

**ESTIMATE OF EQUITY BETA**

**FOR UK MOBILE OWNERS**

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# 1 Introduction

Ofcom has asked us to update our estimates of the equity betas for the parent companies of the four UK mobile phone networks: Vodafone, Telefonica, France Telecom and Deutsche Telekom. We understand that Ofcom intends to use these estimates to inform its forthcoming decision on the level of UK mobile call termination charges. We perform various analyses and present beta estimates for the four parent companies.

Interpretation of the updated results requires care. As we highlighted in previous reports, none of the four UK mobile operators has a dedicated tracking stock. The closest available stock market data relates to the four parent companies and those companies engage in a diverse range of telecoms and IT activities in addition to UK mobile. It remains unclear the extent to which the observed betas for the parent companies reflect the particular risks associated with UK mobile or the risks associated with the parent companies' other activities.

We provide useful economic context in this update, with reference to a sample of large liquidly traded US telecommunications stocks. Some of the companies in the US sample, such as AT&T and Verizon, resemble the four mobile network owners: large diversified telecommunications companies, engaging in a mixture of wireline and wireless activities. In contrast, others in the US sample, such as US Cellular, focus only on the provision of wireless services. The US telecommunications sample is therefore interesting for two reasons: in part because it provides a reference sample of wireless only stocks, and in part because it enables comparison of the relative risks of wireless and wireline telecommunications services.

As well as examining the statistical robustness of the observed betas, in this update we also examine in part the impact of the credit crisis on the observed betas for the mobile network operators. We examine how the credit crisis impacted the market value of the debt of each of the companies, and examine the extent to which volatility in certain sectors of the economy impact the results of our beta calculations. We also consider whether the immediate past could be a reliable guide to the future period of interest to Ofcom.

In this report, we adopt the same methodology as in other previous engagements for Ofcom.<sup>1</sup> We calculate daily returns from holding stock in each of the mobile network owners, and from holding a broad market index. We examine data for three market indices: the FTSE All-Share reflecting all stocks trading on the London Stock Exchange, the FTSE All-World reflecting a large proportion of publicly traded stocks around the world, and the FTSE All-EU reflecting the European portion of the All-World. As is standard, we perform a regression of the daily returns on each company against the daily returns on the market index. The regression coefficient is the equity beta. We use market data up to and including the end of October 2010.

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<sup>1</sup> See, for example, *Updated Estimate of BT's Equity Beta* (October 2008), *An Estimate of the Equity Beta of BskyB* (March 2009), and *Estimate of Equity Beta for UK Mobile Owners* (December 2009).

Previous work for Ofcom examined beta estimation methods.<sup>2</sup> One issue concerned the frequency with which to measure stock returns: whether to use daily, weekly or even monthly returns. Analysts might use weekly or monthly returns if there is a concern about the liquidity of stock trading. No such concern exists in this case. All four of the mobile network owners are amongst the most liquid stocks around. All of our estimates therefore focus on daily returns. Another methodological choice relates to the duration of the data window. We focus on a two-year window in this report, while also reporting the results from a one-year window. Two-years provides a sizeable sample of daily stock returns without extending so far back in time as to include data from periods before the four companies made significant operational changes.

Chapter 2 presents beta estimates for the mobile network owners and the US telecoms sample. Chapter 3 reports the results of several tests of the statistical reliability of the beta estimates for the mobile network owners. Chapter 4 explores the impact of the credit crisis.

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<sup>2</sup> See *Issues in beta estimation for UK mobile operators*, July 2002.

## 2 Equity beta estimates

### 2.1 Up-to-date estimates

Table 1 reports up-to-date beta estimates for the four parent companies. All of the estimates rely on daily return data. We report separate one and two year beta estimates as well as separate estimates against the three market indices. A one-year beta relies on the previous year of trading activity. A two-year beta relies on the previous two years. All of the various estimates reflect data up to and including the end of October 2010.

**Table 1: Up-to-date beta estimates<sup>3</sup>**

	1 Year				2 Year			
	Beta	SE	Low	High	Beta	SE	Low	High
<i>Vodafone</i>								
All-Share	0.68	0.06	0.57	0.79	0.73	0.05	0.64	0.81
All-World	0.59	0.08	0.44	0.74	0.49	0.06	0.38	0.61
All-EU	0.51	0.05	0.42	0.60	0.54	0.04	0.46	0.62
<i>Telefonica</i>								
All-Share	0.87	0.06	0.75	1.00	0.61	0.03	0.54	0.67
All-World	1.10	0.09	0.92	1.28	0.56	0.05	0.47	0.66
All-EU	0.93	0.05	0.84	1.03	0.68	0.03	0.62	0.74
<i>France Telecom</i>								
All-Share	0.70	0.05	0.60	0.80	0.48	0.03	0.41	0.55
All-World	0.82	0.07	0.68	0.96	0.49	0.04	0.40	0.58
All-EU	0.69	0.04	0.62	0.77	0.54	0.03	0.48	0.60
<i>Deutsche Telekom</i>								
All-Share	0.58	0.05	0.48	0.67	0.54	0.04	0.46	0.61
All-World	0.67	0.07	0.53	0.80	0.55	0.05	0.45	0.64
All-EU	0.52	0.04	0.44	0.60	0.53	0.04	0.46	0.60
<i>Simple Average Across Companies</i>								
All-Share	0.71				0.59			
All-World	0.79				0.52			
All-EU	0.66				0.57			

The simple average for the most recent two-years of data comes in at 0.59 against the FTSE-All-share, 0.52 against the All-World, and 0.57 against the All-EU. The simple averages of the two-year betas are down slightly since our last update in November 2009 (0.59 vs 0.66, for the All-Share; 0.52 vs 0.64 for the All-World; and 0.57 vs 0.66 for the All-EU).

At the same time however, the simple average of the one-year betas has moved in the other direction. The simple average of the one-year estimates now comes in as high as 0.71 against the All-Share, 0.79 against the All-World, and 0.66 against the All-EU. Almost a year ago, the simple average of the one year estimates was only 0.51 against the All-Share, 0.48 against the All-World and 0.50 against the All-EU. The slight decline in

<sup>3</sup> Low and high refer to the 95% confidence interval and not to the lowest and highest one and two-year betas observed throughout the year.

the two-year betas remains well within the range of statistical uncertainty. However, at first glance, the large rise in the one-year betas appears statistically significant.

Table 2 compares the raw one and two year betas at three points in time: pre-Lehman, November 2009 when we prepared our last update, and October 2010. The table indicates that the rise in the one-year betas stems largely from the performance of Telefonica and France Telecom.

- Vodafone's one-year beta remains roughly at the level of a year ago, and in fact, Vodafone's one-year beta against the All-Share has slightly declined over the past year (now 0.68 vs 0.77 a year ago).
- Deutsche Telekom's one-year beta registered some gain over the past year but not of the magnitudes observed for Telefonica and France Telecom. Deutsche Telekom's one-year beta now stands at 0.58 against the All-Share up from 0.46 a year ago (0.67 against the All-World up from 0.54 a year ago; and 0.52 against the All-EU up from 0.48 a year ago).
- France Telecom's one-year beta has almost doubled, and now stands higher than it did prior to the collapse of Lehman Brothers. Against the All-Share, the one-year beta now stands at 0.70, compared with 0.35 a year ago, and 0.53 prior to the collapse of Lehman. France Telecom's one-year betas against the All-World and the All-EU display exactly the same development over time.
- Telefonica's one-year beta also has almost doubled over the past year, and now stands higher than before the collapse of Lehman Brothers. Against the All-Share, the one-year beta now comes in at 0.87 compared to 0.47 a year ago, and 0.71 pre-Lehman. The rise against the All-World is even more striking. The one-year beta against the All-World now is 1.10, compared with 0.48 a year ago, and 0.80 pre-Lehman.

**Table 2: Beta estimates over time**

	1 Yr						2 Yr					
	Pre-Lehman		Nov-09		Nov-10		Pre-Lehman		Nov-09		Nov-10	
	Beta	SE	Beta	SE	Beta	SE	Beta	SE	Beta	SE	Beta	SE
<i>Vodafone</i>												
All-Share	0.87	0.08	0.77	0.07	0.68	0.06	0.93	0.06	0.84	0.04	0.73	0.05
All-World	0.82	0.12	0.52	0.08	0.59	0.08	0.90	0.09	0.66	0.06	0.49	0.06
All-EU	0.88	0.09	0.56	0.06	0.51	0.05	0.94	0.06	0.71	0.04	0.54	0.04
<i>Telefonica</i>												
All-Share	0.71	0.06	0.47	0.04	0.87	0.06	0.73	0.04	0.67	0.03	0.61	0.03
All-World	0.80	0.08	0.48	0.05	1.10	0.09	0.84	0.06	0.64	0.04	0.56	0.05
All-EU	0.86	0.06	0.53	0.04	0.93	0.05	0.87	0.04	0.72	0.03	0.68	0.03
<i>France Telecom</i>												
All-Share	0.53	0.07	0.35	0.05	0.70	0.05	0.58	0.05	0.51	0.03	0.48	0.03
All-World	0.58	0.10	0.40	0.06	0.82	0.07	0.65	0.07	0.55	0.05	0.49	0.04
All-EU	0.64	0.07	0.41	0.05	0.69	0.04	0.68	0.05	0.57	0.03	0.54	0.03
<i>Deutsche Telekom</i>												
All-Share	0.45	0.07	0.46	0.05	0.58	0.05	0.49	0.05	0.62	0.04	0.54	0.04
All-World	0.58	0.09	0.54	0.07	0.67	0.07	0.62	0.07	0.69	0.05	0.55	0.05
All-EU	0.54	0.07	0.48	0.05	0.52	0.04	0.57	0.05	0.64	0.04	0.53	0.04
<i>Simple Average Across Companies</i>												
All-Share	0.64		0.51		0.71		0.68		0.66		0.59	
All-World	0.69		0.48		0.79		0.75		0.64		0.52	
All-EU	0.73		0.50		0.66		0.77		0.66		0.57	

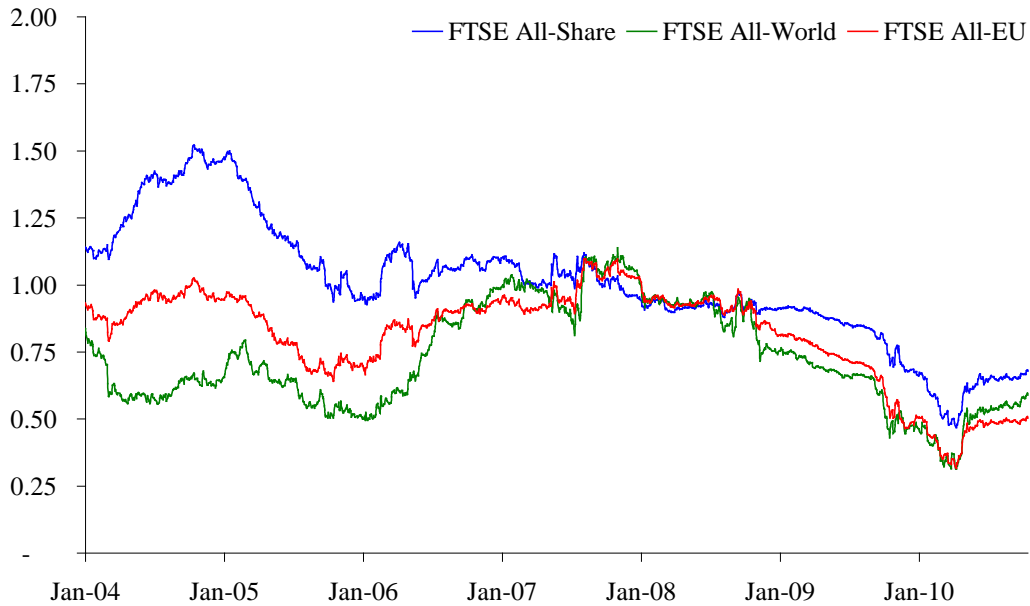
In contrast, the two-year betas generally come in lower than they were a year ago. Vodafone's two-year beta displays the largest decline (0.73 against the All-Share down from 0.84 a year ago; 0.49 against the All-World down from 0.66 a year ago; and 0.54 against the All-EU down from 0.71 a year ago).

Figure 1 to Figure 3 illustrate the development of Vodafone's equity beta over time. Each of the plots keep the duration of the beta estimation window constant through time. It simply shifts the one or two-year data window forward as time passes. Figure 1 plots Vodafone's one-year and two-year betas against the All-Share, and illustrates the divergence of the one and two-year estimates over the past year. The two-year continues on its downward trend until the last month, where it dives sharply. In contrast, the one-year beta dropped sharply around the end of 2009 before coming back somewhat during 2010. Figure 2 and Figure 3 then compare the rolling betas against the three different indices, and confirm the presence of the same general movements in the betas computed against the different indices.

**Figure 1: Vodafone rolling betas – Against All-Share**



**Figure 2: Vodafone rolling betas – one-year**



**Figure 3: Vodafone rolling betas – two-year**

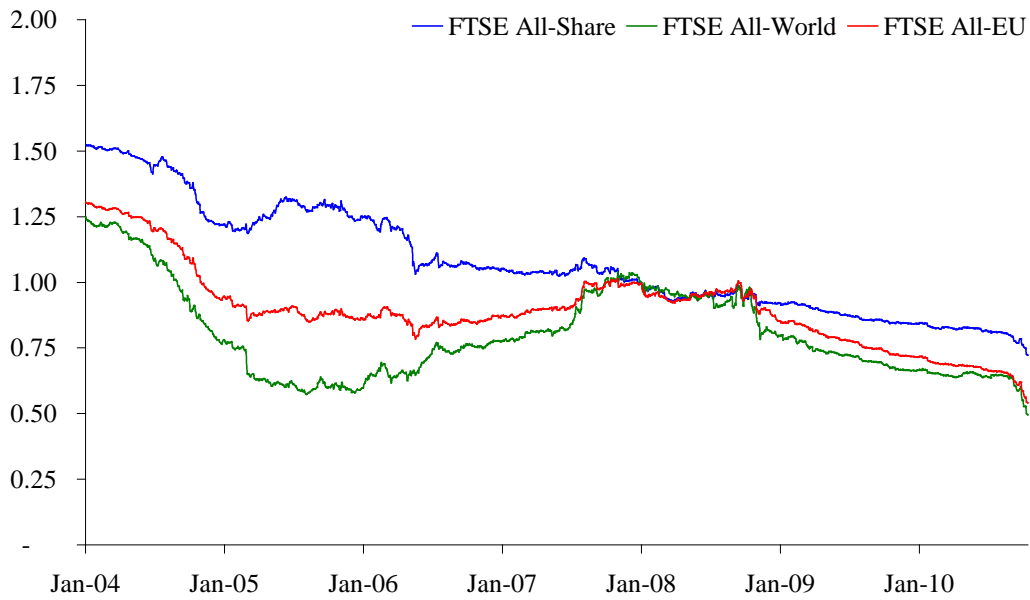
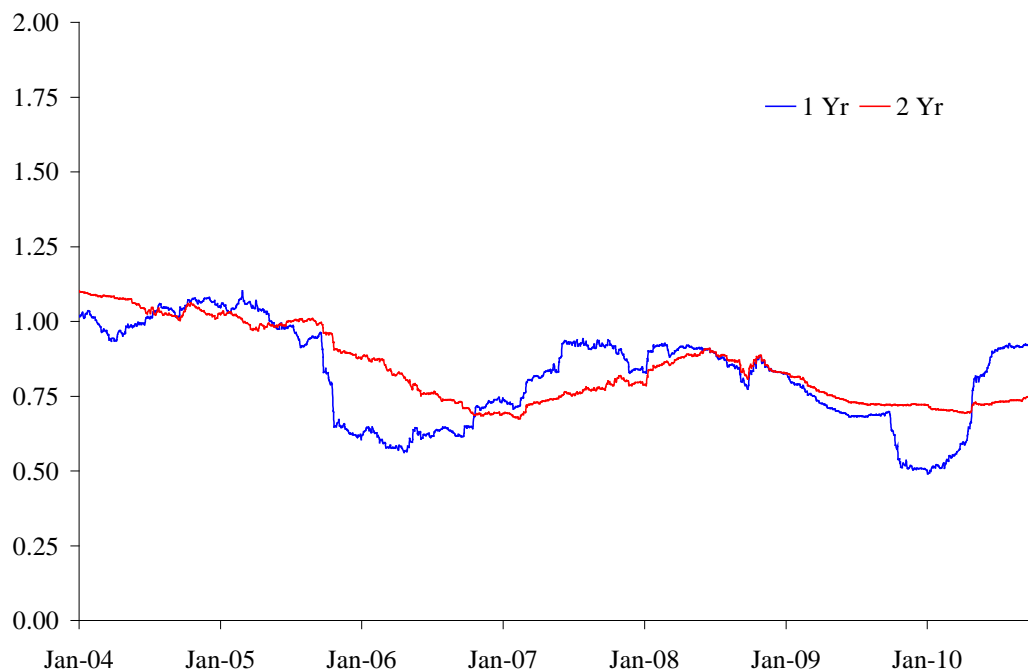


Figure 4 to Figure 6 illustrate the development of Telefonica's equity beta over time. Figure 4 plots Telefonica's one-year and two-year betas against the All-Share, and illustrate the divergence of the one-year from the two-year and the step rise in the one-year estimate during the past year. Interestingly, the step rise in Telefonica's one-year beta estimate occurs at almost the same moment when Vodafone's one-year starts its recent upward trend, albeit to less extent than Telefonica's. The upward movement begins

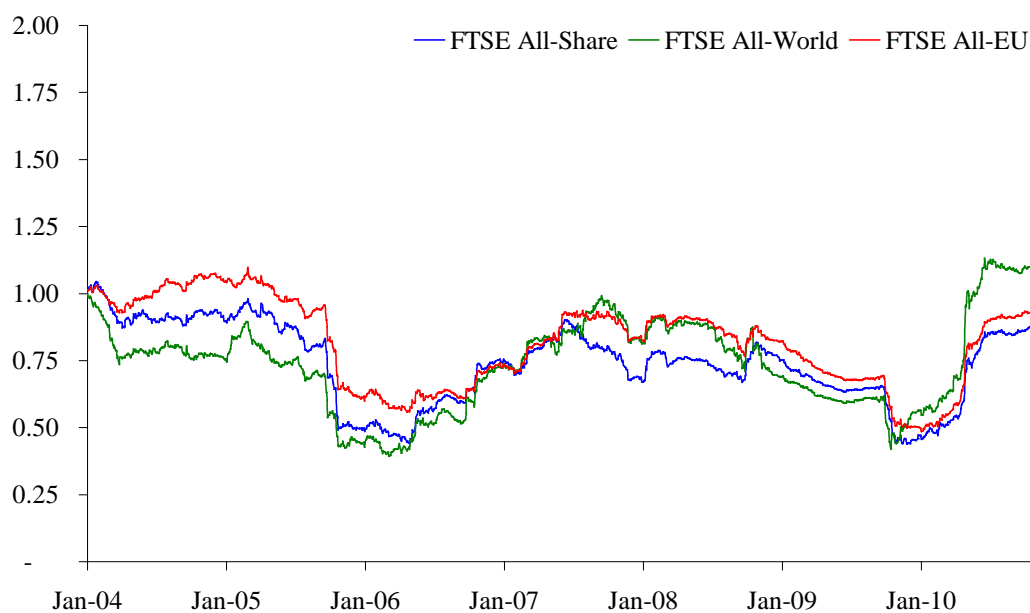


around April-May 2010. Figure 5 and Figure 6 then compare the rolling betas against the three different indices, and confirm the presence of the same general movements in the betas computed against the different indices.

