The impact of regulatory change on EU energy utility returns: The three liberalisation packages

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ABSTRACT:

The EU energy sector is changing due to major policy reforms. In this paper, we examine the impact of major legislative changes which were designed to induce competition in the energy sector: the three liberalisation packages. Competition was expected to benefit the industry by phasing-out inefficient firms. EU citizens were also expected to benefit as competition was likely to promote a more efficient energy sector and more consumer choice of energy products and services. However, this legislative change occurred during a period of extreme market turmoil. We examine the impact of all these changes on the risk profile of the sector. Our results show that the liberalisation legislation significantly increased systematic risk exposure of the sector, reducing its role as a defensive investment asset. We also show that commodities had relatively little impact on sector returns, but this was expected as utilities can offset commodity risk in hedging markets. We compare our results to those obtained in neighbouring EU sectors, and find the impacts are isolated to the energy sector. This paper makes a major contribution to energy policy by empirically showing the change in risk as a result of sector liberalisation.

Keywords: Asset pricing; Systematic risk; Energy utilities; Commodity risk; Liberalisation;

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Introduction

The European Union's (EU) energy sector is undergoing dramatic change. The European Commission has placed creating a European energy union among its top priorities since the mid-1990s. The objective of the energy union is to create a resilient and integrated energy market across the EU, with 'internal energy markets' for electricity and natural gas. The energy union is expected to provide secure, affordable, and clean energy for EU citizens and businesses by allowing the free flow of energy across the EU borders (European Commission 2017).

Traditionally, European energy supply was based on national and regional markets with vertically integrated companies that could produce, transmit, and distribute energy to nearby consumers with natural, regional monopolies. The energy union was designed to unbundle the regulated and monopolistic energy sector, and transition towards a competitive and innovative industry. The main regulatory tool used to deliver this internal energy market was sector liberalisation. Consequently, there have been a number of legislative acts passed over the years which focused on establishing common rules for a single European internal market for energy, replacing the national- and regional-based structures for the energy supply (Newbery 2002; Jamasb & Pollitt 2005; Green 2006). The three most important legislative changes occurred in 1996, 2003, and 2009; known as the 'three packages' of liberalisation.[1]

The objectives of the three packages were to: (1) distinguish between the competitive (supply to customers) and non-competitive (operation of network) elements of the industry, (2) to allow the competitive elements to access the energy infrastructure, (3) to remove any

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[1] The first packages of liberalisation typically include Directives 96/92/EC (electricity) and 98/30/EC (natural gas); the second package typically includes Directives 2003/54/EC and 2003/55/EC (electricity and gas); the third package typically includes Directives 2009/72/EC and 2009/73/EC (electricity and gas).

barriers to competition, (4) remove any restrictions on consumers changing their suppliers, and (5) introduce independent regulators to monitor the industry (European Commission 2012). The three packages of liberalisation fundamentally changed the operating environment of both the EU's electricity and natural gas sectors and is being described as the most extensive cross-border reforms of energy networks and operating structure in the world (Jamasb & Pollitt 2005). The overall objective was to increase transnational competition within the EU, thereby exposing inefficiencies in firm operations and slowly phasing out inefficient firms. EU citizens were expected to be the ultimate beneficiary as induced competition was likely to promote a more efficient energy sector and more consumer choice of energy products and services.

Over the same period, the energy sector also experienced dramatic changes in market conditions. First, and at a more general level, European equity markets have been influenced by market-level macroeconomic events such as the dot-com collapse of 2000, the global financial crisis (GFC) of 2007 to 2009, and the Eurozone debt crisis (EUC) of 2010 to 2011. As a result, the valuation of all European stocks has been characterised by large price changes and associated fluctuations in interest rates which reflect changing economic conditions. Second, there have been dramatic changes in the price of energy-related commodities. By 2008, oil, natural gas, and coal reached record high prices (Oberndorfer 2009). While oil peaked at about $140 per barrel in 2008, the market price had decreased to around $30 per barrel in early-2016. Finally, the implementation of the EU Emissions Trading Scheme (ETS) in 2005 introduced an additional risk factor, carbon price risk, which though expected to affect all European firms, is especially relevant to energy utilities since most have carbon-intensive operations.

This paper is principally concerned with investigating the effects of regulatory changes on utility valuations and changes in the sector's exposure to various stock-market risk factors during this transition. In examining the impact of regulatory changes, we answer three research questions, namely: 1) what is the impact of the three packages on the risk profile of European energy utilities during sector reform, 2) how have these risk premia evolved over time, and 3) do the impacts reflect market-wide conditions or the sector-specific relationships between returns and risk premia?

The contribution of this work is threefold. First, this paper quantifies the impact and ramifications of the three packages of liberalisation on the risk-return profile of European energy utilities. While a large literature on asset pricing and the impact of regulatory change in the context of the oil & gas industry exists,[2] research on EU energy utilities is largely limited to Oberndorfer (2009) and Koch and Bassen (2013). This is surprising given the importance of EU energy utilities in providing energy to 508 million EU citizens[3] and the dramatic changes the industry has experienced in recent years. The second contribution is data related. To complete the analysis, we construct the most comprehensive EU energy utility sample to date. Our sample of 88 energy utilities is considerably larger than that of related literature, Koch & Bassen (2013) and Oberndorfer (2009), who examine 22 and 20 European energy utilities, respectively. These previous studies did not take account of survivorship bias. Third, our inter-temporal analysis between 1996 and 2013 covers a period of considerable policy interest including the GFC, the EUC and the three packages of EU energy sector liberalisation. We perform the intertemporal analysis as previous literature has shown that the estimated relationship between industry returns and risk factors is not stable across time, with temporal sensitivity which affects significance (Huang et al. 1996; Fama & French 1997; Faff & Brailsford 1999; El-Sharif et al. 2005; Boyer & Filion 2007). We pool

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[2] See Manning (1991), Faff and Brailsford (1999), Sadorsky (2001), El-Sharif et al. (2005), Boyer and Filion (2007), Nandha and Faff (2008), Oberndorfer (2009), Elyasiani et al. (2011), Ramos and Veiga (2011).

[3] Data extracted from EUROPA: http://europa.eu/about-eu/facts-figures/living/index_en.htm

our data into distinct regulatory regimes based on the three packages of liberalisation to test whether the underlying risk profile changes over time.

To answer the research questions, we develop an Augmented-Four-Factor model (AFFM), which extends the set of variables used to explain returns, including: four stock-market risk factors (market factor, size premium, value premium, and momentum premium), term premium, and commodities previously found to affect energy utility sector returns (oil, coal, natural gas, and carbon). We also compare results against those obtained from other EU industry sectors, to examine whether changes in the underlying risk profile reflects a sector-specific relationship or a market-wide concern.

The results show that there is a significant increase in systematic risk in the energy utility sector across the three regulatory regimes. This risk is observed in the energy utility and the oil & gas sectors, which is consistent with the publications of the three packages. The result show that the fundamental underlying risk profile has changed, and the sector is becoming less defensive as an investment asset. This increase in systematic risk is not observed in other industries – systematic risk decreases over time for some industries. The commodity risk factors (oil, coal, and gas) have little to no impact in asset pricing, but this is unsurprising as utilities are expected to hedge against fluctuations in commodity profiles in the long-term.

The remainder of this paper is structured as follows. Section 2 outlines the empirical approach, sample and data used in the analysis. Section 3 presents the results of this paper, delineated into descriptive results, for context, and main econometric results which address the research questions. Section 4 concludes the paper, highlighting contributions, limitations, and avenues for further research.

Methodology

Models and econometric approach

For the empirical analysis, this paper implements and extends well-known multifactor asset pricing models from the finance and energy economics literatures. The econometric modelling begins with the Capital Asset Pricing Model (CAPM), estimating a market beta based on the relationship between the excess returns of a portfolio of assets and the market factor. The CAPM is the foundation for many asset pricing models. The second model is the Augmented-CAPM, derived from the energy economics literature. The Augmented-CAPM includes a variety of variables expected to affect returns in the European energy sector, including: term premium and various commodity risk factors such as oil, natural gas, and coal (El-Sharif et al. 2005; Koch & Bassen 2013; Oberndorfer 2009).

