rely on a construct where Total Market Return (TMR) is stable, albeit not fixed. UK regulators typically estimate the TMR and risk-free rate independently and directly, and then infer the ERP as the difference between the two. The implication of this long run approach is that the ERP in regulator's CAPM formula moves in the opposite direction of the risk-free rate. Since risk-free rate (typically proxied by yields on gilts) has risen materially in recent years, and since TMR will not increase one-for-one with RFR, within the UK regulatory construct, the inferred ERP will fall significantly.

[1] Discussed in Section 3

So at this time, when analysis of volatility suggests that it would be appropriate to assume that ERP needs to increase, the regulatory construct used by UK regulators without adjustment will instead impose an implicit assumption that it has *decreased*. This creates a real risk that required returns are underestimated. Viewed differently, the gilt yield has increased around 3.5 percentage points since RIIO GD2/T2, which means that the allowed TMR would have to increase materially more than 3.5 percentage point for the ERP to increase compared to GD2/T2 (a TMR of more than 10% in CPIH-real terms). It is clear that the effect of using beta estimates under high market volatility within the standard GB regulatory methodology would under-estimate the cost of equity.

We also note that some academics and practitioners take an even stronger view around the dangers of using betas estimated during periods of high volatility – it has been argued that these betas should not be used at all.

Consequences for RIIO-3

The low beta puzzle is likely a result of high market volatility. This creates two potential issues, i) when combined with an ERP estimate that is not forward-looking (so as to reflect high market volatility) the result would under-estimate the cost of equity; and ii) some would argue that the beta estimate itself may be unreliable owing to high volatility, even if paired with an appropriate ERP.

Our paper brings together concerns around beta with concerns around ERP, as part of the solution to this problem may come in the form of making changes to the policy surrounding setting the TMR (and hence, ERP). In effect, Ofgem needs to consider whether its overall assessment of CoE, stemming from its choice around beta and TMR, is sufficient when taken together.

Ofgem will need to take extra care when choosing a beta estimate for RIIO-3. Many of the shorter estimation windows are likely to be affected by estimation issues, and it would be wise to place as little weight as possible on periods of high market volatility. Of the candidate set of standard estimation windows, this consideration would point towards maximising reliance on 10 year betas at this time, although, if market volatility levels continue to tail off, then 2-year estimates may prove potentially less problematic down the line, subject to the usual due diligence around potential distortions.

One concern with this reliance on 10 year betas however, is that 10 year betas are least likely to take appropriate account of emerging risks pertaining to the RIIO-3 period, i.e. this emerging risk will be heavily diluted by use of 10 year betas, if such risks have only begun to be priced in recently. So, while considerations around volatility dictate that one cannot rely on 2 and 5 year betas at this time, this then raises the question as to whether 10 year betas, while largely clear of volatility problems, may require uplifting to better reflect crystalising sector forward looking risk. Logic suggests that an uplift of some kind is necessary, and we take the view that this should be considered an open research question for the rest of the RIIO-3 process.

1 Introduction

Frontier has been commissioned by the ENA to comment on prevailing estimates of beta. In particular we have been asked to provide our view on whether, given how they may be employed with the UK regulatory approach to populating CAPM, they are likely to lead to emerging forward looking energy network business risk being adequately captured within CoE estimates.

Following the COVID-19 pandemic and the Ukraine war, there is a widespread sense that global investment risks have heightened. The same is true of risks faced specifically by energy networks, as in addition to macroeconomic events, tight supply chains and inflationary pressures are bringing heightened cost volatility and delivery risks at a time when these networks are being asked to support the challenge of achieving net zero. In this context in RIIO-3:

- electricity networks being required to deliver large investments in network capacity and capability to support the path to net zero; and
- gas networks being required to maintain a safe and reliable network while facing the risk of decreased consumption and stranded assets/decommissioning risks, and the potential challenges of transforming their assets to serve future alternative gas/heating vectors over an uncertain proportion of their network.

One would expect these emerging risks -which could crystalise during the RIIO-3 period - are starting to be "priced into" the recent beta estimates of utility stocks, if they prove undiversifiable. Yet, despite this context, empirical estimates show that utility betas have not started to increase, which is puzzling to say the least. We refer to this as the "low beta puzzle".

This puzzle raises the practical question of whether these recent beta estimates should be considered for estimating the cost of equity in RIIO-3, and whether there are better alternatives / estimates which should be considered instead.