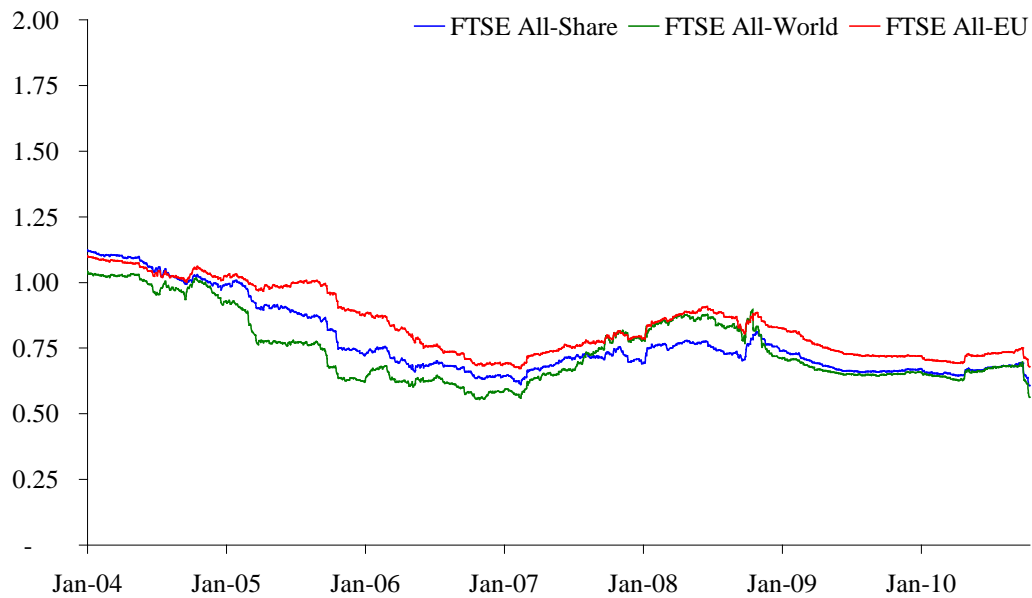
**Figure 4: Telefonica rolling betas – Against All-Share**



**Figure 5: Telefonica rolling betas – one-year**

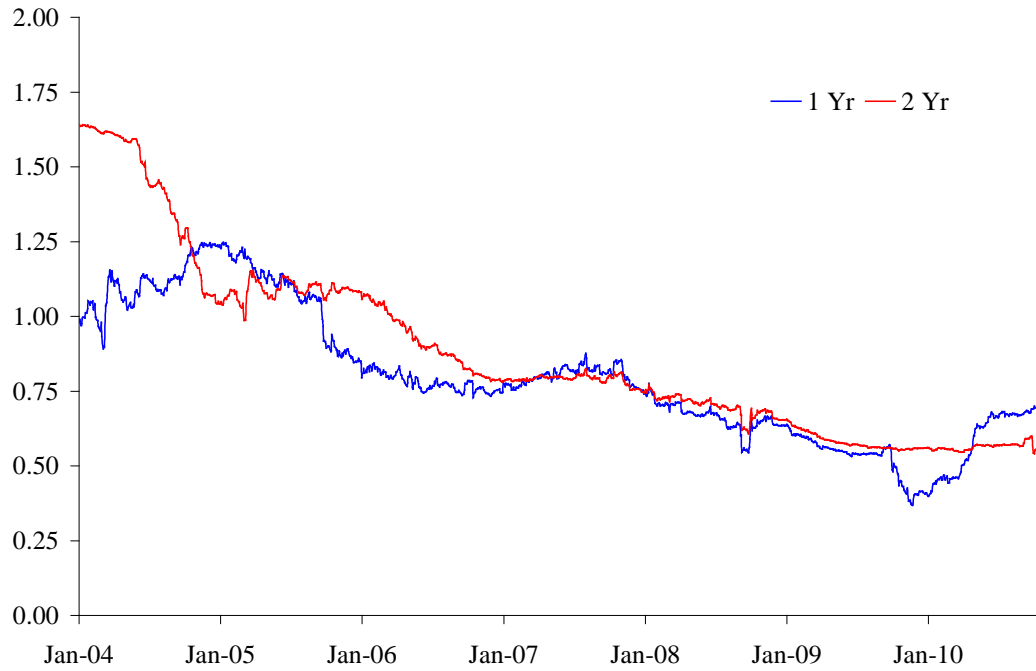


**Figure 6: Telefonica rolling betas – two-year**

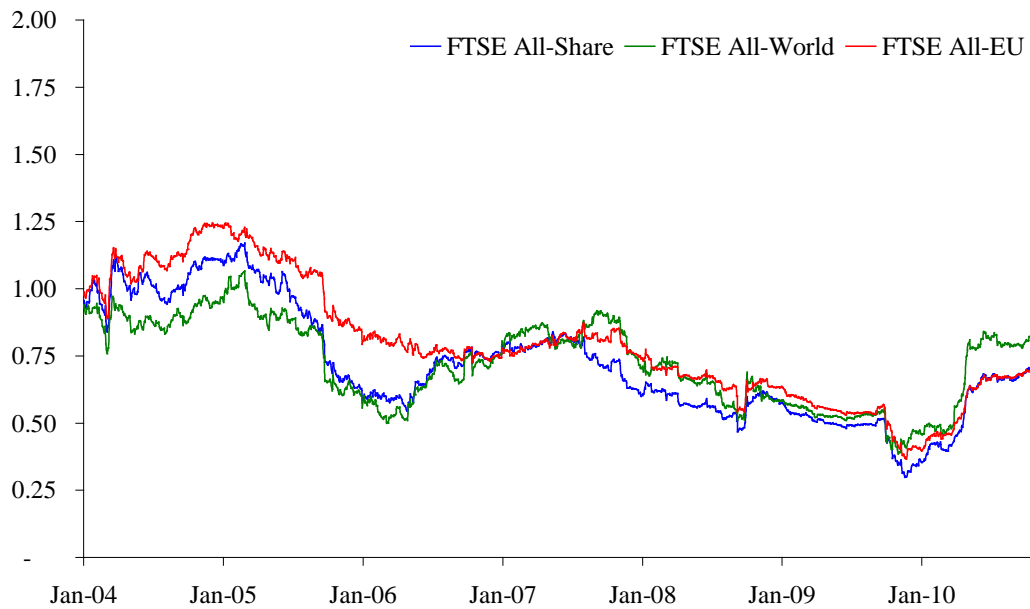


Six further figures plot the development of France Telecom's and Deutsche Telecom's betas over time. These plots illustrate the presence of similar relative movements in the one and two-year beta estimates for France Telecom and Deutsche Telecom during the past year as we have already observed for Telefonica. France Telecom's one-year betas drop in autumn 2009, before rising strongly during 2009, following closely the trend of Telefonica's one-year beta. Deutsche Telecom's one-year estimate also drops in autumn 2009, but it does not recover to quite the same extent as Telefonica and France Telecom. In every case, the two-year betas stay broadly constant before dropping more recently. We also note the presence of an upward movement in both the France Telecom and Deutsche Telecom one-year betas immediately following the collapse of Lehman, and a corresponding downward shift a year later, with the passage of the data window past autumn 2009. The effect is most obvious for Deutsche Telecom.

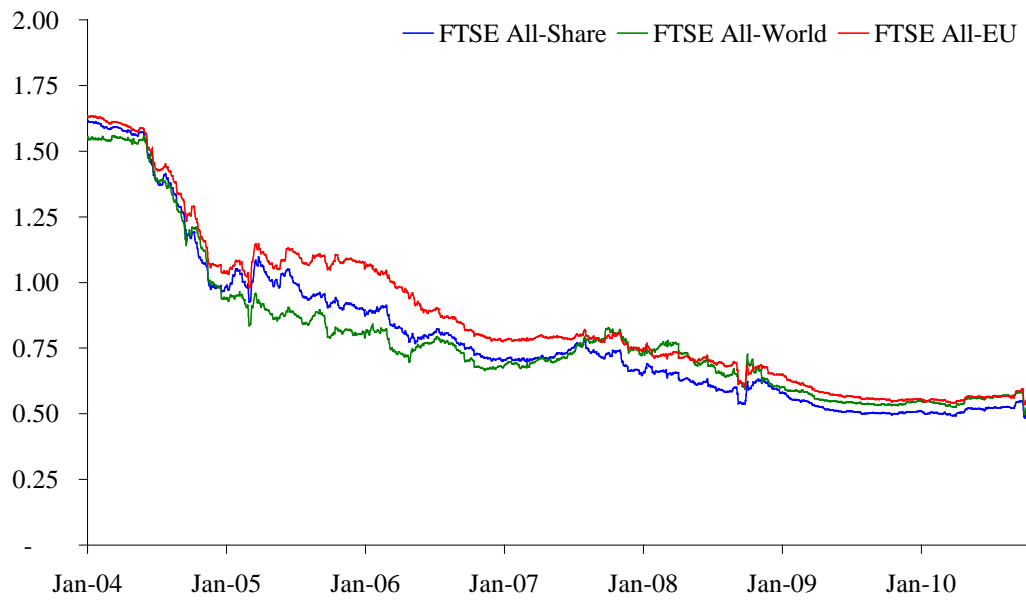
**Figure 7: France Telecom rolling betas – Against All-Share**



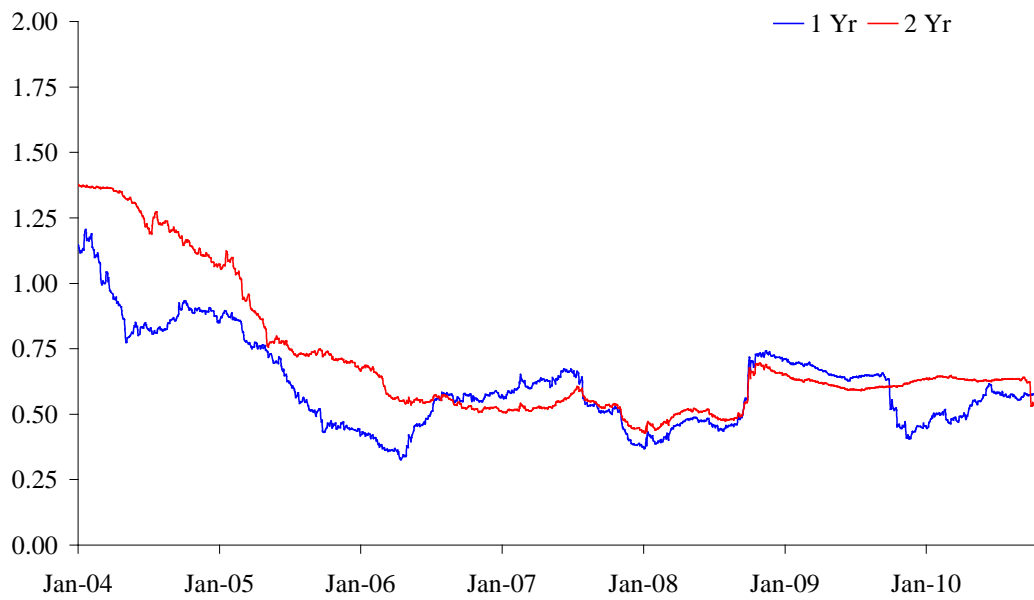
**Figure 8: France Telecom rolling betas – one-year**



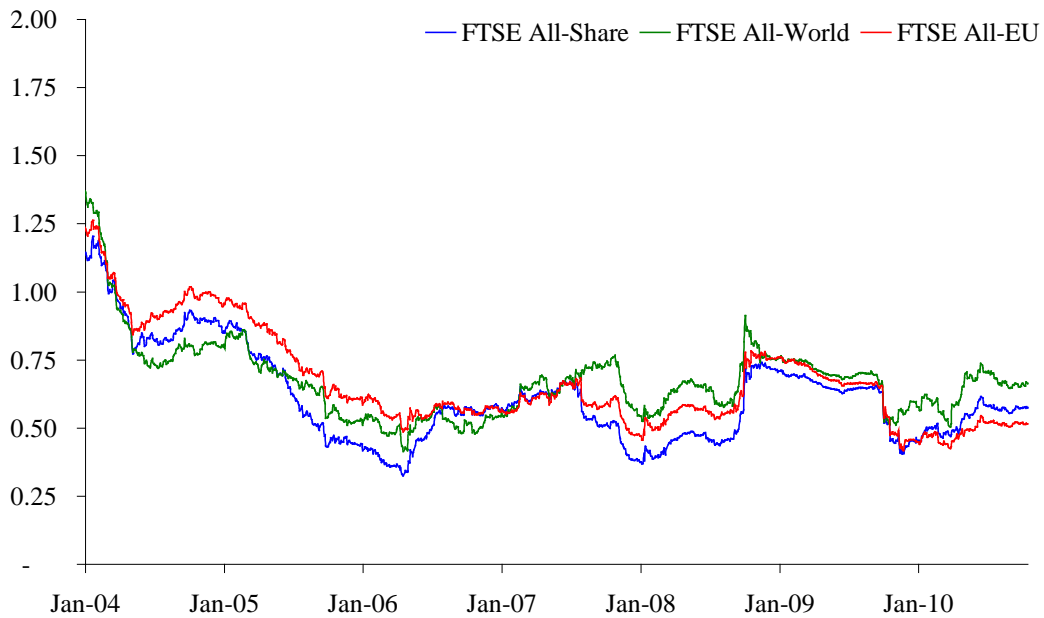
**Figure 9: France Telecom rolling betas – two-year**



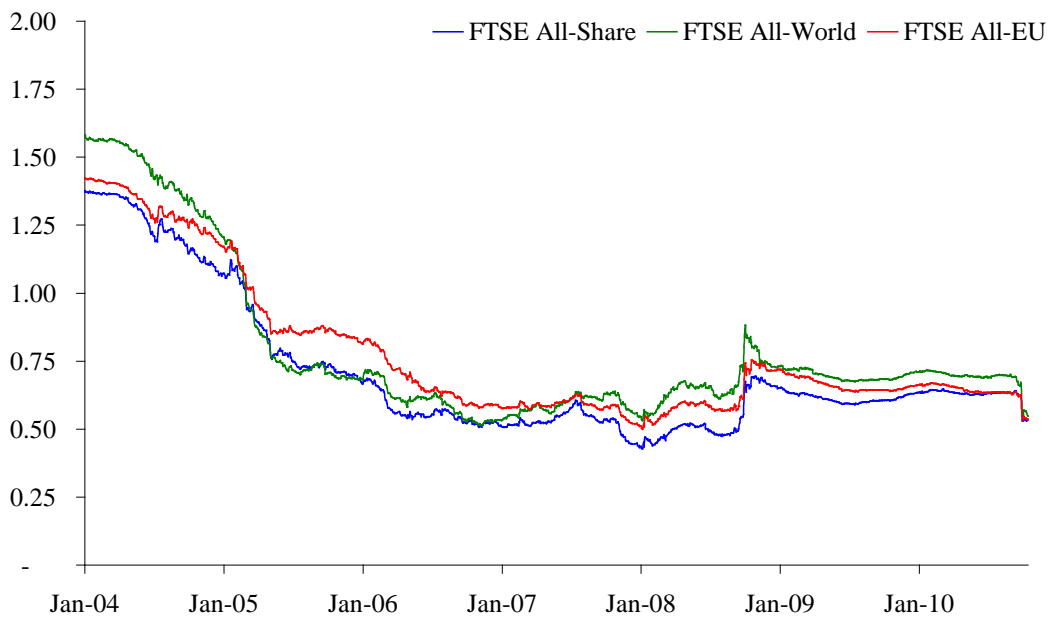
**Figure 10: Deutsche Telecom rolling betas – Against All-Share**



**Figure 11: Deutsche Telecom rolling betas – one-year**



**Figure 12: Deutsche Telecom rolling betas – two-year**



Several comments on our previous update claimed that we should ignore recent data and rely on estimates derived using pre-Lehman data. Perhaps market upheaval during the credit crisis could have affected results and diminished our ability to accurately measure equity beta and the associated leverage of the companies. Others claimed that the most

recent data represented the best evidence for a forward looking assessment of relative risk, especially given ongoing volatility in financial and mining stocks.<sup>4</sup>

Unfortunately, the latest data do not help settle these questions definitively, although it does confirm a substantial reduction in volatility across all sectors since a year ago. WE cannot therefore justify a low beta for the MNOs going forward based on a forecast of continuing uncertainty in the financial and mining segments. Nevertheless, does the smooth downward trend of the two-year beta reflect the true development of the equity beta for mobile over time, and reflect that investors consider the mature UK mobile market much like other utilities. Or is the downward trend in the two-year beta just a temporary phenomenon, soon to correct itself, given the step rise in the one-year estimates since Spring 2010? In other words, does the step rise in the one-year betas represent an enduring return to risk levels witnessed prior to the collapse of Lehman? Or is some of the rise nothing else but noise in the data?

