



Assessment of political and regulatory risk

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National Grid Group

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Executive summary

In our February 2018 cost of equity report for the ENA¹, we recommended setting the regulatory allowed cost of capital for energy networks in RIIO-2 by selecting an asset beta within the top half of the asset beta range based on listed comparator companies. This recommendation was based on a number of considerations including the forward-looking risks that energy networks face and the empirical shortcomings of the capital asset pricing model (CAPM) framework. This report, prepared for National Grid (NG), examines the political and regulatory risks that regulated utilities face today and reinforces the earlier recommendation of selecting a beta point estimate towards the top end of the asset beta range to compensate investors for the increased political and regulatory risk.

There is a perception that since the RIIO-1 price controls were determined in 2012–14, NG and regulated utilities have operated in an increasingly uncertain political and regulatory environment. As an example of the changed political backdrop, at the Labour Party annual conference in September 2018, Shadow Chancellor John McDonnell noted:

Rail, water, energy, Royal Mail: we are taking them back.²

While regulators are established by statute to further their duties independently of political intervention, they do not operate in isolation from the wider political context. Therefore, it is possible and even likely that regulatory uncertainty is influenced by the political environment.

This report provides a very extensive review of evidence to objectively test the hypothesis that increased political and regulatory uncertainty is being priced by investors into the valuation of regulated utilities in general and NG in particular. The increased political and regulatory risk is evident from:

- more frequent political and regulatory news triggering share price falls (i.e. sharp declines in reaction to news);
- an increase in share price volatility since 2016—a period during which the UK Labour party has asserted its manifesto of renationalising utilities if it were to come in power;
- a decline in the status of NG and other regulated utilities as ‘defensive stocks’;
- an increased focus on regulatory and political risk as a valuation driver in analyst assessments.

More frequent political and regulatory news triggering share price falls

Since the start of the RIIO-1 price control, the frequency of political and regulatory news announcements that have triggered falls in NG’s share price has increased. The most recent example was the 9% decline on the day of publication of the sector-specific consultation in December 2018—the largest-ever drop in NG’s share price on a single day since 1998. Given that around half of NG’s business is based in the USA,³ this understates the size of the impact on NGET and NGGT. The 9% drop in the share price represents a

¹ Oxera (2018), ‘[The cost of equity for RIIO-2](#)’, 28 February, prepared for the Energy Networks Association.

² *Financial Times* (2018), ‘CBI warns on Labour’s renationalisation plans’, 16 July.

³ By asset value, the National Grid Group comprises 50% UK regulated businesses (NGET and NGGT), 45% US regulated businesses, and 5% NG Ventures and others.

reduction of £2.6bn in the market cap of the National Grid Group, relative to the UK-based regulated asset value for the gas and electricity transmission businesses of £19bn (nominal prices).⁴

This is reflective of a broader trend affecting regulated utilities, with share price falls linked to political and regulatory news becoming more frequent across the sector.

Increase in share price volatility since 2016

Since 2016, NG equity returns have become more volatile, both in absolute terms and relative to the FTSE All-share index. Comparing the annualised volatility of NG equity returns with FTSE All-share equity returns, volatility was similar during 2013–16. However, since 2016 NG's volatility has been approximately 10% higher than the index. This indicates that the total risk of the equity has increased relative to the risk of the market.

Decline in status of NG and other regulated utilities as 'defensive stocks'

An asset is perceived as relatively low risk or 'defensive' when relative demand for the asset increases during times of higher economic uncertainty—i.e. the share price of the asset does not decline proportionately when the market falls, or may even increase.

Since the start of RIIO-1, there has been a decline in the status of NG and other regulated utilities as defensive stocks and a hedge against economic uncertainty. This is evident from:

- a change in the relationship between NG's share price and the wider stock market. In the RIIO-1 period relative to TPCR4 there have been fewer days when the wider stock market declines and the NG share price has increased. This change in relationship between stock returns and index returns has been observed for other utilities as well;
- a change in the relationship between NG's share prices and the returns of other defensive securities such as UK gilt yields.⁵ Over time, changes in NG's actual share prices as well as the share prices of other regulated utilities seem to be less well explained by changes in UK gilt yields.

Increased focus on regulatory and political risk as a valuation driver in analyst assessments

Since 2016 political and regulatory risk has become more prominent as a valuation factor in reports published by utilities equity analysts. There appears to be a consensus that such risks are increasingly important when deciding whether to invest in UK utilities, particularly when compared with investment opportunities in the USA. The sensitivity of investors to political risk is indicated by the following comment from an investment bank:

'Overall, we feel that National Grid was seeking to move investor focus away from the UK – where the political risk is high and growth low, in our view – and onto growth in the US business'.⁶

⁴ Figures provided by NG.

⁵ If investors consider NG and other regulated utilities to be defensive stocks, the share prices of these firms are expected to be closely related to the prices of UK gilts or other safe assets (e.g. gold); alternatively changes in their share prices are likely to be explained by changes in the yields on UK gilts or changes in gold prices.

⁶ Credit Suisse (2017), 'National Grid: US business strong. But UK remains weak', p. 4.

Implications for the cost of capital in RIIO-2

The above evidence points towards an increase in political and regulatory uncertainty over and above that which might be expected at the start of a price review. Therefore, it cannot be assumed that this uncertainty will subside once the price review engagement process concludes, and the RIIO-2 period starts.

Understanding how this risk affects required returns and the cost of capital requires a set of assumptions about how investors price assets.

The most commonly used asset pricing framework is the CAPM. If this is an accurate model of the actions of investors and capital markets then the equity beta captures all the risks that are relevant for investors. In practice, the performance of CAPM tends to under-predict equity returns for assets whose equity betas are less than 1 (such as regulated utilities). There is a large body of research suggesting that factors other than the market equity beta explain equity returns.⁷

The CAPM is unlikely to provide a full description of how investors determine required rates of return. The implication is that the CAPM market beta is not sufficient to capture all of the risk premium associated with political and regulatory uncertainty, and that relying solely on the CAPM is likely to understate required returns for companies with significant exposure to such risks.

In the absence of a benchmark that includes a factor for political and regulatory uncertainty, a pragmatic adjustment would be to select a beta point estimate towards the top end of the plausible equity beta range derived from the CAPM. Although this will not guarantee that investors will be adequately compensated for exposure to political and regulatory risk, it will reduce the risk of such factors creating an underinvestment problem in network assets that have lives that extend beyond the average duration of a regulatory price control period.

⁷ See Appendix A3 for a summary.

1 Introduction

In light of the current political and regulatory landscape, National Grid Group (NG) requested Oxera Consulting LLP (Oxera) to assess the political and regulatory risk faced by NG and other regulated utilities in the UK.

The report is structured as follows:

- section 2 explains the conceptual framework;
 - section 3 examines NG's and other regulated utilities' share price reactions to political events;
 - section 4 examines NG's and other regulated utilities' long-run share price volatility (a measure of total risk) to ascertain whether there is any evidence of change in volatility in recent years;
 - section 5 tests the characteristics of a defensive stock—i.e. whether NG and other regulated utilities were considered low-risk assets that investors would demand during times of higher economic uncertainty, and whether this has changed in recent times;
 - section 6 considers the impact of political and regulatory risk from the perspective of rating agencies and analysts in the UK and mainland Europe (including the impact on NG's valuation);
 - section 7 provides the conclusion;
 - appendix 1 examines the literature on political and regulatory risk, and whether that risk affects the cost of capital and/or valuations of regulated utilities or other sectors in the UK and elsewhere;
 - appendix 2 provides more detail on the main sections of the report;
 - appendix 3 discusses the arbitrage pricing theory (APT) and multifactor models.
-

2 Conceptual framework

This report focuses on the effect of regulatory and political risk from the perspective of an equity investor.

2.1 How does political and regulatory uncertainty affect required returns?

The total risk of a stock (as measured by share price volatility) can be broken down as shown in the equation below:

$$\text{Total risk (variance of stock)} = \text{market systematic risk} + \text{other systematic risk} + \text{idiosyncratic risk}$$

Political and regulatory risk can therefore have impacts in three areas:

- exposure to market-wide risk (i.e. systematic market risk)—captured by the CAPM equity beta;
- exposure to other systematic risks—factors that affect multiple companies and where investors cannot eliminate their exposure to these risk factors by investing in a larger, more diversified portfolio of companies;
- exposure to idiosyncratic risk i.e. company-specific consequences of political and regulatory actions.

The extent to which these types of risk affect the rates of return required by investors depends on which asset pricing theory best describes the actions of investors and capital markets.

Exposure to market-wide risk

Finance theory predicts that systematic and non-diversifiable sources of risk will be priced, and that investors will require higher returns for taking on exposure to such risks.⁸ The widely used CAPM considers only the correlation of returns with equity markets as a proxy for exposure to systematic risk. If the CAPM is assumed to be a reliable description of reality then all exposure to political and regulatory risk is assumed to be reflected already in the equity beta.

In practice, the performance of the CAPM tends to under-predict equity returns for assets whose equity betas are less than 1 (such as regulated utilities). There is a large body of research suggesting that factors other than the market equity beta explain equity returns.⁹

Exposure to other systematic risks

Multifactor models or APT make fewer restrictive assumptions than the CAPM, and recognise the potential for multiple sources of systematic risk. In general the empirical performance of these models is superior to that of the CAPM.

Political and regulatory risk is frequently manifest in actions that affect an entire sector or multiple sectors of the economy. As such, investors cannot eliminate their exposure to these risk factors by investing in a larger, more diversified

⁸ Chen, N., Roll, R. and Ross, S. (1986), 'Economic Forces and the Stock Market', *The Journal of Business*, 59:3, pp. 383–403.

⁹ See summary at Appendix 4.

portfolio of companies. If exposure to such risks is priced by investors then the CAPM will understate returns for companies that positively load on the political risk factor.

In principle, multifactor models would be used to estimate the risk premium that investors require for exposure to political and regulatory risk factors, and the factor loadings (betas) for regulated utilities. However, there are empirical challenges of applying multifactor models to political and regulatory risk—challenges that include, for example, the small sample of listed utilities.

Exposure to idiosyncratic risk i.e. company-specific consequences of political and regulatory actions

Company-specific consequences of political and regulatory risk will be priced by investors through lower expected cash flows (i.e. expectations that attach a probability of negative shocks to cash flows). Academic research frequently assumes that company-specific risks are diversifiable and do not affect the required rate of return. This view is less prevalent among practitioners, who often make an assessment of total risk and not just the CAPM market beta when determining discount rates.

Academic research that relaxes the assumptions of the CAPM and incorporates the impact of market frictions can, under some circumstances, predict that equity returns will be positively related to **total risk** and not just systematic risk. For example, Merton's (1987) model of capital market equilibrium with incomplete information posits that investors only hold stocks whose risk and return characteristics they are familiar with ('investor recognition hypothesis') i.e. investors only invest in stocks on which they have perfect information. Therefore, relaxing the assumption that all investors are perfectly informed results in investors holding sub-optimally diversified portfolios and therefore requiring compensation for the idiosyncratic risk of stocks.

The model therefore states that, in equilibrium, cross-sectional stock returns will be positively correlated to idiosyncratic risk (i.e. returns required by investors also increase with an increase in idiosyncratic risk, not just systematic risk).¹⁰

Subsequently, empirical research has found that the prediction of Merton (1987) holds in the data, although this remains an area of live debate. For instance, Boehme et al. (2009)¹¹ find strong support for Merton's model among stocks that have low levels of investor recognition and for which short selling is limited; whereas Ang et al. (2006)¹² find that stocks with high idiosyncratic volatility have low average returns, a result opposite to Merton's investor recognition hypothesis.

Nonetheless, the research suggests that investors may price some of the company-specific consequences of political and regulatory risks (i.e. idiosyncratic risks) by requiring a higher rate of return.

To summarise, political and regulatory uncertainty can have an impact in three areas: exposure to market-wide risk; exposure to other systematic risks; and

¹⁰ Merton, R.C. (1987), 'A simple model of capital market equilibrium with incomplete information', *The Journal of Finance*, **42**, pp. 483–510.

¹¹ Boehme R.D., Danielson, B.R., Kumar, P. and Sorescu, S.M. (2009), 'Idiosyncratic risk and the cross-section of stock returns: Merton (1987) meets Miller (1977)', *Journal of Financial Markets*, **12**, pp. 438–68.

¹² Ang, A., Hodrick, R., Xing, Y. and Zhang, X. (2006), 'The cross-section of volatility and expected returns', *Journal of Finance*, **61**, pp. 259–99.

exposure to idiosyncratic risk (company-specific consequences of political and regulatory actions). The impact of these three types of risk on required returns will depend on which asset pricing theory best describes the actions of investors and capital markets.

2.2 How to price political and regulatory risk factors in practice?

The range of frameworks discussed above suggests that the CAPM is unlikely to provide a full description of how investors determine required rates of return. The implication is that the CAPM market beta is not sufficient to capture all the risk premium associated with political and regulatory uncertainty, and that relying solely on CAPM is likely to understate required returns for companies with significant exposure to such risks.

As stated previously, in principle the premium that investors require for exposure to political and regulatory risk factors would be estimated using multifactor models. However, in the absence of appropriately calibrated multifactor models and the preference of UK regulators to use the CAPM, it is important that due consideration be given to other potential systematic and priced idiosyncratic risk factors when interpreting the outputs from the CAPM.

A practical way to do this would be to select a beta point estimate towards the top of the plausible equity beta range derived from the CAPM. Although this will not guarantee that investors are adequately compensated for exposure to political and regulatory risk, it will reduce the risk of such factors creating an underinvestment problem in network assets that have lives that extend far beyond the average duration of a regulatory price control period.

In this report, we examine the evidence on how political and regulatory uncertainty has evolved since the RIIO-1 price controls were determined in 2012–14. The evidence consists of analysis of equity market data and analyst commentaries to understand how regulatory and political uncertainty is reflected in equity returns and investor expectations. The report concludes by considering the implications of the evidence for determining the cost of equity allowance for RIIO-2.

3 NG's and other utilities' share price reactions to political and regulatory events

Key messages

Analysis of NG's and other utilities' share price reactions to political or regulatory events highlights the following.

- Since the start of the RIIO-1 price control, the frequency of political and regulatory news announcements that have triggered falls in NG's share price has increased. The most recent example was the 9% decline on the day of publication of the sector-specific consultation in December 2018—the largest-ever drop in the share price of NG on a single day since 1998. Given that around half of NG's business is based in the USA, this understates the size of the impact on NGET and NGGT. The 9% drop in the share price represents a reduction of £2.6bn in the market cap of the National Grid Group, relative to the UK-based regulated asset value for the gas and electricity transmission businesses of £19bn (nominal prices).¹³
- The share price reaction of other utilities (United Utilities, Severn Trent and the MSCI Utility Index) showed similar results—share prices reacted negatively to political or regulatory events to a substantial degree and the frequency of adverse share price reactions has increased since the start of RIIO-1 period.

Our analysis indicates that investors seem to react strongly to political and regulatory developments, affecting the demand and valuation of NG's stock as well as that of other utilities.

3.1 NG's share price reaction

Political and company-specific news can affect the demand for, and subsequently prices of, a particular stock, with favourable news increasing demand and prices, and adverse news lowering them.

To assess NG's share price reaction to political or regulatory events, we conducted a reverse event study to explore whether the company's stock price reacted to political or regulatory news announcements. The methodology underlying our analysis is as follows:

- we filtered the dates on which NG's stock exhibited a sharp increase or decrease in price (i.e. daily return);¹⁴
- we then filtered the dates on which NG's daily return substantially differed from that of the FTSE All-share (i.e. dates on which NG significantly outperformed or underperformed relative to the market). These dates helped us filter events that are peculiar to regulated utilities and/or NG more specifically and events that are more systematic in nature (i.e. affect both NG and the market).¹⁵

Based on the above criteria, we identified four sets of dates (see Figure 3.1 and Figure 3.2) corresponding to:

- a sharp decline in NG's share price;

¹³ Figures provided by NG.

¹⁴ We filtered the dates on which NG's return was two standard deviations above or below the long-run historical average.

¹⁵ We filtered the dates where the difference between NG's and the FTSE All-Share's return was outside the 95% confidence interval.

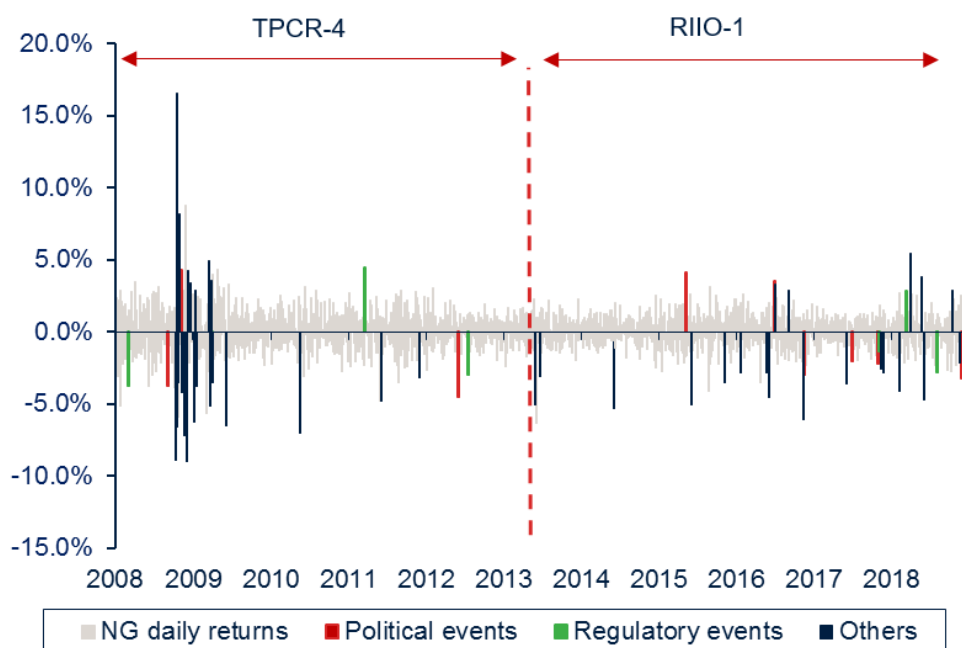
- a sharp decline in NG's share price where the price fell sharply relative to the FTSE All-share index (i.e. the FTSE All-share significantly outperformed relative to NG);¹⁶—i.e. a potential indicator of political or regulatory risk affecting NG only and not the market;
- a sharp increase in NG's share price;
- a sharp increase in NG's share price relative to the market (NG significantly outperformed relative to FTSE All-share)—a potential indicator that NG is considered a defensive stock during times of economic uncertainty when the market underperforms.

We then searched for news around these dates to identify whether a particular political or regulatory news announcement can help to explain NG's share price reaction.¹⁷ We place the news announcements into three broad categories:

- political or market-specific (systematic) news;
- news related to a sector-specific regulatory intervention;
- company-specific news (i.e. an idiosyncratic risk).

From Figure 3.1 and Table 3.1 below, we observe that NG's share price reaction to adverse political and regulatory events has increased in the last 5 years (2013–18) compared to the previous five-year period (2008–13).

Figure 3.1 NG's share price reaction (a sharp increase or decrease in price), 2008–18



Note: NG's daily returns from 2008 to 2018. The statistically significant (highlighted) observations are abnormal returns of NG—approximately 2 standard deviations away from the

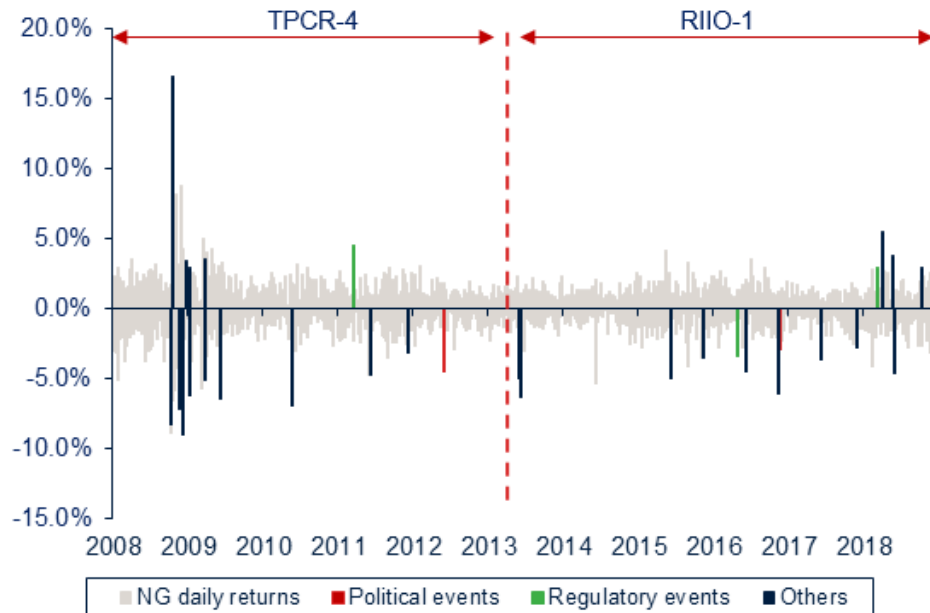
¹⁶ We tested for the difference between NG and the FTSE All-share returns at the 5% significance level.