Fama and French (1993) find that the CAPM's market beta alone has little information about average returns for equities and that additional stock-market risk factors help explain returns. Further, the Augmented-CAPM, commonly used in energy economic literature, is relatively restricted due to its reliance on outdated asset pricing models (El-Sharif et al. 2005; Oberndorfer 2009). We extend the asset pricing models by incorporating standard finance risk factors.

The third model we implement is the Four-Factor model from the finance literature. The Four-Factor model includes additional stock-market risk factors expected to capture variation in returns missed by the market factor, improving estimates of systematic risk. Fama and French (1993) find that size and value premia, a proxy for firm distress, are important variables in a cross-section of average stock returns. Jegadeesh and Titman (1993) and Carhart (1997) find momentum to be an important factor in stock returns. Respectively, the three model specifications are:

CAPM:

$$\boldsymbol{R}_{i,t} = \alpha_i + b_i \boldsymbol{R}_{m,t} + e_{i,t}, \tag{1}$$

Augmented-CAPM:

$$\boldsymbol{R}_{i,t} = \alpha_i + b_i \boldsymbol{R}_{m,t} + tp_i \boldsymbol{R}_{tp,t} + o_i R_{o,t} + c_i R_{c,t} + g_i R_{g,t} + e_{i,t}, \tag{2}$$

Four-Factor Model:

$$\boldsymbol{R}_{i,t} = \alpha_i + b_i \boldsymbol{R}_{m,t} + s_i SMB_t + h_i HML_t + m_i UMD_t + e_{i,t}, \tag{3}$$

where $\boldsymbol{R}_{i,t}$ denotes the excess returns over the risk-free rate of return on the i^{th} portfolio on day t, α_i denotes the intercept, b_i denotes the market factor coefficient, $\boldsymbol{R}_{m,t}$ denotes the excess return on the market factor at time t, tp_i denotes the term premium coefficient, $\boldsymbol{R}_{tp,t}$ denotes the term premium at time t, o_i denotes the oil price risk coefficient, $R_{o,t}$ denotes the return on oil price at time t, c_i denotes the coal price risk coefficient, $R_{c,t}$ denotes the return on coal price at time t, g_i denotes the natural gas price risk coefficient, $R_{g,t}$ denotes the return on natural gas price at time t, s_i denotes the size premium coefficient, SMB_t denotes the size premium at time t, h_i denotes the value premium coefficient, HML_t denotes the value premium at time t, m_i denotes the momentum premium coefficient, UMD_t denotes the momentum premium at time t, and $e_{i,t}$ denotes the error term on the ith portfolio at time t.

Asset pricing models can potentially suffer from both limited power and diminished external validity if they fail to control for industry-specific valuation influences (Henderson & Hughes II 2010). In this paper, we develop an Augmented-Four-Factor model (AFFM), which extends the set of stock-market variables used to explain returns by augmenting the model with industry-specific commodity variables. We combine Equations (2) and (3) to produce the AFFM. These include four stock-market risk factors (market factor, size premium, value premium, and momentum premium), term premium, and commodities previously found to affect energy utility sector returns (oil, coal, natural gas, and carbon). We use this model to examine the change in risk factors over major regulatory changes.

We calculate the European stock market risk factors using the standard portfolio approach from Fama and French (1993). The European stock-market risk factors were calculated using the STOXX® 600 constituent stocks, representing a diverse sample of European equities across a range of industries. The resulting model specification is:

$$\boldsymbol{R}_{i,t} = \alpha_i + b_i \boldsymbol{R}_{m,t} + s_i SMB_t + h_i HML_t + m_i UMD_t + tp_i \boldsymbol{R}_{tp,t} + o_i R_{o,t} + c_i R_{c,t} + g_i R_{g,t} + e_{i,t}. \tag{4}$$

All equations are estimated using Newey-West (1987) Heteroscedasticity and Autocorrelation (HAC) standard errors and subject to standard regression diagnostic tests.[4] In the time-series regressions, coefficients and R^2 values are direct evidence of the ability of the specified risk factor(s) in capturing common variation in returns (Fama & French 1993).

The prior asset pricing literature has shown that the estimated relationship between returns and risk factors is not stable across time, showing temporal sensitivity which affects significance (Boyer & Filion 2007; El-Sharif et al. 2005; Faff & Brailsford 1999; Fama & French 1997; Huang et al. 1996). To address this issue, Equation (4) will also be implemented on three distinct regulatory regimes based on the three packages of

[4] Augmented Dickey-Fuller (1979) (ADF) unit root tests are implemented to examine whether a time series variables are non-stationary. The dependent and independent variables must be integrated to the same order to ensure there can be a linear relationship between the variables. The results of the ADF test, confirm that the time series for all 11 sectors and nine risk factors are integrated to order zero, *I(0)* and stationary. Further, regression diagnostic tests identify heteroscedasticity and autocorrelation in some sector portfolios, which we address using Newey-West HAC covariance matrices. Variance Inflation Factors (VIFs) diagnostic test found no evidence of multicollinearity between the variables.

liberalisation. The three regimes include 1996-2003, 2003-2009, and 2009-2013.[1] We test the significance of the changes in various risk factors over these periods using a dummy variable approach. Such conditional models are not expected to increase regression fit (Fama & French 1997), but provide useful insight into the evolving return profile of European stock returns. Further, the three distinct regimes allow the inclusion of carbon price risk during the 2009 to 2013 regulatory regime, contributing to research question 1. Accordingly, the following specification is implemented on the final regulatory regime between 2009 and 2013:

$$\boldsymbol{R}_i = \alpha_i + b_i\boldsymbol{R}_m + s_iSMB + h_iHML + m_iUMD + tp_i\boldsymbol{R}_{tp} + o_iR_o + c_iR_c + g_iR_g + co2_iR_{co2} + e_i, \tag{5}$$

where $co2_i$ denotes the carbon price risk coefficient and R_{co2} denotes the return on carbon.

The asset pricing models discussed above are not without limitations. There is an ongoing debate regarding the economic nature of the Fama and French (1993) risk factors represent. For example, Petkova (2006) argue size and value premium are proxy for changes in innovations in variables that describe investment opportunities, such as dividend yield and term spread, default spread, and Treasury-bill yield. Whereas Kapadia (2011) argue that both size and value premium together reflect an underlying exposure to aggregate distress risk. It is not the intention of this paper to explain the economic interpretation of these risk factors, but to acknowledge that criticisms exist. The finance models implemented in this analysis remain among the most popular and useful models in the literature.

Data

A combination of weekly stock market and annual accounting data were extracted from Thomson Reuters Datastream, S&P Capital IQ, and publicly available sources. Data were measured in euros (€) to represent value and cost to European market participants. The weekly stock prices and market capitalisations of the energy utilities cover the period 29 June 1995 to 30 June 2013.[5] As the momentum premium, discussed shortly, consumes the first year of data, the empirical analysis occurs between 07 July 1996 and 28th June 2013 (887 weekly observations). No legislative proposal regarding a further reform exists, accordingly, there is little reason to continue the analysis far beyond 2013.

Stock prices are measured at week close and adjusted for capital actions, including: dividends, stock splits, and mergers. Weekly financial returns for all stocks and risk factors are calculated using the first-log difference. Excess returns for equities are calculated as the difference between weekly returns and the yield on the 2-year German Government bond, denoted $R_{i,t}$. Market capitalisation is also recorded at week close. Regarding the accounting data, all data are extracted for fiscal year-end, covering the period 1995 to 2013. To be eligible for analysis, and to allow portfolio rebalancing, all firms must have data on stock price, market capitalisation and book value of equity for both year t and year $t-1$. This condition ensures companies have traded for at least two years (Fama & French 1993).