We provide several perspectives. First, part of the step rise in the betas since Spring 2010 disappears under statistical scrutiny. For example, Telefonica's one-year OLS beta against the FTSE All-World comes in at 1.10. But when we add Dimson adjustments to reflect differences in the closing times for different stock markets, we find a one-year Dimson beta for Telefonica of just 0.66, only a little higher than the one-year beta measured a year ago, and a bit less than the one-year beta measured prior to the collapse of Lehman. Weighted least squares also gives a much lower answer than standard OLS, reflecting that the inclusion of several days in April and May 2010 with large price swings create much of the apparent rise in the one-year betas.<sup>5</sup>

Second, even after adjusting for the statistical problems with the standard OLS betas, all four mobile network owners witness some rise in the one-year beta since Spring 2010, although to varying degrees. The presence of similar movements in the beta for all four companies is important and suggests that the movement could reflect something more than noise in the data. On the other hand, if the upward movement reflected economic reality, we would expect to observe similar movements in the one-year betas for other wireless and telecommunications stocks. As we observe below, we observed a similar reduction in the beta for the telecommunications segment of the S&P 500 at the end of 2009 but no subsequent rise since Spring 2010. And for a sample of pure-play US wireless companies, we observe neither any reduction in the one-year beta at the end of 2009 nor any subsequent gain during 2010. Whatever caused the upward movement in the one-year betas of the mobile network operators in Spring 2010 seems to have affected only the four mobile network owners but not a broad telecoms index nor the wireless sector more particularly.

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<sup>4</sup> Even if ongoing volatility resulted in a reduction to the apparent beta, it would justify a decrease in the cost of capital overall. If crisis-level volatility were to linger indefinitely, it would imply an increase in the equity risk premium demanded by investors. The two effects – a lower beta for telecoms on the one-hand and a higher equity risk premium on the other - would likely cancel each other out in a cost of capital calculation.

<sup>5</sup> For example, Telefonica sees a large price swing on May 10<sup>th</sup> 2010, following Telefonica's \$6.3 billion offer for the entire shares outstanding of BrasilCel.

The presence of common movements for the four mobile network owners but not for US telecoms and wireless suggests that volatility in one or two industry sectors cannot finally explain the overall shape of results, as does the recent decline in overall price volatility at the index and sector levels. If increased volatility in the financial and mining sectors lay behind the overall trend in betas and reflected an important economic shift, then we would expect the change in volatility for these sectors to effect the results for all telecoms and wireless companies in exactly the same way. The absence of any universal effect over time suggests that the true explanation for the observed movements lies elsewhere.

At the same time, the US data poses a puzzle. We observe some decrease in the beta for the S&P 500 telecoms segment towards the end of last year, right in line with the reductions we observed for the four mobile network operators. However, we observe no similar decline in either the one or the two year betas for a sample of pure-play US wireless stocks. On one hand, the decline in the one-year beta for the S&P 500 telecoms segment might prompt us to conclude that the credit crisis had prompted a broad re-evaluation of the relative riskiness of the US telecoms segment. On the other, the lack of any observable decline for pure-play US wireless stocks suggests that the decline is only shared by some of the companies contained in the S&P 500 telecoms segment.

The lack of any decline for pure-play wireless stocks therefore raises a question about the relevance and reliability of the decline observed in the betas for both the US telecoms segment in general and the four mobile network owners in particular. We would have expected a true change in investors' risk perceptions to extend to the US wireless stocks, but it apparently does not. Does the lack of any decline in the US wireless betas therefore point to the continuing relevance of pre-Lehman data?

One potential explanation for the performance of the mobile network operators since 2008 revolves around investor sentiment concerning emerging markets. Telefonica generates roughly 35% of revenues and OIBDA from Latin America, while Vodafone and France Telecom generate roughly 20% of revenues and EBITDA in emerging markets. Of the four mobile network operators, only Deutsche Telecom does not generate substantial value outside of Europe and North America.

Emerging market stocks performed particularly poorly during the heart of the credit crisis. Deteriorating sentiment about emerging market prospects may have contributed to the price declines seen at three of the four mobile network owners, and prompted the profile of the one-year betas for Telefonica and France Telecom during 2009, and Vodafone to a lesser extent. Moreover, perhaps several of the large upward price movements during April and May 2010 were prompted by improving investor sentiment concerning important emerging market investments. In both cases – the large downward price movements in autumn 2008 and the more recent price rises – have corresponded to some degree with overall market movements. The emerging markets explanation remains consistent with the development of the US wireless betas over time, reflecting that, unlike the three of the four mobile network owners, the companies in our US sample obtain most of their revenue from US activities. To illustrate, Figure 13 plots returns over time for Telefonica, the FTSE All-World and the emerging markets component of the FTSE All-World.

**Figure 13: Telefonica Performance Relative to Emerging Markets**



Further analysis beyond the scope of this report would be required to test the emerging market hypothesis and to isolate the precise impact of changing market volatility on the observed betas for the four mobile network owners. Below, we measure the financial leverage of the four mobile network operators, the betas of a sample of US telecoms stocks, and examine the performance of the component sectors and the FTSE All-Share and S&P 500.

## 2.2 Financial leverage

Equity risk reflects the combination of underlying business risk (to do with the variability of revenues and the extent of fixed costs) and financial risk (to do with the presence of fixed debt obligations). Other things equal, the more debt a company has outstanding, the greater the equity risk and the higher the equity beta. In general, extreme changes in financial leverage throughout the measurement window prompt the need for further analyses and checks.

We obtained data on the amount of debt outstanding for the four mobile network owners between 2000 and the present. We obtained data from company annual reports, half-yearly reports and quarterly earnings announcements. We supplement with data from Bloomberg. We use the available data to estimate the companies' capital structures at various points in time between 2000 and the present. We focus on market values rather than book values, since market values better indicate earnings power. That being said, we follow the approach adopted in previous reports and assume that the market value of utility debt remained relatively close to its face value throughout the period in question.

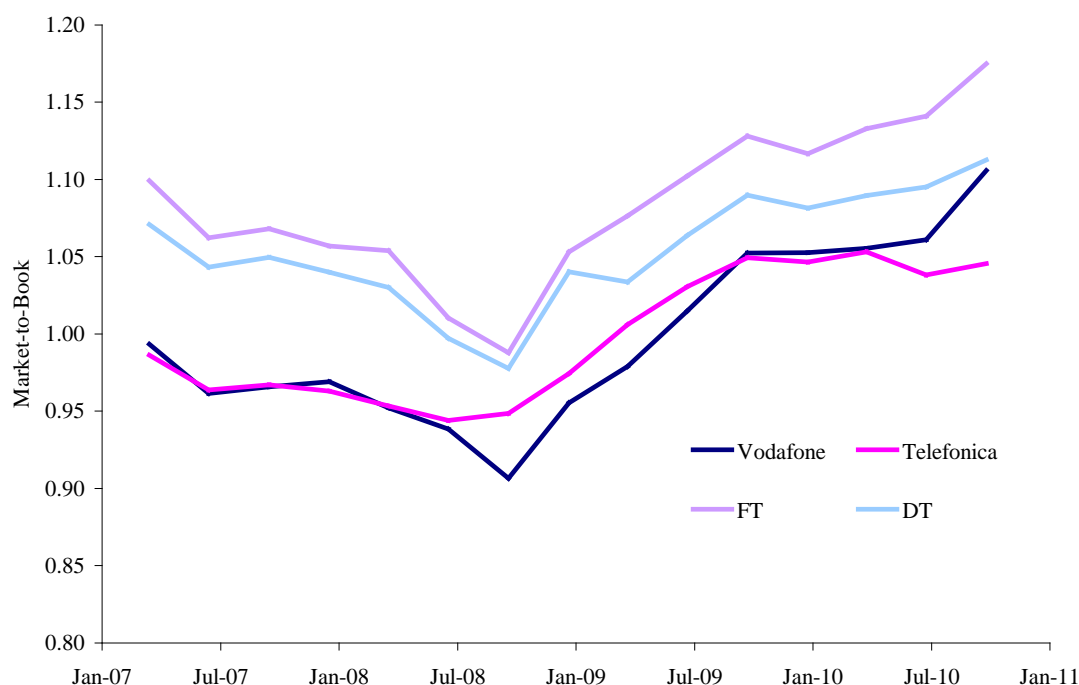
This assumption appears reasonable given that all four mobile network owners maintained investment grade credit ratings throughout the measurement period. Nevertheless, a possible concern is whether the market price of the mobile network



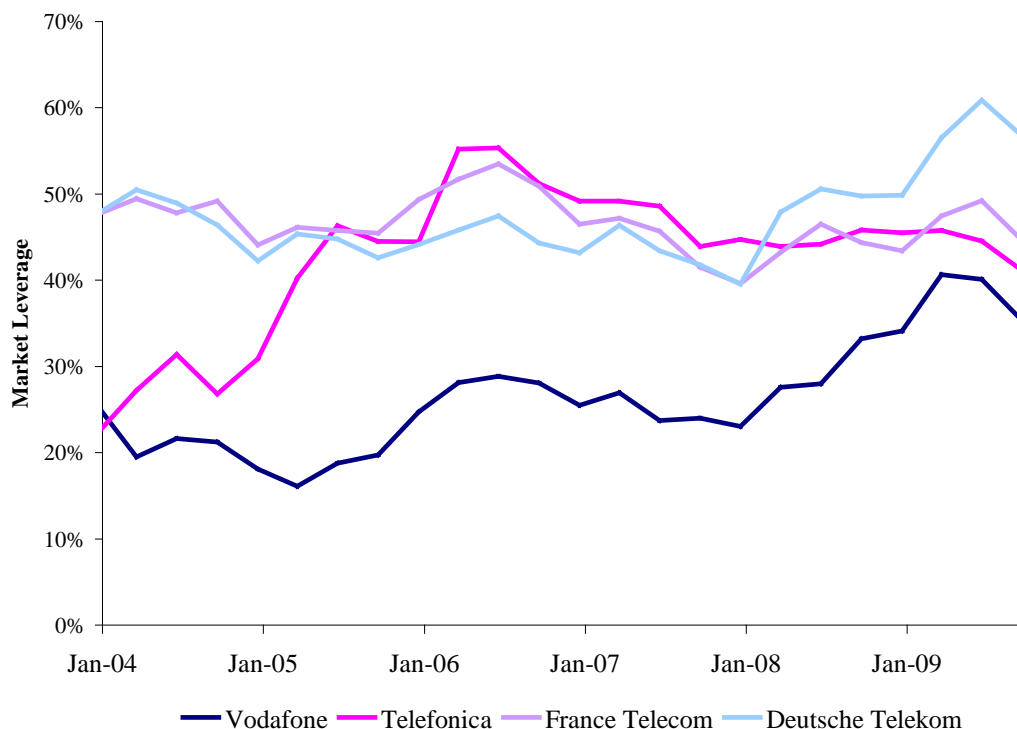
owners' debt diverged somewhat from face value during the height of the credit crisis. If a significant market-to-book difference emerged, then a failure to use market values could bias, probably upward, our estimates of the companies' financial leverage. For example, as credit spreads spiked during the credit crisis, the price on Vodafone's debt may have declined somewhat, reflecting investors' concerns about the prospects for the UK and world economy. Incorporating the reduced market price of the debt in the calculation would reduce the appearance of financial leverage at Vodafone. Overstating leverage could lead us to effectively understate Vodafone's overall asset beta, since we would always expect leverage to add to the equity beta.

We check the potential impact of the financial crisis on financial leverage by estimating the market price of the mobile network owners' debt. A substantial portion of the mobile network owners' long-term debt is publicly traded. We obtained available data concerning debt prices and yields. The available data relates to debt currently outstanding and indicates that the market price of this debt has remained relatively close to its face-value since 2007. Market prices declined somewhat at the end of 2008 during the height of the crisis. Adjusting the amount of debt by less than 10% either way could have only a 2.5% impact on Vodafone's apparent leverage ratio, and even less on the average leverage over an extended measurement window. Figure 14 plots our resulting estimates of financial leverage for the UK utility reference sample.

**Figure 14: Historic market to book ratios for debt currently traded**



**Figure 15: Financial leverage**



A further table and figures explore the effect of financial leverage on the betas of the four mobile network owners. Table 3 reports equity beta estimates assuming that all of the companies maintained only equity financing. We use two separate approaches to relieve the raw equity beta estimates. The first approach uses the simplest possible re-levering formula and assumes that the debt beta is zero.<sup>6</sup> The second approach follows the same approach but is more realistic in that it recognises some correlation between the returns to debt-holders and the broader economy. It assumes a debt beta of 0.15. Under both approaches, we estimate average leverage across the relevant measurement window. In other words, when focussing on one-year betas, we estimate average leverage across the one-year measurement window. When focussing on two-year betas, we estimate average leverage across the two-year measurement window. Figure 15 and Figure 16 then plot rolling one and two year asset for the four companies against the FTSE All-Share. They illustrate a) the decline in Vodafone's one and two year asset beta over the past several years, b) the rebound in the one-year asset betas for all four companies since Spring 2010, and c) the relative stability of the two-year betas for the mobile network owners apart from Vodafone. A further figure illustrates the recent divergence between the one and two-year asset betas.

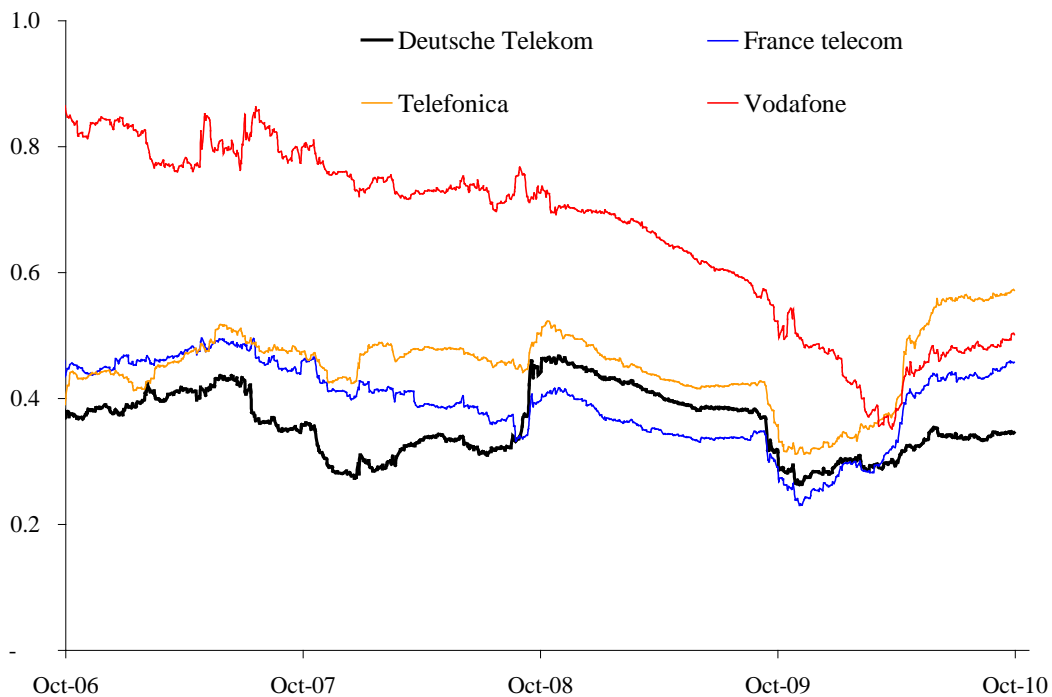
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<sup>6</sup> We use a standard relevering formula (see *Principles of Corporate Finance* (8<sup>th</sup> edition), Brealey Myers and Allen, p. 518).

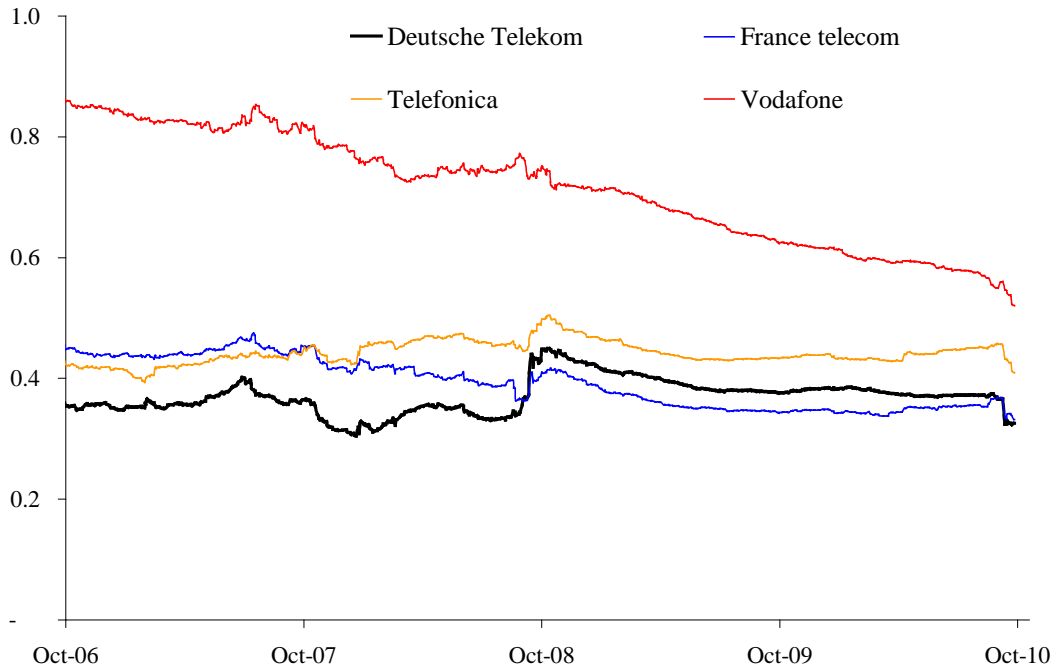
**Table 3: “Asset” betas**

	1 Yr		2 Yr	
	$\beta_{\text{debt}} = 0$	$\beta_{\text{debt}} = 0.15$	$\beta_{\text{debt}} = 0$	$\beta_{\text{debt}} = 0.15$
<b>Vodafone</b>				
All-Share	0.44	0.50	0.47	0.52
All-World	0.38	0.44	0.32	0.37
All-EU	0.33	0.38	0.34	0.40
<b>Telefonica</b>				
All-Share	0.50	0.57	0.34	0.41
All-World	0.63	0.70	0.32	0.38
All-EU	0.54	0.60	0.38	0.45
<b>France Telecom</b>				
All-Share	0.38	0.45	0.26	0.33
All-World	0.45	0.51	0.27	0.33
All-EU	0.38	0.45	0.29	0.36
<b>Deutsche Telekom</b>				
All-Share	0.26	0.34	0.24	0.33
All-World	0.30	0.38	0.25	0.33
All-EU	0.23	0.32	0.24	0.33
<b>Simple Average Across Companies</b>				
All-Share	0.40	0.46	0.33	0.40
All-World	0.44	0.51	0.29	0.35
All-EU	0.37	0.44	0.32	0.38