In this report, we explore a potential explanation for this "low beta puzzle", related to market volatility, and potential remedies. We will cover the following:

- In section 2 we begin by setting out in more detail the wider macroeconomic events highlighted above, and also the sector specific risks being faced by networks.
- Then in section 3 we explore:
  - how volatility may be distorting beta estimates at present;
  - how volatility factors may also drive the equity risk premium; and
  - how these factors might need to be accounted for to ensure that the overall cost of equity reflects increased market risk.
- Section 4 sets out our conclusions and proposed remedies that Ofgem could use in RIIO-3 estimations to address the low beta puzzle.

2 The low beta puzzle

2.1 Market context

There is consensus that overall business risk has increased since Ofgem's RIIO-2 price controls. From a macroeconomic perspective, the COVID-19 crisis followed by the Ukraine war have had large impacts on world-wide economies. The pandemic and associated lockdowns caused severe recessions, which led governments to introduce numerous policies to support businesses and households in order to mitigate the negative economic impacts. The Ukraine war which followed brought additional challenges, as supply chains for critical commodities and goods (such as food and energy) were disturbed and costs increased dramatically. In the UK, inflation rose to levels that had not been observed since the 1980s. This has led interest rates to sharply increase as shown in the figure below.

Figure 3 Bank of England base rate expectations since the RIIO-T2/GD2 FD

Source: *Bank of England*
Note: *Based on instantaneous forwards*

In this environment, it is easy to see that, compared with a lower interest rate environment, investors will be seeking higher returns before deploying their capital, in the face of both rising interest rates and evidence of higher global risk.

2.2 Sector specific risks

In addition, energy networks face a material degree of policy uncertainty with regards to Net Zero, bringing with it a raft of real world consequences.

All energy networks are facing tight supply chains and inflationary pressures, which will bring heightened cost volatility and delivery risks.

At the same time, electricity networks are facing investment programmes of an unprecedented scale, to unlock the renewable generation and sector electrification required to achieve net zero. This step change in investment will exacerbate existing supply chain constraints and wider inflationary pressures. The electricity grid is also facing uncertainty over exactly what to deliver where, and over what timescale. While the scale of the investment programme is known to be large, exactly how large, and the exact make up of it, may not be known in all cases until later. Networks will need to complete pre-development work on numerous projects so they are ready to go if/when needed, manage supply chains to deliver against that uncertain scope of work and then, once decisions are finally taken, deliver those projects on time and at cost. In this regard, TOs are facing tough delivery targets and additional risks of licence breach under the ASTI framework. While TOs are used to managing the delivery of very large projects, ASTI has introduced new risks and the sheer scale of delivery during RIIO-3 will be unprecedented and is likely to increase existing risks

Gas networks face their own set of parallel sector risks. Gas networks must continue to invest in order to maintain a safe and reliable gas supply while customers remain on the network – and under all of the current FES scenarios gas networks continue to play a pivotal role for decades. Yet there is substantial uncertainty over future gas demand trajectories and supply patterns, and where and when parts of the grid will need to be decommissioned. Networks still face a growing risk of running out of customers before it is possible to pay down all of the RAV. The risk of asset stranding has been recognised in Ofgem's SSMC which acknowledges that *"if material, this perceived risk could result in investors seeking compensation via the cost of capital for the gas networks."*[2] While Ofgem is exploring options for reducing stranding risk, such as adjustments to asset lives and depreciation profiles, it has acknowledged that it does not have the tools necessary to provide complete comfort to investors.

All of the factors above would indicate a higher level of risk, and therefore a higher cost of equity for energy networks at RIIO-3, compared to RIIO-2. However, the market data shown in the next section would appear to suggest that beta estimates for Ofgem's beta comparator set have not increased since RIIO-2, and therefore, may not reflect these emerging risks.