¹⁷ To supplement our findings from the reverse event study, we also conducted a conventional event study to ensure that we have captured all the news announcements that could have led to changes in NG's share price in the last ten years. These events are presented in Table A2.5 of the Appendix A2.1. We have not presented these events in the charts and the tables in the main report as NG's share price reaction to these events was not statistically significant.

mean. Events are categorised according to a qualitative assessment of the news content. 'Others' includes systematic, company-specific and safe haven events—i.e. when NG is considered a 'defensive stock'.

Source: Oxera analysis based on Thomson Reuters data.

Figure 3.2 NG's share price reaction (a sharp increase or decrease in price relative to the FTSE All-share), 2008–18



Note: The highlighted statistically significant observations (two standard deviations away from the long-run historical average) represent extreme movements in NG's share price, where its share price deviated substantially from that of the FTSE All-share. Events are categorised based on a qualitative assessment of the news content. 'Others' includes systematic, company-specific and safe haven events.

Source: Oxera analysis based on Thomson Reuters data.

Table 3.1 below presents the number of news announcements in different categories that we identified from the **reverse** event study analysis. We observe that while in TPCR-4 (2008 to 2013), the highest proportion of significant share price reactions was due to systematic events, largely due to the financial crisis, in RIIO-1 (2013-2018) the highest proportion of significant price reactions was due to political and regulatory events, cumulatively constituting 42% of the identified events.

Table 3.1 Types of event identified in NG's event study analysis, January 2008 to December 2018

Type of event	Number of identified events		% of total	
	TPCR-4	RIIO-1	TPCR-4	RIIO-1
Political	3	8	8%	24%
Regulatory	4	6	11%	18%
Systematic	19	9	46%	26%
Company-specific	4	10	11%	29%
Safe haven (where NG's price increased post adverse market related news announcement)	10	1	24%	3%
Total	40	34	100	100

Figures are rounded to the nearest whole number or the nearest percentage. The frequency of the identified events in the TPCR-4 period is normalised relative to the number of days considered in the RIIO-1 period (1st April 2013 to 20th December 2018).

Source: Oxera analysis.

While NG's share price reaction to regulatory and political events was largely negative, there were some instances when its share price reacted positively to regulatory and/or political news announcements (see Table 3.2). However, these are a small proportion of the total political and regulatory events, indicating that such events on average have a negative impact on the share price.

Table 3.2 Distribution of NG's share price reaction to political and regulatory events

	Decrease in NG's share price	Increase in NG's share price
Number of political events that led to a change in NG's share price	8	3
Number of regulatory events that led to a change in NG's share price	8	2
Total number of regulatory and political events that led to a change in NG's share price as a percentage of total political and regulatory events	76%	24%

Source: Oxera analysis.

Below, we discuss NG's share price reaction to major political or regulatory events. A comprehensive list of filtered dates and the associated news announcements is presented in appendix A2.1

Political or market-specific news

Our exploratory event analysis indicates that in the majority of the observations, NG's share price reacted adversely to political events such as:

- statements of renationalisation of energy grids included in the General Election manifesto of the Labour Party;
- the UK referendum to leave the European Union;
- the election of Donald Trump as US president;

- the election of Jeremy Corbyn as leader of the Labour Party;
- the UK–EU draft ‘Brexit’ agreement.

Conversely, some political/market-specific news announcements were followed by an increase in the demand for, and price of, NG’s stock. These included:

- investors’ fear of trade wars (March 2018);
- the effects of US corporate tax cuts (March 2018);
- conservative party winning general elections (May 2015)

In the most recent five-year period (2013–18), the frequency of political and market news that adversely affected NG and/or regulated energy networks have increased relative to the previous five-year period.¹⁸ Recent examples of political and market news include:

- energy suppliers such as Angelic Energy and Liverpool Energy being supported by local authorities to tackle unfair pricing by big utilities;
- Labour Party statements on Ofgem’s replacement;
- intense debates around the renationalisation of energy grids after the proposal was included in the General Election manifesto of the Labour Party.

Regulatory news

NG’s share price has reacted to regulatory news announcements, and the impact on NG’s share price is observed in two main forms: a sharp drop in price; or a gradual downward trend in the run-up to new/revised regulatory frameworks.

Instances of recently observed company-/sector-specific regulatory news after which NG’s share price fell sharply include:

- Ofgem’s publication of sector-specific consultation in December 2018—NG experienced the largest daily share price decline (9%) since 1998;
- Ofgem stating that NG has not evidenced the necessity to replace the Feeder 9 gas pipeline;
- Ofgem’s statements that it would limit NG’s returns on Hinkley Seabank;

There have also been instances when NG’s share price reacted positively to regulatory news announcements. These include:

- Ofgem’s publication of the cost of equity range which was in line with investor expectations (2018);
- Ofgem’s announcement on 18 March 2011 to raise the level of fees that grid operators can charge.

Company-specific news

Company-specific events reflect risks that are inherently associated with NG’s business decisions or the divergence of NG’s profitability relative to investor’s

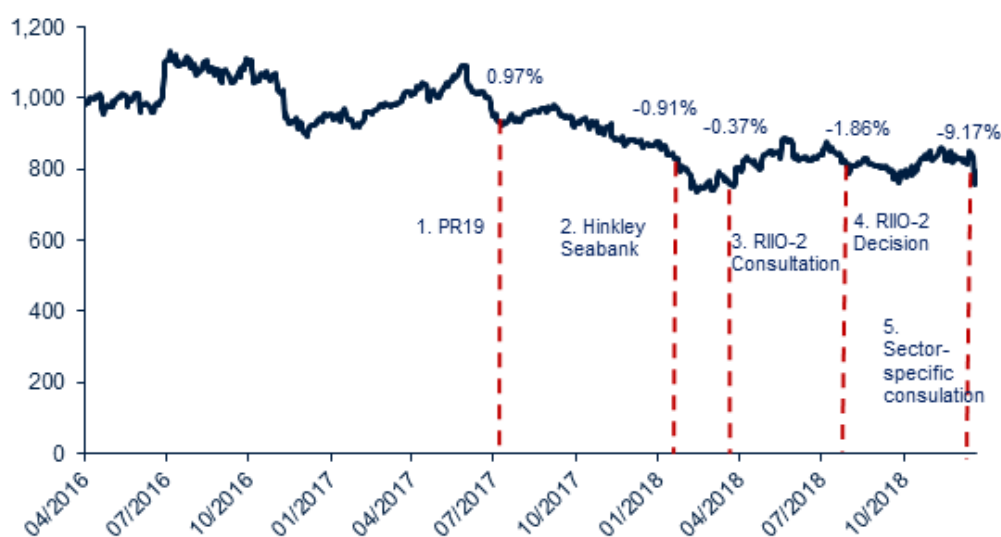
expectations. We note that NG's share price reacted to company-specific news such as strong quarterly results and the issuance of bonds.

While the above analysis has been conducted on almost instantaneous share price reaction to news announcements (i.e. daily returns), we note that investors do not necessarily react immediately to news announcements, nor are the announcements always unexpected. Expectations of future announcements could be reflected in market prices over a period of time and affect the demand for stocks such that there is a downward trend in stock prices prior to the official announcement of the political or regulatory event.

Figure 3.3 provides evidence consistent with markets anticipating future announcements, particularly the announcements made early in the current regulatory review cycle; for example, Ofwat's view on the WACC for PR19; Ofgem's view on the regulatory model for Hinkley Seabank.

- We note that NG's share price began to decline several months prior to the PR19 initial publication (July 2017), as Ofwat's view on the WACC for PR19 drip fed into the market.
- We observe a decline in NG's share price a couple of months before and after Ofgem's publication of the minded-to consultation of the Hinkley Seabank delivery model (published in January 2018).
- We observe a drop in NG's share price in relation to the RIIO-2 framework consultation in March 2018, and a downward trend in the lead up to the publication of Ofgem's framework decision for RIIO-2 in July 2018.

Figure 3.3 NG's share price reaction to major regulatory events, daily returns from April 2016 to December 2018



Note:

1. Ofwat's PR19 initial determination (18 July 2017).
2. Ofgem's publication of the minded-to consultation on the Hinkley Seabank delivery model (23 January 2018).
3. Publication of the RIIO-2 framework consultation (22 March 2018).
4. Publication of Ofgem's RIIO-2 decision framework (30 July 2018).
5. RIIO-2 sector-specific consultation (18 December 2018).

Source: Oxera analysis based on Thomson Reuters data.

Figure 3.4 shows NG's share price overlaid with major political and regulatory events over the last ten years. While its share price trended up throughout the majority of the regulatory announcements for the RIIO-T1 period, the share price has trended down through the major regulatory announcements in recent times (as evident from Figure 3.3), with the largest-ever one-day price drop (9%) since 1998 observed on 18 December 2018, in response to the sector-specific consultation.

Figure 3.4 NG's share price reaction to major political and regulatory events, January 2008 to December 2018



Note: Data labels represent daily price reactions following the news announcement.

1. UK General Election (6 May 2010).
2. RIIO-T1 Consultation, 'Providing a greater role for third parties in electricity transmission early thinking' (31 March 2011).
3. Initial assessment of RIIO T1 business plans and proportionate treatment (24 October 2011).
4. RIIO-1 publication of the revised business plans of National Grid (13 March 2012).
5. RIIO-T1 'Initial Proposals for NGET and NG Gas' (27 July 2012).
6. RIIO-T1 'Consultation on Ofgem's assessment of NGET proposed Network Development Policy' (3 May 2013).
7. UK General Election (7 May 2015).
8. RIIO-2 sector-specific consultation (18 December 2018).

Source: Oxera analysis based on Thomson Reuters data.

The analysis in this section shows that NG's share price underperformed relative to the FTSE All-share in response to adverse political or regulatory events. However, the share price reaction cannot be attributed solely to these events as there may have been multiple other factors at play simultaneously. For instance, company or market events leading to NG's financial underperformance would also be reflected in the adverse share price reactions.

Therefore, to isolate the effect of regulatory or political news announcements on NG's share price, we examined analyst commentaries around the dates¹⁹

¹⁹ We considered the analyst commentaries on the date of the filtered news announcement and one day before and after.

on which NG's stock experienced a sharp price increase or decrease in price.²⁰ This helped to identify the risk factors or performance metrics that analysts discuss when forming their buy or sell recommendations.

For a large majority of the dates that we filtered, the analyst commentaries attributed the share price reaction to the news announcements we identified.²¹ For dates where analyst commentaries do not discuss the identified news announcements (3 dates), we noted that this does not imply that share price did not react to the news. Rather, the implication is that share price reaction cannot be attributed solely to the news announcements, and may be explained by other factors as well.

Appendix A2.1 presents the dates where the news announcements did not correspond to analyst commentaries.

3.2 Share price reactions of other regulated utilities

To assess whether the share prices of other UK utilities reacted in a similar way as that of NG, we conducted a similar filtering analysis to extract dates where the stock prices of Severn Trent (SVT), United Utilities (UU) and the MSCI Utility Index (utility index) exhibited significant movements in response to regulatory, political or systematic news announcements.

For many of the dates on which NG's share price reacted to political, regulatory or market news announcements, we noted that the share prices of UU, SVT and the utility index also exhibited significant price movements (see Figure 3.5 to Figure 3.7 below).

- Of the 113 statistically significant share price reactions of UU between 2008 and 2013, 26% occur on the same date as the events identified in NG's exploratory analysis (Figure 3.5).
- Of the 116 statistically significant share price reactions of SVT between 2008 and 2013, 22% occur on the same date as the events identified in NG's exploratory analysis (Figure 3.6).
- Of the 163 statistically significant share price reactions of the utility index between 2008 and 2013, 34% occur on the same date as the events identified in NG's exploratory analysis (Figure 3.7).

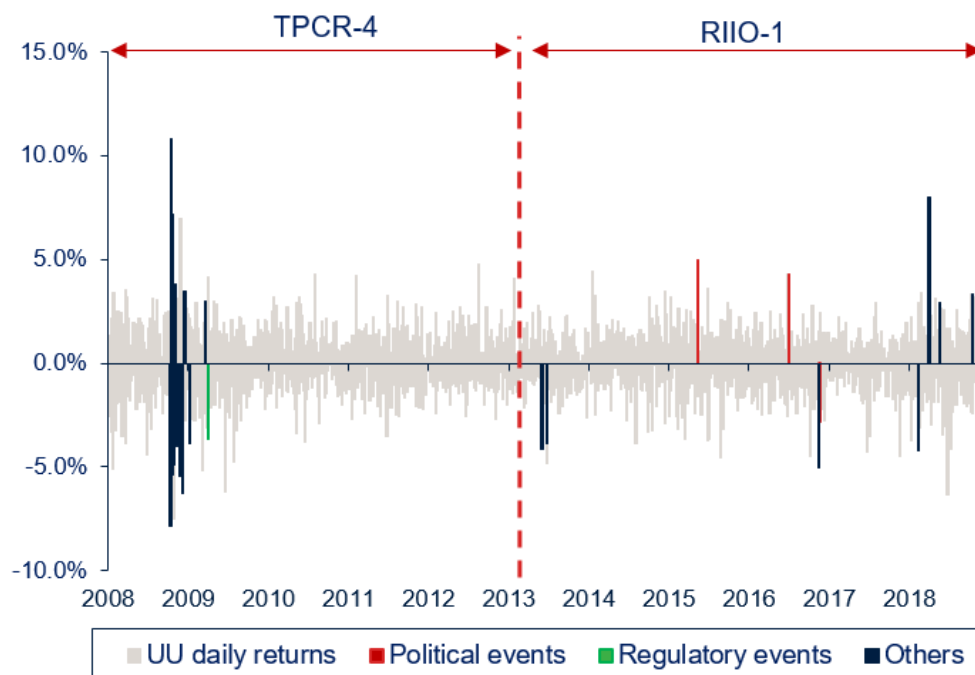
To conclude, the analysis of the share price reactions of UU, SVT and the utility index suggests that, similar to NG's share price reactions, adverse regulatory or political news announcements led to a decrease in the share prices of these utilities.

Moreover, similar to the trend observed in NG's share prices, the adverse share price reactions of these utilities to political news announcements has increased in frequency, in the last five years.

²⁰ The filtered dates correspond to NG's share price reaction where the price was two standard deviations away from the long-run average.

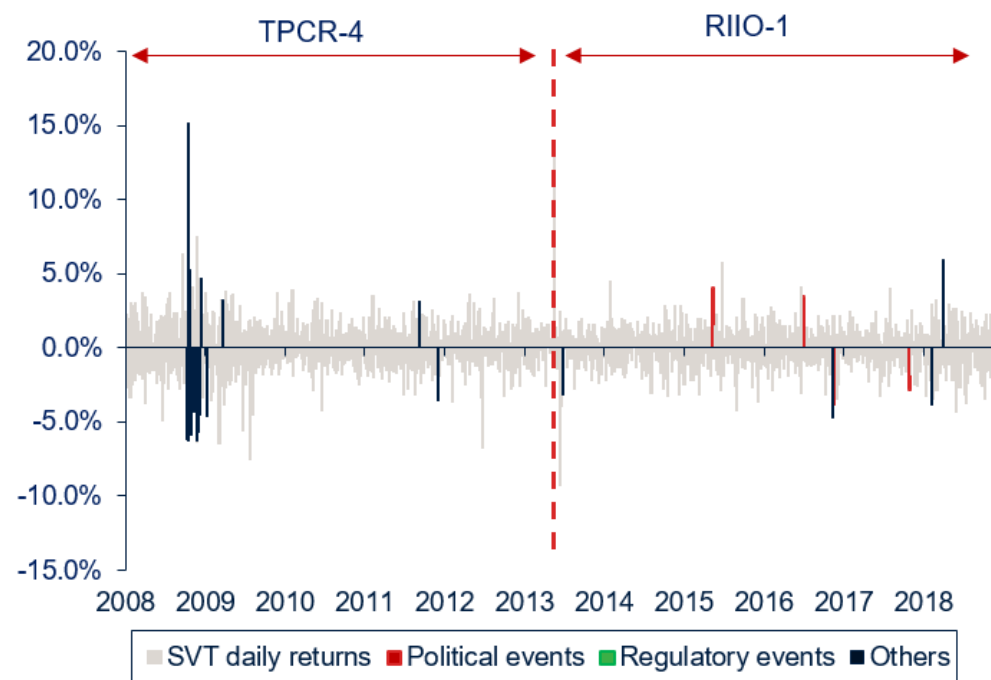
²¹ We reviewed the analyst commentaries that NG provided to Oxera. These were available for the majority of the filtered dates after 2012. However, for the pre-2012 dates, relatively few reports were available, and none were available for the dates identified during the 2008–10 period. Nevertheless, due to the financial crisis and the associated uncertainty in this period, share price reaction could be attributed to the identified political and/or systematic news announcements.

Figure 3.5 UU's significant share price movements that occur on the same dates as those of NG



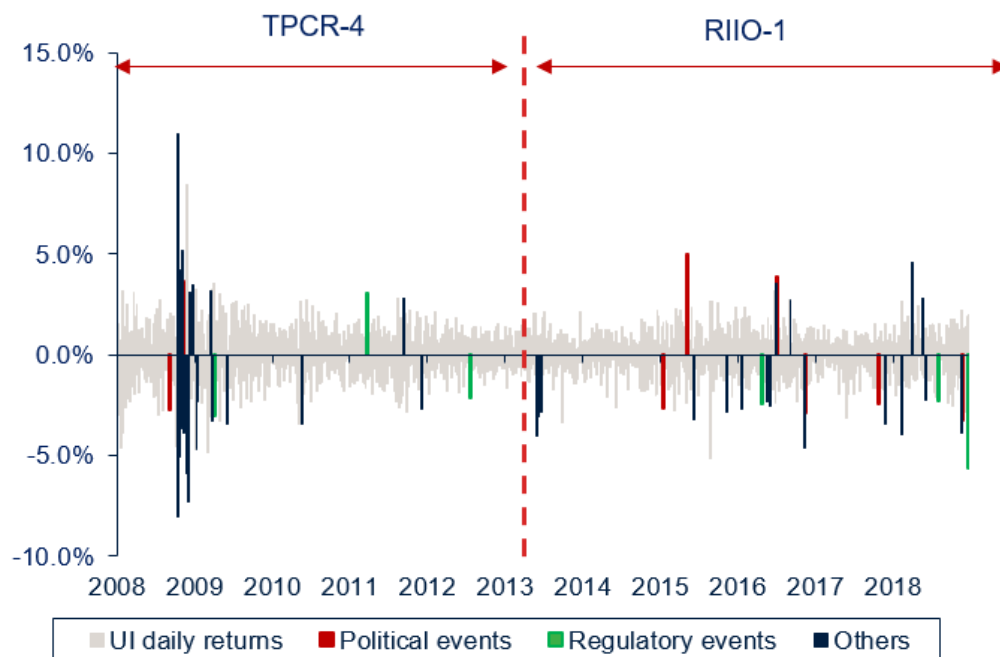
Note: UU's statistically significant returns (two standard deviations away from the long-term average) that fall on the same dates as the events identified in the exploratory analysis of NG. 'Others' includes events identified as systematic, safe haven and company-specific in NG's exploratory event analysis.

Figure 3.6 SVT's significant share price movements that occur on the same dates as those of NG



Note: SVT's statistically significant returns (two standard deviations away from the long-term average) that fall on the same dates as the events identified in NG's exploratory analysis. 'Others' includes events identified as systematic, safe haven and company-specific in NG's exploratory event analysis.