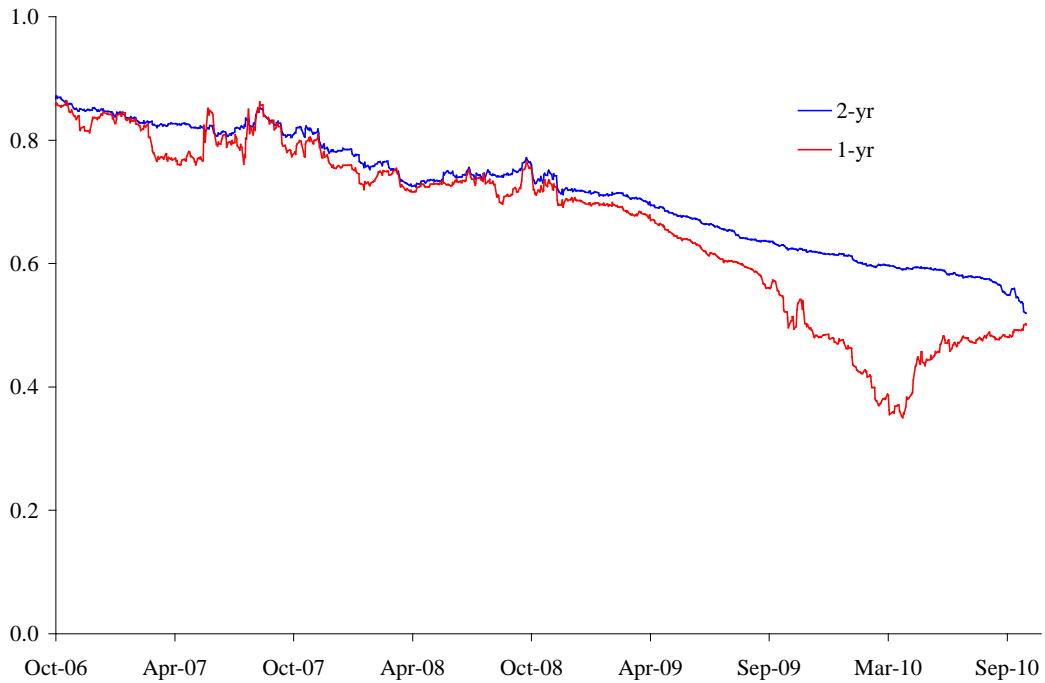
**Figure 16: One-year asset betas - FTSE All-Share**



**Figure 17: Two-year asset betas - FTSE All-Share**



**Figure 18: One and two year asset betas – Vodafone vs FTSE All-Share**



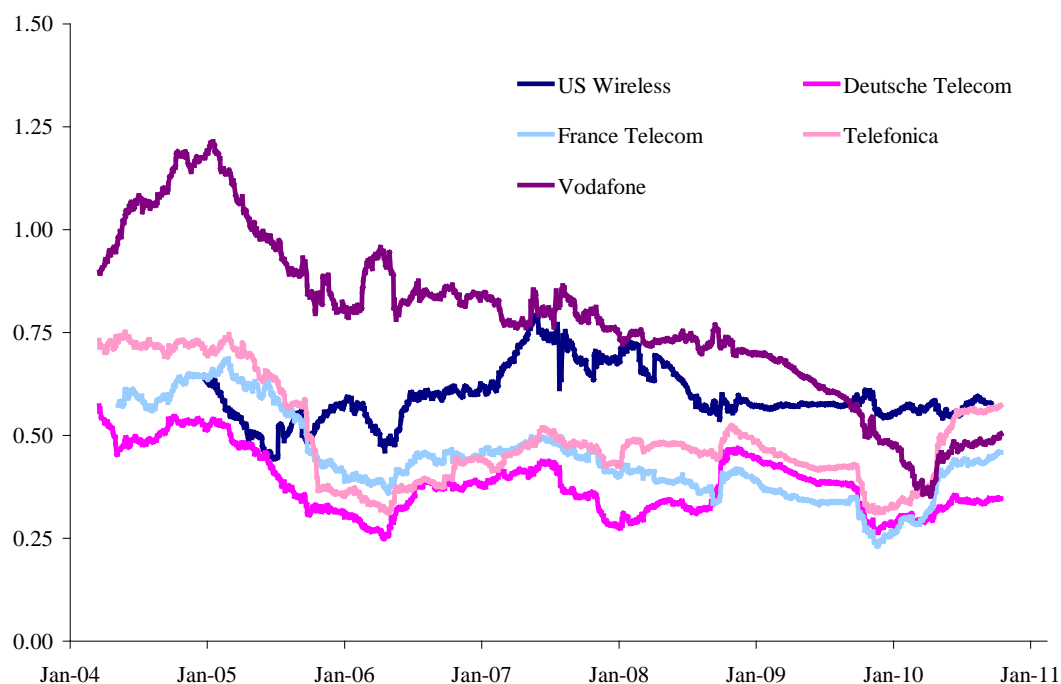
### 2.3 US Telecoms Sample

In addition to the UK mobile network owners, we examined data for eleven US telecommunications companies. The companies are engaged in both wireline and wireless activities. Three of the companies were pure-play wireline (Frontier, Qwest and Windstream), meaning that the core business of these companies involved local loop

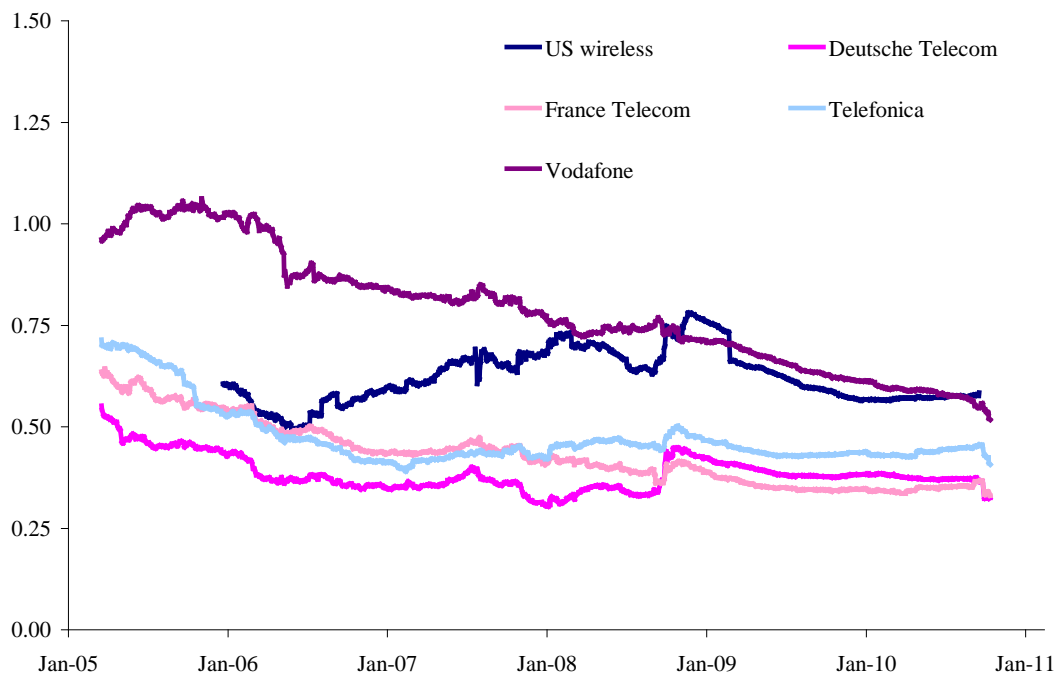
access and the provision of associated telephone services such as local telephone calls and retail broadband. Wireline activities accounted for half the revenues of two other of the US companies (AT&T and Verizon), with wireless accounting for the remaining revenues. Six further companies are engaged predominately in the provision of wireless services, such as mobile phones and wireless broadband. Data for the US telecoms companies is relevant for our purpose to the extent that it reflects businesses whose principal activity is the provision of wireless services.

Using the standard techniques, we estimated asset betas for all of the US telecoms companies. Figure 18 to Figure 19 plot the development of the asset beta for the pure-play wireless stocks. Asset betas for the wireless stocks against the S&P 500 come in just slightly above the level for the mobile network owners against the FTSE All-Share. The one-year betas for the wireless stocks have displayed no significant reduction since the onset of the credit crisis.

**Figure 19: One-year asset betas - Wireless**

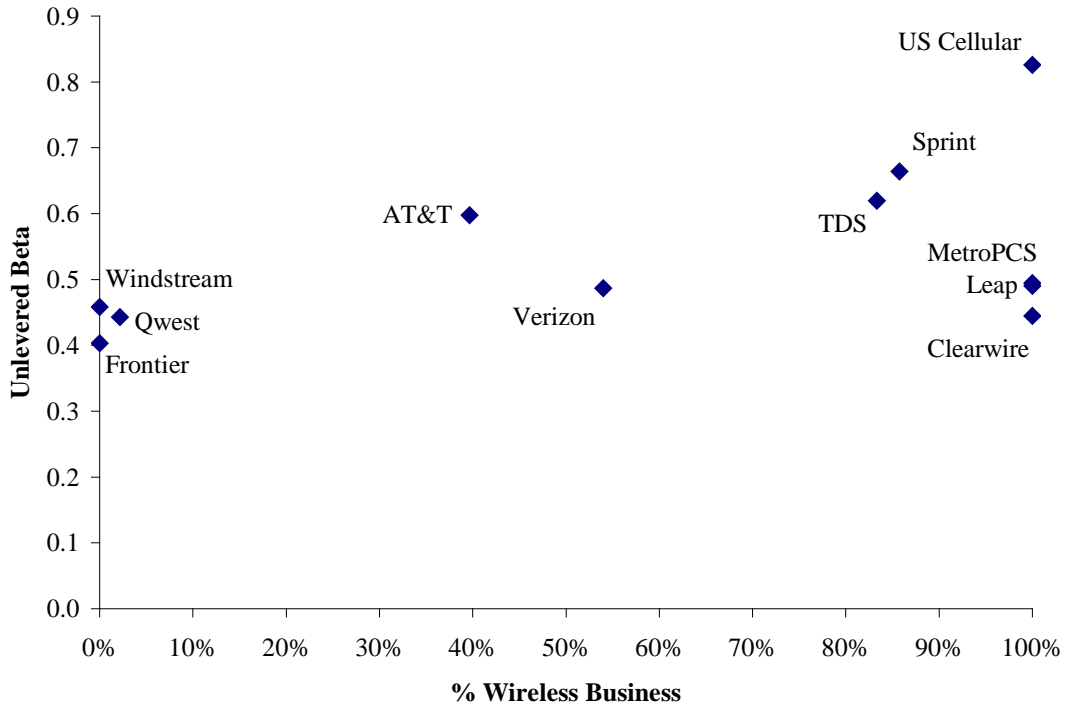


**Figure 20: Two-year asset betas – Wireless**



We use the broader sample of US telecom stocks to test whether the beta for wireless activities is much different from that for wireline. Figure 20 organises the latest two year beta estimates for the US companies according to the percentage of revenues coming from different activities. The pure-play wireline stocks appear on the left hand side of the graph, while pure-play wireless appear on the right-hand side. Diversified telecoms companies such as AT&T appear somewhere in the middle. There is no obvious trend from left-to-right for either the one-year or two-year beta estimates, indicating a similar level of beta for wireline and wireless activities.

**Figure 21: Two-year betas**



## 2.4 FTSE All-Share Performance

Figure 21 plots the returns on the FTSE All-Share with those of several underlying industry segments since 1990. In addition to the telecommunications industry segment, we plot the returns for banks, utility and mining companies. The telecommunications segment peaked around 2000, reflecting the collapse of the tech bubble, while banks and mining stocks dropped precipitously during 2008 and the credit crisis. Mining stocks have risen sharply since then reflecting the overall rises in commodity prices, while banks stocks have improved somewhat since their 2008 lows but remain well short of the previous highs.

**Figure 22: FTSE All-Share Price Movements**

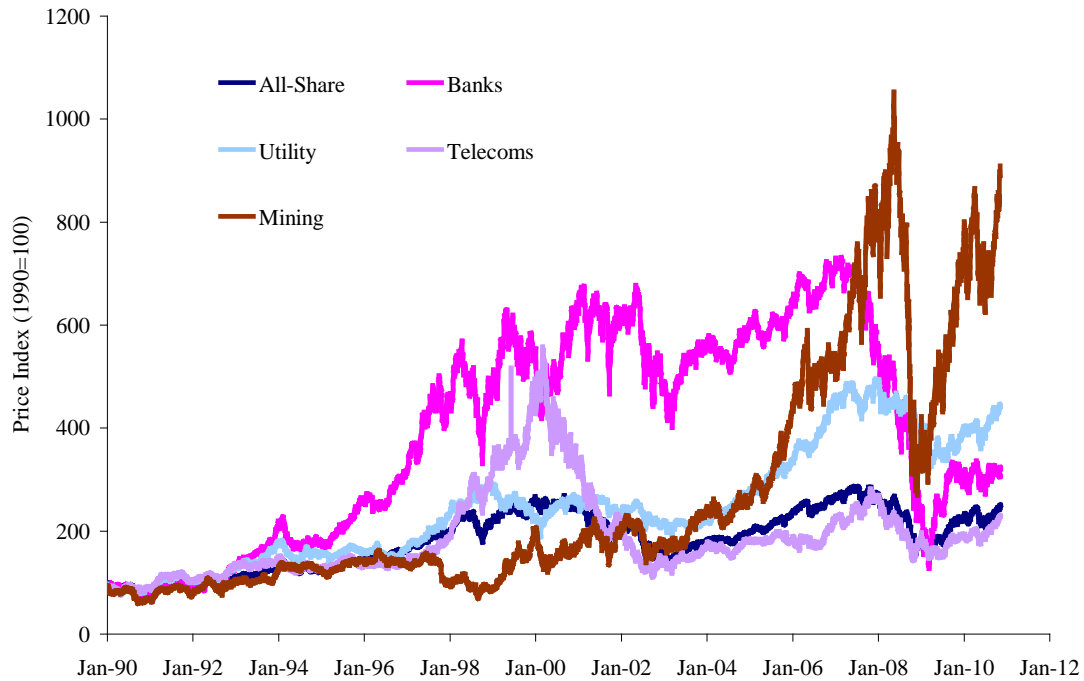
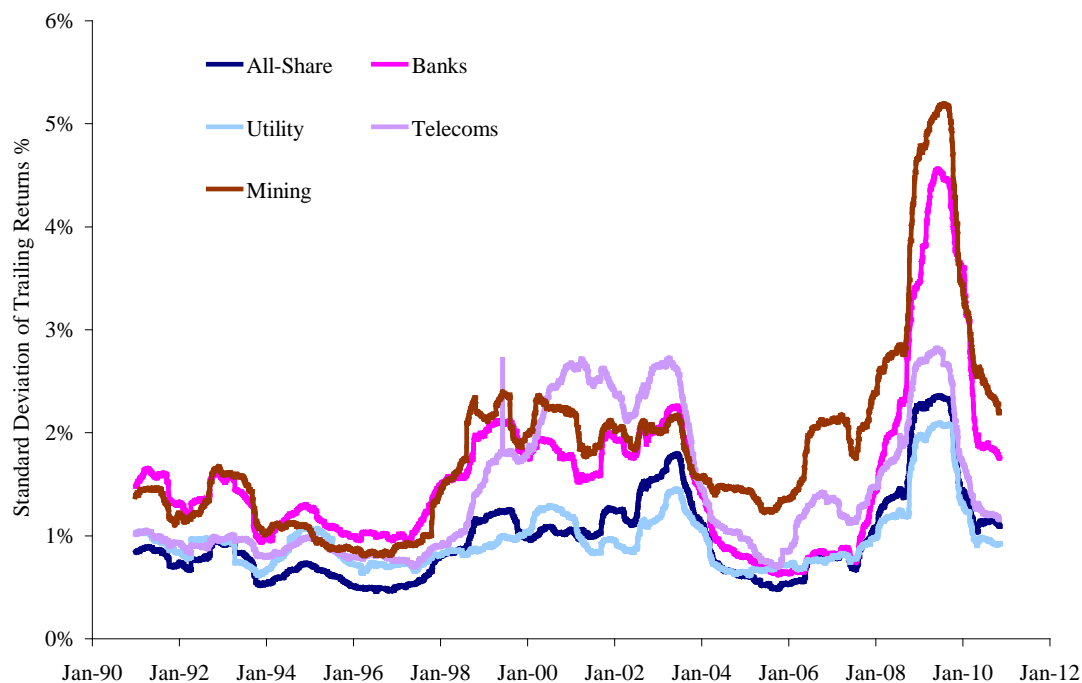


Figure 22 measures the corresponding price volatility for the FTSE All-Share and the same constituent industry segments over time. For volatility, we compute the standard deviation of daily returns over a trailing one-year data window. The volatility of the overall index rose towards the end of the 1990s, remaining high through the collapse of the tech bubble and invasion of Iraq, before coming down during 2004-7. Volatility then spikes up dramatically with the development and onset of the credit crisis, but has now moderated in large part. The recent spike in volatility is driven to some degree by the financial and mining segments, but some upward spike in volatility also is witnessed for telecoms and utilities albeit to a lesser degree. The moderation in price volatility over the past year undermines any suggestion that looks forward and bases a lower beta for the mobile network operators on the lingering presence of crisis level volatility in future.