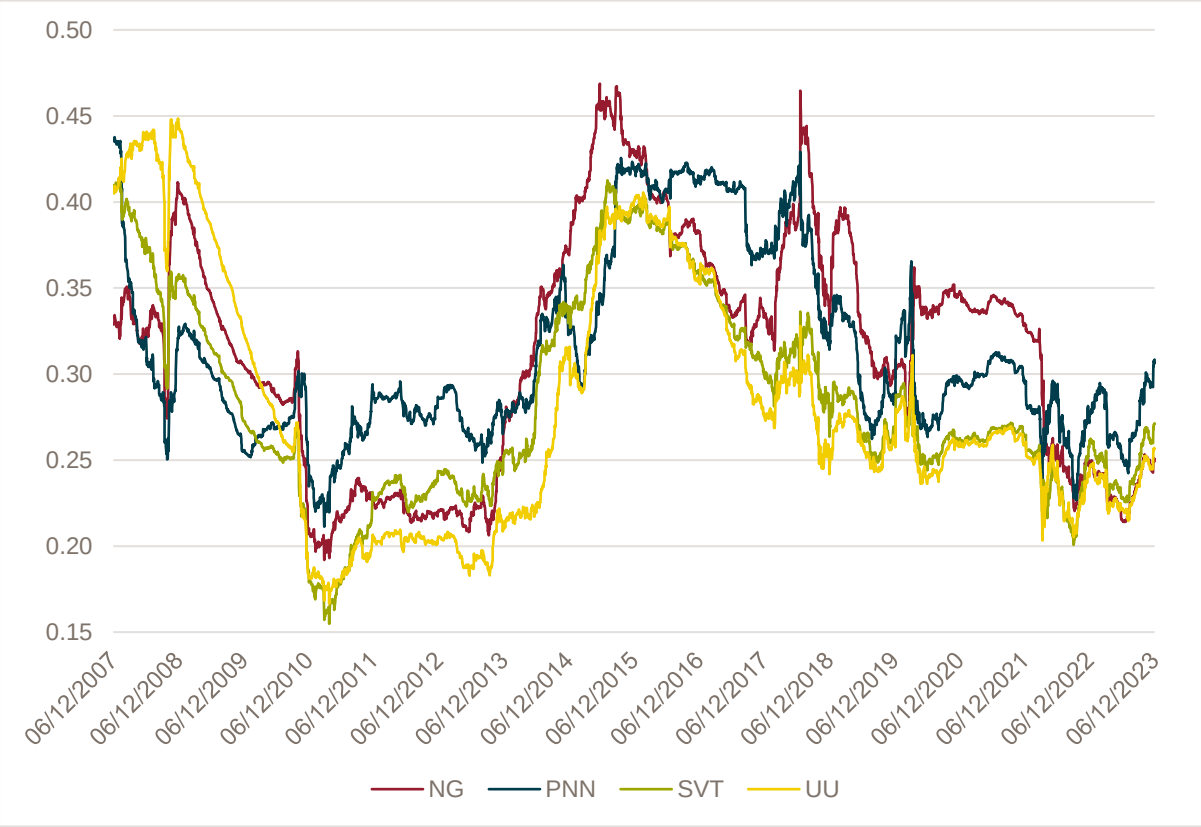
2.3 Beta estimates

Despite the assessment of risks set out above, beta estimates have not increased in the recent past, as shown in the figure below. The figure shows short-term beta estimates of the three, publicly traded, regulated water networks in the UK (Pennon Group, United Utilities and Severn Trent Water Ltd) as well as National Grid since 2007.[3]

[2] Ofgem (2023) RIIO-3 Sector Specific Methodology Consultation: Finance Annex, 8.12.

[3] We note that this is the peer group used by Ofgem to determine the beta level applicable to energy networks in the UK

Figure 4 Utilities unlevered beta estimates using a 2-year estimation window



Source: Frontier Economics based on Bloomberg data

2.4 The low beta puzzle

As betas are a measure of risk, it seems counterintuitive that the betas of utility stocks have not increased, even though sector risk and overall market risk exposure have increased due to clearly attributable events. There is therefore, a “low beta puzzle”.

In what follows, we explore potential explanations for this puzzle.

3 Volatility, beta and the Equity Risk Premium

In this section we explore the following:

- how periods of high volatility are capable of distorting the betas of defensive stocks, including utility stocks, downwards;
- how, on the contrary, the contemporaneous forward-looking ERP will increase during periods of high volatility; and,
- how this may cause Ofgem to underestimate required returns for energy networks, given prevailing regulatory practice.
- We conclude this section by asking whether beta estimates from the most recent period of high volatility should be relied upon at all.