The STOXX® 600 Europe index ($R_{m,t}$) is used as a proxy for market returns, representing 600 large, mid, and small-capitalisation firms across 18 countries of the EU. The inclusion of mid- and small-cap firms prevents bias towards larger companies. The three additional stock-market risk-factors of size (SMB_t), value (HML_t), and momentum (UMD_t) premia are calculated using all 600 firms and the extensive portfolio method outlined by Fama and French (1993) and Carhart (1997), with annual portfolio rebalancing. Briefly, the

[5] Based on Fama and French (1993), the portfolios are rebalanced annually, at the beginning of July. This six-month lag is due to Alford et al. (1994), who find that 19.8% of U.S. firms fail to submit their 10-K reports with the SEC within 90 days of fiscal year end. Similarly, Conover et al. (2008) also find the mean percentage of late reports is 24% across all European countries.

size premium represents the spread in returns between a portfolio of small firms against a portfolio of big firms; the value premium represents the spread in returns between high book-to-market (BE/ME) firms and low-BE/ME firms;[6] while momentum premia represents the spread in returns between upper-momentum (winners) stocks and down-momentum (loser) stocks. We compare our stock-market risk factors to those provided by French (2015) and find the series to be comparable.[7] The stock-market risk factors are calculated using the same 600 firms as the STOXX® 600 Europe index.[8]

We include additional term premium and commodity risk factors based on empirical evidence of their significance in explaining oil industry and energy utility returns (El-Sharif et al. 2005; Koch & Bassen 2013; Oberndorfer 2009; Sadorsky 2001). Term premium represents the risk-free short-term discount rate and is an indicator of the present state of the economy, tending to be lower during economic downturns and higher during growth (Sadorsky 2001), thereby controlling for macroeconomic effects. Term premium ($R_{tp,t}$) is calculated as the difference between the weekly yield on the two- and 10-year German Government bond. We select these two yields as shorter yields, such as the three- and one-

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[6] Typically, the market capitalisation of high-BE/ME stocks trade close to, or below, the book-value of equity. These firms are 'value' stocks, argued to trade at a low market price due to firm distress factors or low growth opportunities. Low-BE/ME stocks have market capitalisations above their book-value of equity, and are often referred to as 'growth' stocks. Value premium is perhaps the most contentious stock-market risk factor due to its empirically determined origin, yet statistical significance is routinely found in a variety of sectors, model specifications, and time periods (Rosenberg et al. 1985; Chan et al. 1991; Fama & French 1993; Fama & French 1995; Fama & French 1997; Fama & French 2012).

[7] French (2015) provides a monthly series for the European equity market which is incompatible with our weekly data.

[8] This is a key requirement of Fama and French (1993), where the premia of size and value are argued to be buried *within* the market factor. Thus, we must isolate our size and value premia from the same sample of companies which proxy for the market factor.

month UK Treasury bills consistent with Harvey (1989), may be too short to represent an accurate term spread. Further, the EU had a prolonged period where short-term interest rates are near zero following the GFC and EUC. Returns on the London Brent Crude Oil Index proxies for oil price risk, sourced from the Intercontinental Exchange (ICE), denoted $R_{o,t}$. Returns on a European-specific coal index, sourced from the Hamburg Institute of International Economics, proxies for coal price risk, denoted $R_{c,t}$. Returns on the one-month forward index, also sourced from the ICE, proxies for natural gas price risk, denoted $R_{g,t}$. We include carbon prices from ICE European Climate Exchange Futures: one of the most liquid, pan-European platforms for emissions trading. Continuous settlement prices are used to represent the market price of carbon.[9] Carbon returns are denoted $R_{co2,t}$. The carbon series is restricted to the third regulatory regime only, due to the relatively short time series, beginning in 2005. The returns for all commodities and carbon are also measured in euros.

Sample selection

As stated earlier, we construct a sample of 88 European energy utilities. The STOXX® 600 Europe Utilities index is used to provide an initial list of 28 utilities currently operating and traded on equity markets. We remove all utilities whose primary revenue is derived from

[9] The transition between Phase I and Phase II of the EU ETS resulted in an overnight price jump in EU Allowances (EUAs) from €0.01 to €20.88, 29 Feb 2008 to 03 Mar 2008, respectively. The associated return was a weekly 766.76%. This single observation was deleted and replaced with zero as its inclusion resulted in unusual summary statistics and insignificant carbon risk exposure across all sector portfolios. Post-deletion, carbon risk exposure was detected, which was consistent with Koch and Bassen (2013). While carbon futures may have been preferable, sufficient data was unavailable. Consideration was given to using the ICE ECX continuous average settlement price, which minimises the large price change, but the series produced inconsistent results with the coal series. The method outlined above provided results consistent with theory, with minimal data manipulation, and was deemed the sensible option.

waste or water operations to prevent estimated coefficient bias. We extend the sample by including all companies explicitly mentioned in energy sector restructuring legislation or are elected members of various electricity and gas groups.[10] Using Standard Industrial Classification (SIC) codes, we control for survivorship bias by including all active and non-active energy utilities registered under the same product segments and SICs; an improvement over Oberndorfer (2009) and Koch and Bassen (2013), who respectively examine 20 and 22 of the largest European energy utilities. We create a portfolio of value-weighted returns for the analysis.

Additional European sectors

To examine whether the impacts reflect market-wide conditions or the sector-specific relationships between returns and risk premia, we repeat the analysis on four additional European sectors. This inter-sectoral analysis has been implemented by a variety of authors (El-Sharif et al. 2005; Faff & Brailsford 1999; Fama & French 1997). The four sectors include: banking, oil & gas, telecommunication, and technology sectors. The excess returns for each time series are respectively denoted: $\boldsymbol{R}_{util}$, $\boldsymbol{R}_{banks}$, $\boldsymbol{R}_{O\&G}$, $\boldsymbol{R}_{tele}$, and $\boldsymbol{R}_{tech}$. Each sector will replace $\boldsymbol{R}_{i,t}$ in Equations (1) to (4), regressed independently.

The oil & gas sector was chosen as the sector is expected to be closely related to natural gas utilities; both sectors benchmark output prices to market prices for oil and natural gas, responding positively to price fluctuations. The natural gas sector underwent liberalisation objectives closely related to those which occurred in the electricity industry. The three packages of liberalisation, specific to natural gas, occurs in 1998, 2003, and 2009 –

[10] Groups include: European Distribution System Operators' Association (EDSO), ENTSO-E, Gas Infrastructure Europe (GIE), Gas Transmission Europe (GTE), Gas Storage Europe (GSE), Gas LNG Europe (GLE), ENTSO-G, and Eurogas.

the latter two dates were published simultaneous to the electricity packages. As such, we expect the change in underlying risk in the oil & gas sector to closely resemble that observed in the energy sector, as both sectors are related through natural gas operations.

The telecommunication sector is a selected sector which is also dependent on transnational transmission networks. Competition provided access to historically monopolistic markets, which led to lower prices and improves services for both consumers and businesses. The liberalisation of the EU's telecommunications sector was completed in 1998 (European Commission 2006). The restructuring of the telecommunication sector proxies for the impact of network liberalisation and induced competition.

The banking sector was included as it also experienced a push towards greater liberalisation and market integration, being subject to EU sector liberalisation objectives (Gual, 1999). The integration and liberalisation of financial markets and payments systems, to create a single market for financial services, placed considerable pressure on banks' traditional lines of business (Goddard et al. 2007). EU Member States saw the number of banks fall, mostly the result of mergers and acquisitions (Casu et al. 2006). This greatly increases concentration in the financial market. There were concerns that the creation of a single market for financial services was not likely to bring about strong efficiency gains expected, as cross-border barriers may still prevent the single market becoming a reality (Berger 2003). The banking sector is also expected to positively respond to economy-wide conditions. The banking sector is not expected to be directly exposed to commodity price risk from operations, any sensitivity must be the result of either direct investment in commodities or indirectly through changes in valuation of (primarily energy) loan books and stock investment portfolios. The latter point relates to various reports in which bank and financial institutions have begun to acknowledge their exposure to commodity risk and stranded assets through stock investment portfolios (Spedding et al. 2013; Carney 2014).