Figure 3.7 Utility index's significant share price movements that occur on the same dates as those of NG



Note: Utility index's statistically significant returns (two standard deviations away from the long-term average) that fall on the same dates as the events identified in the exploratory analysis of NG's stock. 'Others' includes events identified as systematic, safe haven and company-specific in NG's exploratory event analysis.

4 Analysis of share price volatility of NG and other utilities

Key messages

Share price volatility is a measure of total risk of the stock. Increase in share price volatility suggests an increase in risk and vice versa.

Analysis of share price volatility highlights the following:

- NG's share price volatility has increased relative to the FTSE All-share since July 2016. Volatility has also increased in absolute terms (albeit slightly).
- The volatility of other utilities (UU and the utility index) has also increased over time in both absolute and relative terms (i.e. relative to the FTSE All-share).

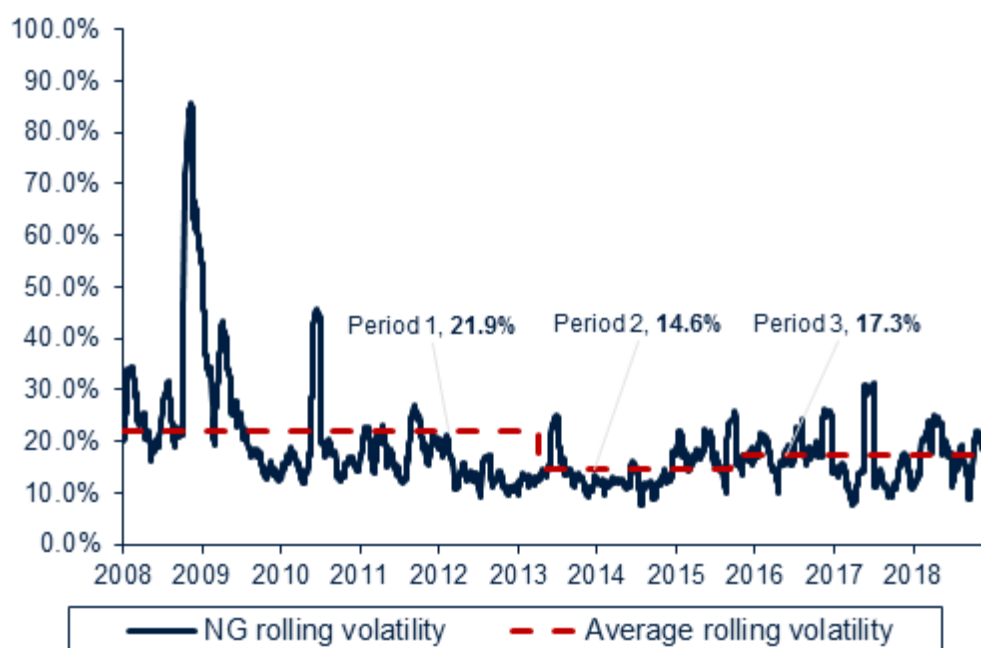
The analysis suggests that the increase in total risk (as measured by share price volatility) in the last two years is due to an increase in political and regulatory risk peculiar to NG and other utilities.

4.1 Impact on NG's share price volatility

We estimate the volatility of NG's share price and the FTSE All-share index as a measure of total risk (see Figure 4.1 and Figure 4.2). Volatility is estimated as the moving annualised standard deviation of 30 observations of daily returns.²²

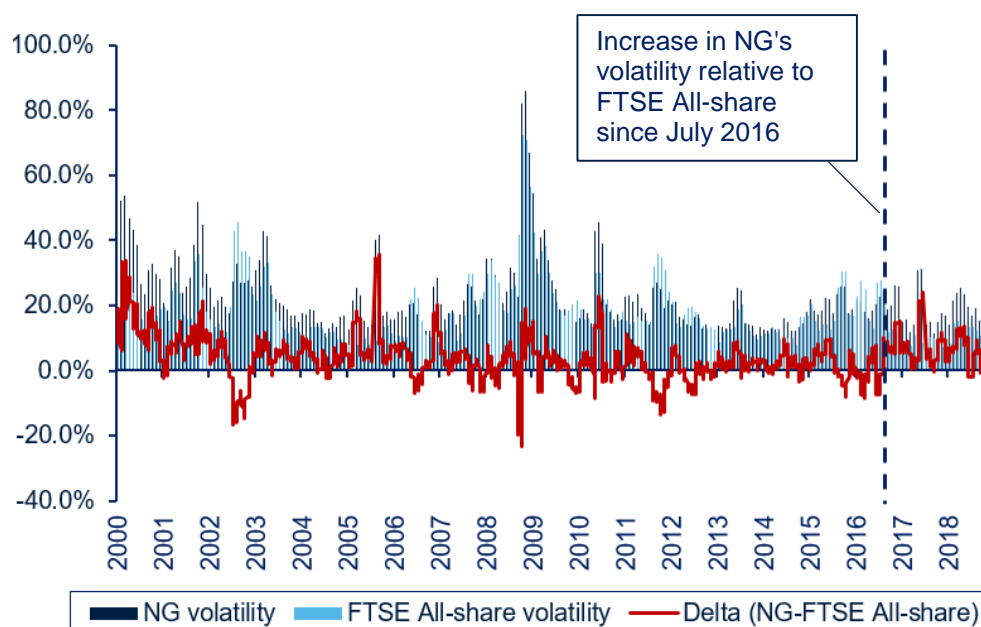
From Figure 4.1, we observe that NG's average share price volatility has increased in absolute terms in period 3 (September 2015 to December 2018) relative to period 2 (April 2013 to September 2015). From Figure 4.2, we observe that NG's volatility relative to the FTSE All-share index has consistently increased since July 2016.

²² Standard deviation is estimated using 30 observations of daily returns and multiplied by the square root of 252 trading days within a year to convert it to annualised volatility. This is consistent with Bloomberg's methodology of reported historical volatility.

Figure 4.1 Annualised 30-day rolling volatility of daily returns: NG

Note: NG's volatility of daily returns is calculated using the standard deviation of 30 observations of daily returns. This value is then multiplied by the square root of 252 to convert it to annualised volatility. 'Period 1' refers to 01 January 2008 to 31 March 2013. 'Period 2' refers to 01 April 2013 to 11 September 2015. 'Period 3' refers to 12 September 2015 (election of Jeremy Corbyn as the leader of Labour Party) to 20 December 2018. Reported historical volatility in each period is estimated as the average value of rolling volatilities within the period.

Source: Oxera analysis based on data from Thomson Reuters and Bloomberg.

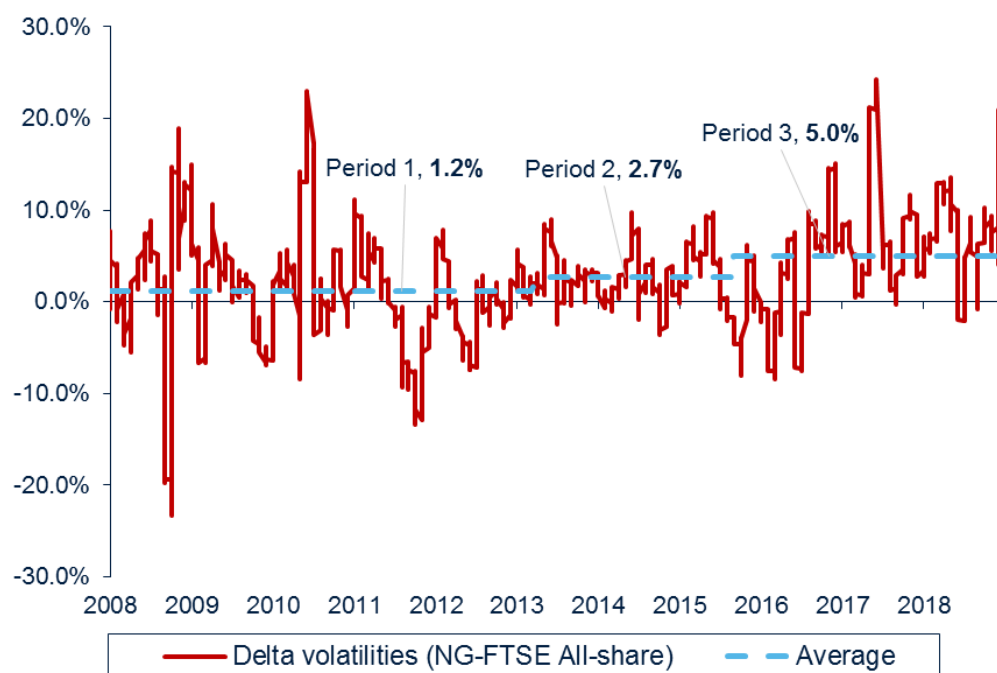
Figure 4.2 NG's volatility relative to the FTSE All-share (delta)

Note: Annualised rolling volatility is calculated using the standard deviation of 30 observations of daily returns multiplied by the square root of 252 trading days within a year. Delta of standard deviation is calculated as the difference between NG's volatility and the volatility of FTSE All-share. The dotted blue line marks the beginning of the period (end of July 2016), beyond which delta has consistently been on the positive territory (i.e. NG's volatility is greater than that of FTSE All-share).

Source: Oxera analysis based on data from Thomson Reuters and Bloomberg.

To further aid our understanding of NG's increased share price volatility relative to the market, Figure 4.3 shows the difference in volatility between NG and FTSE All-share over time. We observe that on average there is a substantive increase in NG's volatility relative to FTSE All-share across the three periods. The difference in volatilities (NG-FTSE All-share) in period 3 is approximately twice as high as the difference in volatilities in period 2 (and approximately four times as high as the difference in volatilities in period 1).

Figure 4.3 Difference in volatility between NG and FTSE All-share

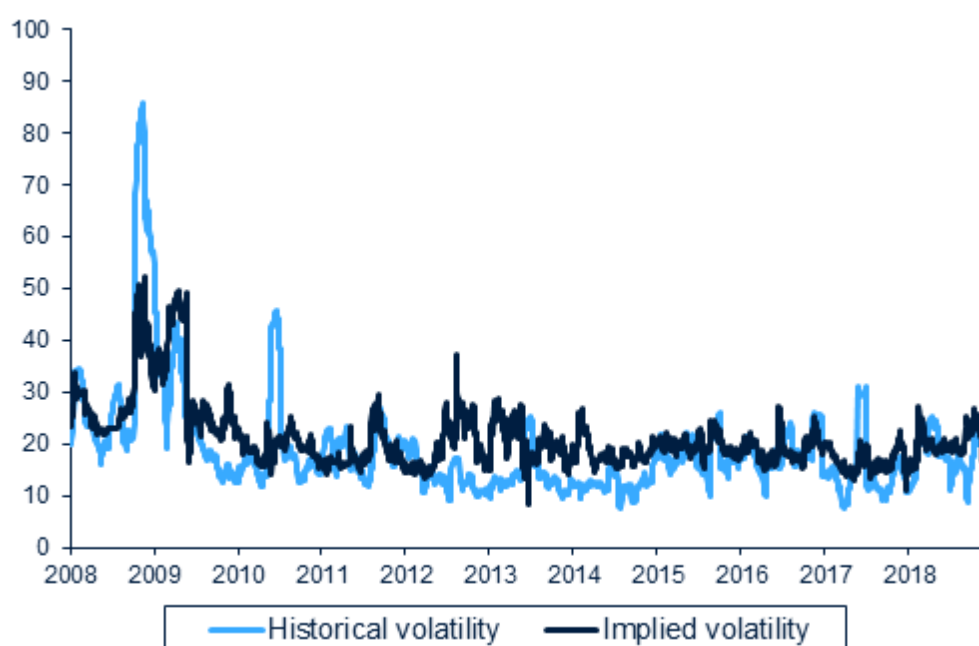


Note: Delta in standard deviation is estimated as the difference between NG and the FTSE All-share annualised rolling volatilities of 30 daily returns. The average is estimated as the arithmetic average of daily volatility observations from January 2008 to April 2013 (Period 1); from April 2013 to 11 September 2015 (Period 2); from 12 September 2015 to December 2018 (Period 3).

Source: Oxera analysis based on data from Thomson Reuters and Bloomberg

We also cross-checked how historical volatility compares with implied volatility—i.e. the volatility estimated from the prices of put options on NG's stock. As expected, the two are highly correlated, as can be observed in Figure 4.4 below.²³

²³ Implied volatility is a measure of perceived investor risk estimated using the Black-Scholes equation. As widely acknowledged in finance literature, the Black-Scholes equation does not hold in practice, which means that historical and implied volatility do not overlap perfectly.

Figure 4.4 NG's implied versus actual volatility

Note: Historical volatility is annualised based on 30 observations of daily returns. Implied volatility is the annualised value of the volatility derived from 30-day put options on NG's stock.

Source: Oxera analysis based on data from Thomson Reuters and Bloomberg.

To conclude, NG's share price volatility has increased in recent years both in absolute terms and relative to the FTSE All-share.

4.2 Volatility analysis of other utilities

The volatility analysis of UU, SVT and the utility index highlights the following.

- UU's average annualised rolling volatility increased in period 3 (2015 to 2018) compared to the previous period 2 (2013 to 2015). Period 2 volatility was 18.0%, rising to 19.4% in period 3 (see Figure A2.1; Figure A2.2 in the annex A2.2.1).
- SVT's average annualised rolling volatility has remained constant around 18.6% in period 2 and period 3 (Figure A2.3; Figure A2.4), although there was a spike in SVT's volatility in period 2, which is not seen in the data on UU's returns.
- The average annualised volatility of the utility index increased by 15% from period 2 to period 3. It increased from 13.8% to 15.9% in absolute terms (Figure A2.5; Figure A2.6).
- The average differential in annualised volatilities relative to the FTSE All-share (delta volatility) has increased for UU and the utility index. There is a substantial increase in the relative volatilities across the three periods. This indicates that regulated utilities have progressively become riskier relative to the market, as shown in Table 4.1 below.

Table 4.1 **Average differential (%) in annualised volatilities relative to the FTSE All-share**

Constituents	Period 1 (2008–13)	Period 2 (2013–15)	Period 3 (2015–18)
National Grid	1.2	2.7	5.0
United Utilities	2.0	6.0	7.1
Severn Trent	1.9	6.7	6.2
MSCI UK Utility Index	-2.4	1.9	3.6

Note: The average differential is calculated as the simple average of the daily differential in volatilities across the periods. Percentages are rounded to the nearest decimal. 'Period 1' refers to January 2008 to March 2013. 'Period 2' refers to April 2013 to 11 September 2015. 'Period 3' refers to 12 September 2015 to December 2018.

Source: Oxera analysis based on data from Thomson Reuters.

To conclude, the results derived from the volatility analysis of other utilities show a trend similar to that of NG: volatility has increased in absolute terms and relative to the market, indicating an increase in total risk of all the regulated utilities. This suggests that the impact on risk is, at least in part, systematic in nature.

5 Testing for ‘defensive stock’ characteristics

Key messages

The characteristic of a defensive stock is that it will be demanded by investors during times of higher economic uncertainty, leading to relatively higher returns for the assets in question.

Analysis of the hypothesis suggests that since the start of RIIO-1, there has been a decline in the status of NG and other regulated utilities as a defensive stock and a hedge against economic uncertainty. This is evident from the following.

- The lower returns observed on NG’s shares in periods of economic uncertainty. In the RIIO-1 period relative to TPCR4, there was a reduction in positive share price movements of NG on days when the wider stock market declined. This change in relationship between stock returns and index returns was also observed for other utilities.
- A change in the relationship between NG’s share prices and the returns of other defensive securities such as UK gilt yields. Over time, changes in NG’s actual share prices as well as the share prices of other regulated utilities seem to be less well explained by changes in UK gilt yields. The squared residuals from the regression of share prices on UK gilt yields increased from around 515 on average during 2008–13 to around 680 on average during 2013–18, suggesting a decline in the status of NG and other regulated utilities as a defensive stock.

An asset is perceived as relatively low risk or ‘defensive’ when relative demand for the asset increases during times of higher economic uncertainty—i.e. the share price of the asset does not decline proportionately when the market falls, or may even increase.

If investors consider NG to be a defensive stock, its share price would be expected to closely follow the prices of UK gilts or other defensive stocks (e.g. gold); alternatively changes in NG’s share price would likely be explained by changes in UK gilt yields or changes in gold prices.

Below, we assess whether investors consider NG and other utilities to be defensive assets and whether this perception has changed over time.

5.1 Positive share price reaction of NG and other utilities relative to the market

As discussed, if investors consider NG to be a defensive stock, one would expect an increase in its share price relative to the market in times of economic uncertainty, implying outperformance of its stock relative to the FTSE All-share.

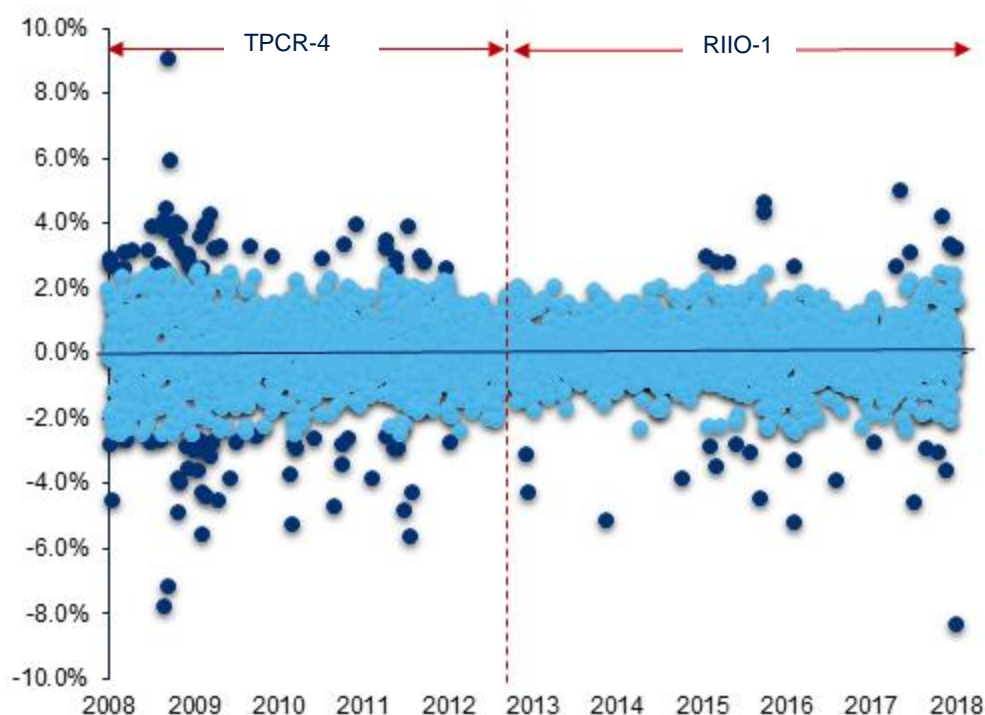
Defining ‘delta’ as the differential of returns between NG and the FTSE All-share, the frequency of statistically significant **positive delta** of returns between NG and the FTSE All-share (i.e. instances where NG outperformed the market) has notably reduced in the last five years (2013–18) compared to the 2008–13 period.²⁴ From 2008 to 2013, there were 46 observations where NG significantly outperformed the market; this compares to only 12 observations in the 2013–18 period (as shown in Figure 5.1).²⁵

²⁴ We note that some of NG’s share price outperformance relative to FTSE All-share could also be driven by other factors such as NG’s positive financial performance.

²⁵ Some of NG’s outperformance relative to the market can be attributed to the 2008 financial crisis when investors rushed to buy defensive stocks. However, acknowledging this potential distortion and excluding the

While NG's significant share price outperformance relative to FTSE All-share could also occur on days when the market return is positive (i.e. FTSE All-share price also increased), the number of days when NG's share price increased and the wider market declined has reduced in the 2013-18 period relative to 2008-13 period.

Figure 5.1 Statistically significant delta of daily returns between NG and the FTSE All-share



Note: Statistically significant delta of returns marked in dark blue. The delta is calculated as the difference between NG and FTSE All-share daily returns. Statistically significant deltas are the observations located more than two standard deviations away from the mean. The positive y-axis shows positive delta of returns where NG outperformed the market.

Source: Oxera analysis based on Thomson Reuters data.