3.1 Market volatility

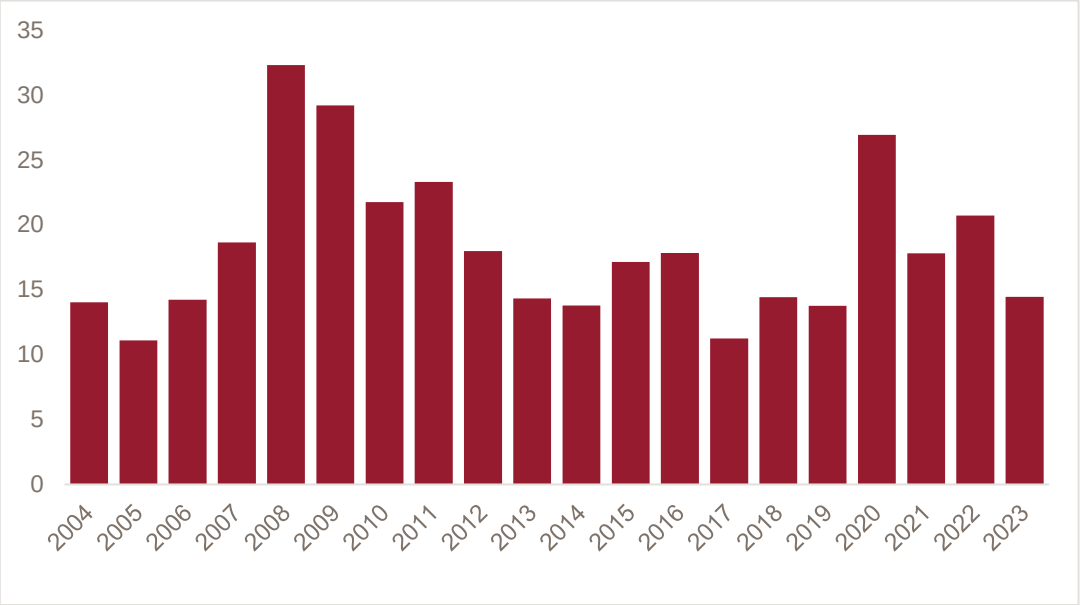
The increased risk in the UK economy more generally (described in the previous section) has translated in the equity market in terms of higher observed market volatility, especially in the period following Ofgem consultation and determination of the RIIO-2 settlement.

- The RIIO-2 settlement was developed in 2018 and 2019, at the end of a prolonged period of relatively low market volatility following the GFC in 2009.
- Since the COVID-19 pandemic and following the Ukraine war, market volatility levels have risen.

The figure below shows the level of general expected equity market volatility for the past twenty years. This is measured by the VIX index[4] which is calculated based on option price implied market volatility.

[4] The VIX index is a real-time market index representing the market's expectations for volatility over a fixed period ahead, usually 30 or 60 days. Investors usually use the VIX index to get a forward sense of the level of risk, fear, or stress in the market when making investment decisions. The VIX does not report historical (outturn) volatility of the FTSE Allshare. The VIX infers forward volatility based on available options prices, which is why it is a forward-looking indicator. The VIX is a helpful indicator here, as it does highlight periods where the market expected high volatility and this did indeed come to pass.

Figure 5 Expected market volatility over time measured by the FTSE UK allshare implied volatility index



Source: Frontier Economics based on data from Bloomberg

It can be seen that over the last two decades, there are two events that were associated with a particularly heightened level of expected market volatility. The first one is associated with the GFC and the second one with COVID and the Ukrainian war.

3.2 The relationship between beta and market volatility

Market volatility plays an important role in beta estimation. Empirical estimates of beta are calculated using the following formula:

$$\beta_i = \frac{Cov\,(R_i, R_m)}{Var\,(R_{m)}}$$

Where:

- $Cov\,(R_i, R_m)$ is the expected covariance between the excess return of security i and the excess return of the market; and
- $Var\,(R_{m)}$ is the expected variance of excess return on the overall stock market, this is what we refer to as the volatility of the market.

According to the beta formula, it can be seen that the level of beta is inversely related to the level of market volatility, i.e. the higher the market volatility, the lower the beta (all else equal). Of course, the covariance between stock and market may also move when market volatility changes. However, it is clear that for stocks whose betas are lower than 1, such as utility