Finally, the technology sector is expected to have no direct relationship with any commodity risk factors. Therefore, any relationship between these three sectors and commodities reflects the impact of macroeconomic variables on the demand conditions in the economy as a whole (El-Sharif et al. 2005). The technology sector is also used to proxy future and emerging technologies, and the EU's digital revolution. The technology sector represents industry growth primarily driven by technological and market innovation, which are the expected outcomes of energy sector liberalisation.

Results and Discussion

Descriptive and summary statistics

Table 1 reports the summary statistics for the weekly returns of the five European sectors and nine risk factors. Mean weekly returns are also annualised for comparison against relevant literature. The *t*-statistics for the mean shows the average weekly excess returns, across all five sectors, are not statistically different from zero. For the risk factors, mean weekly excess return on the market factor (0.25%), term premium (0.33%), and carbon prices (-2.12%) were significantly different from zero. The results were congruent with expectations. The market returns were generally positive over the 1996 to 2013 period, with the exception of the GFC. There is a significant and large momentum return from a self-financing porfolio of buying positive momentum stocks and short selling negative momentum stocks. Term premium shows that returns on 10-year German sovereign bonds were, on average, 0.33% per annum higher than two-year sovereign bonds. Finally, carbon prices generally fell between 2005 and 2013. Weekly returns on all other risk factors were indistinguishable from zero.

The lack of significant weekly means for the energy utility sector and some commodities is similar to Oberndorfer (2009). While Oberndorfer (2009) and El-Sharif et al. (2005) find an insignificant term premium coefficient, our positive and significant coefficient is congruent with Sadorsky (2001). The insignificant term premium found in Oberndorfer (2009) and El-Sharif et al. (2005) may be due to the period analysed. The yield on the German Government bonds decline post-GFC, whereas the term premium, the spread between the two- and 10-year yields, increases post-GFC. The lack of consistency across papers, especially Oberndorfer (2009), suggests term premium is sensitive to the period analysed. For the stock-market risk factors, the weekly means are congruent with expectations from Fama and French (1993): small firms outperform big firms, high-BE/ME firms generally outperform low-BE/ME firms. The HML factor is time-sensitive, experiencing reversals following financial crises. Further, congruent with Jegadeesh and Titman (1993) and Carhart (1997), upper momentum firms outperform down momentum firms.

Table 2 presents the pairwise correlations among the utility sector returns and the independent variables to examine collinearity. The stock market risk factors have low magnitude of correlations with each other, congruent with Fama and French (1993). In the absence of competition from the market factor, the SMB and HML are able to capture some variation in stock returns, however drawing inferences at this stage can be misleading (Fama & French 1993). Across all commodities, the magnitudes of significant correlations are all small, ranging from 0.059 to 0.138. Therefore, the economic impact of commodities on a sector's returns is likely to be small regardless of statistical significance, and statistical significance may disappear when included in multivariate regressions with more relevant stock market risk factors.

[INSERT TABLE 1 HERE]

[INSERT TABLE 2 HERE]

The impact of risk factors of energy sector returns

The econometric results begin by presenting the estimated coefficients using the three existing asset pricing models from the literature: the CAPM, the Augmented-CAPM, and the Four-Factor model (respectively Equations 1, 2, and 3). The results are respectively presented in Table 3, Columns A to C. The model in Column D is the AFFM (Equation 4), which extends the set of variables used to explain stock returns in the energy sector, providing a better goodness of fit – as judged by the adjusted R^2. The following sections elaborate on the result, addressing the four research questions.

[INSERT TABLE 3 HERE]

The impact of market and commodity price changes on energy sector returns

Model A of Table 3, shows that the European energy utility sector has a b_i of 0.700, making the sector a defensive investment. The estimated market beta coefficient falls within the range observed, for the energy utility sector, in previous literature. Further, the intercept is significant but near zero, indicating that CAPM captures *most* of the spread in average returns (Fama & French 1993). The adjusted R^2 shows that the CAPM explains 58.8% of the total variation in returns; marginally greater than Fama and French's (1997) R^2 of 55% for energy utilities.[11] Although the market beta is expected to be the greatest determinant of average energy utility returns, term, commodity, and stock-market risk factors serve as likely candidates to explain the fraction of variance unexplained by the CAPM.

Model B shows that the inclusion of term and commodity (oil, coal, and gas) variables have a small impact on the estimate of systematic risk. The minor decrease in b_i to 0.694 shows term premium and commodities are relatively unimportant determinants of asset

[11] Fama and French's (1997) utility sample may include water and waste firms, therefore is not representative of energy-specific utilities.

returns, but have some minor role in asset pricing (Chen et al. 1986). As coal and gas represent major fuels in thermal electricity generation, and both have some significant impact on the sector. Our results show the impact is typically small, with significant coefficient of 0.032 (coal) and 0.019 (gas). These results are consistent with Koch and Bassen (2013), who find varying significant results between -0.06 and 0.27 at the firm-level. The impact of these commodities may be small as utilities are expected to hedge against natural gas price fluctuations in the long term. Further, the ability of firms to pass on increasing costs will also bias the results (Faff & Brailsford 1999). The negative term premium suggests that increases in borrowing costs decrease returns in the industry (Sadorsky 2001). For research question 1, the results show that term premium and coal and gas are the risk factors beyond market beta to have a significant impact on energy sector returns in the long-term. While many papers find a significant and positive relationship between oil price risk and the oil & gas industry, the lack of oil price risk significance in the utility sector is congruent with Elyasiani et al. (2011) and Koch and Bassen (2013), while Nandha and Faff (2008) and Oberndorfer (2009) find a small, negative impact.

The impact of stock-market risk factors on energy sector returns

Model C presents the results for the Four-Factor model from the finance literature, including stock-market risk factors expected to affect stock returns. The inclusion of the stock-market risk factors also affects the estimated market beta coefficient, evidence the additional variables must capture average return which was previously absorbed by the CAPM's market factor. This result is congruent Fama and French (1993), who argue that the market factor is a 'hodgepodge' of multiple stock-market risk factors. While market return continues to be the most significant risk factor in explaining average returns, value and momentum are major determinants of returns in the energy sector. Overall, the results are also fairly consistent with

Fama and French (1993; 1997) and Faff and Brailsford (1999).

The SMB coefficient for energy utilities is found to be insignificant, suggesting there is little difference between the returns on big and small stocks using weekly data.[12] The positive HML coefficient of 0.184 ($p \leq 0.01$) shows high-BE/ME stocks outperform low-BE/ME stocks. The common interpretation of this result is that high-BE/ME represents distressed stocks, but the BE/ME metric is subject to criticism as it is empirically determined. If the interpretation of stock distress holds, the results are congruent with the perceived negative impact of liberalisation in the energy sector for incumbent generators. For the energy utility sector, the marginally significant estimated UMD coefficient of -0.038 ($p \leq 0.10$) shows the sector returns behave like down momentum European stocks. This is unsurprising as the market value of the sector fell by €500bn, a third of its total market capitalisation, in 2009 following the GFC and third package of liberalisation.

The AFFM proposed in this paper, Model D, can incorporate both Models B and C into a single asset pricing model. Where significant, the term, commodity, and stock-market risk factor coefficients between the AFFM and alternative specifications are near identical. The following sections perform an inter-sectoral and inter-temporal analysis using the AFFM.

An intertemporal analysis: The impact of the three regulatory regimes

To examine the impact of regulatory changes over time, answering research question 2, we pool data from the three district regulatory regimes and test the significance of each estimated coefficient. The pooled approach gives greater insight into the evolution of risk exposure over these three periods and how risk has evolved. This approach was taken as previous asset pricing papers have reported substantial inter-temporal, inter-sectoral, and transnational variability in the relationship between average returns and risk factors (El-

[12] Using daily data, we find a premium for small utility stocks versus big utility stocks.

Sharif et al. 2005; Faff & Brailsford 1999; Fama & French 2012; 1998; 1997; Oberndorfer 2009; Sadorsky 2001). The three regulatory periods are (A) 1996-2003, (B) 2003-2009, and (C) 2009-2013. The structural breaks are based on the publication of the three packages of liberalisation. Table 4 reports the coefficients for the energy utility sector, estimated using Newey-West HAC standard errors and subject to standard regression diagnostic tests.