Similar results were obtained when analysing the statistically significant share price outperformance of other regulated utilities. Share price outperformance relative to FTSE All-share became less frequent for other utilities between 2008–13 and 2013–18—from 32 to 18 observations for UU; from 40 to 18 observations for SVT; and from 59 to 22 observations for the utility index. For details, see appendix A2.3.1

5.2 How well are NG's and other utilities' prices explained by UK gilt yields?

To test whether investors perceive NG as a defensive stock, we conducted an indicative analysis by regressing its share price on UK gilt yields over the RIIO-1 period (April 2013 to December 2018) and the previous five-year period (January 2008 to March 2013).²⁶

observation of daily returns in 2008, NG's outperformance relative to the market prior to RIIO-1 (2009–13) was still twice as high as in the current RIIO-1 period (2013–18).

²⁶ This is an illustrative regression analysis to assess the relationship between NG's share price and UK gilt yields. The purpose of the regression is not to forecast NG's price, but to see what proportion of the price is explained by UK gilt yields and whether this relationship has changed over time.

The regression of NG's share price on UK gilt yields is described as follows²⁷:

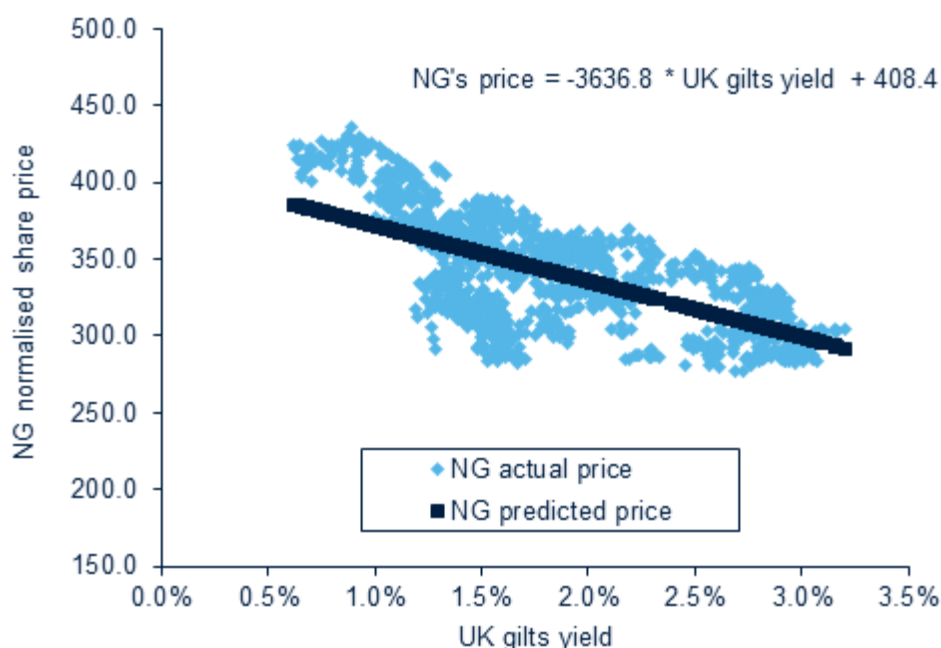
$$NG's \text{ normalised Price} = \alpha + \beta * UK \text{ gilt yield} + \varepsilon$$

where α is the model's intercept; β is the regression coefficient which measures the change in NG's normalised price for one unit of change in UK gilt yields; and ε is a random error.

To observe whether investors' perception of NG as a defensive stock has changed over time, we estimate the residuals from the above regression. Residuals are defined as the changes in NG's price that are not explained by changes in UK gilt yields, and are estimated as the difference between NG's actual price and NG's predicted price from the regression. Figure 5.2 below provides the scatter plot of NG's actual and predicted price.

Residuals can be negative or positive, indicating whether the actual price is above or below the predicted price (the estimated equation or line of best fit). The direction of the residuals does not have any implications for the relationship between NG's share price and UK gilt yields.

Figure 5.2 NG's actual and predicted price



Note: The predicted values of the regression analysis are shown by the dark blue line. This is the line of best fit resulting from the regression analysis. The light blue dots indicate actual daily prices observed from 2013 to 2018. The distance between the predicted and the actual price shows the residuals from the regression.

Source: Oxera analysis based on Thomson Reuters data.

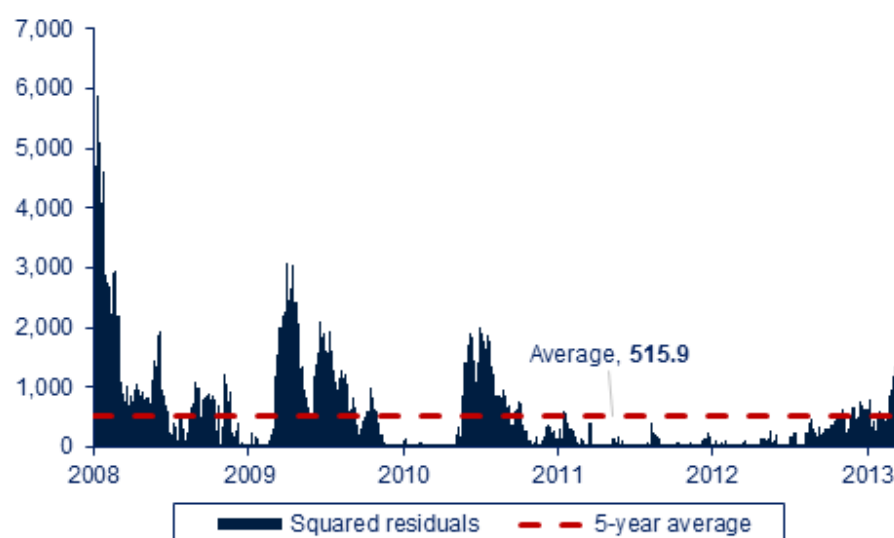
We note that the magnitude of the squared residuals has increased over the last five years (April 2013 to December 2018) (see Figure 5.4) compared with the previous five-year period (January 2008 to March 2013, see Figure 5.3). A consistent increase in the value of the squared residuals implies a greater differential between NG's actual share price and the predicted price. This

²⁷ The dependent variable of the regression is NG's normalised price (relative to the price on 2 January 1998), and the independent variable is the ten-year UK gilt nominal yields.

suggests that NG's actual prices are no longer as well explained by UK gilt yields, or that there may be an omitted variable in the regression.

Abstracting from issues of heteroskedasticity²⁸, this indicative analysis suggests that investors perhaps do not perceive NG to be as defensive an asset as they did in the past and that the increased political risk is being incorporated in their investment decisions.

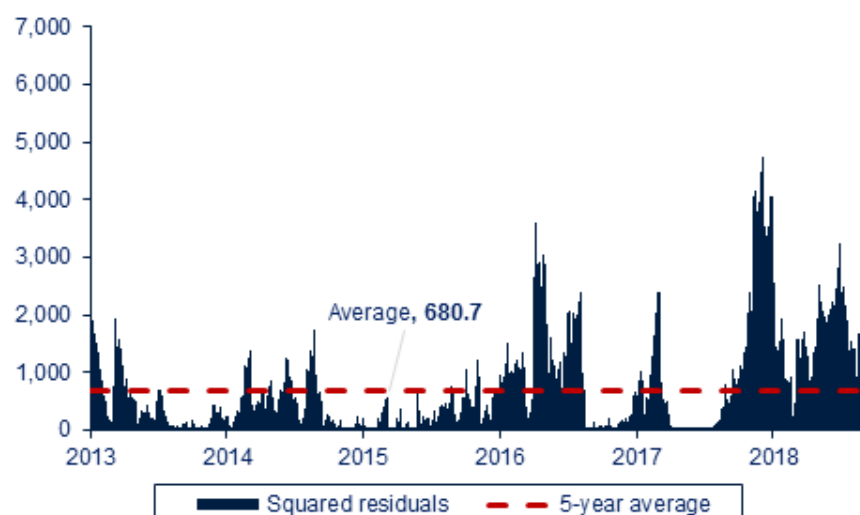
Figure 5.3 Squared residuals of NG's share price regression on UK gilt yields, 2008–13



Note: Residuals are an indicator of the proportion of movements in NG's share price that are unexplained by movements in UK gilt yields.

Source: Oxera analysis based on Thomson Reuters data.

Figure 5.4 Squared residuals of NG's share price regression on UK gilt yields, 2013–18



Note: There is a consistent growing trend in squared residuals from the regression of NG's share price relative to UK gilt yields.

²⁸ Heteroskedasticity is a term used to describe non-constant standard deviations of a variable overtime.

Source: Oxera analysis based on Thomson Reuters data.

To cross-check our results from the regression analysis of NG's price on UK gilt yields, we regressed NG's price on gold prices—another defensive asset. We obtained largely consistent results, indicating that changes in NG's price over time are less well explained by gold prices. This implies that the decline in NG's status as a defensive stock can potentially be attributed to the enhanced riskiness of the stock itself, rather than intrinsic factors embedded in the returns on/prices of UK gilts or gold.

The regression analysis of NG's price on gold price is presented in appendix 7A2.3.2.

We conducted similar analysis for UU, SVT and the utility index (i.e. we regressed the prices of these utilities on UK gilt yields). The results obtained were similar to the results obtained for NG. The squared residuals from the regressions increased over time between the two periods: 2008–March 2013, and April 2013 to December 2018. This indicates that, similar to NG, investors now perceive these utilities to be less defensive than they were previously. For detail, please see appendix A2.3.3.

To conclude, assessing the market data of NG, UU, SVT and the utility index reveals that, over time, these utilities have behaved less like conventional defensive stocks. This conclusion is substantiated by the results of the complementary empirical analysis, which shows that:

- NG, as well as the other utilities reviewed, have become more risky, both in absolute terms and relative to the market, as depicted by the volatility analysis conducted in section 4;
 - the share price outperformance of NG, as well as the other utilities reviewed, relative to the market has reduced in the last five years;
 - the price movements of NG, as well as the other utilities reviewed, are less well explained by UK gilt yields and gold prices over time.
-

6 Review of rating agencies and analyst commentary

Key messages

A review of rating agencies and analysts commentaries in the UK, USA and mainland Europe highlights the following.

- Political and regulatory risk is a key factor that can have an impact on a regulated company's valuation and more specifically on NG's value. The focus on political risk has changed over time in the UK, with the UK's withdrawal from the EU (Brexit) and the Labour Party's proposals to renationalise regulated utilities being identified as key risk factors for NG's valuation in recent periods.
- The assessment of regulatory risk in the UK has also changed over time. In particular, Ofgem's RIIO-2 sector-specific consultation published in December 2018 is being viewed as negative for the sector and for NG.
- NG's geographically diversified business is considered to offset some of the UK-specific risk factors at the group level—especially because of NG's strong presence in the USA, where commentators assess the regulatory environment to be more stable than in the UK. This obscures the impact of NGET and NGGT risk exposure on the valuation of the Group.
- Regulatory and/or political risk is reflected in commentaries on transmission operators in Germany, Italy and Spain, with positive regulatory/and or political developments seen as credit-enhancing, and vice versa.

To consider the impact of political and regulatory risk from the perspective of investors, we assessed commentaries on NG from rating agencies and analysts in the UK, mainland Europe and the USA. Moreover, we reviewed the commentaries on transmission system operators in mainland Europe.

Our analysis considered:

- 36 analyst reports on (mainly) NG's UK business, provided by NG (2016–2018);²⁹
- 13 credit rating reports on NG's US business, provided by NG (2018);
- 32 credit rating reports on comparator companies from Germany, Italy and Spain (2008–18).

6.1 Political and regulatory risk in analyst commentaries

6.1.1 Political risk

Of the 30 analyst reports on NG analysed, 20 discussed political risk and its impact on NG's valuation. The extent to which the reports discuss political risk varies. Some reports mentioned the overall political environment only broadly as one factor that could have an impact on NG; others highlighted specific key issues such as the UK's withdrawal from the EU or the Labour proposal to renationalise regulated utilities.

While many of the analyst reports in 2016 and early 2017 discussed political risk as only a potential risk that could hypothetically affect NG's share prices,

²⁹ NG provided Oxera with 260 analyst reports covering the period from 2016 to 2018. These reports discuss NG and competing utility companies, as well as the utilities sector as a whole. We narrowed down the selection to include only reports that a) exclusively focus on NG and b) are of a higher significance—i.e. quarterly updates, detailed research reports, and reports that focus on political and regulatory risk.

from mid-2017 onwards political risk has become something more tangible in the analyst reports. For example, in September 2017, Credit Suisse noted:

Overall, we feel that National Grid was seeking to move investor focus away from the UK – where the political risk is high and growth low, in our view – and onto growth in the US business³⁰.

The tone of the analyst reports has also changed over time. In recent periods analysts often place more emphasis on NG's US business and how this would help offset potential implications of political risk in the UK. This in principle means that political risk is an increasingly important factor in the UK and has the potential to affect NG's UK business, although NG's geographical diversity will obscure the impact of NGET and NGGT risk exposure on the valuation of the Group.

The change in the assessment of political risk in the analyst reports can be observed when considering what they write about Brexit and the possible renationalisation of UK utilities over time.

In light of the UK referendum on the EU membership in 2016, Credit Suisse, RBC Capital Markets, and Morgan Stanley considered NG to be a safe haven, with Credit Suisse stating that the referendum:

has [had] a large 'safe-haven premium' on NG shares in recent months, and is behind the +c24% total return outperformance of the shares across the past year.³¹

However, by mid-2017 this assessment changed, with Barclays stating that even though it does not expect a negative impact on NG's fundamental business, Brexit could have a negative impact on its interconnectors to mainland Europe and its UK property business.³² In December 2017, RBC stated that it would expect the Brexit negotiations and their unclear outcome to lead to an increase in share price volatility over the course of the next 12 months.³³

The assessment of a possible renationalisation of UK utilities has changed over time as well. In May 2017, Bank of America/Merrill Lynch considered Labour's renationalisation policy as a potential yet distant threat,³⁴ whereas in 2018 Citi and Macquarie cite this as one of the main political risks that has an impact on NG's share price.^{35 36}

The emphasis on political risk in the USA is much lower than in the UK. Of the 13 credit reports on NG's US business, only two mentioned political risk as one of the factors affecting credit ratings, although there has been no impact on NG's credit rating of US bonds.

The main theme in the analyst reports is that while the UK political environment appears to become riskier, ultimately having a negative impact on NG, the Group's geographically diversified business model is expected to offset this risk to some extent—mainly due to NG's US business.

³⁰ Credit Suisse (2017), 'National Grid: US business strong. But UK remains weak', p. 4.

³¹ Credit Suisse (2016), 'National Grid: Top-down macro at odds with fundamentals', p. 5.

³² Barclays (2017), 'National Grid plc: Hitting the valuation glass ceiling', p. 9.

³³ RBC Capital Markets (2017), 'National Grid PLC: Built to last... even into RII02', p. 12.

³⁴ Bank of America/Merrill Lynch (2017), 'National Grid: US Renaissance - upgrade to Buy', p. 18.

³⁵ Citi (2018), 'National Grid PLC: Attractive valuation with risks priced in. Buy', p. 1.

³⁶ Macquarie (2018), 'National Grid: Our preferred UK utility through 2018', p. 3.

6.1.2 Regulatory risk

Of the 36 analyst reports, 30 discussed regulatory risk and its positive or negative impact on NG's valuation, although UBS, in 2016, in its reasoning for its downgrade of NG from 'Neutral' to 'Sell', included the fact that increasing short-term regulatory risks and uncertainty were *not* being priced in.³⁷

Many other reports list a potential, adverse change in the regulatory framework either in the UK or the USA as a threat to NG's valuation.³⁸ The impact of such regulatory framework changes can be observed when assessing the content and the language of the analyst reports over time. For example, in March 2017 JP Morgan Cazenove stated that the 'UK regulatory framework remains a key positive'.³⁹ However, around a year and a half later, when Ofgem published its RIIO-2 sector specific methodology in December 2018, the analysts highlighted how Ofgem's proposals would be negative for the whole sector in general and NG in particular.⁴⁰ Though none of the analysts changed NG's rating or target price based on Ofgem's consultation, this was largely due to the impact on NG expected to be (partly) diluted by NG's US and interconnector businesses.^{41,42} According to the analysts, NG's core business in the UK remains exposed to the regulatory risk brought about by Ofgem's proposals.⁴³

All of the credit rating reports on NG's US business highlighted 'established', 'supportive', and 'favourable' regulatory regimes, as well as the 'effective management' of any regulatory risk, as having a positive effect on NG's and its subsidiaries' credit ratings in the USA.⁴⁴

The analyst reports consider regulatory risk in the UK as more prevalent than in the USA. As with the impact of political risk, this suggests that NG's US business, which operates in a more stable regulatory regime, can offset the regulatory risk in the UK to a certain extent, although Morgan Stanley states that this could change in the 2020s.⁴⁵

6.2 What does Moody's Ofwat downgrade imply for Ofgem's regulatory regime?

In May 2018, Moody's changed its assessment of the stability and predictability of the UK water regulatory regime from 'Aaa' to 'Aa'. Moody's cited as the main reason for this downgrade a heightened risk of future political interference in the design of the newly proposed regulatory framework.⁴⁶ It criticised Ofwat's proposals, noting that these would give the regulator greater influence over the water companies' capital structures and dividends.

The UK energy network regulatory regime is currently assessed as 'Aaa' by Moody's. The introduction of the RIIO regime in 2013 did not change this, as fundamental aspects⁴⁷ of the framework were retained. While there is no

³⁷ UBS (2016), 'National Grid: Expensive growth - downgrade to Sell', p. 1.

³⁸ For example, Macquarie (2018), 'National Grid: Our preferred UK utility through 2018', p. 3.

³⁹ JP Morgan Cazenove (2017), 'National Grid: Strong fundamentals, growth and capital management', p. 3.

⁴⁰ For example, Goldman Sachs (2018), 'UK Utilities. RIIO-2 Sector Specific Methodology; further thoughts post release', p. 1.

⁴¹ HSBC (2018), 'National Grid. Buy: Regulatory obfuscation (but work in progress)', p. 1.

⁴² Société Générale (2018), 'UK Utilities. RIIO-2: Ofgem's tougher proposals on financial parameters', p. 1.

⁴³ UBS (2018), 'UK Infrastructure Utilities. RIIO-2 consultation: end of extreme returns confirmed. CoE proposal below previous range', p. 1.

⁴⁴ For example, S&P Global Ratings (2018), 'National Grid North America Inc.', p. 2.

⁴⁵ Morgan Stanley (2018), 'National Grid plc: A New Perspective', p. 1.

⁴⁶ Moody's (2018), 'Announcement: Moody's changes outlook to negative on ratings of 4 UK water groups', p. 1.

⁴⁷ These include: 'The concept of a regulatory asset value (RAV), an allowed financial return, ex-ante allowances for operating and capital expenditure, Retail Prices Index (RPI) indexation, incentives, uncertainty mechanisms, true-ups and re-openers as well as the right to seek independent arbitration from

indication yet that Moody's might change this assessment, it revised its outlook to negative for both the financing subsidiary of Wales & West Utilities,⁴⁸ and Electricity North West Limited,⁴⁹ based on its expectation of further reductions in returns in the RIIO-ED2 regulatory period. The overall focus on regulatory risk in the analyst reports suggests that regulatory or political risk could be one of the main factors leading to a lower assessment of the stability and predictability of the regulatory regime (if it were to happen), which would subsequently have an impact on NG's valuation.

6.3 Analyst commentary on political and regulatory risk in mainland Europe

Moody's announcements on comparator companies from Germany (Amprion GmbH, 50Hertz Transmission GmbH), Italy (Terna S.p.A., Snam S.p.A.), and Spain (Red Electrica de Espana S.A.U., Enagas S.A.) placed emphasis on regulatory and/or political risk.

In 24 of the 32 announcements, Moody's stated that in general it considers a positive track record of regulatory developments, or regulatory stability, as one of the drivers of potential rating upgrades; while it considers adverse regulatory developments affecting companies' returns as one of the drivers of potential rating downgrades.⁵⁰ If we take into account the emphasis on regulatory risk as well as Moody's recent assessment of Ofwat's proposals, we observe that regulatory risk is a significant factor in how Moody's determine its ratings.