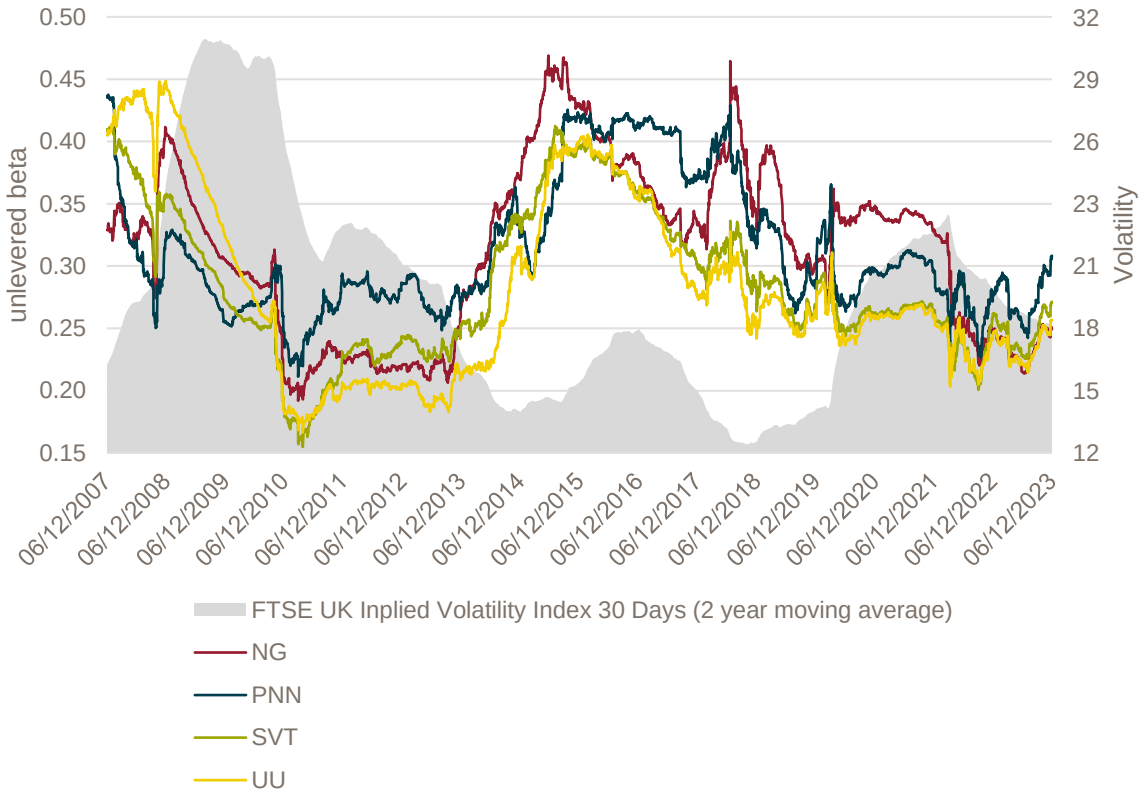
betas, the covariance between returns on the stock and the market is *lower* than the variance of market returns.

In times of market turbulence, what we typically observe is that stocks with high betas (higher than 1) become particularly volatile. Trading in these stocks then causes the entire market index to consequently become more volatile, although this effect will be dampened by trade in stocks with lower betas (lower than 1) that are less sensitive to such market developments.

The combined result of these processes is that when market volatility is high, high betas tend to become even higher, and low betas even lower. Utility stocks, which typically have asset betas of much less than one, are amongst the subset of stocks which will experience a more than proportionate decreased in beta estimates during periods of high market volatility.

We have explored whether these volatility related effects may have influenced beta estimates for the four listed UK utility stocks often relied on to determine beta for energy networks. The figure below shows estimated betas over a rolling 2-year estimation window alongside market volatility, presented as the 2-year moving average of the implied volatility index derived from options.

Figure 6 30d implied volatility and (unlevered) utility betas estimated using a 2-year estimation window



Source: Frontier Economics based on Bloomberg data

Note: Daily frequency of the underlying data for beta estimation. We consider a 2-year moving average of the VIX index as the VIX index is inherently forward-looking, while betas are inherently backward looking. Using a 2-year moving average for the VIX attempts to 'match' the appropriate time period of expected market volatility to the beta estimation windows.

From the chart we observe an approximately inverse relationship between market volatility and the utility betas. For example

- **GFC, 2008 – 2012**: In this period, market volatility was markedly higher than the rest of the period, ranging from 20 – 30 (right hand side scale), and such high levels of volatility are highly unusual. At the same time, we can see that this period of elevated volatility coincides with falling, very low utility betas.
- **Covid-19 pandemic and Ukrainian conflict, 2020-2023**: We observe another period of relatively high volatility over these years, coinciding with the onset of the pandemic and implementation of lockdowns globally. Again, this period coincides with relatively low utility betas e.g. compared to the post-GFC period, where volatility was quite low for most of this period.

It is of course reasonable to expect betas to move over time. This is a normal response to price fluctuations, and potentially the underlying changes in business risk of the stock. However, this figure highlights that the two recent periods of high uncertainty, resulting in

unusually high market volatility, have clearly coincided with very low beta estimates for stocks with betas lower than one.