[INSERT TABLE 4 HERE]

The results in Table 4 show the impact of the market factor between 1996 and 2013. The market beta remains the most statistically significant risk factor and has increased from 0.507 in the first regulatory regime to 0.836 in the second and third regulatory regimes; the energy utility sector is becoming increasingly exposed to systematic risk and losing their role as a defensive investment asset.

Regarding the stock market risk factors, size premium only became statistically significant from the second regulatory regime (2003) onwards. The negative SMB slope shows that energy utility returns covaried closely with a portfolio of big European stocks. This is consistent with the rapid expansion of utilities observed in the second regime. The removal of national barriers allowed the larger utilities to rapidly expand into previously isolated international markets (i.e. other EU member states) using debt finance acquisitions. Domestic utilities also used debt to secure their foothold in their local market and defend against predatory competitors (Tulloch & Caldecott 2016). During this period, energy utilities companies became among the largest European stocks. The third package of liberalisation attempted to create a level playing field and to reduce market dominance and predatory behaviour.

For the value premium, the positive coefficients show that the energy utility sector behaved like high-BE/ME (value) European stocks. This slope is congruent with expectation in the first regime, as national monopolies meant there were little growth opportunities.

However, during the second regime, some utilities began to expand into the markets of other EU member states using debt and lost their ‘value status’. This issuance of debt and equity increased the value of total assets, and the new growth opportunities increased the sector’s market capitalisation. The third regulatory regime coincides with the GFC and EUC; the utility sector saw market capitalisation fall from €1.5bn to €1bn in a few months. Being saddled with debt, the fall in market capitalisation pushed utilities back into the low-BE/ME category.

The momentum premium and commodity risk factors had a small but limited effect on energy sector returns across the regimes. The momentum premium showed no significant impact during the first and second regime. However, the statistical significance in the third regime shows that industry returns were consistent with the poorly performing stocks in the EU. This is unsurprising given utilities never fully recovered the market capitalisation lost following the GFC. Consistent with El-Sharif et al. (2005), our results also show varying commodity risk exposure over time.

There was no significant commodity risk exposure observed during the first regulatory regime. This period was still characterised by regulated operations, therefore all commodity price changes could be passed through to consumers. The returns in the energy sector covaried with the returns on coal and natural gas during the second period, when sectors began to become liberalised. The liberalisation of the sector removed the buffering effect regulated operations by shifting the burden of inefficiencies onto the firms, rather than the consumers (Nwaeze 2000). Huang et al (1996) also argue that if industries’ output is benchmarked against commodity prices, or energy generators and gas producers are holding large quantities of fuels benchmarked against a commodity, then market efficiency would suggest that an increase (decrease) in the commodity price will increase (decrease) firm valuation as each market quickly reacts to information shocks in the other markets. This period saw exponential increase in both sector market capitalisation and the cost of the two commodities.

An inter-sectoral comparison

The impact risk factors on inter-sectoral returns

Fama and French (1997), Faff and Brailsford (1999), and El-Sharif et al. (2005) all report varying sensitivities to risk factors across a variety of sectors. As industries are not homogeneous, there is likely to be negative price sensitivities in industries with a relatively high proportion of their costs devoted to commodity-based inputs (Faff & Brailsford 1999). An understanding of the impact of risk factors on equity returns facilitates greater understanding of risk premia and management within the sector. Further, the comparison of estimated coefficients across a variety of sectors help establish whether results for the energy utility sector reflect a sector-specific relationship with the risk factor or a market-wide concern across the economy (El-Sharif et al. 2005).

We implement the AFFM on an additional four European sectors, purposefully selected to represent a broad range of expected sensitivities to the various risk factors. The results are provided in Table 5, Panels A to E. Overall, the results show that there is heterogeneous risk exposure across European sectors. Addressing research question 3, the multivariate regression results show that returns in the energy sector reflect a sector-specific relationship and each sector shows distinct sensitivity to various risk factors.

[INSERT TABLE 5 HERE]

The stock-market risk factors had various impacts across the sectors. For the market factor, the coefficient b_i is statistically significant across all sectors examined, coefficients ranged from 0.667 to 1.374, showing unique systematic risk. The mean b_i is 0.970. Being close to unity, the mean b_i shows that the selection of sectors is a good proxy for average stock returns in Europe. Utilities are the most defensive stock relative to other sectors. For size premium, the SMB coefficient s_i is significant in two of the sectors tested, ranging from -0.401 to 0.313. For value premium, the HML coefficient h_i is significant in all sectors tested, ranging from -0.736 to 0.510. For momentum premium, the UMD coefficient m_i was significant in three of the sectors tested, ranging from -0.204 to -0.034.

While some term and commodity variables were significant, the coefficient's magnitudes were small in comparison to the stock-market risk factors. For term premium, the tp_i coefficient was only significant for the energy utility sector. Oil price risk was significant in four of the sectors tested, but not energy utilities. Naturally, the oil & gas sector is the most sensitive to oil price risk with a coefficient (o_i) of 0.177, $p \leq 0.01$. Energy utilities were the only sector which showed sensitivities to coal and natural gas price risks, with coefficients of $c_i = 0.036$ ($p \leq 0.1$) and $g_i = 0.015$ ($p \leq 0.05$), respectively. These results are expected as some generators use coal and/or natural gas as a primary fuel for thermal generation.

An inter-temporal comparison

We example the evolution of risk factors for the four additional EU sectors: Banking, Oil & Gas, Telecommunications and Technology. The purpose is to investigate whether the changes in risk exposure observed in the utility sector reflect a market-wide concern observed across all EU sectors or, in fact, demonstrate an idiosyncratic and sector-specific relationship. This will help better identify the risks which are specific to energy utilities.

Table 6 presents the estimated coefficients for all five EU sectors, across the three regulatory regimes. Figure 1 illustrates the estimated coefficients for all five sectors, each risk factor and across the three regulatory regimes. Analysis of these results show marked differences across the five sectors.

While the Banking, Telecommunications and Technology sectors saw stable or falling market betas over time, the Energy Utility and the Oil & Gas sectors both experience increases, approximately an additional 0.30 to 0.35, after the first regulatory regime. The timing coincides with the liberalisation of electricity and natural gas sectors. The inference of this result is that the two latter sectors are losing their role as defensive investments because of sector liberalisation. While the utility sector began to covary with a portfolio of the largest EU stocks during the second and third regime, this was not observed across all sectors. In fact, the technology sector showed opposite results, behaving like small EU stocks during the second and third regime. Again, this is consistent with expectations. The energy utilities were among the largest stocks in the EU, whereas companies in the technology sector were among the largest EU stocks pre-2003 – during the dot-com crisis. The value premium also shows unique responses across sectors. The technology and telecommunication sectors have extremely negative value premiums during the first regulatory regime, which indicates a high market capitalisation relative to book value of equity. The first regime covers the 1997 to 2001 dot-com crisis, a historic period of growth opportunities for technology and telecommunication-based companies and a speculative bubble for internet-based firms. In contrast, the banking sector experienced low market capitalisation following the GFC, which is captured by the positive value premium during the second and third regimes. Finally, the momentum premium captures some of the major downturns in each sector. The utility sector experienced downward momentum following the third package of liberalisation and GFC (third regime), the banking sector experiences downwards momentum following the GFC and EUC (second and third regime), while the technology sector experienced downward momentum during the dot-com bubble (first regime).

