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Measuring the impact of the 2009 COP15 Copenhagen Summit

An event study of coal and solar portfolios in the United States of America and China

Bachelor's thesis in Economics

15HP

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ABSTRACT

One of the biggest challenges currently facing mankind is tackling the challenge of climate change. To mitigate this, there have been several multilateral conferences, where some steps have been taken. The Copenhagen Summit in 2009 was one such conference, where the expectations before the conference were significant. Unfortunately, the conference was later described to be a failure.

This paper uses an event-study methodology to analyse the effect of this unexpected event. Portfolios of companies in the coal and solar industries, listed in the United States of America and China, are used. The results show that the conference did not have any discernible effect on the coal and solar industries in either of the analysed markets. A significant effect was found for Chinese Solar, but the economic reasoning behind this change is unsatisfactory.

There were many events that together thwarted the ability of the conference to get to an agreement. Any one event during or before the conference is not likely to have been the direct cause of the observed outcome. The inability of this study to unambiguously find evidence of the coal and solar industries being affected by the outcome of the conference can perhaps be explained by climate change being a natural part of everyday life today. The efforts of top-level politicians might not have a direct impact on the day-to-day valuation of industries.

Key words: event study, COP15, stock market, environmental economics, environment.

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1 INTRODUCTION

For the last decades, climate change has been one of the most pressing and discussed challenges facing mankind (Klein, 2014). It has long been established that the trajectory of world economic development is not in tune with a long-term sustainable climate situation, and that a new economic model is needed (Brundtland & Khalid, 1987). As a result, many of the world's leaders and countries are working towards reducing the impact of climate change on future generations. Starting with the First World Climate Conference of 1979 in Geneva, the international community of nation states started a long path towards negotiating targets and actions related to climate change (United Nations, 2017). Several notable conferences and outcomes have followed, along with landmark documents and treaties.

As a result of the 1992 Earth Summit in Rio, the United Nations Framework Convention on Climate Change (UNFCCC) was created. This document outlines the nature and seriousness of the issue and that all countries of the world needs to be part of the solution. It also highlighted the important distinction between developing and developed nations, and the responsibilities carried by each category of nation. The document also dictated that environmental data should be recorded and reported. The document also established the following goal: "[Greenhous gas (GHG) concentrations shall be kept] at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system." The UNFCCC has been a fixture around which unilateral climate negotiations are centred; at the time of writing, a total of 197 countries have ratified the convention. (United Nations, 2014)

The countries which have ratified the convention regularly meet at Conferences of Parties (COP) to the UNFCCC; one of which was The Copenhagen Summit (COP15) in 2009. The expectations were high that the conference would produce a binding agreement for the post-2012 period, i.e. the period following the first commitment-period stipulated by the 1997 Kyoto protocol (Daniel, 2010). COP15 was called "[the] most important international gathering since the Second World War" (Campbell, 2016), and slogans such as "Hopenhagen" and "Seal the deal" were used. The summit was also framed strongly with the idea of being time-critical, and that it was a "decisive moment", and that "time is running out" (Kunelius & Eide, 2012). The conference was also unusual, in that many heads-of-states were to be in attendance during the closing days (Daniel, 2010). This made the stakes extraordinarily high from a political standpoint (Death, 2011). However, as the conference proceeded, it was becoming ever clearer

that no significant breakthrough could be expected. In the last moments of the conference, the Copenhagen Accord was crafted through largely closed negotiations between the United States of America and the BASIC countries (a block of newly industrialised countries, including Brazil, South Africa, India, and China). This accord fell short of the anticipated outcomes of the conference, and there was resentment of the way it had been crafted among the conference participants (Daniel, 2010). As a result, the Copenhagen Accord was never officially adopted as the outcome of the conference, but merely "taken note of" (Daniel, 2010).

1.1 BACKGROUND

The outcome of the COP15 conference was unexpected, in that it failed to live up to the pre-conference expectations of a binding agreement for the period after the Kyoto protocol (Daniel, 2010). Because of the time-critical nature of actions towards the mitigation of climate change (Thompson, 2010), and that a failure on such a high inter-governmental level causes severe delays for any corrective action (Christoff, 2010), the failure of COP15 could be potentially devastating to the ability of the international community to initiate action in this area. Therefore, determining just how important the inability to reach an agreement at COP15 was for keeping climate change under control is interesting. Other Conferences of the Parties of the UNFCCC could also be a focus for investigation, such as COP21 in Paris. However, these negotiations did not produce unexpected results compared to expectations going into the conferences; at minimum, they were not considered to be clear failures, as the COP15 is remembered as being.

One way to measure how surprising the outcome of COP15 was, is to use the valuation of relevant companies on the stock market as proxy. Because stock markets reflect available information – at least to some degree – a sudden influx of new information should influence the valuation (Campbell et al., 1997). There was a substantial media presence and degree of attention around the COP15 conference (Kunelius & Eide, 2012). Because of this attention, the stock markets would have had a vast amount of information available about the process, projected outcomes, and development of the conference. Therefore, a listed company operating in a field likely affected by the outcome of the conference – for example through new emissions regulations – could have its valuation altered because of the outcome of the conference.

1.1.1 Industries affected by the outcome of the COP15 conference

As the conference concerned climate change policy, industries related to increasing or decreasing emissions is of interests. Any new policy change – or probable change in the future

– could have a direct effect on such companies: the long-term economic viability of the company would change due to new environmental factors (Slack et al., 2010). One of the cornerstones of the climate change debate is transitioning to energy sources that carry less environment impact and maintain economic viability (Brundtland & Khalid, 1987), making companies in the energy sector an attractive entry point.