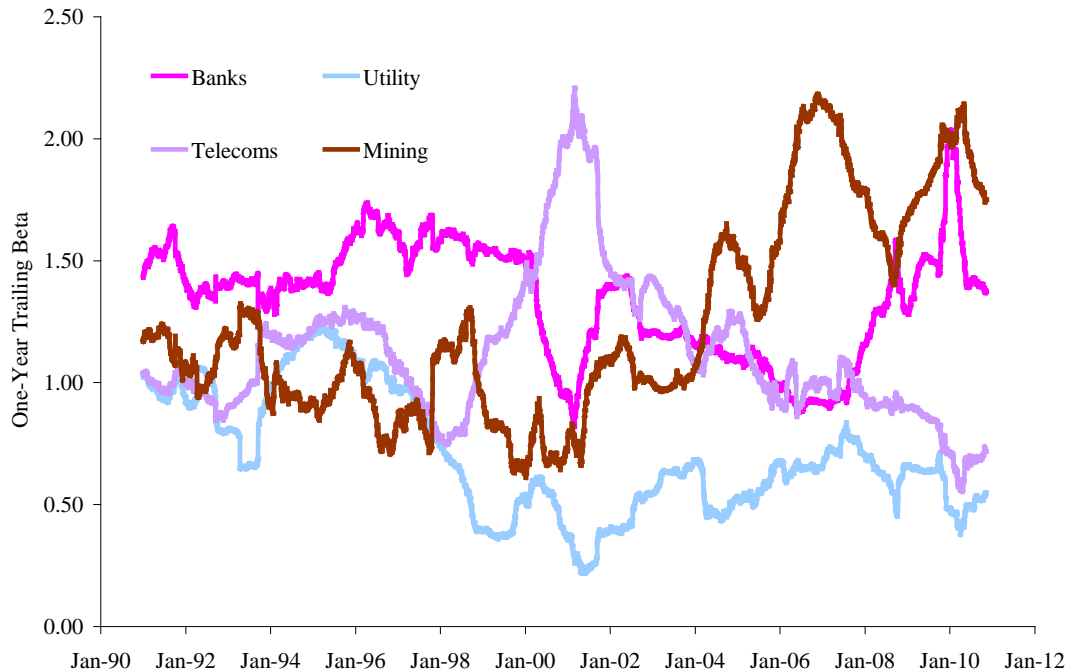


**Figure 23: FTSE All-Share Price Volatility**



A further figure examines the development of the betas of the four different industry sectors over time. As we might expect, the one-year betas for the financial and mining segments show recent gains, perhaps reflecting that their collapse and recovery drove to some extent the performance of the overall index during the credit crisis or perhaps reflecting that the precipitous collapse in stock prices raised their financial leverage dramatically. The beta for the utility segment remains within the range observed since 2004, but displays a decline at the end of 2009 before recovering slightly more recently. The beta for the telecoms segment peaked in 2000 with the tech bubble but declined sharply as the data window passes beyond 2000-2001. The level of the one-year beta for the telecoms segment then remained broadly flat between 2006 and autumn 2009, before the recent decline in line with the utilities segment. Also in line with the utilities segment, we observe a slight recovery in the one-year beta for telecoms since April 2010. Yet despite the recent recovery, neither the beta for the utilities nor telecoms sectors has regained the levels seen in mid-2009. The recent net *decline* in the betas for telecoms and utilities corresponds with the general *moderation* in price volatility.

**Figure 24: Industry Betas vs FTSE All-Share**

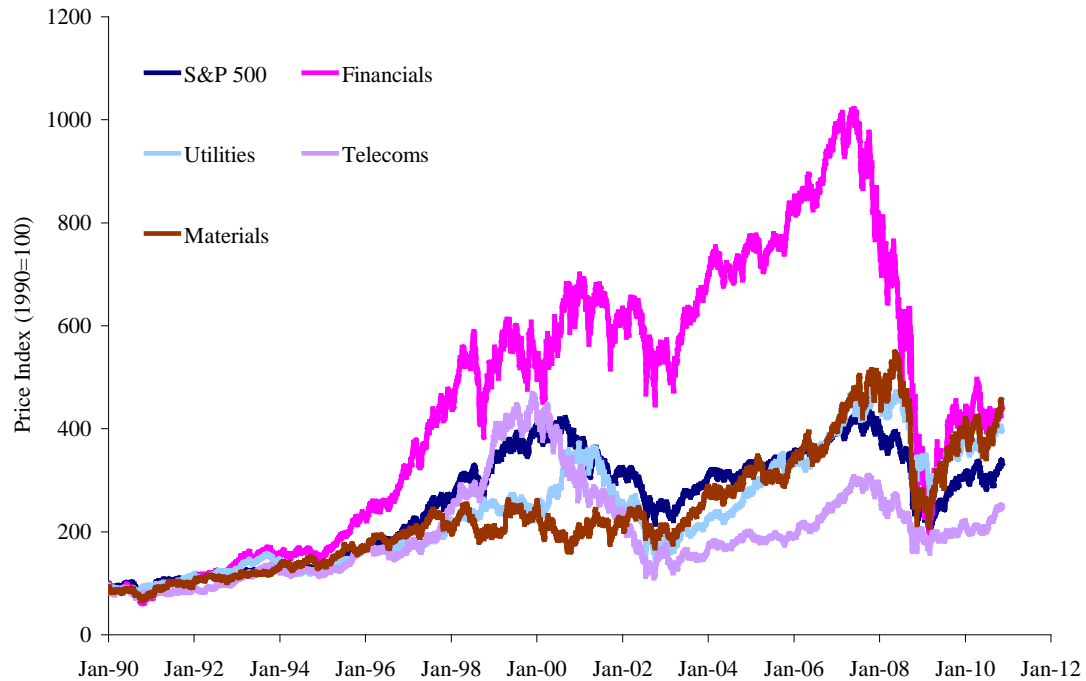


## 2.5 S&P 500 Performance

We extend our analysis to cover the S&P 500, to investigate whether or not the patterns witnessed in price volatility and industry betas reflect economic reality or just statistical noise. If price volatility in certain sectors were the true cause of the recent movements in the betas for the mobile network operators, then we should expect to find the same pattern of industry performance and betas for the S&P 500 as we observed for the FTSE All-Share.

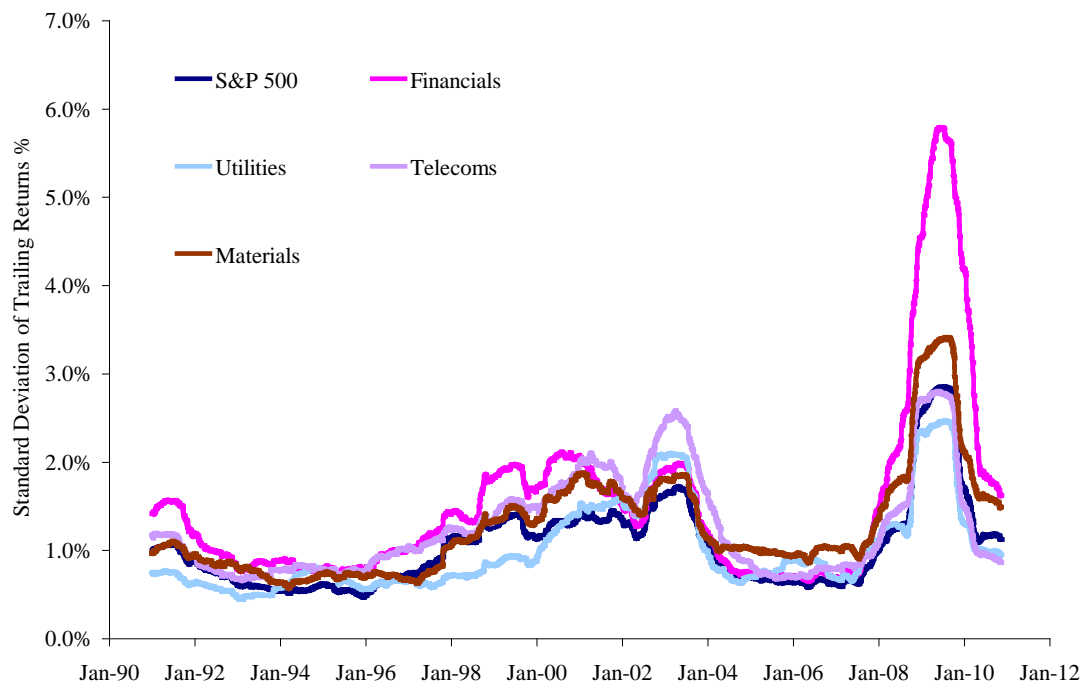
As before, we begin by plotting the performance of the overall S&P 500, along with that of the underlying financial, utilities, telecoms and materials sectors. Although not perfectly comparable, we plot the S&P 500 materials sector as it represents the closest available comparable to the FTSE All-Share mining segment. The overall shape of the returns on the S&P 500 industry segments resembles those for the FTSE All-Share. Financial stocks register tremendous returns up to the end of 2007, before their dramatic collapse. The materials sector also witnessed a peak prior to the 2008 collapse, but to less of an extent as the FTSE All-Share mining segment. The S&P 500 telecoms segment peaks in 2000 at exactly the same moment as the FTSE All-Share telecommunications segment, and has performed similarly since. S&P 500 utilities show the same upward trend as the FTSE All-Share utilities before a dip in 2008 and a subsequent recovery.

**Figure 25: S&P 500 Performance**



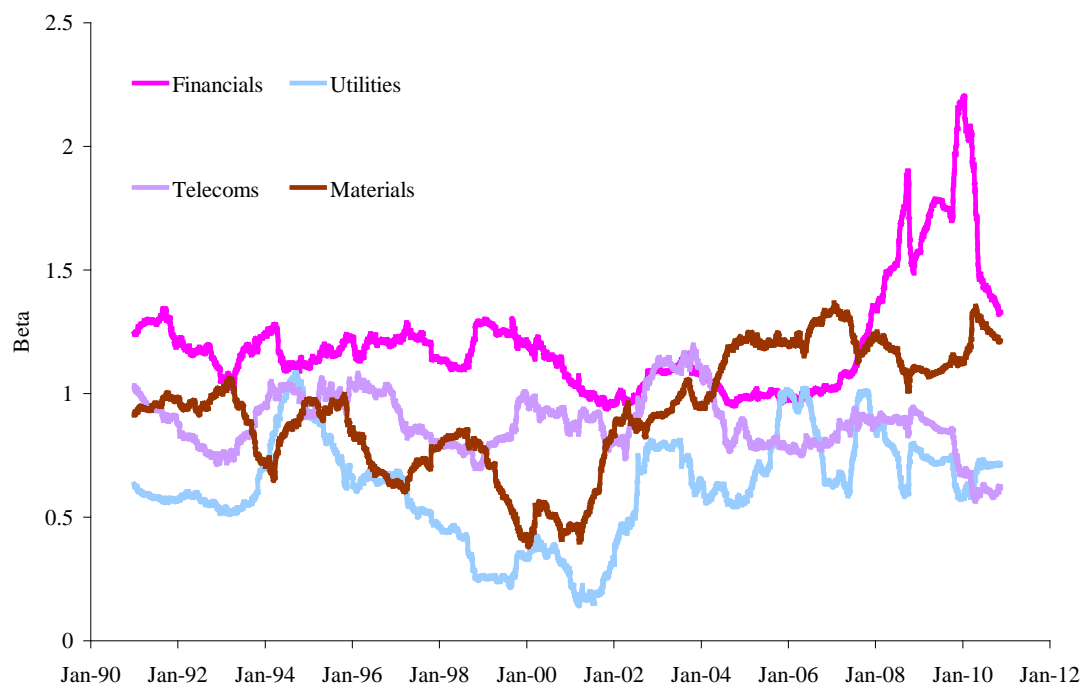
Next we examine S&P 500 price volatility in exactly the same way as we did for the FTSE All-Share. We compute the standard deviation of trailing one-year daily returns for each of the segments. Like before, we observe a rise in volatility towards the end of the 1990s, which remains through the invasion of Iraq, before subsiding at the beginning of 2004. Volatility then stays flat between 2004 and 2007, before spiking dramatically with the development and onset of the credit crisis in 2008. Like for the FTSE All-Share, the increase in price volatility during 2008 was led by the financial and materials segments. During the crisis, price volatility in the telecoms segment roughly matched that of the index overall, while price volatility in the utilities segment came in below that of the index overall. Also like for the FTSE All-Share, we observe a substantial moderation in price volatility since the climax of the credit crisis during late 2008. Price volatility now stands at a level only slightly higher than during the 2004-2007 period.

**Figure 26: S&P 500 Price Volatility**



We plot the rolling one-year betas for the S&P 500 industry segments. We see a slight rise in the beta for the S&P 500 financials sector in line with that observed for the FTSE All-Share banking sector, probably reflecting both that the financial sector has led overall index performance over the last several years and that the stock price collapse implies a concomitant rise in financial leverage. We make two additional observations. First, there is a distinct lack of any peak in the beta for the S&P 500 telecommunications segment around 2000. This is in direct contrast with what we observed for the FTSE All-Share telecommunications segment. Second, unlike for the pure-play wireless segment, the beta for the S&P 500 telecommunications segment registers a 0.2 decline towards the end of 2009 and has remained broadly flat since, even while the utilities segment has gone down and up since the end of 2009. The decline in the beta for the telecommunications segment at the end of 2009 is not statistically significant. Nevertheless, it matches that observed for the four mobile network operators.

**Figure 27: Industry Betas vs S&P 500**



## 2.6 Conclusions

We remain concerned about the reliability of both the recent drop in the two-year betas for the mobile network owners, and the step rise in the one-year betas since Spring 2010. The rise in the one-year estimates is not statistically robust. We also remain concerned about the overall divergence between the one and two year beta estimates over the past year. Divergence between the one and two year estimates has not been prolonged previously.

Based on our regressions, the last two years of data generates an estimate for the equity beta of Vodafone of 0.73 against the FTSE All-Share. This estimate corresponds with average leverage during the two-year measurement window of 37%, and implies an asset beta for mobile of just over 0.5. The last year of data generates slightly lower estimates: an average equity beta of 0.68 against the FTSE All-Share<sup>7</sup>, corresponding with average leverage of 35% and implying an asset beta of just under 0.5.

We also observe no significant decline in the betas for a sample of US wireless companies since 2008. The most recent beta estimates for US wireless companies remain a little above those observed for Vodafone and the other mobile network owners, and imply an asset beta as high as 0.58.

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<sup>7</sup> Based on a “robust regression” using the weighted least squares procedure.

### 3 Statistical reliability

The use of daily returns data in regressions to estimate equity beta can risk introducing statistical problems, for example in relation to thin trading. We discussed these problems in earlier papers for Ofcom.<sup>8</sup> We perform a number of statistical tests to check for potential problems in this case.

#### 3.1 Dimson adjustment

To test for possible bias relating to trading illiquidity and to assess if time differences<sup>9</sup> caused distortions, we perform the “Dimson” adjustment to the estimated betas by including a one period lag and a one period lead. For the four mobile network owners, the separate lead and lag terms are seldom significantly different from zero and the Dimson adjustment overall was significantly different from zero in only three cases out of a total of 24 different beta estimates. Nevertheless, we note that the Dimson adjustments appear to reduce the latest one-year estimates for Telefonica by a substantial amount (1.10 against the All-World reduces to 0.66 when we add one-day lead and lag terms; 0.87 against the All-Share reduces to 0.65, and 0.93 against the All-EU reduces to 0.80). In effect, including the Dimson adjustments more-or-less brings the most recent one-year betas into line with the pre-Lehman results. Table 4 reports Dimson betas for the four companies.

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<sup>8</sup> See *Issues in beta estimation for UK mobile operators*, July 2002.

<sup>9</sup> The London Stock Exchange closes at 5pm BST, while the markets in other countries may close earlier or later. Broad index data may therefore combine closing prices relating to different time of day.

**Table 4: Dimson adjustments – up-to-date data**

	1 Yr				2 Yr			
	Beta	Dimson Beta	Dimson SE	Significance	Beta	Dimson Beta	Dimson SE	Significance
<i>Deutsche Telekom</i>								
All World	0.67	0.63	0.14	Neither lag nor lead	0.55	0.64	0.11	Only lead
All Share	0.58	0.63	0.10	Neither lag nor lead	0.54	0.45	0.08	Only lag
All EU	0.52	0.65	0.09	Neither lag nor lead	0.53	0.55	0.08	Neither lag nor lead
<i>France Telecom</i>								
All World	0.82	0.68	0.14	Only lead	0.49	0.50	0.10	Only lead
All Share	0.70	0.58	0.10	Neither lag nor lead	0.48	0.34	0.07	Only lag
All EU	0.69	0.69	0.09	Neither lag nor lead	0.54	0.46	0.07	Only lag
<i>Telefonica</i>								
All World	1.10	0.66	0.17	Only lag	0.56	0.69	0.10	Only lag
All Share	0.87	0.65	0.13	Neither lag nor lead	0.61	0.45	0.07	Only lead
All EU	0.93	0.80	0.10	Neither lag nor lead	0.68	0.61	0.07	Neither lag nor lead
<i>Vodafone</i>								
All World	0.59	0.63	0.15	Neither lag nor lead	0.49	0.59	0.13	Neither lag nor lead
All Share	0.68	0.60	0.12	Neither lag nor lead	0.72	0.59	0.11	Only lag
All EU	0.51	0.49	0.11	Neither lag nor lead	0.54	0.47	0.10	Only lag
<i>Simple Average</i>								
All World	0.79	0.65			0.52	0.61		
All Share	0.71	0.61			0.59	0.46		
All EU	0.66	0.66			0.57	0.52		