The reports also reflected developments in regulatory risk over time. For example, when Moody's first rated Eurogrid, the holding company of 50Hertz, in 2010, it described Germany's (then) new and untested incentive-based regulatory regime as 'modestly riskier in relation to its transparency and predictability than the more established regimes, such as the UK framework'.⁵¹ The identified modest regulatory risk did not have a negative effect on Moody's rating, as the German regulatory body had acknowledged this risk by demonstrating 'willingness to address a number of potential risk factors'.⁵² In the latest report on Eurogrid from July 2018 (when the regulatory regime is far more developed than it was back in 2010), Moody's considered the developed regulatory regime as one of the positive factors for Eurogrid's Baa1 credit rating:

Eurogrid's Baa1 rating is further underpinned by the strong business risk profile of the monopoly electricity transmission business operated by its principal subsidiary and guarantor of Eurogrid's debt, 50Hertz, and the relatively stable and predictable cash flows it generates under a developed regulatory framework.⁵³

In Spain, when Moody's upgraded Red Electrica de Espana's credit rating in 2016, one of the three reasons it gave was 'the more settled regulatory

the Competition Commission'. Moody's (2013), 'Announcement: Moody's: Transition to RIIO is credit neutral for UK gas distribution networks', p. 1.

⁴⁸ Moody's (2018), 'Rating Action: Moody's changes outlook on Wales & West's rating to negative; affirms rating', p. 1.

⁴⁹ Moody's (2018), 'Rating Action: Moody's changes outlook on Electricity North West's Baa1 ratings to negative; affirms ratings', p. 1.

⁵⁰ For example, Moody's (2012), 'Rating Action: Moody's assigns Baa1 issuer rating to SNAM; outlook stable', p. 2.

⁵¹ Moody's (2010), 'Rating Action: Moody's assigns (P)Baa1/P-2 ratings to Eurogrid's proposed EMTN programme; outlook stable', p. 1.

⁵² Ibid.

⁵³ Moody's (2018), 'Rating Action: Moody's confirms Eurogrid's Baa1 rating, stable outlook', p. 2.

framework'.⁵⁴ Spain's regulatory framework had been revised before in 2014 and 2015.

Of the announcements analysed, 12 discussed political risk, and stated that evidence of political interference, especially in regulatory competences, can have a negative effect on credit ratings.⁵⁵ However, unlike what we observed in the commentary on regulatory risk, a development of or change in the commentary on political risk overtime could not be observed.

⁵⁴ Moody's (2016), 'Rating Action: Moody's upgrades REE's ratings to Baa1; outlook stable', p. 1.

⁵⁵ For example, Moody's (2018), 'Rating Action: Moody's downgrades the ratings of four Italian utilities', p. 2.

7 Conclusion

This report reviews a broad base of evidence to objectively test the hypothesis that increased political and regulatory uncertainty is being priced by investors into the valuation of regulated utilities in general and NG in particular. The increased political and regulatory risk is evident from:

- more frequent political and regulatory news triggering share price falls (i.e. sharp declines in reaction to news);
- an increase in share price volatility since 2016—a period during which the UK Labour party has asserted its manifesto of renationalising utilities if it were to come in power;
- a decline in the status of NG and other regulated utilities as a ‘defensive stock’;
- an increased focus on regulatory and political risk as a valuation driver in analyst assessments.

The evidence points towards an increase in political and regulatory uncertainty over and above that which might be expected at the start of a price review. Therefore, it cannot be assumed that this uncertainty will subside once the price review engagement process concludes, and the RIIO-2 period starts.

Understanding how this risk affects required returns and the cost of capital requires a set of assumptions about how investors price assets. In theory, political and regulatory risk can have impacts in three areas:

- exposure to market-wide risk (i.e. systematic market risk)—captured by the CAPM equity beta;
- exposure to other systematic risks—factors that affect multiple companies and where investors cannot eliminate their exposure to these risk factors by investing in a larger, more diversified portfolio of companies (exposures to these risks are best captured by multifactor models);
- exposure to idiosyncratic risks i.e. company-specific consequences of political and regulatory actions which at times are priced by investors.

The premium that investors require for exposure to political and regulatory risk factors would in principle be best estimated using multifactor models. However, in the absence of appropriately calibrated multi-factor models and the preference of UK regulators to use the CAPM, it is important that due consideration is given to other systematic and priced idiosyncratic risk factors when interpreting the outputs from the CAPM model for determining the cost of equity allowance for RIIO-2.

A practical way to do this would be to select a beta point estimate towards the top of the plausible equity beta range derived from the CAPM. Although this will not guarantee that investors are adequately compensated for exposure to political and regulatory risk, it will reduce the risk of such factors creating an underinvestment problem in network assets that have lives that extend far beyond the average duration of a regulatory price control period.

A1 Review of literature

Key messages

The literature on political and regulatory risk highlights the following:

- There is evidence that the nature of the regulatory regime affects the exposure of regulated companies to systematic risk as measured through the asset beta;
- The literature provides evidence that share price volatility increases when there is unexpected regulatory intervention, although the evidence for an impact on systematic risk as measured by the CAPM equity beta is less clear.
- There is evidence of political uncertainty affecting systematic risk as well as leading to an increase in the equity risk premium (i.e. political risk premium). The effect on systematic risk is not always consistent; with some studies showing that systematic risk increases and others indicating that it decreases during periods of political uncertainty.

The literature review supports the hypothesis that political and regulatory risk affects both exposure to market-wide risk and firm specific risk. While the directional impact on the exposure of firms to market-wide risk (i.e. equity beta) is inconclusive, the increase in political risk results in a higher market equity risk premium. This suggests that the impact of an increase in political and regulatory risk on the rate of return required by investors is dependent on circumstances.

Source: Oxera analysis based on review of relevant literature.

The existing literature on the impact of political and regulatory risk can be broadly categorised as follows:

- impact of regulatory system risk i.e. risk due to the form of regulation;
- impact of regulatory intervention risk due to a particular event or action of a regulator where the event or action could be driven by changes in the political landscape; and
- impact of political uncertainty on markets.

The *most relevant* literature for the topic under consideration in this report is the literature on the effect of political uncertainty on exposure to systematic risk (i.e. the equity beta) or the equity risk premium (i.e. the political risk premium).

A1.1 Regulatory system risk

How a company is regulated affects its exposure to systematic risk—i.e. risk that cannot be eliminated by holding a diversified portfolio. Investors expect to earn returns in proportion to their exposure to systematic risk.

There are two main forms of regulation: price cap regulation; and rate of return regulation. Other regulatory regimes that fall within the spectrum of these two forms of regulation are:

- price cap regulation with cost pass-through—most price cap regimes allow for the pass-through of unavoidable costs;
- revenue cap regulation—the total revenue a company can charge is limited. This regime is applied when the regulated company has high fixed costs where and a pure price cap regime would impose significant demand-side risk;

- hybrid regulation—price and revenue caps are applied in combination to different vertically integrated parts of a regulated company, depending on the level of fixed costs. Hybrid regulation can also take the form of a floor or ceiling on the rate of return that the company can earn;
- discretionary systems—prices are set by committees without any explicit framework, as prevalent in some European countries (for example, Austria).

Of the two main forms of regulations, price cap regulation provides greater efficiency incentives leading to lower prices for consumers in the long run but raises the regulated company's exposure to market risk (defined in the literature as regulatory system risk). This is because, unlike rate of return regulation, under price cap regulation a company's revenue changes according to changes in demand. The price cap regulated firm (with a pure form price cap) faces uncertainty over the recovery of its fixed costs, thereby increasing risk for investors. The literature investigates whether this higher exposure to market risk is priced by investors in the form of a higher cost of capital (reflected in higher asset betas) of price-cap regulated companies relative to companies with a regulated rate of return.

Alexander, Mayer and Weeds (1996) assessed regulatory system risk for a number of regulated utilities in Canada, Europe and Latin America using a narrow definition of different regulatory regimes and controlling for sectoral decomposition. This ensures that all risks other than those associated with the form of regulation are controlled for. They find that high powered incentive regimes (such as price cap) are related to higher systematic risk reflected in higher asset betas (estimated over January 1990 to August 1995) compared to low powered incentive regimes (rate of return regulation).⁵⁶ The results from Gandolfi, Jenkinson and Mayer (1996) and by Alexander et al. (2000) found a similar relationship between the regulatory regime and beta risk in the transport sector.⁵⁷ Wright and Mason et.al. (2003) also found a similar relationship in the asset betas of price cap vs rate of return regulated firms.⁵⁸

A report on regulatory risk for National Audit office (2001)⁵⁹ highlights the studies that compare the relative riskiness of regulation with competitive markets. Some studies argue that regulation can reduce the risks faced by the companies due to the 'buffering effect' by limiting the upside and downside earnings of a firm and therefore leading to a lower cost of capital (Binder and Norton 1999, Nwaeze 2000) and lower earnings volatility (Peltzman, 2001). Other empirical studies provide evidence that suggests that regulatory factors can actually increase the cost of capital for regulated utilities above that which would be observed in competitive conditions.

The regulated factors leading to increased regulatory risk include:⁶⁰

- **regulatory lags**—regulated companies can under or over perform on the allowed returns due to higher costs or efficiency gains over the price control as the allowed revenues are fixed for the duration of the price control and

⁵⁶ Alexander, I., Mayer, C. and Weeds, H. (1996), 'Regulatory Structure and Risk and Infrastructure Firms: An International Comparison', World Bank Policy Research Working Paper.

⁵⁷ As summarised in Grayburn J., Hern, R. and Lay, H. (2002), 'A report for the National Audit Office on regulatory risk', 10 April.

⁵⁸ Wright, S., Mason, R. and Miles, D. (2003), 'A Study Into Certain Aspects of the Cost of Capital for Regulated Utilities in the U.K.', Report by Smithers & Co for the UK economic regulators and the Office of Fair Trading.

⁵⁹ Grayburn J., Hern, R. and Lay, H. (2002), 'A report for the National Audit Office on regulatory risk', 10 April.

⁶⁰ Grayburn J., Hern, R. and Lay, H. (2002), 'A report for the National Audit Office on regulatory risk', 10 April.

are re-set at subsequent reviews. This regulatory lag can result in increases in systematic risk.

- **imperfect and asymmetric price adjustment mechanisms**—imperfect adjustment mechanisms that for instance compensate for changes in inflation but not for changes in input costs (which can increase more than inflation) would lead to greater risk for price cap regulated firms compared to competitive firms which can adjust their prices with changes in input costs.
- **imperfect information**—UK regulators set prices on a forward looking basis based on information collected for the previous year. This imperfect information leads to inaccurate forecasts and more volatile returns compared to companies operating under perfect competition that can change their prices continuously to align with costs.
- **inconsistencies in the actions of a regulator**—inconsistencies in the price review process (including unpredictability of the regulatory regime) increases regulatory risk and may lead to increases in the cost of capital.⁶¹

The conclusion from this strand of the literature is that there is evidence that the nature of the regulatory regime affects the exposure of regulated companies to systematic risk as measured through the asset beta.

A1.2 Regulatory intervention risk

The literature provides evidence that share price volatility increases when there is unexpected regulatory intervention, although the evidence for an impact on systematic risk as measured by the CAPM equity beta is less clear.

Robinson and Taylor (1998) found that the announcement by the regulator (Director General of Electricity Supply) on March 7 1995 to re-open the price review process previously concluded in August 1994, increased the volatility of stock prices for eight out of the twelve regional electricity companies (RECs) in the UK and this increase in volatility displayed some persistence. The authors' findings were based on an analysis of companies' share price variances before and after the event.⁶² In another study (Robinson and Taylor (1998), the authors further corroborated this finding when they assessed the regulatory risk in the UK electricity distribution industry for a wider set of regulatory 'events' and found that for two thirds of the 58 events examined, the share price volatility of firms increased persistently in the following post-event periods.⁶³

However, both these studies did not test for the change in systematic risk (reflected in higher or lower equity betas) for the perceived regulatory intervention risk. Though the authors reflect that if increase in individual asset return volatility affects the cost of capital as suggested by some arbitrage pricing theory models, then this increase in volatility should increase the company's cost of capital.

Antonio and Pescetto (1997), analysed the impact of regulatory announcements on BT's shares between December 1984 and December 1993. They find evidence for a strong relationship between unanticipated

⁶¹ Grayburn J., Hern, R. and Lay, H. (2002), 'A report for the National Audit Office on regulatory risk', 10 April.

⁶² Robinson T. A. and Taylor M. P. (1998), 'The effects of regulation and regulatory risk in the UK electricity distribution industry', *Annals of Public and Cooperative Economics*, **69**:3, pp 331-346.

⁶³ As summarised in Grayburn J., Hern, R. and Lay, H. (2002), 'A report for the National Audit Office on regulatory risk', 10 April.

regulatory interventions and systematic beta risk and therefore its cost of capital. However, the authors conclude that the directional impact of the regulatory intervention on beta is not always easy to predict—some regulatory interventions which were expected to reduce beta risk in fact increased it.⁶⁴

Wright and Mason et. al. (2003) argue that regulatory intervention risk only increases the cost of capital when the regulator's action introduces risk that co-varies with the market. Any other risk introduced by the regulator is diversifiable and therefore does not merit a higher cost of capital.⁶⁵

Paleari and Redondi (2005) analyse the effect of regulation on a sample of 12 UK Regulated Energy Companies. In particular, they consider two determinants of systematic risk: the company's overall risk and the correlation between the regulated company's value and the market. Theory indicates that, as regulation gets stricter, the company's abnormal returns will turn negative. This is because if regulation becomes tighter, then the probability of bankruptcy would increase, increasing overall risk. The authors conduct an event study analysis and a time-varying beta estimation to verify the regulatory impact on risk and returns in the English electricity distribution industry. They find that systematic risk varies significantly during the period considered (December 1990-October 1995). Furthermore, the analysis points to a negative relationship between abnormal returns and both market correlation and the overall risk variations. In other words, the regulatory events affect both overall risk and market correlation in the same direction, thus leading to a higher beta. (i.e. when regulation becomes stricter, abnormal returns are negative and betas increase because both overall risk and market correlation increase). Thus, the implication of regulatory risk is that it leads to a higher systematic risk.⁶⁶

Kobialka and Rammerstorfer (2009) conduct an event study to assess whether regulatory news related to 12 regulatory events (not accompanied by market events) affect returns of four German electricity companies. They conclude that not all regulatory initiatives have an impact on returns and nor are all companies affected in an equal manner. They further explore the effect of the events on firm specific share price volatility (using GARCH models) and time-varying betas (using Kalman filter) and find mixed evidence. The authors conclude that volatility did not increase persistently due to regulatory events. Beta analysis, too showed similar results.⁶⁷

A1.3 Political uncertainty

Evidence from the literature suggests that political uncertainty due to the changing political landscape (which can also subsequently lead to regulatory intervention) is reflected either through increases in the systematic risk (a higher equity beta) or a 'risk premium' added to the discount rate.

Political uncertainty affecting systematic risk

⁶⁴ Antoniou, A. and Pescetto, G. (1997), 'The Effect of Regulatory Announcements on the Cost of Equity Capital of British Telecom', *Journal of Business Finance and Accounting*, **24**:1, pp. 1–26

⁶⁵ Wright, S., Mason, R. and Miles, D. (2003), 'A Study Into Certain Aspects of the Cost of Capital for Regulated Utilities in the U.K.', Report by Smithers & Co for the UK economic regulators and the Office of Fair Trading.

⁶⁶ Paleari, S. and Redondi, R. (2005), 'Regulation Effects on Company Beta Components', *Bulletin of Economic Research*, **57**:4 October.

⁶⁷ Kobialka, M. and Rammerstorfer, M. (2009), 'Regulatory Risk and Market Reactions - Empirical Evidence from Germany', *Zeitschrift für Energiewirtschaft*, **33**:3, pp. 221–27.

Antoniou and Pescotto (1997),⁶⁸ Grout and Zalewska (2004)⁶⁹ and Buckland and Fraser (2001)⁷⁰ show that political uncertainty effects systematic beta risk.

Antoniou and Pescotto (1997) tested the significance of dummy variables (referring to the time period of UK general elections in 1992 and 1997) in the beta regression for British Telecommunications (BT). They found that the dummy variables were statistically significant (positive in 1987 when the Labour party promised renationalisation of BT if it were to come into power and negative for 1992, where this policy was absent). This suggests that political risk (threat of re-nationalisation) lead to a higher equity beta for BT.

Grout, and Zalewska (2004) showed that betas for regulated utility stocks fell during the period of July 1997 and August 1999. They attributed this fall in betas to political and regulatory debate over government proposals for a move towards profit sharing regulation in the UK, a lower risk regulatory regime compared to price-cap regulation.

Buckland and Fraser (2001) test whether the beta estimates of 12 UK Regulated Electricity Companies (REC) are time variant and whether this variation over time can be explained due to political or regulatory influences. They employ Kalman filter techniques to estimate daily betas over the period of 1990-1998 and conclude that betas are time variant. They then conduct an event study to explain the various structural breaks in the beta series due to political and regulatory events. The evidence found supported the impact of the political event on 10 April 1992 (UK General Election) on systematic risk. The event had an upward and persistent impact on the level of betas until a correction 5 months later. However, the authors note that the impact of the political event on beta series was not uniform across all the electricity companies. They further state that the beta series exhibited mean reverting tendencies with little evidence of cyclical variation across the regulatory review cycle.

Alexander, Mayer and Weeds (1996) note that under the discretionary system of regulation, the scope for political interference may expose companies to excessive risk and cause their beta values to be higher than those of US utility companies regulated under the rate of return regulation.⁷¹

Political uncertainty affecting equity risk premium

Several studies support evidence of political uncertainty contributing to the equity risk premium. Pastor and Veronesi (2011) develop a general equilibrium model of government policy choice in which stock prices respond to political news. The model assumes that government tends to intervene when the economy is weak. The model's predictions and the evidence that follows from empirical analysis⁷² are consistent suggesting that:

- political uncertainty is higher in poor economic conditions;

⁶⁸ Antoniou, A. and Pescotto, G. (1997), 'The Effect of Regulatory Announcements on the Cost of Equity Capital of British Telecom', *Journal of Business Finance and Accounting*, **24**:1, pp. 1–26.

⁶⁹ Grout, P. A. and Zalewska, A. (2004), 'The impact of regulation on market risk', November, Department of Economics and Leverhulme Centre for Market and Public Organisation, University of Bristol.

⁷⁰ Buckland, R. and Fraser, P. (2001), 'Political and Regulatory Risk in Water Utilities: Beta Sensitivity in U.K. Electricity Distribution', *Journal of Regulatory Economics*, **19**:1, pp. 5–25.

⁷¹ Alexander, I., Mayer, C. and Weeds, H. (1996), 'Regulatory Structure and Risk and Infrastructure Firms: An International Comparison', World Bank Policy Research Working Paper.

⁷² The authors note that the degree of statistical significance varies across the predictions.

- stocks are more volatile and more correlated when political uncertainty is higher;
- political uncertainty commands a risk premium; and
- the effects of political uncertainty on volatility, correlation, and risk premia are stronger in a weaker economy.⁷³

Kelly, Pastor and Veronesi (2015) use a theoretical framework to analyse the impact of political uncertainty (captured by price variations around major events such as national elections and global summits), using evidence from the equity option market of 20 European countries. The authors find that political uncertainty is priced in the equity option market, by comparing pricing of the options whose lives span include political events (treatment options) with options whose maturity does not cover any major political event (control options). The empirical results of the model suggest:

a sizable risk premium for political uncertainty, especially in a weak economy and a close link between the variance and jump risk premia associated with political events. Due to this link, the elevated variance risk premium around political events suggests that the equity risk premium contains a jump component driven by such events. By raising the cost of financing, political uncertainty can thus have real effects.⁷⁴

Bekaert et al. (2016) decompose the sovereign yield spread into a political risk component and suggest that international project valuation should augment the discount rate by using the decomposed political risk premium instead of the sovereign yield spread as the latter reflects other risks that are likely included in the valuation analysis—leading to the double-counting of risks.⁷⁵

⁷³ Pastor, L. and Veronesi, P. (2011), 'Political Uncertainty and Risk Premia', NBER Working Paper Series 17464.

⁷⁴ Kelly, B., Pastor, L. and Veronesi, P. (2015), 'The Price of Political Uncertainty: Theory and Evidence from the Option Market', Fama-Miller Working Paper.

⁷⁵ Bekaert, G., Harvey, R.H., Lundblad, C.T. and Siegel, S. (2016), 'Political risk and internal valuation', *Journal of Corporate Finance*, **37**, pp. 1–23.