The term premium and commodity risk provided a range of results. Term premium tends to be higher during periods of economic growth. We observe positive coefficients for term premium during the dot-com bubble for the telecommunication and technology sectors, when both had huge growth opportunities. Term premium is insignificant for all other sectors and regimes. Regarding commodities, the first observation is that the magnitudes of coefficients are generally small, less than 0.10 with a few exceptions. Considering the five sectors as a whole, the results indicate that the economic impacts of commodity price risks are generally small-to-non-existent. Also, the significance of the commodity risk factors tends to only be significant in one or two regimes, suggesting a momentary relationship with industry returns. An exception is the Oil & Gas industry, where the positive coefficient with oil returns is reasonably large and consistent across all regimes. Even for the energy utility sector, the coefficients for coal and gas are small which indicates minor economic impacts on the value of utilities. The weak to low impacts of commodity risk factors is surprising, as commodities, particularly oil, are expected to impact sectors through general macroeconomic conditions (Faff & Brailsford 1999). However, detecting commodity risk exposure is complicated by the fact that many hedging markets exist which allow companies to offset potential losses and gains on commodity prices in the long-term, and many of these markets are easily accessible. However, the inter-sectoral results showed that many of the risk exposures do indeed represent sector-specific relationships with risk factors, and that these relationships also vary over time in different sectors.

Conclusions and Policy Implications

This paper conducts an analysis on the impact of regulatory change on the financial returns of EU energy utilities between 1996 and 2013. Specifically, the paper examines the impact of the three liberalisation packages, published in 1996, 2003 and 2009. The overall objectives of the three packages of liberalisation was to increase transnational competition within the EU, thereby exposing inefficiencies in firm operations and slowly phasing out inefficient firms by competing them against modern, more efficient operations. EU citizens were expected to be the ultimate beneficiary as induced competition was likely to promote a more efficient energy sector and more consumer choice of energy products and services.

The results of this paper show that the three packages increase the systematic risk exposure of the energy utility sector over time, reducing the sector's role as a defensive investment. These results were expected as the sector progressively unbundled vertically integrated utilities, removed regional monopolies and induced competition from EU competitors. The results also show varying exposure to other stock market risk factors, which proxy for changes in sector performance and growth opportunities. We identified significant changes in sector performance following the second liberalisation package, and the GFC and third package of liberalisation. The sector experienced a fall in market capitalisation brought about by new market conditions, and never fully recovered. Commodities had relatively little impact on sector returns, but this was expected as utilities can offset commodity risk in hedging markets – making this difficult to detect with an asset pricing model. Where significance was found, the economic impact on sector returns was relatively small. From a policy perspective, the liberalisation of the energy sector is having its intended consequences: exposing the inefficiencies of utilities to competition but, as we show, there is an offsetting effect on the risk of these utilities.

We compared the results of the asset pricing model against four neighbouring EU sectors. The purpose was to identify whether the estimated coefficients for the EU energy utility sector represented a sector-specific relationship, or in fact a market-wide concern. The Banking, Oil & Gas, Telecommunications, and Technology sectors were chosen due to varying similarities or differences compared to the energy utility sector. The results showed that the change in risk factors did indeed represent a sector-specific relationship for the utility sector. Utilities and the Oil & Gas sectors were the only two sectors to experience an increase in systematic risk, while systematic risk fell in other sectors. Further, the stock-market risk factors of size, value, and momentum premium represented sector-specific impacts which were not shared across the market, but consistent with each sector's experience in recent years. Commodities were found to have little economic impacts on sector returns, except for the Oil & Gas sector which positively responded to innovations in oil prices. These results further support the literature which find that exposure to particular risk factors are sector-specific, having an idiosyncratic impact on each sector (Faff & Brailsford 1999; El-Sharif et al. 2005).

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Declaration Statement

In accordance with Taylor & Francis policy and my ethical obligation as a researcher, I declare no financial interest or benefit that has arisen from the direct application of this research.

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Tables

Table 1: Summary Statistic for the European Sectors and Risk Factors

PANEL A: DEPENDENT VARIABLES	$R_{util,t}$	$R_{banks,t}$	$R_{O\&G,t}$	$R_{tele,t}$	$R_{tech,t}$
N	887	887	887	887	887
Mean Weekly	-0.0638%	0.0074%	0.0641%	0.0484%	0.0288%
t-Mean	(-0.75)	(0.06)	(0.57)	(0.43)	(0.19)
Std. Dev. Weekly	2.53%	3.94%	3.35%	3.35%	4.46%
Annualized Mean	-3.26%	0.39%	3.39%	2.55%	1.51%
Min	-29.92%	-31.61%	-25.69%	-22.08%	-21.14%
Max	10.67%	17.99%	17.30%	15.17%	17.84%
Skew	-2.20	-0.92	-0.56	-0.42	-0.47
Kurt	26.51	11.17	8.87	6.31	5.37

PANEL B: INDEPDENDANT VARIABLES	$R_{m,t}$	SMB_t	HML_t	UMD_t	$R_{tp,t}$	$R_{o,t}$	$R_{c,t}$	$R_{g,t}$	$R_{co2,t}$
N	887	887	887	887	887	887	887	855	427
Mean	0.2493%	0.0652%	0.0523%	1.4218%	0.3263%	0.1912%	0.0805%	0.1963%	-2.1222%
t-Mean	(2.68)***	(1.63)	(0.91)	(14.90)***	(56.16)***	(1.27)	(0.83)	(0.70)	(-2.70)***
Std. Dev. Weekly	2.77%	1.19%	1.72%	2.84%	0.17%	4.49%	2.88%	8.18%	16.26%
Annualized Mean	13.82%	3.45%	2.76%	108.36%	18.46%	10.44%	4.28%	10.73%	-67.22%
Min	-23.59%	-11.05%	-7.20%	-11.51%	-0.06%	-26.52%	-14.77%	-33.37%	-207.94%
Max	13.05%	5.04%	16.78%	19.08%	0.69%	15.40%	18.63%	44.99%	109.86%
Skew	-0.82	-1.07	1.33	0.66	-0.19	-0.62	0.34	0.68	-4.67
Kurt	10.88	13.09	15.52	8.53	2.18	5.60	7.59	7.23	69.24

This table presents summary statistics for the five European sectors and nine risk factors, including: number of weekly observations (N), mean weekly return, the t-statistic of the mean, standard deviation of mean weekly return, annualised mean weekly return, minimum and maximum observations, skewness, and kurtosis. The t-mean statistic is the ratio of the mean to its standard error. Panel A presents the five value-weighted sector portfolios (dependent variables) include: energy utility ($R_{util,t}$), banking ($R_{banks,t}$), oil & gas ($R_{O\&G,t}$), telecommunication ($R_{tele,t}$), and technology ($R_{tech,t}$). Panel B presents the nine risk factors (independent variables) include: market factor (R_{mt}), size premium (SMB_t), value premium (HML_t), momentum premium (UMD_t), term premium (R_{tpt}), oil price risk (R_{ot}), coal price risk (R_{ct}), natural gas price risk (R_{gt}), and carbon price risk (R_{co2t}). A ***, ** or * denotes significance at 1%, 5% or 10%, respectively. As mentioned, the statistics for the carbon series hereon in are based on the data which excludes the abnormal price increase of March 2008.

Table 2: Pairwise Correlation Matrix

Variables	$\boldsymbol{R_{util,t}}$	$\boldsymbol{R_{m,t}}$	SMB_t	HML_t	UMD_t	$\boldsymbol{R_{tp,t}}$	$R_{o,t}$	$R_{c,t}$	$R_{g,t}$	$R_{co2,t}$
$\boldsymbol{R_{util,t}}$	1.000									
$\boldsymbol{R_{m,t}}$	0.767***	1.000								
SMB_t	-0.286***	-0.404***	1.000							
HML_t	0.291***	0.210***	0.009	1.000						
UMD_t	-0.193***	-0.161***	-0.135***	-0.246***	1.000					
$\boldsymbol{R_{tp,t}}$	0.006	0.063*	-0.001	-0.001	-0.063*	1.000				
$R_{o,t}$	0.144***	0.140***	-0.022	0.063*	-0.021	0.024	1.000			
$R_{c,t}$	0.106***	0.089***	-0.048	-0.016	-0.020	-0.023	0.059*	1.000		
$R_{g,t}$	0.054	-0.012	-0.031	0.092***	-0.049	-0.016	0.043	-0.034	1.000	
$R_{co2,t}$	0.067	0.033	-0.046	0.090*	0.033	0.138***	0.044	-0.046	0.096**	1.000

This table provides information regarding the magnitude and significance of collinearity among the variables used in this study. The dependent variable is energy utility ($\boldsymbol{R_{util,t}}$), while the independent variables include: market factor ($\boldsymbol{R_{mt}}$), size premium (SMB_t), value premium (HML_t), momentum premium (UMD_t) term premium ($\boldsymbol{R_{tpt}}$), oil price risk (R_{ot}), coal price risk (R_{ct}), natural gas price risk (R_{gt}), and carbon price risk (R_{co2t}). A ***, ** or * denotes significance at 1%, 5% or 10%, respectively.