3.3 The relationship between the Equity Risk Premium (ERP) levels and market volatility

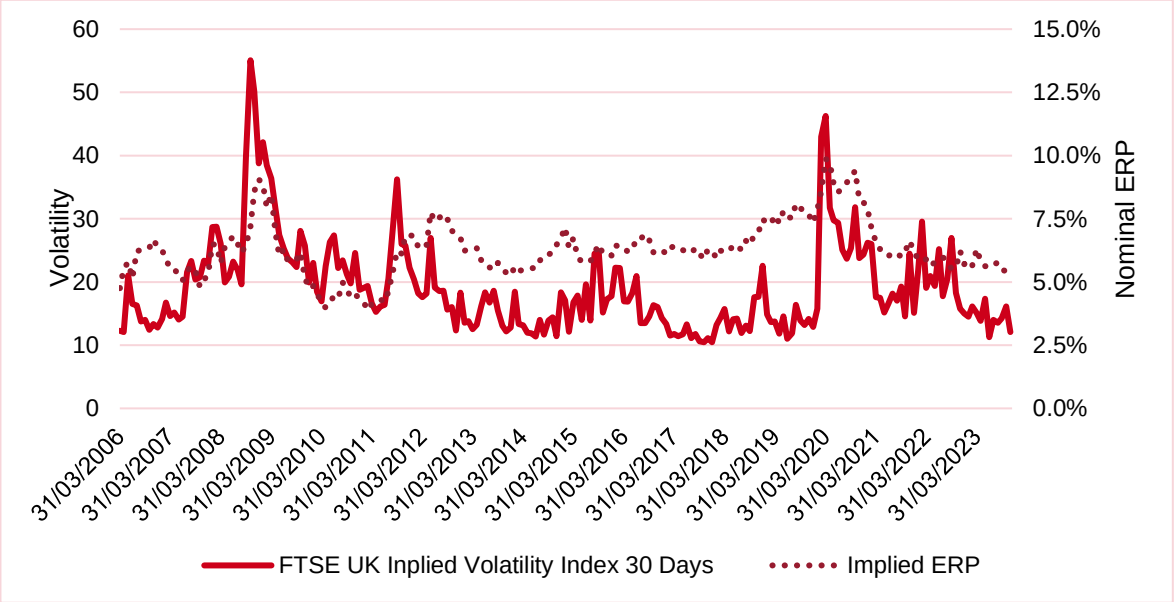
Within CAPM, the excess return on equity over the risk-free rate required by investors (which is higher if overall risk is higher) is not only a result of beta. It is the result of beta *multiplied by* the equity risk premium. We have considered above what happens to beta during periods of high volatility. But what happens to the equity risk premium?

In times of high market volatility, it would be logical to expect the required equity risk premium to be heightened. Typically markets are more volatile than usual precisely because of higher uncertainty than usual, i.e. high market volatility is typically a symptom of heightened risk. During such time, uncertain events are unfolding with potentially profound consequences for the appropriate market value of stocks. The market moves materially in response to news, and daily reports may cause large daily swings.

Investors will adapt to "price in" heightened risk, when it induces heightened volatility. The required return on equities during such times will be higher so that it is commensurate with the level of risks investors perceive they are exposed to.

This is illustrated by the chart below which shows the implied volatility with the implied ERP estimated using a Dividend Discount Model with market data.