A2 Appendix

A2.1 NG's share price reaction to political events

To assess NG's share price reaction to news announcements, we first identified the dates on which NG's share price reaction was significant i.e. NG's daily return was two standard deviations away from the long run average.⁷⁶

This filtering criteria resulted in a set of 115 observations of daily returns and corresponding dates for the January 2008–December 2018 period. These dates were then used as a reference point to search for news announcements that could potentially explain the abnormal daily returns. The search for news resulted in a list of 71 news announcements that could potentially explain the abnormal reactions in NG's share price (i.e. daily returns).

We next filtered the dates where NG's statistically significant share price reactions coincided with statistically significant differential of returns between NG and FTSE All-share, indicating NG's significant outperformance or underperformance relative to the market (see Table A2.1).

Table A2.1 Events where NG's share price significantly outperformed or underperformed relative to the market

Type of event	Number of events
Political	2
Regulatory	4
Systematic	14
Company-specific	8
Safe haven	4

Source: Oxera analysis based on news sourced from Financial Times

Given that the market does not necessarily react immediately to news announcements, we quantified the time lag that captures the difference between the news announcement date and the closest date when a statistically significant share price movement is observed. The average reaction time for each event category is summarised in Table A2.2. We observe that investors react to political and regulatory events on average 1.9 days and 1 day respectively after the event is announced.

Table A2.2 Average reaction time for each event category

Type of event	Average reaction time ¹ (days)
Political	1.9
Regulatory	1.0
Systematic	1.0
Company-specific	0.4
Safe haven	2.2

Note: ¹ Estimated as the difference between the date of the news announcement and the filtered date on which NG's share price reaction was significant.

Source: Oxera analysis.

⁷⁶ The long run average was estimated as the average of the daily return time series ranging from 1998 to 2018.

Table A2.3 describes the news announcements from the reverse event study on NG's share price reaction, while Table A2.4 describes the news announcements from the conventional event study on NG's share price reaction.

Table A 2.3 Exploratory event analysis on NG's share price reaction

Filtered dates	News Article Abstract	Return	Type of event
18/12/2018	National Grid does not believe cost of equity range in Ofgem's consultation appropriately reflects level of risk borne by transmission networks, Ofgem says consumers should pay less towards networks such as National Grid. NG shares fell immediately by more than 6% and the company said it was disappointed by the decision	-9.17%	Regulatory (sector-specific) ***
22/11/2018	UK shares fell sharply on Thursday as sterling rallied after the European Commission and Britain agreed on a draft text for future EU-UK ties	-3.20%	Political (systematic) ***
15/11/2018	The UK's scheme for ensuring power supplies during the winter months has been suspended after a ruling by the European court of justice that it constitutes illegal state aid	-2.20%	Systematic (sector-specific) *; **, ***
10/10/2018	'National Grid Concludes Disposal Of Former Gasworks North Of Church Way In Doncaster'	2.89%	Company-specific *
01/08/2018	'Ofgem rebuffs National Grid's attempt to pass on £260m in costs to customers'—Ofgem claims that NG had not demonstrated that replacing an existing gas pipeline across the Humber estuary would be in the best interests of consumers	-2.80%	Regulatory (company-specific) ***
30/07/2018	'Ofgem tightens returns for energy networks'—The regulator said it would limit the returns that NG can make on a major project to connect the Hinkley Point C nuclear power station in Somerset to the electricity network	-1.86%	Regulatory (sector-specific)
31/05/2018	Dividend announcement	-4.71%	Company-specific ***
17/05/2018	'UK's National Grid reports profit rise helped by U.S. business'—NG's full-year profit rose 3.5%, helped by growth in its US business	3.80%	Company-specific *, ***
28/03/2018	'European utilities jump on safe-haven buying, lower yields'- European utilities saw sharp rise as fears of a trade war led investors to seek out defensive stocks, while lower bond yields also helped the sector	5.47%	Safe haven (sector-specific) *, **, ***
07/03/2018	UK utilities up as Ofgem's cost of equity range in line with expectations	2.85%	Regulatory (sector-specific)
06/02/2018	Large movements in US treasury yields (upward movements of yields b 3.55%)	-4.16%	Systematic*, **, ***
23/11/2017	'FTSE sluggish after Centrica dives'—A fall in Centrica's shares had an adverse impact on FTSE and UK regulated utilities. <i>Centrica faces high customer attrition due to the rise in electricity prices in September.</i> Next year appears unlikely to offer a reprieve for the company. The prime minister's price cap on energy bills is due to take effect in late 2018 or early 2019 and new suppliers are still entering the market and undercutting British Gas on price	-2.83%	Systematic (systematic and sector-specific) ***
09/11/2017	Dividend announcement	-2.60%	Company-specific
30/10/2017	'Network companies under scrutiny for rising UK electricity price'—a review into rising UK energy costs has focused scrutiny on the ownership and regulation of electricity networks	-1.33%	Regulatory (sector-specific) **
25/10/2017	'Energy bills 'significantly higher' than necessary, review shows'—UK businesses and households are not benefiting as much as they should from renewable energy according to government	-2.18%	Political (sector-specific) **, ***
24/10/2017	'Australian investor warns on UK nationalisation threats'—the plan by the leader of the UK Labour Party to nationalise water companies would harm foreign investment in the country's infrastructure projects, according to one of Australia's biggest investment managers.	-1.28%	Political (systematic and sector-specific) **
27/06/2017	'Theresa May confirms start date for Brexit talks after pressure from the EU to start formal opening for their	-2.03%	Political (systematic)

	long-awaited negotiations rather than first holding "technical discussions" between officials.		
01/06/2017	Dividend announcement	-3.63%	Company-specific
14/11/2016	The yield jump that greeted the advent of Donald Trump coincided with a predictable fall in NG shares	-3.0%	Political (systematic) *; **, ***
10/11/2016	Large movements in US treasury yields (yields increase by 4.5% on the same day and by 10.9% the following day)	-6.13%	Systematic *; **, ***
02/09/2016	'Good results and performance on track on 6-months results of National Grid'	2.88%	Company-specific ***
30/06/2016	Positive reported quarterly performance	3.25%	Company-specific ***
29/06/2016	National Grid future seems stable even after the advent of Donald Trump. While most of the FTSE shares are falling, NG is on the upside as new and intermittent supply only highlights NG's values of electricity balancing skills	3.56%	Political (systematic) *; **, ***
02/06/2016	Dividend announcement	-4.57%	Company specific ***
19/05/2016	National Grid profits powered by French connection—NG's gas distribution arm, which serves nearly 11m customers in the Midlands, north-west and eastern England and north London, will be sold off by the start of 2017	-2.86%	Company-specific ***
21/04/2016	The obvious risk on regulated utilities are tougher regulatory regime. Electricity grids, in particular, require substantial investment to cope with the demands that renewable energy places on them	-3.49%	Regulatory (sector-specific) ***
20/01/2016	'GE cuts 6,500 jobs at former Alstom units'—potentially setting itself up for clashes with several governments and unions	-2.87%	Systematic ***
04/06/2015	Dividend announcement	-5.08%	Company-specific**
08/05/2015	Energy shares soar as Conservatives win majority	4.09%	Political *; **, ***
14/01/2015	UK utilities: power to the people. Labour has stated that it would replace the current body, Ofgem, with one which would force utilities to cut prices, as necessary	-2.79%	Political (sector-specific) ***
20/06/2013	Large movements in US treasury yields (increase by 2.5%)	-3.12%	Systematic *; **, ***
05/06/2013	FTSE 100 finishes more than 2% lower on Fed fears, Japan and Australian growth worries. A number of companies saw their shares go ex-dividend, including National Grid, down 50.5p at 740p	-6.39%	Systematic ***
29/05/2013	Utilities stocks lead FTSE 100 lower. A sell-off among utilities led the FTSE 100 to its second-biggest fall of the year so far as a sovereign bond rally triggered profit-taking. National Grid, Centrica and SSE all dropped in tandem with benchmark government debt, which lifted yields on US Treasuries to 14-month highs	-5.06%	Systematic *; **, ***
17/07/2012	'Ofgem plans £22bn energy network upgrade'—but National Grid criticised the plan, saying that more investment was needed to keep the lights on	-3.00%	Regulatory (company and sector-specific) ***
30/05/2012	'Supply: European 'supergrid' dream has merit'—Discussions between UK energy minister and Iceland's ambassador about the concept of exporting geothermal electricity derived from Iceland's active volcanic system.	-4.59%	Political (sector-specific)
02/12/2011	A European Commission energy roadmap predicts that energy consumption in Europe will creep up until 2030 and then stabilise even as the bloc's economy continues to grow. The biggest reason for this divergence is the mass market use of more efficient appliances as well as the development of smarter electricity grid.	-3.19%	Systematic (sector-specific)**; ***
07/09/2011	National Grid is looking to tap into concerns about high inflation with the launch of an index-linked corporate bond aimed at UK retail investors, the FT reports	2.85%	Company-specific **, ***
01/06/2011	Dividend announcement	-4.79%	Company-specific

18/03/2011	Shares in National Grid rose 4.43% to 577p on Friday after Ofgem said it would raise the level of fees that grid operators can charge	4.43%	Regulatory (Sector-specific) ***
20/05/2010	National Grid shares fall 7% after rights issue	-7.02%	Company-specific ***
03/06/2009	London's FTSE 100 came under pressure from eight of its constituents trading without further rights to their latest dividend payments on Wednesday.	-6.50%	Systematic ***
26/05/2009	National Grid: A prospective dividend yield of 6% covered 1.4 times by earnings, which are defensive and regulated. Dividend growth should be around 8% a year until 2012	3.05%	Safe haven ***
03/04/2009	Bank intervention creates pension pain. The likes of British Airways, National Grid, M&S, J Sainsbury, Rolls-Royce and United Utilities have all just embarked on their triennial reviews of the health of their pension funds.	-3.49%	Systematic *, ***
25/03/2009	London stocks finish volatile session flat. Defensive sectors were underpinned by the start of the government programme to buy corporate bonds. National Grid was among the top performers	3.56%	Safe haven **
19/03/2009	Large movements in foreign exchange by 3.97%	-5.19%	Systematic ***
18/03/2009	UK pension funding. The decision to focus much of the UK's £75bn quantitative easing initiative on purchasing gilts has sent bond prices soaring. Yields on 10-year gilts have dropped 60 basis points since early March, dipping below 3% for the first time in 50 years	-2.77%	Systematic
16/03/2009	Financials fuel FTSE rally. National Grid bounced 5% to 581½p after Morgan Stanley, its house broker, scotched recent gossip about a possible rights issue	4.96%	Safe haven (systematic) *, **, ***
30/03/2009	Ofgem wants powers to probe grid use. It estimates that customers may have paid up to £125m (\$178m) too much for their electricity in the past financial year as a result of market exploitation	-3.38%	Regulatory (sector specific)*, **, ***
14/01/2009	CDS report: sentiment sours	-3.81%	Systematic ***
08/01/2009	Corporate bonds find hope from new issues. National Grid, the UK company, reopened the European corporate bond market this week	2.85%	Systematic
07/01/2009	Utilities shares are among the worst performers across Europe after Scottish & Southern (SSE.L) says it is to place about 40m shares to boost its balance sheet, representing up to 5 percent of its capital	-6.26%	Systematic *, **
18/12/2008	Keeping the right companies. Some of the fund's largest holdings are in companies such as National Grid, Serco, HSBC and Tesco—companies with robust balance sheets	3.36%	Safe haven (systematic) *, ***
08/12/2008	Defensives are no longer the safe option. Utilities are seen as stable, though water companies carry some regulatory risk, but offer lower dividends than other defensives. However, investors should not expect to make much of a capital return by investing in defensives; most of their return will come from dividends	4.25%	Safe haven (systematic) **, ***
01/12/2008	Monday Midday Market: London near day lows as miners fall back	-9.02%	Systematic *, **, ***
26/11/2008	On November 26, the Fed announced it planned to spend \$800 billion to purchase mortgage-backed securities from Fannie Mae and Freddie Mac, as well as consumer loans. As a result, rates for 30-year fixed mortgages fell to 5.5 percent from 6.38 percent.	-4.30%	Systematic *, **, ***
21/11/2008	On November 21, the FDIC agreed to guarantee up to \$1.3 trillion in loans that banks made to one another. About 1.2 million unemployed workers received an extra three months of benefits.	-7.21%	Company-specific *, **, ***
19/11/2008	National Grid 1H Pre-tax profit seen down by 28%	-5.67%	Company-specific *, ***
11/11/2008	FTSE falls sharply as earnings worries grow	-3.58%	Systematic **, ***
06/11/2008	Fall in use of power highlights downturn. Electricity consumption has fallen sharply in the past two months,	-4.25%	Systematic*, **, ***

	in the latest sign of the deepening downturn in the economy		
04/11/2008	Obama wins elections	4.33%	Political ***
29/10/2008	A combination of astute strategic thinking and luck enabled National Grid to enter the credit crunch with its coffers topped up. It began an asset disposal programme in 2005 which brought in £7.5bn of cash	8.17%	Safe haven (company-specific) *, **
24/10/2008	Competition in the water industry should focus on preventing shortages rather than increasing consumer choice, says the chief executive of one of the UK's biggest water companies	-3.49%	Systematic *, **, ***
20/10/2008	Desperately seeking dividends. National Grid, has said its dividend growth will be 8% per annum for the next four years. 'With a 5% yield at the current price, that looks attractive compared with other equities, and even gilts.'	7.27%	Safe haven (company-specific) *, **, ***
17/10/2008	Investors are desperately seeking dividends	3.77%	Safe haven (company-specific) *, **, ***
15/10/2008	FTSE ends at fresh 4-year low. National Grid fell 8.3% to 610p and United Utilities dropped 7.5% to 577p.	-6.64%	Systematic *, **, ***
13/10/2008	'Low risk' National Grid to invest more	16.56%	Systematic (safe haven) *, **, ***
10/10/2008	Banks may be bailed out, but a long recession could hit demand for power from the utilities	-8.93%	Sector-specific *, **, ***
03/09/2008	Ofgem is asked to investigate to see if there are excessive price rises and whether competition is working, Ofgem is already investigating the energy market and will report next month.	-3.77%	Political (sector-specific) ***
09/10/2008	Late dive for FTSE after nervous start on Wall Street	-8.27%	Systematic *, **, ***
28/02/2008	Ofgem has fined National Grid £41.6m for breaching competition rules in its gas meters business. It is the biggest fine imposed in the UK for anti-competitive behaviour.	-3.78%	Regulatory (company-specific)

Note: Events summarised in this table result from the reverse exploratory event analysis, representing news announcements that can be potentially linked to NG's share price reactions. * represents statistically significant events for United Utilities. ** represent statistically significant events for Severn Trent. *** represent statistically significant events for the MSCI UK Utilities Index.

Source: Financial Times, Thomson Reuters.

Table A 2.4 Conventional event analysis on NG's share price reaction

Date of the news	News abstract	Returns	Categorisation
23/01/2018	'National Grid attacks Ofgem over Hinkley Point' over Ofgem's proposals to cut the cost of connecting the Hinkley Point nuclear station to the electricity grid	-0.91%	Regulatory (company-specific)
21/12/2017	A slate of U.S. tax reforms could provide a lift for European companies that sell in the USA. For NG it affected the stock negatively, due to a non-cash tax credit of around \$2bn as a result of revaluation of deferred tax balances	-0.36%	Political (systematic and company-specific)
29/11/2017	'UK local authorities plug into energy market'. Angelic Energy and Liverpool Energy community company are among a number of suppliers launched by local authorities to tackle what they see as unfair pricing by the big utilities	-0.40%	Political and regulatory (sector-specific)
14/07/2017	UK electricity and gas networks making 'unjustified' profits	-0.56%	Regulatory (sector-specific)
08/07/2016	National Grid announces it has emergency measures in place to avoid blackouts during winter	0.63%	Regulatory (company-specific)
22/09/2015	Jeremy Corbyn sets out 'people's railways' plan—New Labour leader says he will renationalise routes as their franchises expire	-0.41%	Political (systematic and sector-specific)
20/04/2015	'FTSE 100 ends week on record high'—London's stock market brushes off election jitters, as hopes that weaker currencies will boost corporate profits	0.82%	Political (systematic)
10/06/2014	'Britain is at risk of an electric shock'—Britain's supply of electricity is dangerously close to resurgent demand. The safety margin of capacity has been shrinking and is below the 20% necessary to insure against shocks	-0.95%	Systematic (sector-specific)

Note: Events summarised in this table result from the conventional exploratory event analysis representing news announcements that can potentially be linked to NG's share price reaction. However, the corresponding daily return was not statistically significant based on our filtering criteria of two standard deviations away from the long run average.

Table A2.5 sets out the dates on which analyst commentaries did not discuss the news announcements we identified in the reverse event study analysis.

Table A2.5 NG's share price reaction where analyst commentary differed from news announcements

Filtered dates	Type of news identified	Analyst report	Analyst commentary
15/11/2018	Systematic	Credit Suisse	Discussed H1 FY19 results for NG
10/10/2018	Company-specific	Berenberg	Related to political and regulatory developments in the UK
20/01/2016	Systematic	HSBC	Increased NG target price to 1,040p from 1,000p and retain Buy rating. Criticised new proposals for UK regulation but acknowledge that NG is focusing on US growth, where the regulatory regime is more favourable in HSBC's view

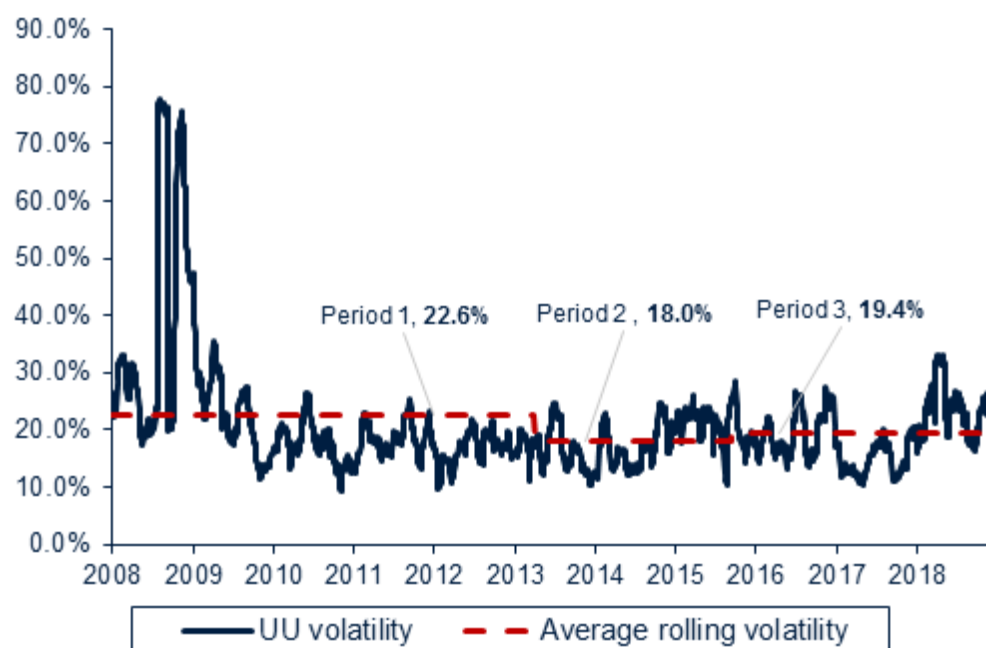
Source: Oxera analysis based on analyst reports provided by NG.

A2.2 Analysis of share price volatility

A2.2.1 Volatility analysis of other utilities

The figures below present the absolute and relative rolling volatilities of UU SVT and the utility index. The relative rolling volatilities (i.e. delta volatilities) are estimated relative to FTSE All-share.