### 3.2 Tests for heteroscedasticity and auto-correlation

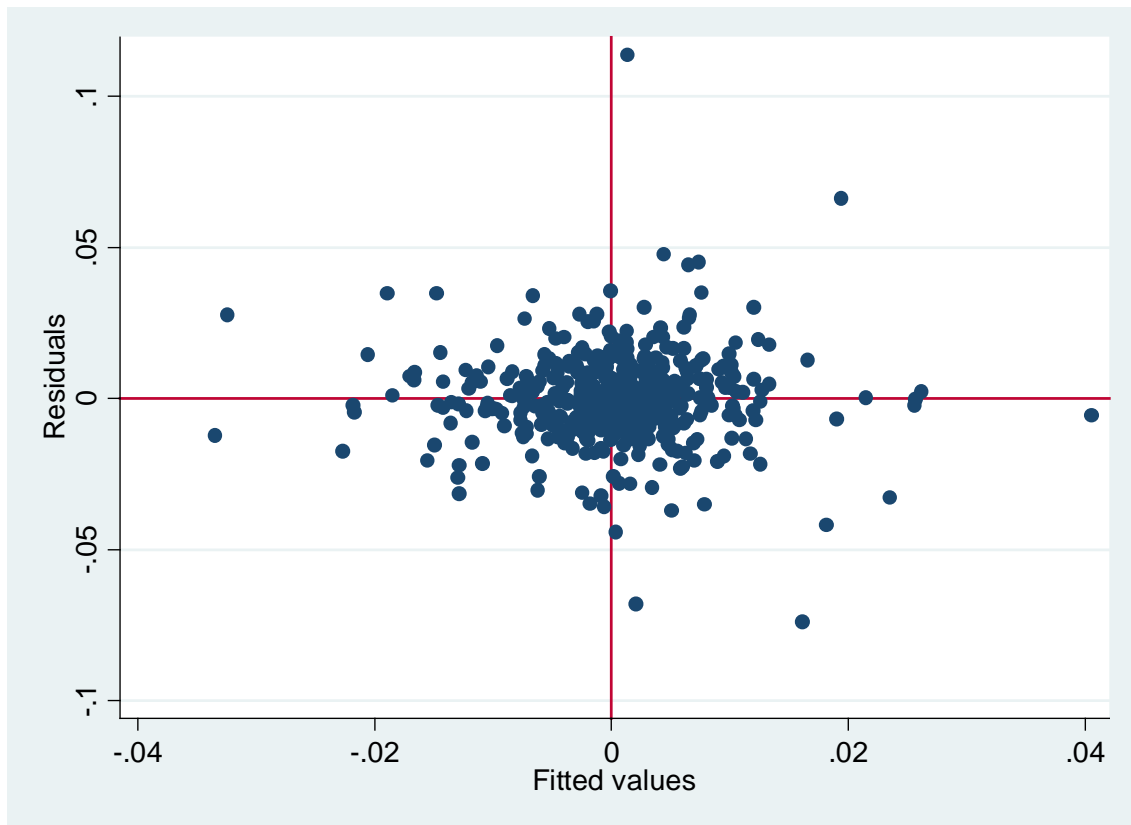
We perform a series of standard diagnostic tests to assess if the beta estimates satisfy the standard conditions underlying ordinary least squares regression. The standard conditions are that the error terms in the regression follow a normal distribution and that they do not suffer from heteroscedasticity (linked to the fitted values) or auto-correlation (follow some pattern over time). Failure to meet these conditions would not invalidate the beta estimates, but would have the following consequences:

1. Although OLS is still an unbiased procedure in the presence of heteroscedasticity and/or autocorrelation, it is no longer the best or least variance estimator.
2. In the presence of heteroscedasticity and/or autocorrelation, the standard error calculated in the normal way may understate the true uncertainty of the beta estimate.
3. Heteroscedasticity and/or auto-correlation may indicate that the underlying regression is mis-specified (i.e. we have left out some explanatory variable).
4. Failure of normality does not *per se* undermine the validity of OLS, but the presence of outliers raises difficult questions about the robustness of the beta estimates.

### *Heteroscedasticity*

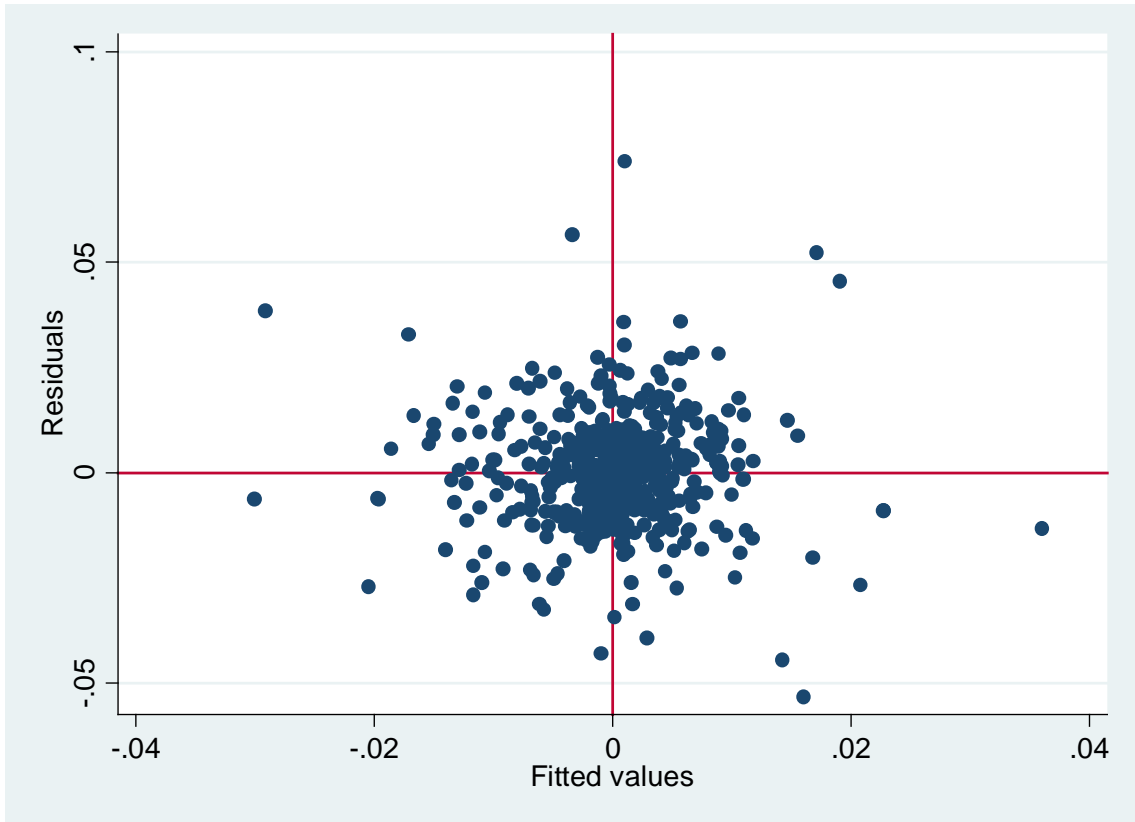
Figure 27 to Figure 30 show scatter plots of the residuals against the returns predicted by the regression, for two-year regressions against the FTSE All-World. We constructed comparable plots for our regressions against the other indices and for our shorter one year beta estimates. Visual inspection does not reveal any obvious pattern - the “vertical spread” does not appear to change in any systematic way as we move horizontally across the graph. However, there are clearly a number of outliers.

**Figure 28: Deutsche Telekom - residuals against fitted values**

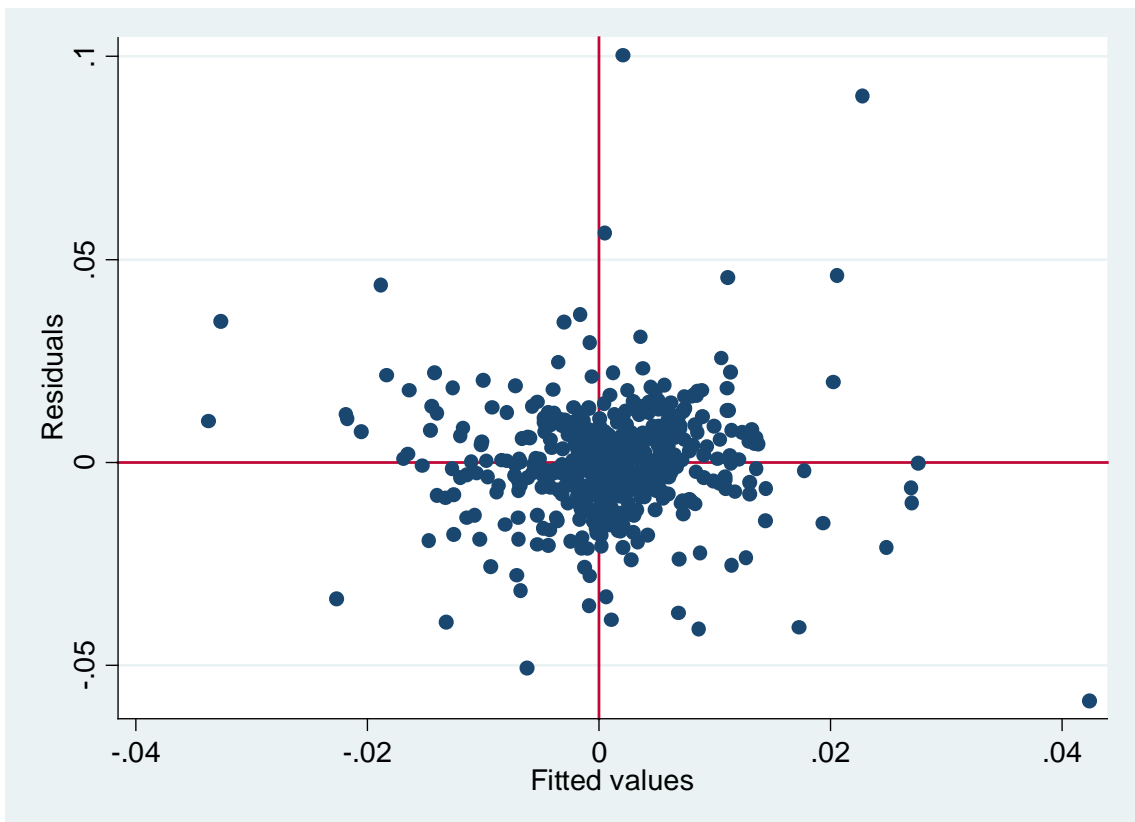




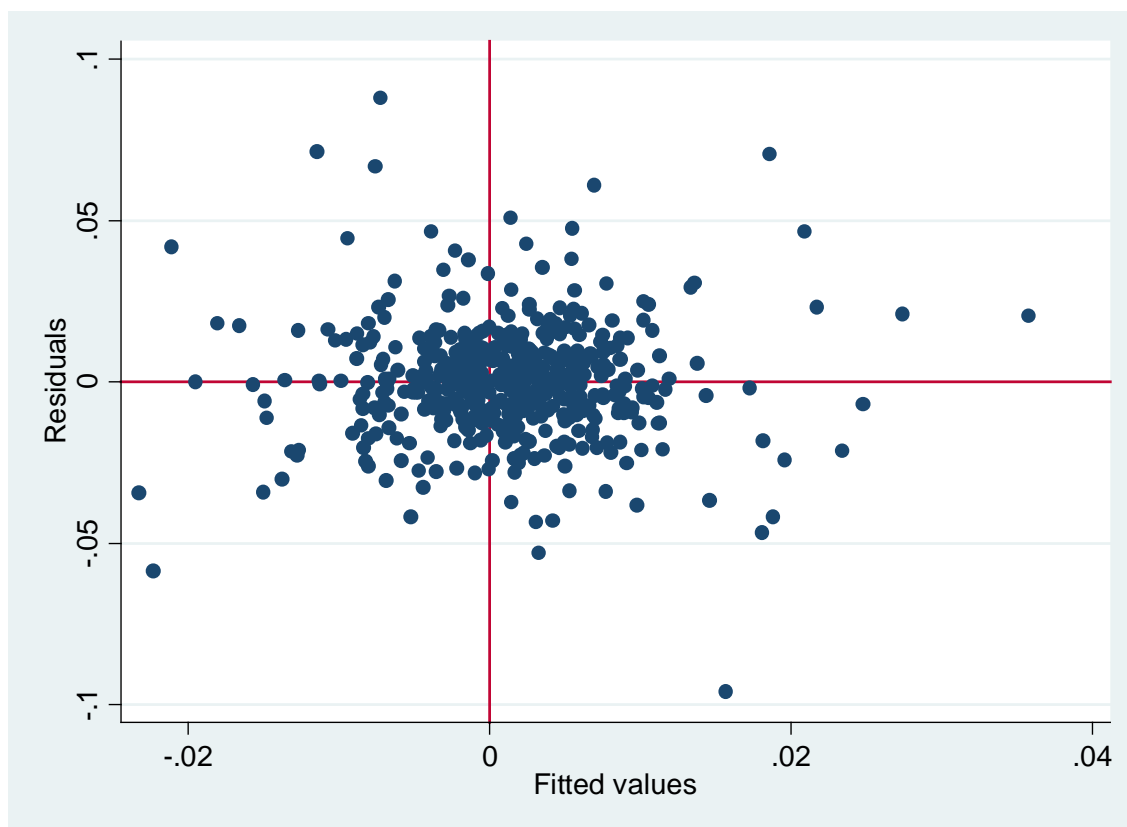
**Figure 29: France Telecom - residuals against fitted values**



**Figure 30: Telefonica – residuals against fitted values**

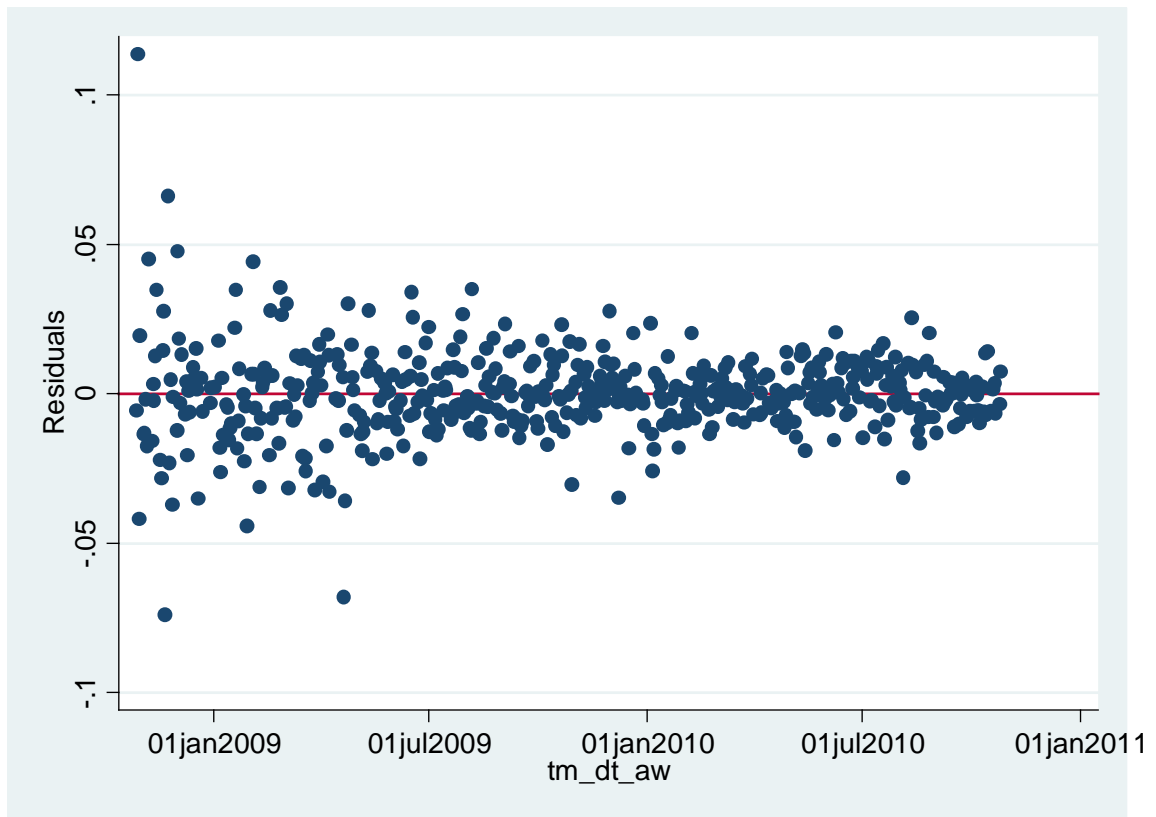


**Figure 31: Vodafone – residuals against fitted values**

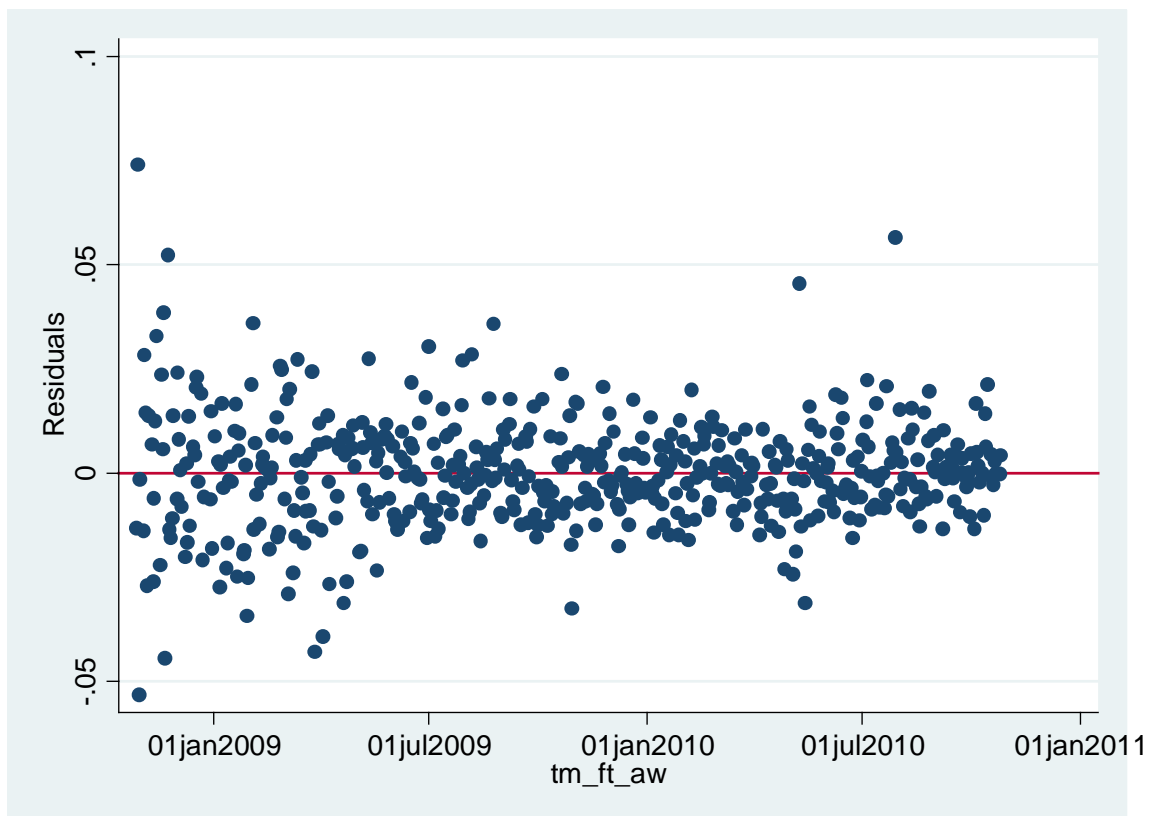


We also examine whether there is change in the pattern of residuals over time. Figure 31 to Figure 34 show an apparent decline in the magnitude of the residuals since the end of 2008. All this appears to reflect market turmoil, and the extreme volatility witnessed during the heart of the credit crisis, as well as some recovery since then. The plots again relate to two-year beta estimates calculated against the FTSE All-World.