Table 3: The CAPM, Four-Factor and Augmented Asset Pricing models

	(A) CAPM		(B) Augmented-CAPM		(C) Four-Factor		(D) AFFM	
α_i	-0.002	***	0.000		-0.002	***	0.000	
b_i	0.700	***	0.694	***	0.671	***	0.667	***
s_i	-		-		0.009		0.017	
h_i	-		-		0.184	***	0.179	***
m_i	-		-		-0.038	*	-0.038	*
tp_i	-		-0.723	**	-		-0.745	**
o_i	-		0.020		-		0.017	
c_i	-		0.032	*	-		0.036	*
g_i	-		0.019	***	-		0.015	**
$\boldsymbol{Adj.R^2}$	0.588		0.595		0.606		0.613	
$\boldsymbol{F} =$	1266.04	***	252.36	***	341.87	***	169.83	***

Notes: This table presents the Newey-West regression output for the energy utility sector ($\boldsymbol{R_{util,t}}$) using four model specifications. The nine risk factors include: market premium ($\boldsymbol{R_{m,t}}$), size premium (SMB_t), value premium (HML_t), momentum premium (UMD_t) term premium ($\boldsymbol{R_{tp,t}}$), oil price risk ($R_{o,t}$), coal price risk ($R_{c,t}$) and natural gas price risk ($R_{g,t}$). A ***, ** or * denotes significance at 1%, 5% or 10%, respectively. Reported coefficients and significances have been corrected for any autocorrelation or heteroskedasticity. No evidence of multicollinearity was found. Model specifications are:

Model (A), CAPM: $\boldsymbol{R_{util,t}} = \alpha_i + b_i\boldsymbol{R}_{m,t} + e_{i,t}$,

Model (B) Augmented-CAPM: $\boldsymbol{R_{util,t}} = \alpha_i + b_i\boldsymbol{R}_{m,t} + tp_i\boldsymbol{R}_{tp,t} + o_iR_{o,t} + c_iR_{c,t} + g_iR_{g,t} + e_{i,t}$,

Model (C), Four-Factor: $\boldsymbol{R_{util,t}} = \alpha_i + b_i\boldsymbol{R}_{m,t} + s_iSMB_t + h_iHML_t + m_iUMD_t + e_{i,t}$,

Model (D) AFFM: $\boldsymbol{R_{util,t}} = \alpha_i + b_i\boldsymbol{R}_{m,t} + s_iSMB_t + h_iHML_t + m_iUMD_t + tp_i\boldsymbol{R}_{tp,t} + o_iR_{o,t} + c_iR_{c,t} + g_iR_{g,t} + e_{i,t}$.

Table 4: The impact of risk factors across the three regulatory regimes

	(A) 1996-2003		(B) 2003-2009		(C) 2009-2013	
α_i	0.000		-0.001		0.003	
b_i	0.507	***	0.840	***	0.836	***
s_i	0.072		-0.404	**	-0.319	***
h_i	0.155	***	-0.092		0.275	***
m_i	-0.052		0.048		-0.236	***
tp_i	-0.607		-0.340		-0.657	
o_i	0.007		0.027		-0.050	*
c_i	0.064		0.054	**	0.024	
g_i	0.007		0.020	**	-0.006	
$co2_i$					0.011	
$\boldsymbol{Adj.R^2}$	0.478		0.725		0.794	
$\boldsymbol{F} =$	22.34	***	16.79	***	87.69	***

Notes: This table presents annual AFFM regressions using Newey-West HAC standard errors. Due to the method of portfolio construction, coefficients are estimated between July 1996 and June 2013. The value-weighted returns of the energy sector ($\boldsymbol{R_{util}}$) are used as the dependent variable. The nine risk factors include: market premium ($\boldsymbol{R_m}$), size premium (SMB), value premium (HML), momentum premium (UMD) term premium ($\boldsymbol{R_{tp}}$), oil risk (R_o), coal risk (R_c), natural gas risk (R_g), and carbon risk (R_{co2}). The intercept and error term are denoted α_i and e_i, respectively. A ***, ** or * denotes significance at 1%, 5% or 10%, respectively. The specification used is:

$$\boldsymbol{R}_i = \alpha_i + b_i\boldsymbol{R}_m + s_iSMB + h_iHML + m_iUMD + tp_i\boldsymbol{R}_{tp} + o_iR_o + c_iR_c + g_iR_g + co2_iR_{co2} + e_i,$$

Table 5: Inter-Sectoral AFFM

Panel	Sector	α_i	b_i	s_i	h_i	m_i	tp_i	o_i	c_i	g_i	$\boldsymbol{Adj.R^2}$	$\boldsymbol{F=}$ $\boldsymbol{Sig.}$
(A)	**Energy Utilities**	0.000	0.667 ***	0.017	0.179 ***	-0.038 *	-0.745 **	0.017	0.036 *	0.015 **	0.613	169.83 ***
(B)	**Banking**	0.001	1.177 ***	0.313 ***	0.510 ***	-0.204 ***	-0.314	-0.028 **	-0.001	-0.008	0.827	511.17 ***
(C)	**Oil & Gas**	-0.001	0.802 ***	-0.048	0.109 **	-0.045	-0.199	0.177 ***	0.039	0.008	0.582	149.71 ***
(D)	**Telecommunications**	-0.002	0.831 ***	-0.401 ***	-0.275 ***	-0.034	0.457	-0.051 ***	0.020	-0.010	0.552	132.49 ***
(E)	**Technology**	-0.002	1.374 ***	-0.042	-0.736 ***	-0.190 ***	0.676	-0.054 ***	-0.004	0.007	0.733	293.73 ***

Notes: Panels (A) of this table presents the Newey-West regression output for the energy utility sector using the AFFM model, while Panels (B) to (E) report the Newey-West regression output for the five. The five value-weighted sector portfolios include the: energy utility ($\boldsymbol{R_{util,t}}$), banking ($\boldsymbol{R_{banks,t}}$), oil & gas ($\boldsymbol{R_{O\&G,t}}$), telecommunication ($\boldsymbol{R_{tele,t}}$), and technology ($\boldsymbol{R_{tech,t}}$) sectors. The nine risk factors include: market premium ($\boldsymbol{R_{m,t}}$), size premium (SMB_t), value premium (HML_t), momentum premium (UMD_t) term premium ($\boldsymbol{R_{tp,t}}$), oil price risk ($R_{o,t}$), coal price risk ($R_{c,t}$) and natural gas price risk ($R_{g,t}$). A ***, ** or * denotes significance at 1%, 5% or 10%, respectively. Reported coefficients and significances have been corrected for autocorrelation or heteroskedasticity. No evidence of multicollinearity was found. Model specifications is:

$$\boldsymbol{R}_{i,t} = \alpha_i + b_i\boldsymbol{R}_{m,t} + s_iSMB_t + h_iHML_t + m_iUMD_t + tp_i\boldsymbol{R}_{tp,t} + o_iR_{o,t} + c_iR_{c,t} + g_iR_{g,t} + e_{i,t},$$

where $\boldsymbol{R}_{i,t}$ denotes one of the five sectors as the dependent variable.