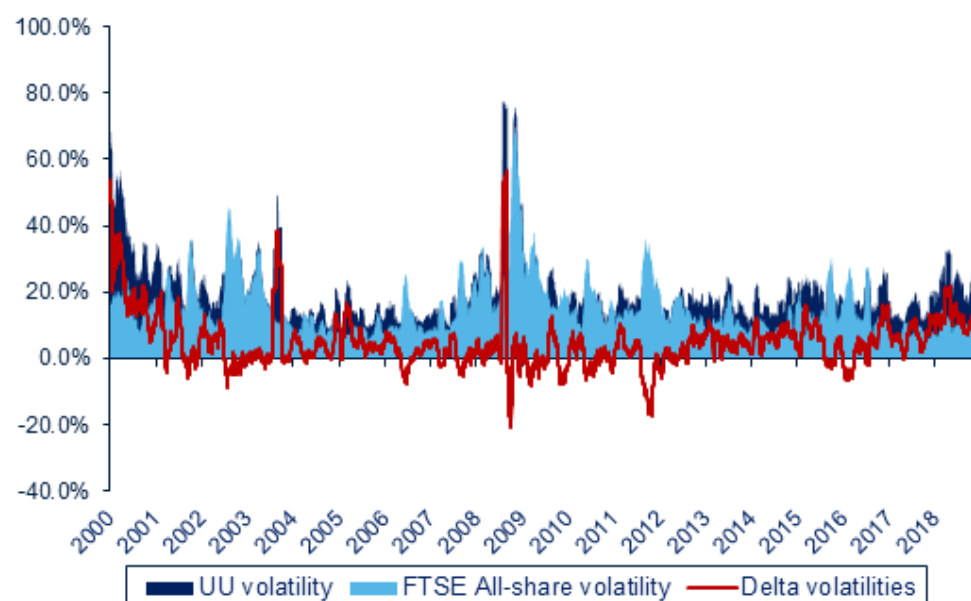
Figure A2.1 Annualised rolling volatility of UU stock, 2008–18



Note: UU volatility of daily returns is calculated using the standard deviation of 30 observations of daily returns. This value is then multiplied by the square root of 252 to convert it to annualised volatility. Reported historical volatility in each period is estimated as the average value of rolling volatilities within that period.

Source: Oxera analysis based on data from Thomson Reuters and Bloomberg.

Figure A2.2 Annualised rolling volatilities of UU and FTSE All-share, 2000–18

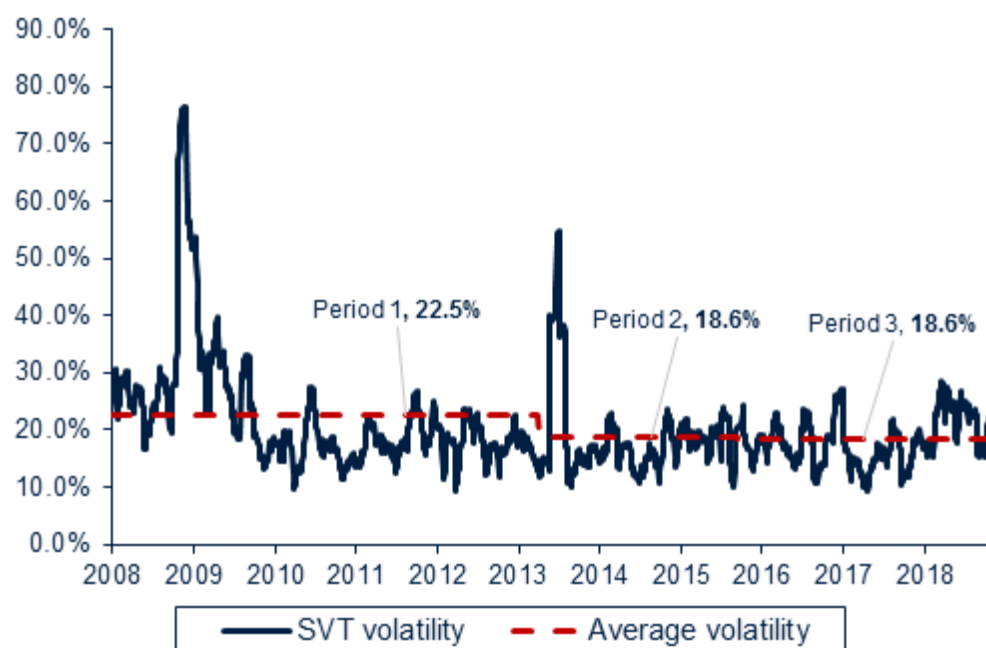


Note: Annualised rolling volatilities of daily returns are calculated using the standard deviations of 30 observations of daily returns multiplied by the square root of 252 trading days within a year.

The delta of standard deviation is calculated as the difference between the volatilities of UU and the FTSE All-share.

Source: Oxera analysis based on data from Thomson Reuters and Bloomberg.

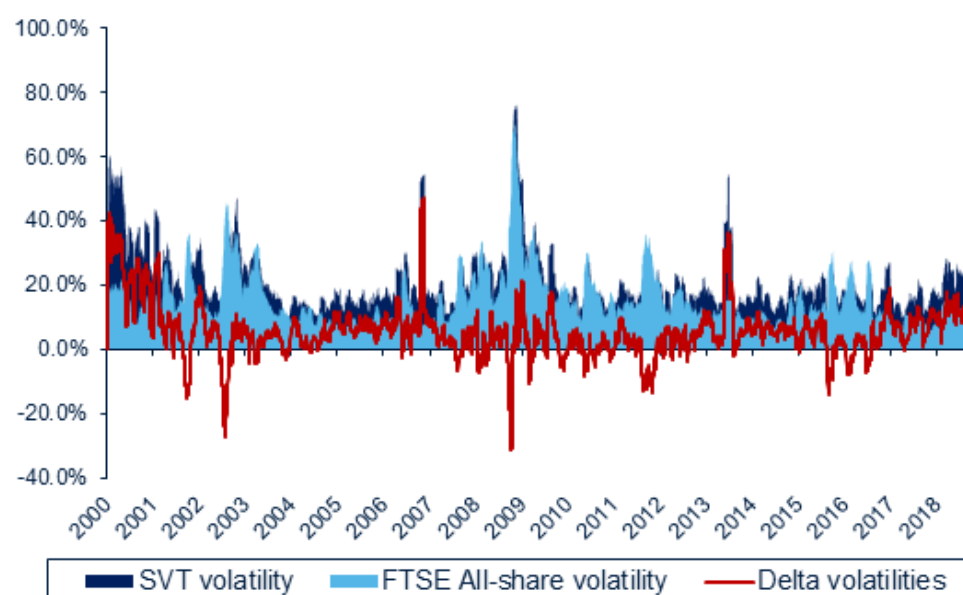
Figure A2.3 Annualised rolling volatility of SVT stock, 2008–18



Note: SVT volatility of daily returns is calculated using the standard deviation of 30 observations of daily returns. This value is then multiplied by the square root of 252 to convert it to annualised volatility. Reported historical volatility in each period is estimated as the average value of rolling volatilities within the period.

Source: Oxera analysis based on data from Thomson Reuters and Bloomberg.

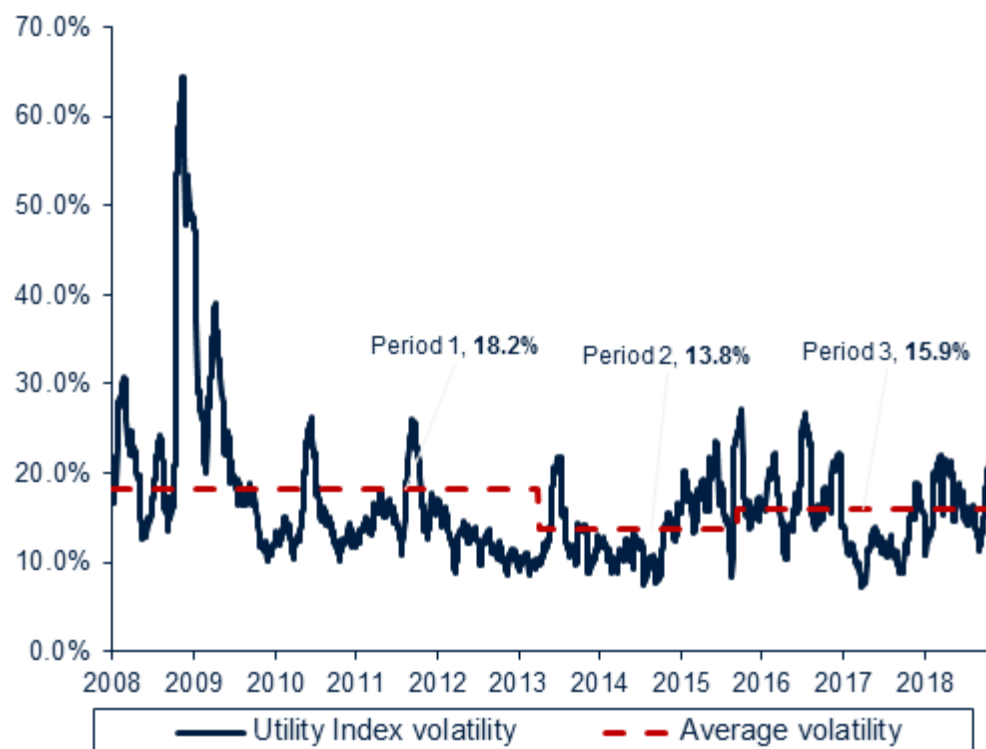
Figure A2.4 Annualised rolling volatilities of SVT and FTSE All-share, 2000–18



Note: Annualised rolling volatilities of daily returns are calculated using the standard deviations of 30 observations of daily returns multiplied by the square root of 252 trading days within a year. The delta of standard deviation is calculated as the difference between the volatilities of SVT and the FTSE All-share.

Source: Oxera analysis based on data from Thomson Reuters and Bloomberg.

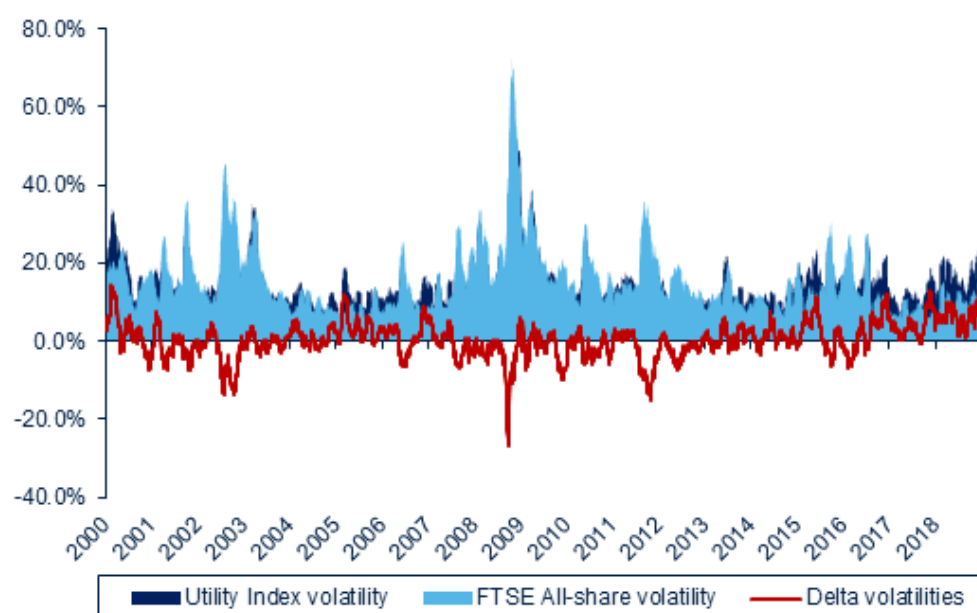
Figure A2.5 Annualised rolling volatility of the utility index, 2008–18



Note: The Utility index volatility is calculated using the standard deviation of 30 observations of daily returns. This value is then multiplied by the square root of 252 to convert it to annualised volatility. Reported historical volatility in each period is estimated as the average value of rolling volatilities within the period.

Source: Oxera analysis based on data from Thomson Reuters and Bloomberg.

Figure A2.6 Annualised rolling volatilities of the utility index and FTSE All-share



Note: Annualised rolling volatilities of daily returns are calculated using the standard deviations of 30 observations of daily returns multiplied by the square root of 252 trading days within a year.

The delta of standard deviation is calculated as the difference between the volatilities of the Utility index and the FTSE All-share.

Source: Oxera analysis based on data from Thomson Reuters and Bloomberg

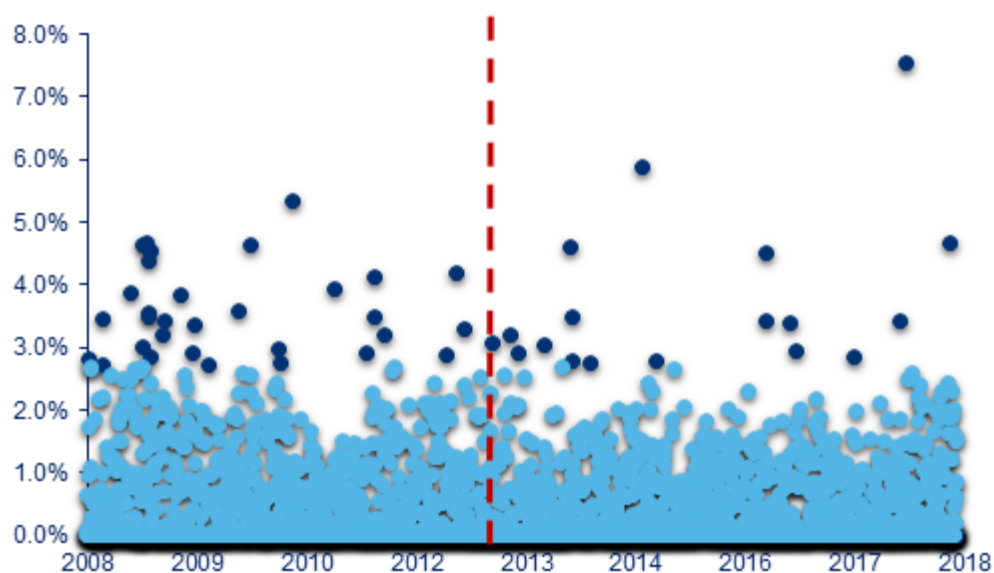
A2.3 Testing 'defensive stock' hypothesis

A2.3.1 Positive share price reaction of other regulated utilities' relative to FTSE All-share

Analysis of the statistically significant daily return differential between regulated utilities and the FTSE All-share shows that statistically significant positive deltas of returns (where utilities outperform FTSE All-share) have decreased in the recent 5 years (2013-18) compared to the 2008–13 period.

This result is consistent across all the regulated utilities (see figures below).

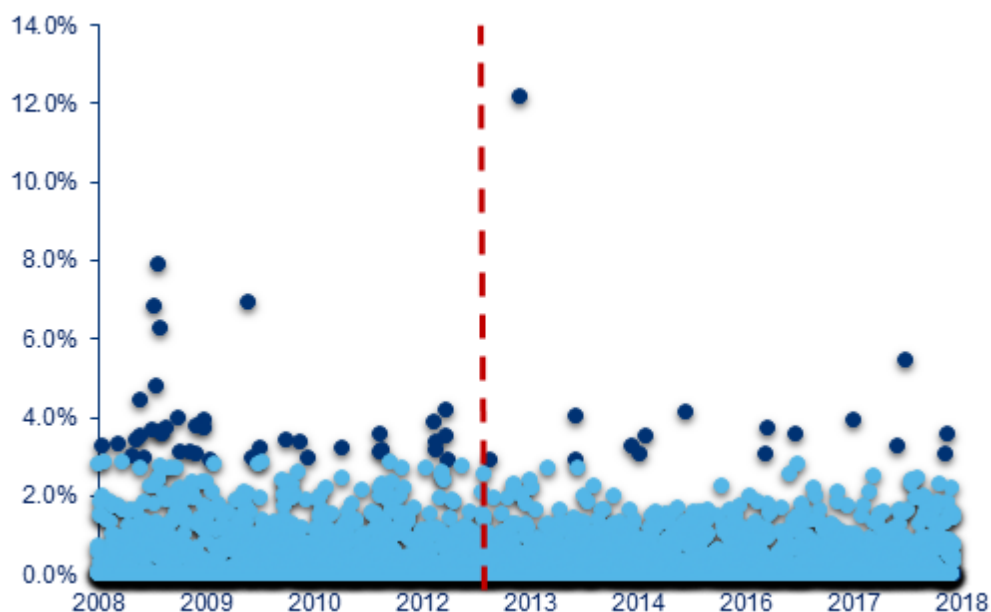
Figure A2.7 Positive delta of returns (UU - FTSE All-share) as an indicator of UU's relative over-performance



Note: Positive delta is estimated as the positive difference between the daily returns of the stock and the market. Statistically significant positive deltas (dark blue dots) reflect the observations of positive delta of returns located more than 2 standard deviations away from the mean.

Source: Oxera analysis based on Thomson Reuters data.

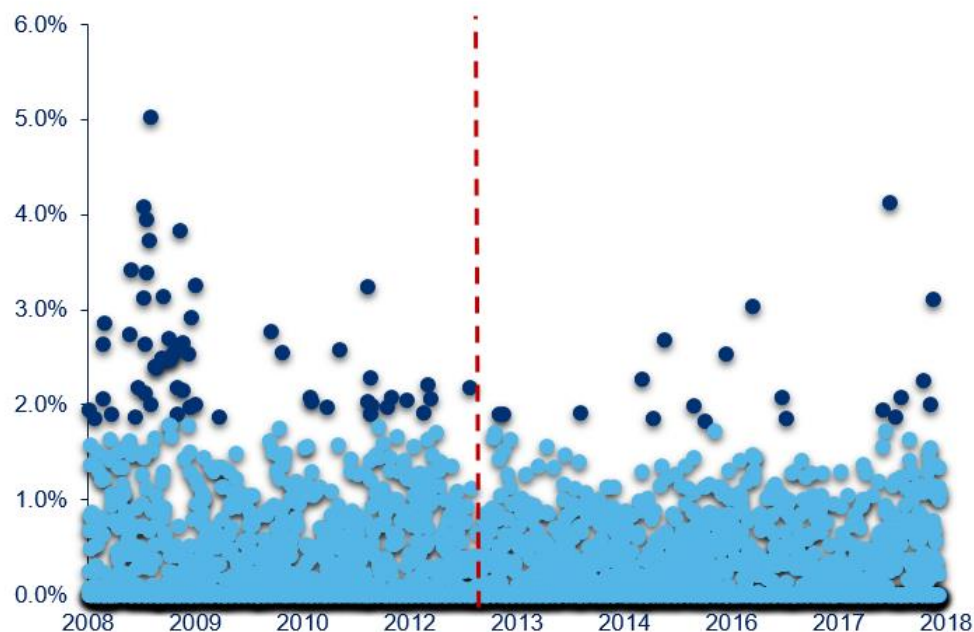
Figure A2.8 Positive delta of returns (SVT - FTSE All-share) as an indicator of SVT's relative over-performance



Note: Positive delta is estimated as the positive difference between the daily returns of the utility and the market. Statistically significant positive deltas (dark blue dots) reflect the observations of positive delta of returns located more than 2 standard deviations away from the mean.

Source: Oxera analysis based on Thomson Reuters data.

Figure A2.9 Positive delta of returns (MSCI Utilities Index - FTSE All-share)



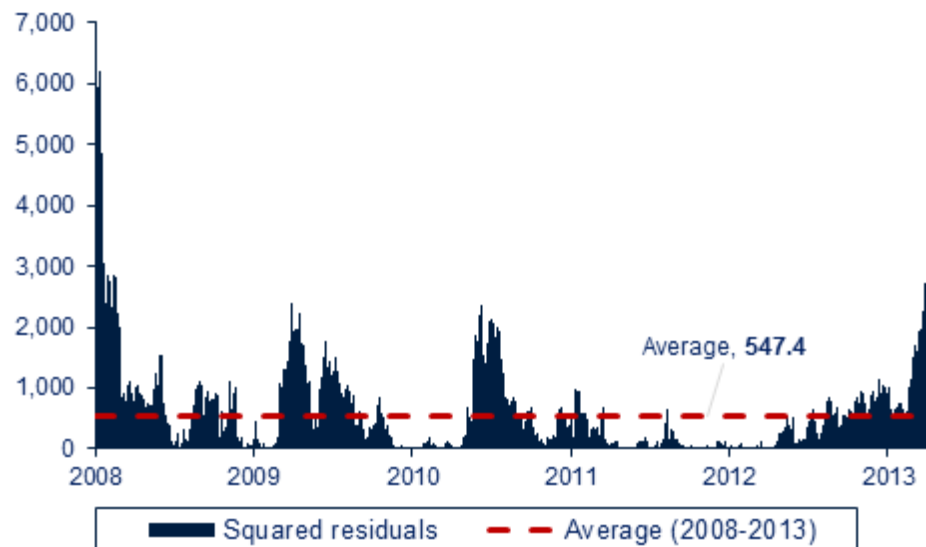
Note: Positive delta is estimated as the positive difference between the daily returns of the MSCI UK Utilities Index and the market. Statistically significant positive deltas (dark blue dots) reflect the observations of positive delta of returns located more than 2 standard deviations away from the mean.