Figure 7 Relationship between ERP and volatility

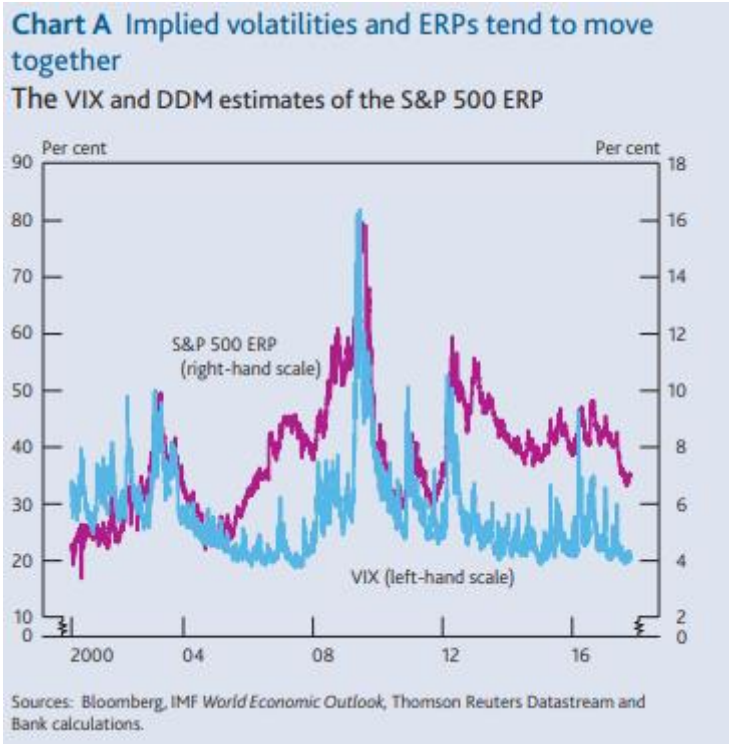


Source: *Frontier DDM analysis, Bloomberg, Bank of England*

Note: *The implied ERP shown in the figure above is derived from a market-wide DGM approach. We first estimate the forward-looking required total market return using a market-wide DGM model. Then, we estimate the implied ERP by subtracting the yield on a nominal gilt with a 20-year maturity.*

This relationship has also been observed by the Bank of England in a study conducted in 2017, where they used the VIX index of implied volatility on the S&P 500 as a measure of macroeconomic uncertainty, and plotted its evolution against a measure of the ERP. The following chart shows that the S&P 500 ERP and the VIX tend to move together.

Figure 8 Bank of England – relationship between market volatility and ERP



Source: Bank of England, Quarterly Bulletin 2017 Q2, Topical article, An improved model for understanding equity prices

The above evidence suggests that the ERP typically moves in line with market volatility. This is logical and also conforms with equity market pricing movement. In times of high volatility, markets tend to price in perception of higher risk. Share prices tend to reduce as a result (during bear markets), which in turn translates to a higher ERP when measured by a DDM based on share prices. Conversely, when the market is less volatile, share prices tend to be more stable and higher (e.g. bull markets), which in turn translates to lower ERP. Indeed, the VIX index is often used by equity analysts as an indicator of the "fear gauge" in the market and hence one of the defining factors of whether or not to invest more/less in riskier equities versus other safer asset classes.

3.4 Risk of a mismatch given UK regulatory construct

Above we have identified that there is a negative relationship between the market volatility and the beta of utilities, but that there is a positive relationship between the market volatility and the forward-looking market-implied ERP. That is, during periods of high volatility, utility betas will tend to fall, while ERP will tend to rise, and there is therefore a negative relationship between utility betas and the ERP.

For an equity analyst estimating the cost of capital for a utility stock for short term use in valuation, this arguably may not be a significant problem. The analyst would be likely to

combine a short run measure of market returns with a contemporaneous estimate of beta. Hence the overall calculation of allowed return would at least be internally consistent – it would combine a higher short run measure of required returns, with a shorter run estimate of beta to capture the relative risk of the stock. Such an estimate would rely on a beta/TMR combination that were a suitably matched pair.

However, in the context of the prevailing approach to setting allowed returns in the UK, there is a clear problem. When setting the allowed equity returns, regulators have preferred to rely on a construct that Total Market Return (TMR) is stable, albeit not fixed. UK regulators typically estimate the TMR and risk-free rate independently and directly, and then infer the ERP as the difference between the two. This long run approach is well understood and has its merits in bringing stability to the regulatory construct. However, the implication of this approach is that the ERP in regulator's CAPM formula moves in the *opposite* direction of the risk-free rate. Since risk free rate (proxied by yields on gilts) has risen materially in recent years, and since TMR will not increase one-for-one with RFR, within the UK regulatory construct inferred ERP will fall materially.

So at this time then, when analysis of volatility suggests that it would be appropriate to assume that ERP needs to go up, the regulatory construct used by UK regulators will instead impose an assumption that it has gone down. This creates a real risk that required returns are underestimated.

Viewed differently, the gilt yield has increased around 3.5 percentage points since RIIO GD2/T2, which means that the allowed TMR would have to increase materially more than 3.5 percentage point for the ERP to increase compared to GD2/T2 (a TMR of more than 10% in CPIH-real terms). It is clear that the effect of using beta estimates under high market volatility within the standard GB regulatory methodology would under-estimate the cost of equity.

To summarise, if Ofgem follows the same method as per RIIO-2, but also estimates a low beta based on the recent high market volatility periods, this would create an inconsistency which violates the relationship between beta and ERP that we have identified above.