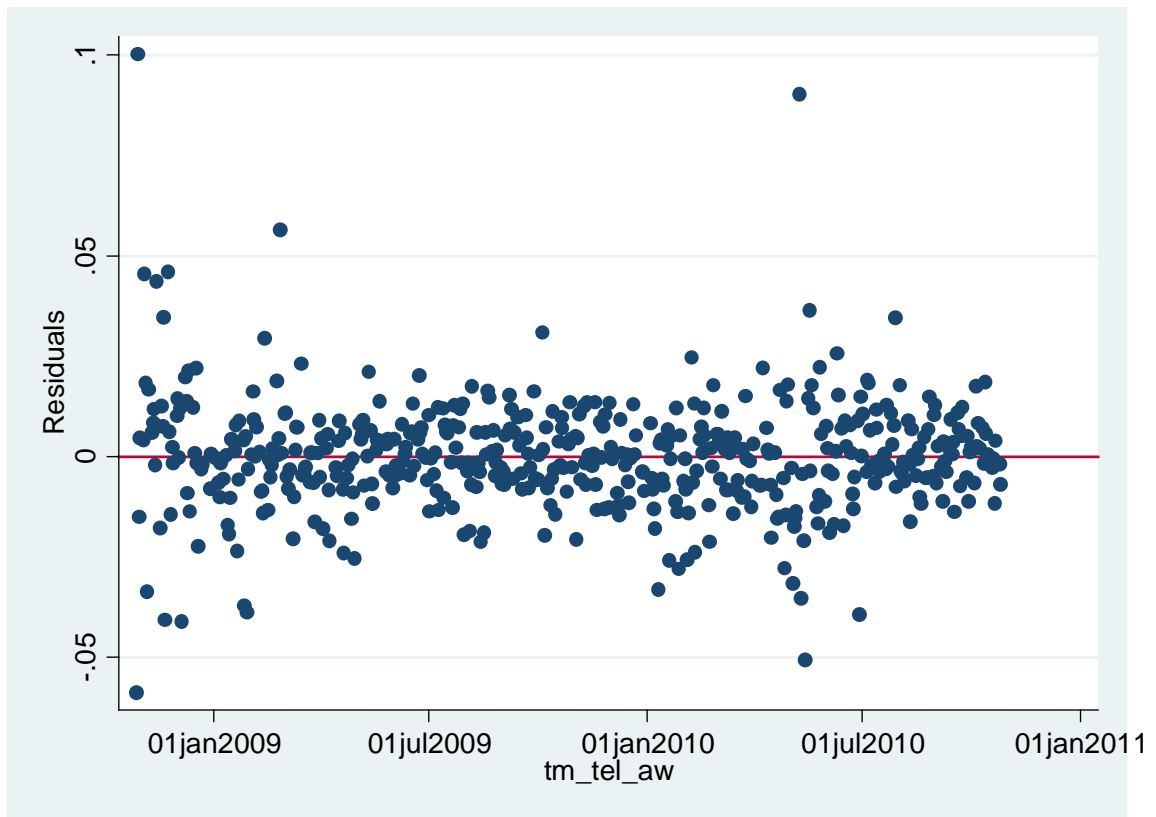
**Figure 32: Deutsche Telekom - residuals over time**



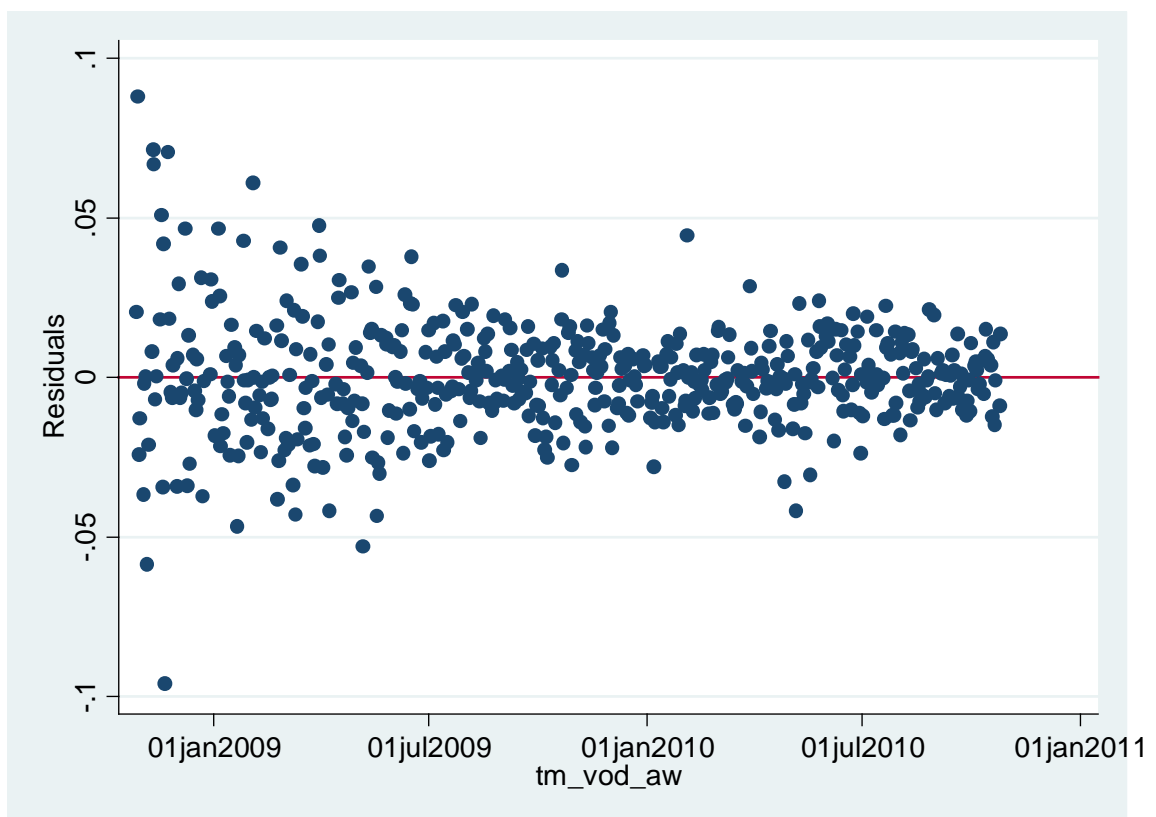
**Figure 33: France Telecom – residuals over time**



**Figure 34: Telefonica – residuals over time**



**Figure 35: Vodafone – residuals over time**



Since simple inspection suggests that there may be some heteroscedasticity, we apply a formal test (White's test) to investigate further. Table 5 report results.

**Table 5: White's test for heteroscedasticity – up-to-date data**

	1 yr			2 yr		
	White Stat	p-value	Heterosk- edascity	White Stat	p-value	Heterosk- edascity
<i>Deutsche Telekom</i>						
All World	1.10	0.58	No	5.31	0.07	No
All Share	1.20	0.55	No	54.30	0.00	Yes
All EU	2.08	0.35	No	54.18	0.00	Yes
<i>France Telecom</i>						
All World	11.21	0.00	Yes	18.64	0.00	Yes
All Share	8.79	0.01	Yes	31.69	0.00	Yes
All EU	1.56	0.46	No	48.79	0.00	Yes
<i>Telefonica</i>						
All World	92.24	0.00	Yes	39.24	0.00	Yes
All Share	72.59	0.00	Yes	43.48	0.00	Yes
All EU	84.71	0.00	Yes	126.29	0.00	Yes
<i>Vodafone</i>						
All World	13.28	0.00	Yes	28.97	0.00	Yes
All Share	13.08	0.00	Yes	20.67	0.00	Yes
All EU	9.54	0.01	Yes	44.11	0.00	Yes

Notes

If the p value is reasonably low then the null hypothesis of no heteroskedasticity can be rejected

The tables indicate the presence of heteroscedascity in most of the estimates. This most likely relates to the significant increase in market volatility around the heart of the crisis, a subsequent decrease, and then a spike in the level of the residuals around April-May 2010.

#### ***Auto-correlation***

We also perform a formal test for auto-correlation (the Durbin-Watson test). Unsurprisingly, this test indicates autocorrelation in all of the regressions, also likely reflecting the development of the credit crisis and the changing extent of market volatility over time. The effect of this auto-correlation is that standard errors computed in the standard way will over-estimate the precision of the regression.

**Table 6: Durbin–Watson test for autocorrelation – up-to-date data**

	1 yr		2 yr	
	DW Stat	Serial Correlation	DW Stat	Serial Correlation
<i>Deutsche Telekom</i>				
All World	1.616	Yes	1.754	Yes
All Share	1.546	Yes	1.582	Yes
All EU	1.633	Yes	1.661	Yes
<i>France Telecom</i>				
All World	1.521	Yes	1.704	Yes
All Share	1.440	Yes	1.500	Yes
All EU	1.519	Yes	1.516	Yes
<i>Telefonica</i>				
All World	1.442	Yes	1.716	Yes
All Share	1.530	Yes	1.430	Yes
All EU	1.561	Yes	1.522	Yes
<i>Vodafone</i>				
All World	1.588	Yes	1.551	Yes
All Share	1.504	Yes	1.457	Yes
All EU	1.531	Yes	1.456	Yes

***Robust regression***

We performed a robust regression that accommodates the presence of some heteroscedasticity in the data. The robust regression is a standard feature of computerised statistical packages like STATA. The robust regression derives the same coefficients as standard OLS, but calculates standard errors robust to heteroscedasticity. We find that the robust standard errors are close to the OLS ones for most of the estimates (see Table 7). The Telefonica one-year betas are the one exception, where the robust standard errors are more than twice the OLS ones. The presence of auto-correlation should not affect the central beta estimates, but means that even the robust standard errors will underestimate the true level of uncertainty associated with the measurements.

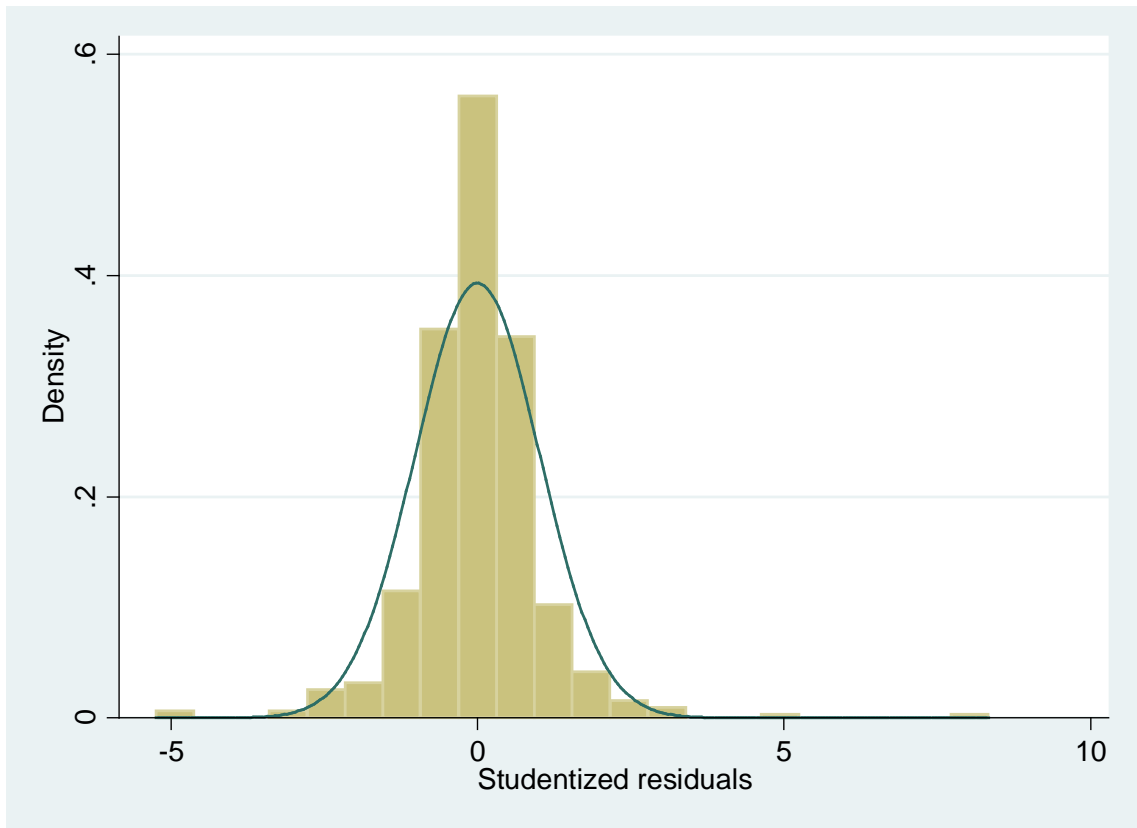
**Table 7: Robust standard errors – up-to-date data**

	1 yr			2 yr		
	Beta	SE	Robust SE	Beta	SE	Robust SE
<i>Deutsche Telekom</i>						
All World	0.67	0.07	0.07	0.55	0.05	0.06
All Share	0.58	0.05	0.05	0.54	0.04	0.06
All EU	0.52	0.04	0.05	0.53	0.04	0.06
<i>France Telecom</i>						
All World	0.82	0.07	0.11	0.49	0.04	0.06
All Share	0.70	0.05	0.07	0.48	0.03	0.05
All EU	0.69	0.04	0.05	0.54	0.03	0.05
<i>Telefonica</i>						
All World	1.10	0.09	0.19	0.56	0.05	0.08
All Share	0.87	0.06	0.12	0.61	0.03	0.06
All EU	0.93	0.05	0.10	0.68	0.03	0.06
<i>Vodafone</i>						
All World	0.59	0.08	0.10	0.49	0.06	0.09
All Share	0.68	0.06	0.07	0.72	0.05	0.06
All EU	0.51	0.05	0.06	0.54	0.04	0.06

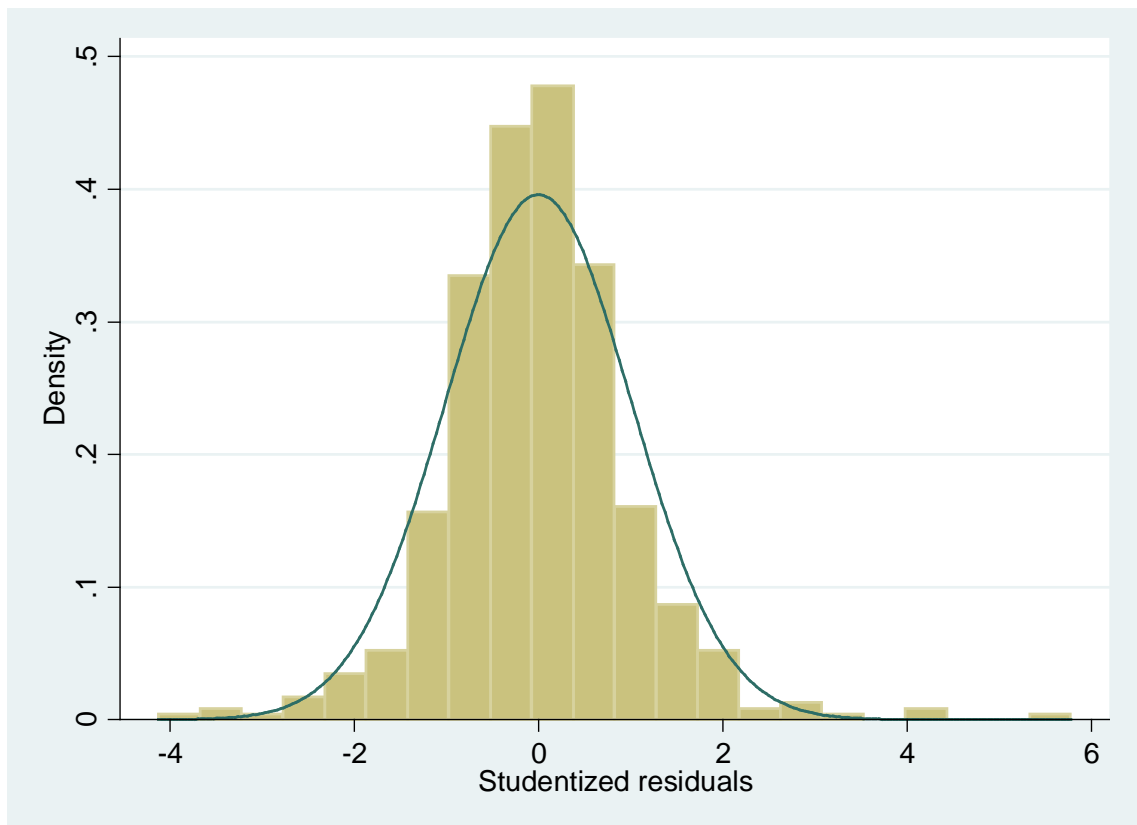
### 3.3 Normality of residuals

We plot histograms of the “studentised residuals” to test for the normality of the residuals. The curve superimposed on the histograms is a standard normal distribution. If the error terms follow a normal distribution then the studentised residuals should follow the t-distribution, which for our size of sample is practically indistinguishable from the standard normal distribution. The histograms broadly resemble normal distributions except for the outliers: there are a few too many points a large number of standard deviations away from zero. Figure 35 to Figure 38 show histograms for two-year FTSE All-World regressions.