Source: Oxera analysis based on Thomson Reuters data.

A2.3.2 Regression of NG's share price relative to gold price

NG's share price regression relative to gold price yields consistent results with the regression analysis of NG's share price relative to UK gilt yields. This is reflected in the relatively growing trend of square residuals in the recent 5 year period compared to the 2008–13 period, indicating that NG's share price is less well explained by gold prices over time.

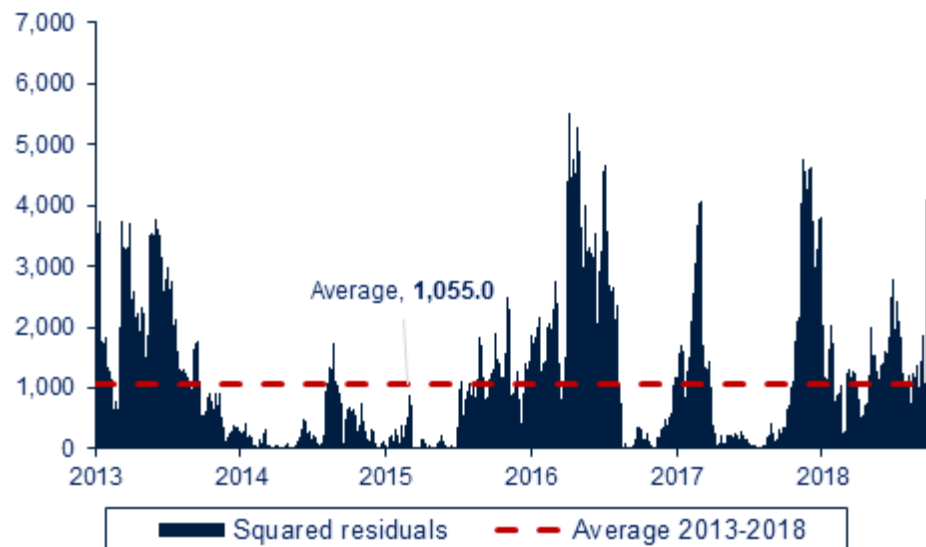
Figure A2.10 Squared residuals of NG's price regression relative to gold prices, 2008–13



Note: The abnormally high residuals in 2008 come from the inflated price variability due to the financial crisis.

Source: Oxera analysis based on Thomson Reuters data.

Figure A2.11 Squared residuals of NG's share price regression relative to gold price, 2013–18



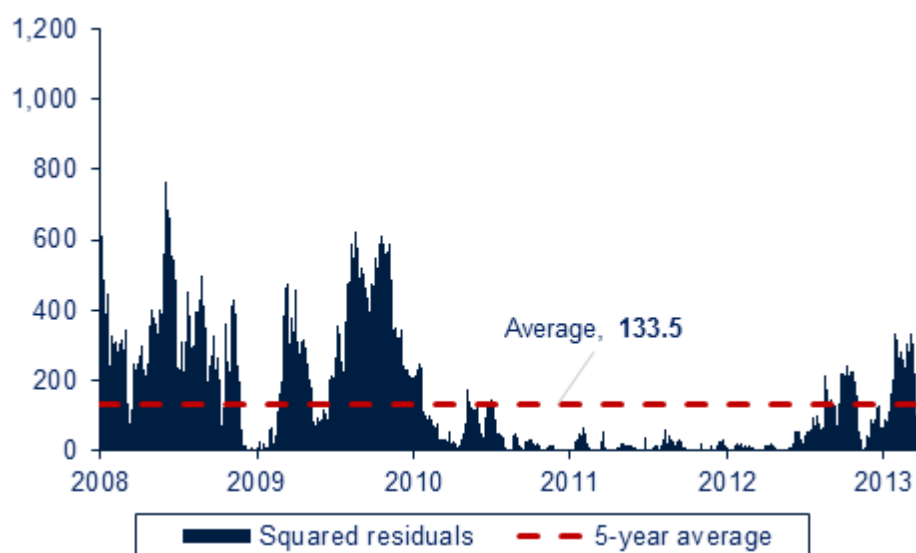
Note: This graph shows the square residuals of the NG share price relative to gold price regression analysis from 2013 to 2018.

Source: Oxera analysis based on Thomson Reuters data.

A2.3.3 Regression results of other utilities

The regression analyses of UU, SVT and the utility index relative to UK gilts give results which are consistent with that of the regression analysis of NG relative to UK gilts. There is an increase in squared residuals (between the 2008–13 period and 2013–18 period) as shown in the graphs below indicating that over time share prices of these utilities are less well explained by changes in UK gilt yields.

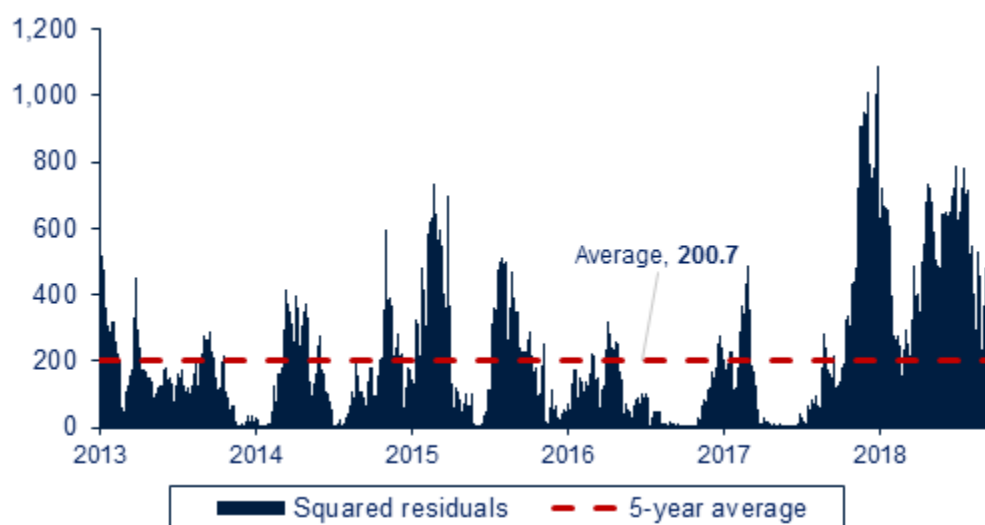
Figure A2.12 Squared residuals of UU's share price regression relative to UK gilts yield, 2008-13



Note: This graph shows the squared residuals of the UU share price relative to UK gilts yield. Regression residuals are consistently below average from January 2010 to August 2012. The abnormally high residuals in 2008 are likely due to the high price variability during financial crisis.

Source: Oxera analysis based on Thomson Reuters data.

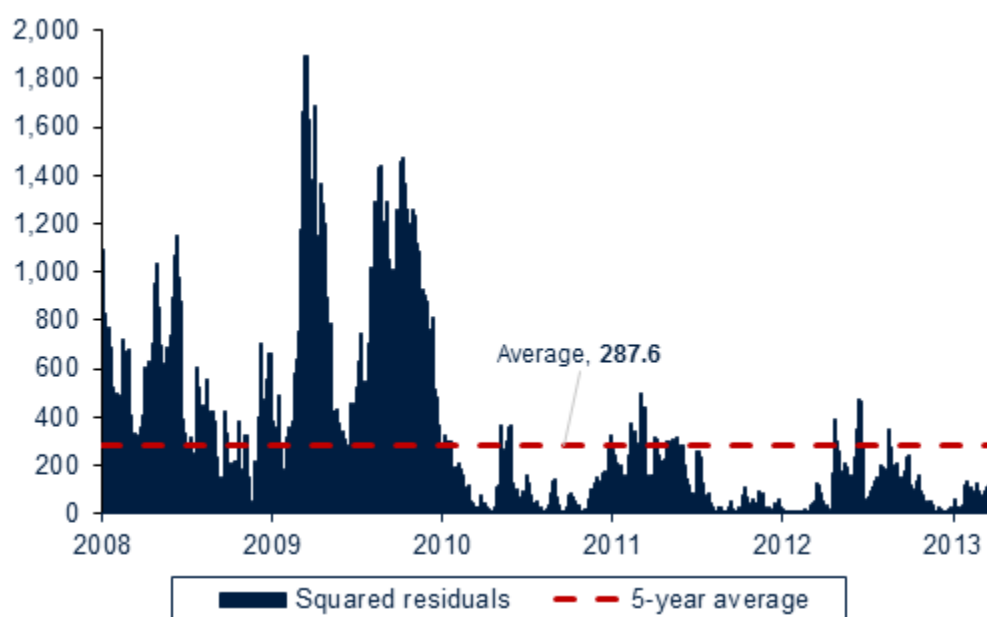
Figure A2.13 Squared residuals of UU's share price regression relative to UK gilt yields, 2013–18



Note: This graph shows the squared residuals of the UU share price relative to UK Gilts yield regression analysis from 2013 to 2018. The trend in residuals is visibly increasing in this period compared to the 2008–13 results. Square residuals are consistently above the 5-year average, indicating that UK Gilts movements are less reliable to explain UU share price variability compared to the previous 5 years.

Source: Oxera analysis based on Thomson Reuters data.

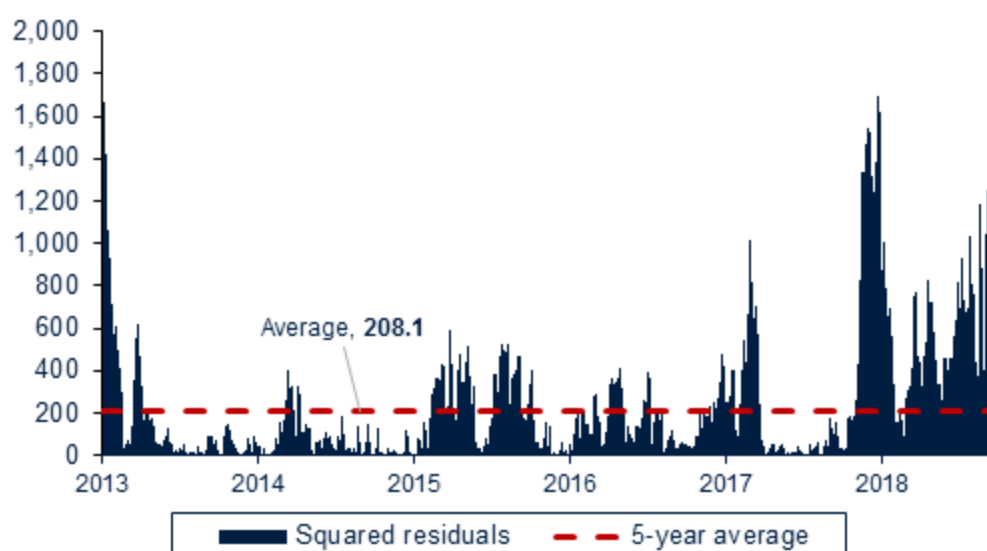
Figure A2.14 Squared residuals of SVT's share price regression relative to UK gilt yield, 2008-13



Note: This graph shows the squared residuals of SVT's share price relative to UK gilts yield. Regression residuals are generally below average from February 2010 to March 2013. The abnormally high residuals in 2008 are likely due to the inflated price variability during the financial crisis.

Source: Oxera analysis based on Thomson Reuters data.

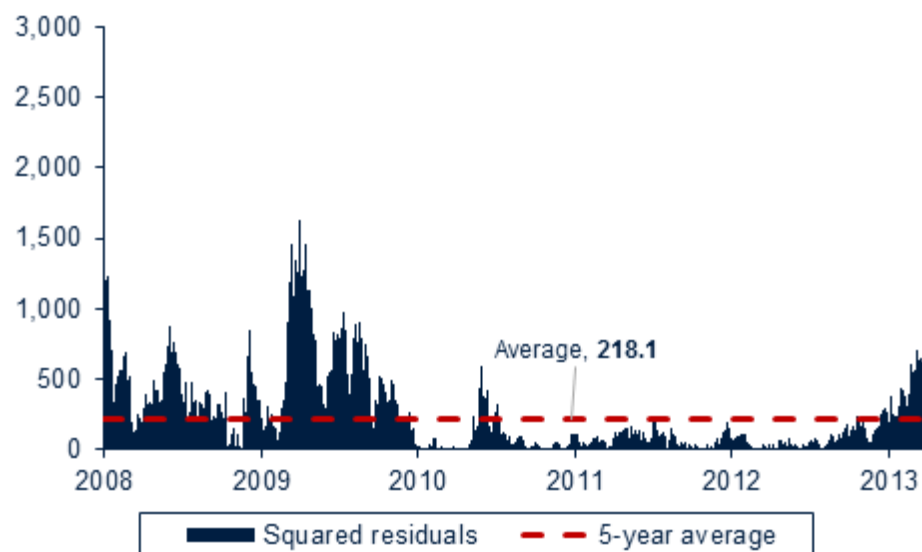
Figure A2.15 Squared residuals of SVT's share price regression relative to UK gilt yield, 2013-18



Note: The trend in residuals is visibly increasing in this period compared to the 2008-13 results.

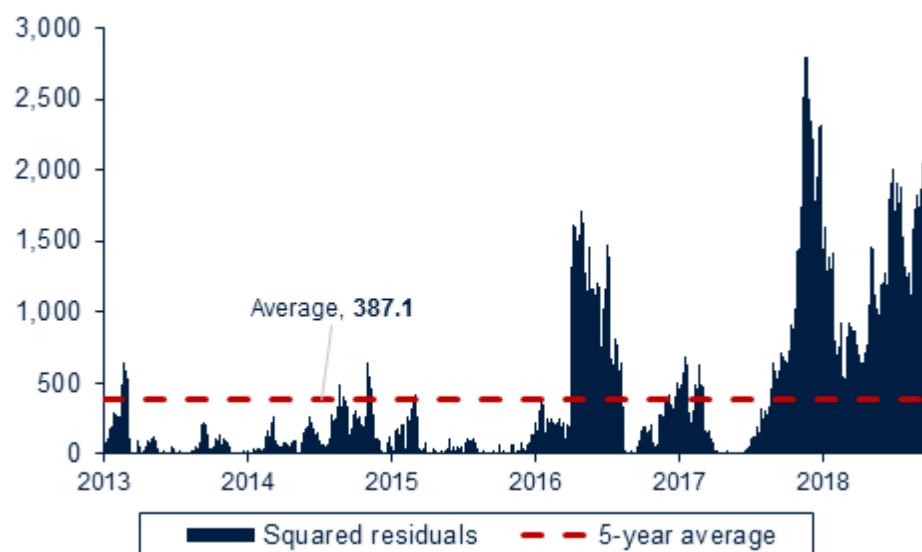
Source: Oxera analysis based on Thomson Reuters data.

Figure A2.16 Squared residuals of MSCI UK Utility price relative to UK gilt yields, 2008–13



Source: Oxera analysis based on Thomson Reuters data.

Figure A2.17 Squared residuals of utility index price regression relative to UK gilt yield, 2013–18



Note: This graph shows the squared residuals of the utility index price relative to UK gilts yield regression analysis from 2013 to 2018. The trend in residuals is visibly increasing in this period compared to the 2008–13 period. Squared residuals are consistently above the 5-year average in the later years, indicating that UK gilts movements are less reliable to explain utility index price variability compared to the previous 5 years.

Source: Oxera analysis based on Thomson Reuters data.

A3 Arbitrage pricing theory and multifactor models

A3.1 Arbitrage pricing theory

APT, a multifactor model developed by Ross (1976), is based on the assumption that there should be no arbitrage opportunities in an economy.⁷⁷ It looks at expected stock returns based on risk factors such as macroeconomic variables. Theoretically, APT could capture every single factor that explains stock returns.

In general, APT could be described by the pricing model in Box A3.1.

Box A3.2 Arbitrage pricing theory

$$R_i = RFR + \beta_{i1} * K_1 + \beta_{i2} * K_2 + \dots + \beta_{ik} * K_k + \eta_i$$

R_i equity return; RFR risk-free rate; K_{ik} risk factor; β_{ik} sensitivity of equity returns to the risk factor K ; η_i idiosyncratic risk or residual term that is independent across securities.

APT could include any number of risk factors that could explain the equity returns. In theory, if there are no arbitrage opportunities, the equity return of any asset could be explained by K risk factors (i.e. there is no idiosyncratic risk). In practice, however, idiosyncratic risk would exist. Nevertheless, the linear relationship between the equity return and the risk factors may hold approximately—APT is better at explaining the equity returns as the idiosyncratic risk becomes smaller.

Source: Oxera analysis, based on Ross (1976), op. cit.; and Wright, Mason, and Miles (2003), op. cit., pp. 65–67.

The general formulation of the APT model does not help to identify an exhaustive list of relevant risk factors. In theory, any non-diversifiable risk factor could be added into the model. Therefore, the APT model supports a broader view of risk exposures than implied by the CAPM. However, the precise formulation, and the effect of these risk exposures on equity returns, is not clear and should be tested empirically.

A3.2 Factor models

Fama and French (1993) proposed to include two factors in addition to the overall market factor captured by the CAPM: size factor and value factor. The size factor captures the additional return associated with companies with small market capitalisation. The value factor captures the additional return associated with companies with high book-to-market ratios. The specification of the three-factor model is outlined Box A3.3.

Box A3.4 Fama–French three-factor model

$$\mathbb{E}[R_i] - RFR = \beta_i * (\mathbb{E}[R_m] - RFR) + s_i * \mathbb{E}[SMB] + h_i * \mathbb{E}[HML]$$

$\mathbb{E}[R_i] - RFR$: expected additional expected equity return; $\mathbb{E}[R_m] - RFR$: equity risk premium—i.e. overall market factor; β_i : sensitivity of a stock to the overall market factor; $\mathbb{E}[SMB]$: additional return for small companies—i.e. size factor; s_i : sensitivity of a stock to the size factor; $\mathbb{E}[HML]$: additional

⁷⁷ Ross, S. (1976), 'The Arbitrage Theory of Capital Asset Pricing', *Journal of Economic Theory*, 13, pp. 341–360.

return for companies with high book-to-market ratios—i.e. value factor; h_i ; sensitivity of a stock to the value factor.

Source: Oxera analysis, based on Fama, E. and French, K. (1993), 'Common risk factors in the returns on stock and bonds', *Journal of Financial Economics*, **33**, pp. 3–56.

The results of the three-factor model suggest that the risk premium associated with the two additional factors is large and that the model provides a good explanation of stock returns.⁷⁸

This multi-factor framework was subsequently expanded in Fama and French (2015) in the five-factor asset pricing model.⁷⁹ In particular, the authors added profitability and investment factors to the three-factor model. The profitability factor captures additional returns associated with stocks that have robust profitability. The investment factor captures additional returns associated with conservative firms—i.e. the firms that have low total asset growth. The paper found that both profitability and investment factors could explain equity returns. In addition, once these two new factors are included, the value factor in the original three-factor model (i.e. high book-to-market ratio) becomes redundant, such that the model with four factors performs as well as with five.

The presence of some of these factors was tested outside the USA. It was found that the value factor and momentum factor⁸⁰ are present in the USA, UK, Europe and Japan.⁸¹ However, a different paper that tested the Fama–French three-factor model and the momentum ('Carhart') factor in the UK concluded that Fama–French factors fail to reliably describe the cross-section of returns in the UK.⁸² Therefore, there is still some ambiguity about the extent to which such factors would be relevant in the UK.

⁷⁸ Fama and French (1993), op. cit.

⁷⁹ Fama, E. and French, K. (2015), 'Dissecting Anomalies with a Five-Factor Model', *The Review of Financial Studies*, 29:1, pp. 69–103.

⁸⁰ Momentum factor captures the tendency of a stock price to continue rising if it is on the up and declining if it is on the down. See Carhart, M. (1997), 'On persistence in mutual fund performance', *Journal of Finance*, 52:1, March.

⁸¹ For example, see Asness, C., Moskowitz, T.J. and Pedersen, L.H. (2013), 'Value and momentum everywhere', *The Journal of Finance*, LXVIII: 3.

⁸² Gregory, A., Tharyan, R. and Christidis, A. (2011), 'Constructing and Testing Alternative Versions of the Fama-French and Carhart Models in the UK', Paper No 11/02, University of Exeter Business School, October.

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