The resulting cost of equity would only partially reflect the market environment (the relative risk element) but ignore the size of the total market risk premium, and therefore leading to an under-estimation of the cost of equity for the energy companies.

3.5 Should betas from high volatility periods be relied on at all?

Above we have set out the logical co-movements one should expect in beta and ERP, and how those may be driven by periods of high volatility. We have also described how a forward-looking short-term estimation can be arrived at by, for example, a practitioner, provided that the ERP and beta pair used in estimation of the underlying CoE are matched.

However, we note that some researchers and commentators go further, and question whether beta estimates made over estimation windows where markets are highly volatile should not be used at all.

A well-known finance text summarises this as a potential pitfall of beta estimation for academics and practitioners alike who wish to estimate betas:

> *"Research has shown that volatility affects the accuracy of beta estimates. at times when the market is highly volatile, beta estimates are less reliable, as are the correlations of individual stock returns with returns on the market…This means that estimating betas during periods of high volatility of market returns* ***will generally provide less reliable estimates of beta*** *than during periods of low volatility."*[5] *[emphasis added.]*

These ideas have also been explored, and serious health warnings sounded, by practitioners. For example, McKinsey commented on exactly this set of phenomena in a paper from 2003, setting out recommendations for how to estimate accurate betas in the aftermath of the dotcom bubble, in particular for industrial stocks that may have had their beta artificially lowered. In short, McKinsey recommended that years affected by high volatility should simply be excluded, and betas estimates from past years unaffected by volatility.

> *"By excluding those years entirely, we can calculate betas that are more consistent with long-term historical results and are a better indication of the relative risk of companies. Without this correction, data drawn from the period of the TMT bubble will generate artificially low betas through 2006."* [6]

Ofgem will need to consider carefully whether to rely on current beta estimates, in particular if the business planning process brings forward compelling evidence of higher business risk.

5 Pratt & Grabowski (2014), Cost of Capital – applications and examples, fifth edition, page 277.

6 André Annema and Marc H. Goedhart, "Better Betas". McKinsey on Finance, Number 6, Winter 2003. Accessible here : https://www.mckinsey.com/client_service/corporate_finance/latest_thinking/mckinsey_on_finance/~/media/C5BAB75D838B403582F1FB87B5E24A7F.ashx

4 Conclusions and recommendations

The low beta puzzle is likely a result of high market volatility. This creates two potential issues, i) when combined with an ERP estimate that is not forward-looking so as to reflect high market volatility, the result would under-estimate the cost of equity; and ii) some would argue that the beta estimate itself may be unreliable owing to high volatility even if paired with an appropriate ERP.

Ofgem will need to take extra care when choosing a beta estimate for RIIO-3. Many of the estimation windows are likely to be affected by estimation issues, and it would be wise to place as little as possible weight on periods of high market volatility.

More specifically, we note that the beta estimates that rely on estimation windows that contain the GFC period or the COVID/Ukrainian War period are notably affected by high volatility. If we consider the regulators' usual choice of beta estimation windows of 2, 5 and 10 years, both the 2-year and 5-year betas are currently heavily affected by the COVID/War volatility, while the 10-year window is much less affected. We also observe that the GFC period has fallen out of the 10 year window at this time, while at RIIO T2/GD2 where we cautioned against the 10-year window then because it then contained a significant proportion of the GFC period.

Of the candidate set of standard estimation windows, this consideration would point towards maximising reliance on 10 year betas at this time. Looking forward, it appears the recent market volatility levels in the majority part of 2023 have tailed off. If this trend continues, then in future 2-year estimates could become less problematic, subject to the usual due diligence around any other possible distortions.

One concern with this recommendation, is that 10 year betas are least likely to take appropriate account of emerging forward looking risk that could materialise during RIIO-3, i.e. these emerging risks (that will likely fall in the RIIO-3 period) could be heavily diluted by use of 10 year betas if such risks only started to be priced in recently. So while considerations around volatility dictate that one cannot place reliance on 2 and 5 year betas at this time, this then raises the question as to whether 10 year betas, while less severely affected by volatility problems, will require uplifting to better reflect crystalising sector forward looking risk. Logic suggests that an uplift of some kind is necessary, and we take the view that this should be considered an open research question for the rest of the RIIO-3 process.

We also note that, since our paper brings together concerns around beta with concerns around ERP, part of the solution to this problem for Ofgem may come from making changes to TMR (and hence, ERP). Ofgem may need to consider whether its overall assessment of CoE, stemming from its choice around beta and TMR, is sufficient when taken together.