Table 6: Intersectoral comparison across regulatory regimes

Panel	**Sector**	**Regime**	α_i	b_i	s_i	h_i	m_i	tp_i	o_i	c_i	g_i	$co2_i$	$\boldsymbol{Adj.R^2}$	$\boldsymbol{F=}$	$\boldsymbol{Sig.}$
(A)	**Energy Utilities**	1996-2003	0.000	0.507 ***	0.072	0.155 ***	-0.052	-0.607	0.007	0.064	0.007		0.4775	39.16	***
		2003-2009	-0.001	0.840 ***	-0.404 **	-0.092	0.048	-0.340	0.027	0.054 **	0.020 **		0.7245	104.87	***
		2009-2013	0.011	0.836 ***	-0.319 ***	0.275 ***	-0.236 ***	-0.657	-0.050 *	0.024	-0.006	0.011	0.7939	87.44	***
(B)	**Banking**	1996-2003	0.001	1.131 ***	0.387 ***	0.254 ***	-0.112 **	-0.209	-0.047 **	0.085 **	-0.004		0.7503	126.47	***
		2003-2009	0.001	1.037 ***	-0.009	0.666 ***	-0.349 ***	-0.334	-0.006	-0.028	0.000		0.8798	290.16	***
		2009-2013	0.002	1.129 ***	0.076	0.851 ***	-0.247 ***	-0.500	-0.054 *	0.055 *	-0.033 **	-0.008	0.9049	214.65	***
(C)	**Oil & Gas**	1996-2003	0.001	0.718 ***	0.082	0.279 ***	-0.115 **	-0.081	0.193 ***	0.163 *	-0.003		0.4178	30.96	***
		2003-2009	-0.003	1.004 ***	-0.481 ***	-0.147	0.060	0.168	0.154 ***	0.018	0.011		0.7666	130.71	***
		2009-2013	-0.002	0.989 ***	-0.023	-0.162 **	-0.028	-0.016	0.153 ***	-0.011	-0.020	-0.010	0.7774	79.36	***
(D)	**Telecommunications**	1996-2003	-0.007	0.804 ***	-0.530 ***	-0.488 ***	-0.032	2.089 *	-0.008	0.180 **	-0.005		0.5818	59.08	***
		2003-2009	-0.001	0.708 ***	-0.285	0.034	0.026	-0.241	-0.085 ***	-0.004	-0.001		0.5397	47.32	***
		2009-2013	0.001	0.749 ***	-0.248 **	0.031	-0.138 ***	-0.072	-0.045	0.008	-0.042 **	-0.047 ***	0.6342	39.91	***
(E)	**Technology**	1996-2003	-0.004	1.449 ***	-0.314 *	-0.942 ***	-0.292 ***	1.985 **	-0.008	0.018	0.014		0.8065	175.01	***
		2003-2009	-0.001	1.138 ***	0.357 **	-0.325 **	-0.091	-0.353	-0.074 ***	-0.008	0.008		0.6580	76.99	***
		2009-2013	-0.001	1.107 ***	0.649 ***	-0.212 ***	-0.013	-0.097	-0.044	0.033	0.009	-0.019	0.7729	77.38	***

Notes: Panels (A) of this table presents the Newey-West regression output for the energy utility sector using the AFFM model, while Panels (B) to (K) report the Newey-West regression output for the additional 10 European sectors. The 11 value-weighted sector portfolios include the: energy utility ($\boldsymbol{R_{util,t}}$), banking ($\boldsymbol{R_{banks,t}}$), oil & gas ($\boldsymbol{R_{O\&G,t}}$), telecommunication ($\boldsymbol{R_{tele,t}}$), industrial ($\boldsymbol{R_{ind,t}}$), insurance ($\boldsymbol{R_{ins,t}}$), retail ($\boldsymbol{R_{ret,t}}$), technology ($\boldsymbol{R_{tech,t}}$), media ($\boldsymbol{R_{media,t}}$), chemical ($\boldsymbol{R_{chem,t}}$), and financial ($\boldsymbol{R_{fin,t}}$) sectors. The nine risk factors include: market premium ($\boldsymbol{R_{m,t}}$), size premium (SMB_t), value premium (HML_t), momentum premium (UMD_t) term premium ($\boldsymbol{R_{tp,t}}$), oil price risk ($R_{o,t}$), coal price risk ($R_{c,t}$) and natural gas price risk ($R_{g,t}$). A ***, ** or * denotes significance at 1%, 5% or 10%, respectively. Reported coefficients and significances have been corrected for autocorrelation or heteroskedasticity. No evidence of multicollinearity was found. Model specifications is:

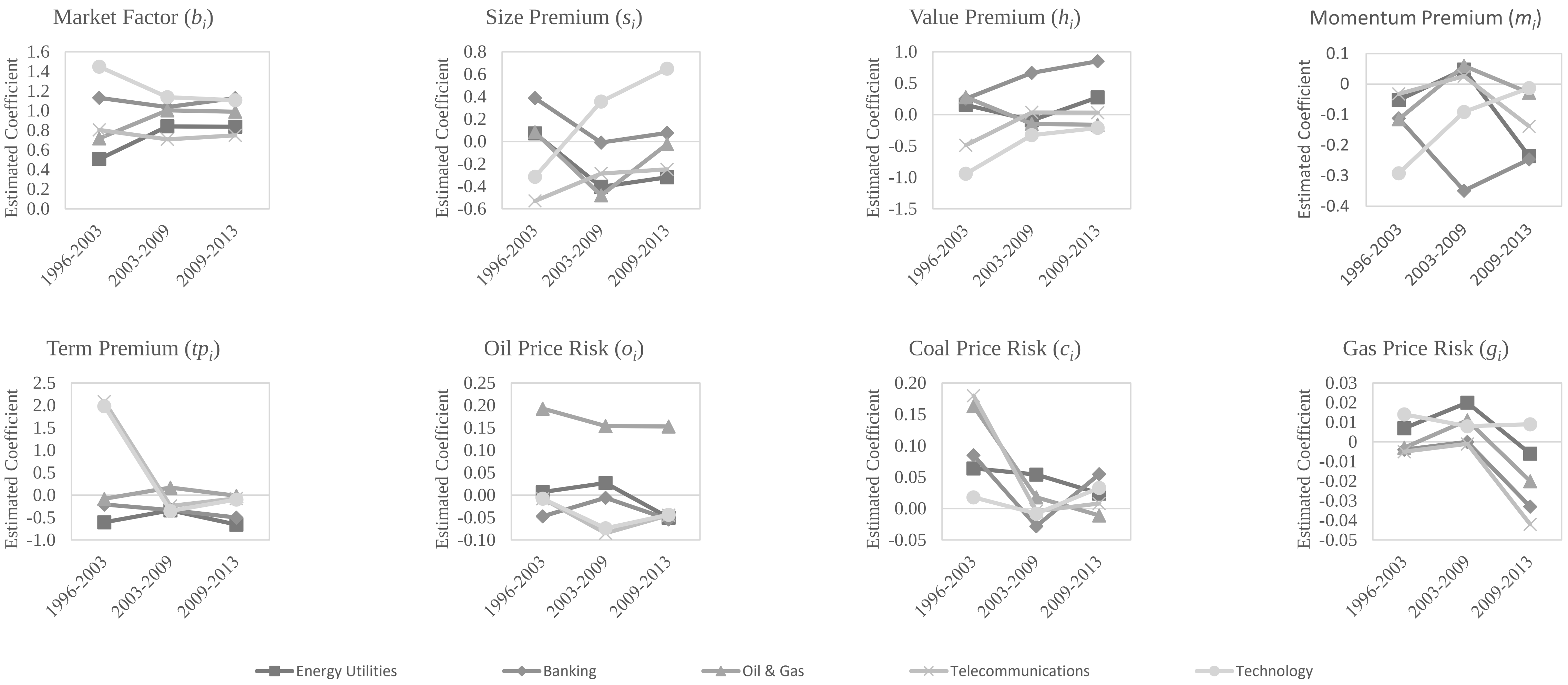

FIGURE 1: ESTIMATED COEFFICIENTS FOR ALL SECTORS AND REGULATORY REGIMES

This figure illustrates the estimated coefficients for all five sectors, each risk factor and across the three regulatory regimes.