**Figure 36: Studentized residuals – Deutsche Telekom**

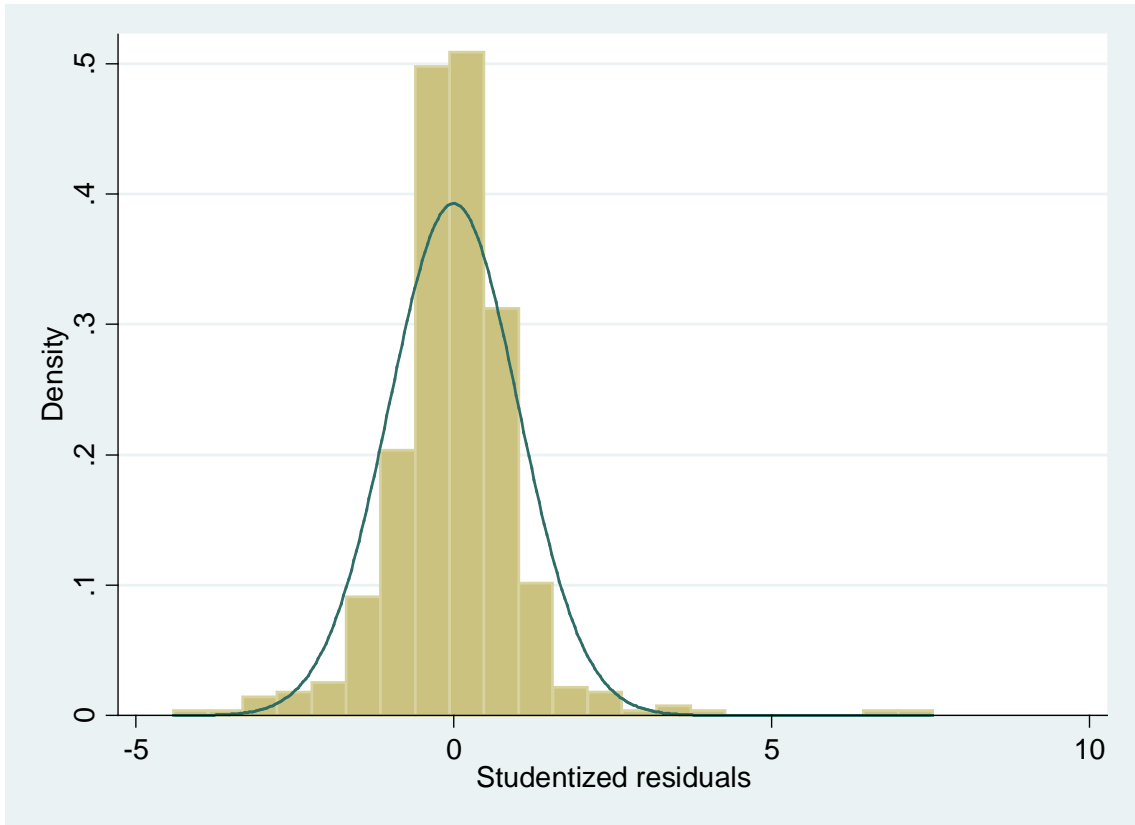


**Figure 37: Studentized residuals – France Telecom**

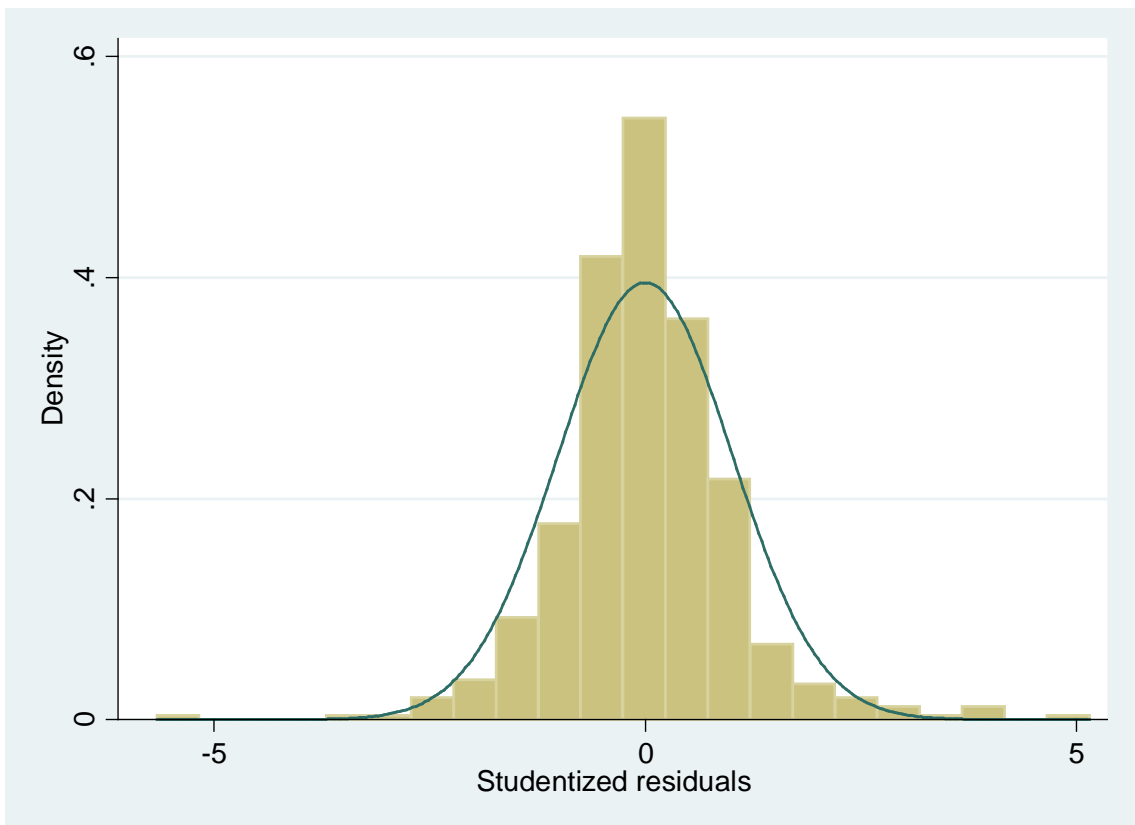




**Figure 38: Studentized residuals – Telefonica**



**Figure 39: Studentized residuals – Vodafone**



### 3.4 Outliers

We perform two analyses to understand the influence of particular points on our beta estimates. We repeat the standard OLS regressions but only after removing “influential outliers”. We also perform an iterative regression that gives less weight to data points reporting large residuals and enjoying high leverage (i.e. influence on the regression line).

To identify potential outliers we calculate the ‘Cook’s D’ measure of the influence of each point on the regression outcome. A usual threshold is to classify points with a Cook’s D score over  $4/N$  (number of observations) as influential. Table 8 lists such influential dates for the two year betas calculated using up-to-date data. More than half of the influential “outliers” occurred during September to December 2008 – i.e. in the immediate aftermath of the collapse of Lehman Brothers. No other period of the data window contributes as many outliers.

**Table 8: influential outliers, two-year regressions**

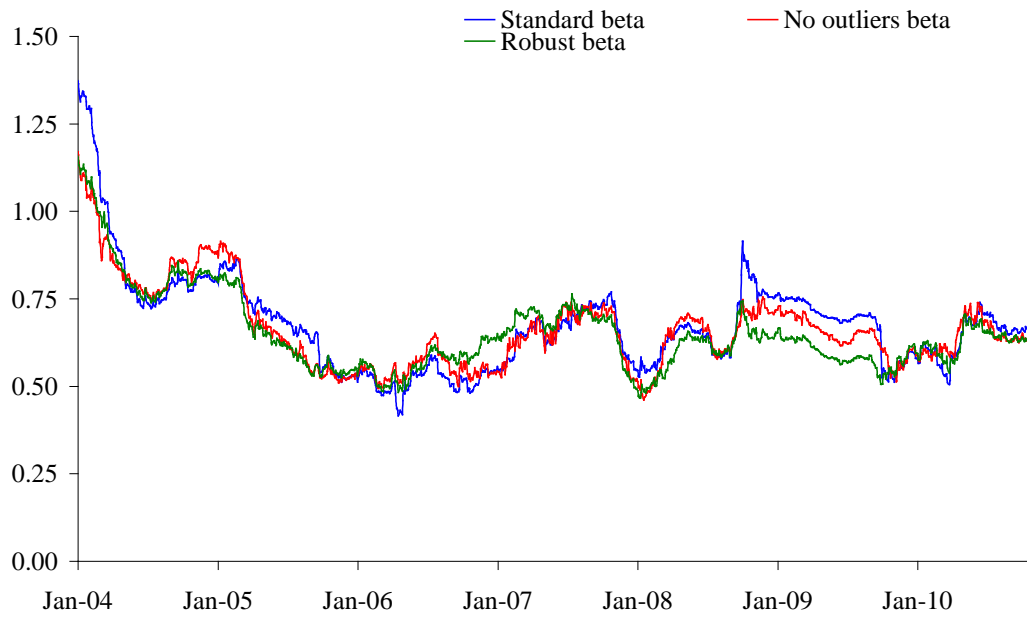
Deutsche Telekom		France Telecom		Telefonica		Vodafone	
All World		All World		All World		All World	
1 Yr	2 Yr	1 Yr	2 Yr	1 Yr	2 Yr	1 Yr	2 Yr
20-May-10	05-Mar-09	29-Jul-10	21-Jan-09	04-Feb-10	08-Dec-08	06-Jul-10	10-May-10
12-Aug-10	21-Apr-09	22-Jul-10	04-Nov-08	11-May-10	06-Nov-08	04-Jan-10	01-Dec-08
08-Dec-09	09-Apr-09	30-Oct-09	29-Jul-10	14-May-10	20-May-10	27-May-10	07-May-09
01-Dec-09	07-Jan-09	28-Oct-09	21-Nov-08	27-Apr-10	04-May-10	10-May-10	31-Mar-09
14-May-10	29-Oct-08	07-May-10	14-Nov-08	10-May-10	30-Apr-09	01-Jun-10	30-Mar-09
05-Aug-10	21-Nov-08	22-Jan-10	17-Feb-09	06-Apr-10	04-Feb-10	14-May-10	10-Mar-09
28-Oct-09	17-Jun-09	04-May-10	30-Oct-09	11-Feb-10	04-Nov-08	11-Nov-09	24-Feb-09
08-Feb-10	27-Nov-08	08-Feb-10	14-May-10	04-May-10	26-Feb-09	30-Oct-09	21-Jan-09
01-Jul-10	03-Feb-09	27-Apr-10	28-Oct-08	22-Jan-10	10-May-10	28-Oct-09	07-Jan-09
06-Jan-10	29-Jan-09	10-May-10	09-Apr-09	29-Jul-10	14-May-10	27-Apr-10	02-Jan-09
12-May-10	30-Oct-08	14-May-10	03-Feb-09	20-May-10	21-Nov-08	24-Jun-10	30-Dec-08
30-Oct-09	24-Jun-09	06-Apr-10	20-Jan-09	28-Oct-09	21-Jan-09	04-Jun-10	03-Nov-08
07-May-10	19-Dec-08	20-May-10	03-Apr-09	30-Jun-10	17-Dec-08	19-May-10	06-Nov-08
04-Jan-10	19-Nov-08		11-Nov-08	18-May-10	05-Dec-08	04-Feb-10	30-Oct-08
	24-Nov-08		30-Oct-08	29-Jun-10	01-Dec-08	07-May-10	29-Oct-08
	17-Feb-09		11-Dec-08	08-Feb-10	14-Nov-08		02-Mar-09
	20-Nov-08		17-Nov-08	10-Jun-10	27-Apr-10		20-Nov-08
	20-Jan-09		08-Dec-08		09-Apr-09		21-May-09
	02-Dec-08		20-Nov-08		29-Jun-10		23-Mar-09
	17-Nov-08		22-Dec-08		27-Jan-09		12-Nov-08
	07-Aug-09		27-Mar-09		24-Nov-08		17-Nov-08
	01-Dec-08		05-Mar-09		29-Oct-08		07-May-10
	06-Nov-08		07-May-10		14-Jan-09		18-Nov-08
	14-Nov-08		17-Dec-08		28-Oct-08		19-Nov-08
	30-Oct-09		07-Aug-09		30-Oct-08		21-Nov-08
	07-Nov-08		24-Nov-08		11-Dec-08		24-Nov-08
	04-Mar-09		12-Jan-09		20-Nov-08		08-Dec-08
			29-Oct-08		10-Jun-10		09-Apr-09
			10-May-10				04-Feb-10
			06-Nov-08				11-Nov-08
							03-Feb-09
							28-Oct-08
							03-Dec-08
							05-Jan-09
14	27	13	30	17	28	15	34

Table 9 compares the beta estimates obtained using standard OLS with those obtained through the iterative regression giving less weight to outliers and through a regression with all influential outliers removed. Figure 39 and **Error! Reference source not found.** then plot the rolling estimates of the one-year betas for the four companies against the FTSE All-World. They compare the results of the standard OLS regression, robust regressions and regressions omitting all “outliers”. Results are broadly similar, providing confidence that outliers are not driving the general shape of our results. However, we note that removing outliers reduces the latest one-year beta for Telefonica by over 0.10.

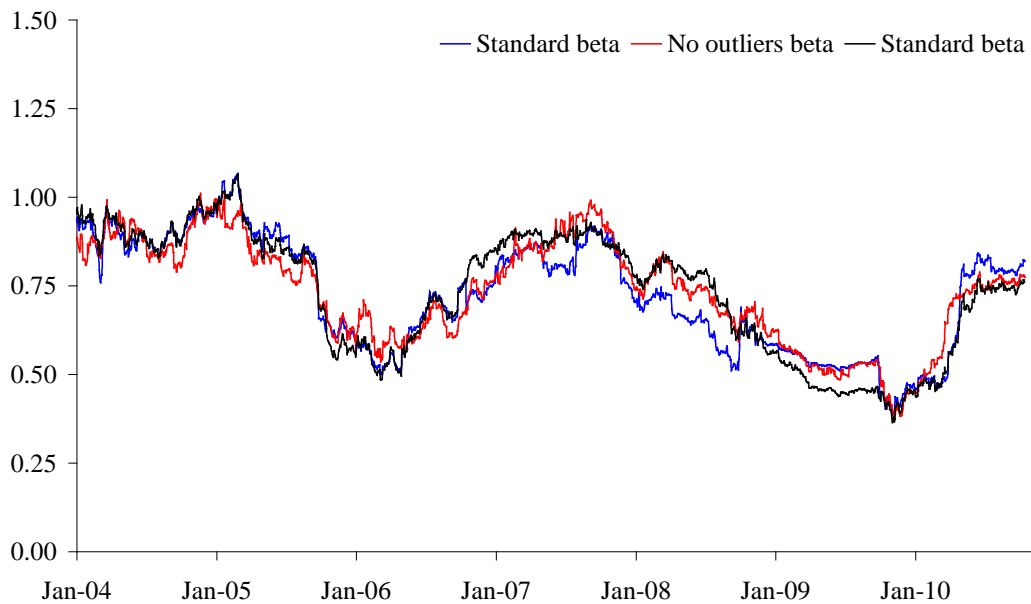
**Table 9: Influential outliers – up-to-date data**

	1 yr				2 yr			
	Standard	Robust	No Outliers	Number of Outliers	Standard	Robust	No Outliers	Number of Outliers
<i>Deutsche Telekom</i>								
All World	0.67	0.63	0.67	14	0.55	0.58	0.55	27
All Share	0.58	0.54	0.58	16	0.54	0.46	0.68	30
All EU	0.52	0.50	0.69	1	0.53	0.47	0.53	1
<i>France Telecom</i>								
All World	0.82	0.76	0.82	13	0.49	0.51	0.49	30
All Share	0.70	0.68	0.70	16	0.48	0.52	0.48	34
All EU	0.69	0.72	0.69	1	0.54	0.58	0.54	1
<i>Telefonica</i>								
All World	1.10	0.92	1.10	17	0.56	0.57	0.56	28
All Share	0.87	0.72	0.87	15	0.61	0.51	0.61	29
All EU	0.93	0.83	0.93	1	0.68	0.61	0.68	1
<i>Vodafone</i>								
All World	0.59	0.59	0.59	15	0.49	0.54	0.49	34
All Share	0.68	0.71	0.68	12	0.72	0.74	0.72	33
All EU	0.51	0.53	0.51	1	0.54	0.51	0.54	1

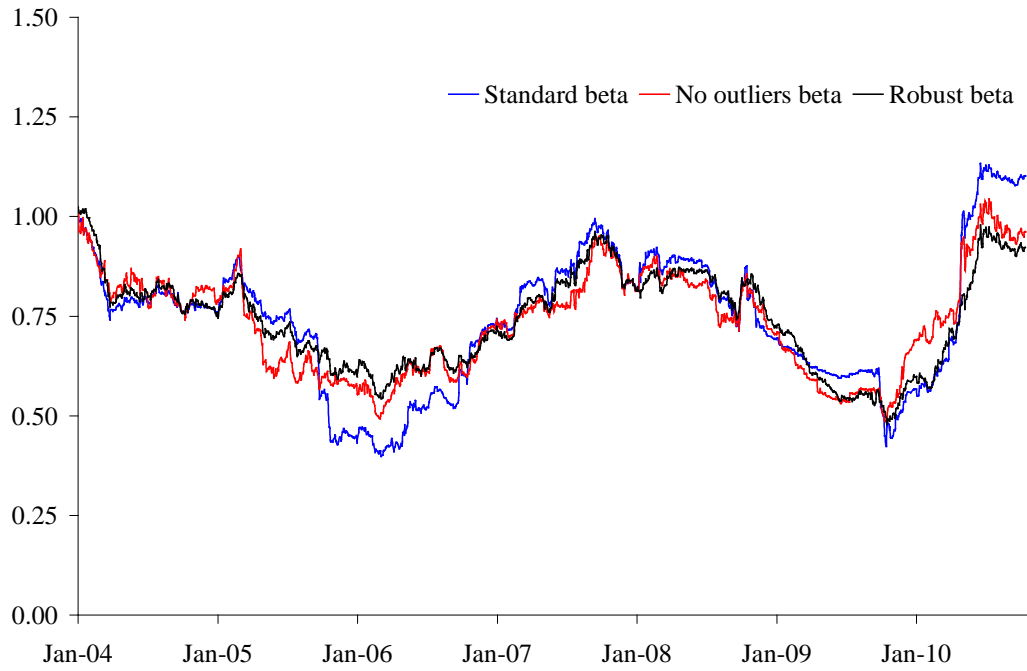
**Figure 40: One-year beta against FTSE All-World – Deutsche Telekom**



**Figure 41: One-year beta against FTSE All-World – France Telecom**



**Figure 42: One-year beta against FTSE All-World – Telefonica**



**Figure 43: One-year beta against FTSE All-World – Vodafone**