One industry which is often mentioned in conjunction with climate change is the coal industry (Klein, 2014; Thompson, 2010). In a comparison by Klein & Whalley (2015), coal was markedly worse from an environmental sustainability standpoint, compared to all other energy sources. The valuation of coal securities could therefore be assumed to be negatively affected by advances towards the mitigating climate change: coal-based energy sources are a clear target by policy-makers when attempting to reduce GHG-emissions (Klein & Whalley, 2015). Conversely, the unexpected failure of COP15 could provide a respite for companies in the industry, by postponing new regulation and reduction of subsidies which might have resulted from a binding agreement.

On the other side, there are industries which would be positively affected through emissions regulation. For example, an industry which provides less CO_2-intensive alternative to a competing industry's products could gain competitive power through policy changes which target GHG emission reductions. Renewable energy, in contrast to fossil-based energy, provide clear advantages from an environmental sustainability standpoint (Klein & Whalley, 2015). Solar energy is an interesting energy source to study, as it is comparatively novel, provides clear benefits in comparison to coal, and can provide decentralised energy production attractive to developing countries.

1.1.2 Markets affected by the outcome of the COP15 conference

The backdrop to the COP15 conference was the dichotomy between developing and developed countries (Daniel, 2010). Neither the developed countries – among others including the United States of America and the European countries – nor the developing countries – including China, Brazil, India and many more – provided a homogenous front in the COP15 negotiations: the national interests of each individual country manifested in variations in the façade of the two negotiating blocks (Daniel, 2010). However, the leaders of respective group are indubitably the United States of America and China. These two countries both have vast internal markets, as well as being significant contributors to world's GHG emissions each year (Christoff, 2010), and occupying the number one and number two positions in total national GDP (The World

Bank, 2017). Negotiations within UNFCCC are intrinsically linked to the political moves of these two countries (Christoff, 2010).

China has experienced significant growth since the 1990s. Consequently, the urbanisation and industrialisation of the country has grown the country's energy demand (Christoff, 2010). Despite the lower per-capita GHG emissions compared to western countries, the populous country has thusly become the world's largest emitter of CO_2 (Mizo, 2016). During the past decades, the country's increasing energy demand has, to a considerable extent, been covered by expansion in fossil energy sources, such as coal (Campbell, 2016). China is also an important market for solar cell technology (Mizo, 2016). The country has emerged as the world's largest manufacturer of solar cells (Hughes & Meckling, 2017), and is continually working towards adding more renewable energy capacity (Mizo, 2016), being a world leader in solar cell deployment (International Energy Agency, 2014).

The United States of America has been at the forefront of economic development since the start of the 20th Century and is an essential actor in world politics. By extension, the actions of the country concerning climate change mitigation is of paramount importance (Christoff, 2010). The country's energy production has a relatively high dependence on coal, constituting 29.8 percent of the country's energy mix in 2009 (U.S. Energy Information Administration, 2017). In solar energy, the United States of America has not been as impactful as China, but was still the 2nd largest OECD country by solar deployment in 2014 (International Energy Agency, 2014).

1.2 PURPOSE

The purpose of this thesis is as follows: *To investigate if the 2009 United Nations Climate Change Conference had any noticeable impact on the valuation of companies in the coal & solar industries in China and the United States of America*.

As a path towards answering this purpose, two research questions have been devised. These questions will be presented below, along with a justification for their formulation in relation to the overarching purpose.

Economists are often asked to measure the impact of an event. A common method to do so is the event-study methodology (Campbell et al., 1997). To test the influence of the COP15 conference, a multi-country, multi-industry event study will be conducted. The coal and solar industries in the United States and China have been selected as the focus for this study. Ex-

ante, the expectation is that the unexpected results of the COP15 conference will be discernible, with the null hypothesis H_0: there are no abnormal returns during the period. The first research question is:

I. Using an event study of coal & solar portfolios in the United States and China, can any noticeable impact be found from the 2009 United Nations Climate Change Conference?

The COP15 conference lasted between 7th December and 18th December 2009. During the conference, several noticeable events took place which eventually culminated in the crafting of the Copenhagen Accord. As all events during the conference were met with significant media attention, the financial markets would be continually infused with information, and the security valuations should change accordingly. Because of this, determining the exact moment when the market took the conference outcome into account is not clear. The second research question is therefore:

II. What were some notable events during the 2009 United Nations Climate Change Conference which contributed to, or signalled, the inability to establish a binding agreement?

2 LITERATURE STUDY

The literature study in this section is divided in two parts. The first part covers characteristics of event studies relevant to the thesis. After this, an overview of efficient market theory is made.

2.1 CHARACTERISTICS OF EVENT STUDIES

The event-study methodology is commonly used when economist try to determine the effect a specific event has on the value of a company (Campbell et al., 1997). One of the earlies example of an event study can be found in Dolley (1933a), and the follow-up articles in Dolley (1933b). Here, an overview of stock split-ups in the 1920s was made, along with the effect these splits had on the valuation of the companies. As the methodology of event study analysis was in its infancy, the study reported the effects of the splits on trading volumes around the event, the change in number of shareholders, as well as the "price effect" of the splits. The price effect, which is what is commonly tested in today's event studies, was reported as the proportion of companies where the price increased and decreased.

Since the early series of papers by Dolley in 1933, the event-study methodology has developed significantly in sophistication. Another important series of papers, which compares the viability of common event-study methodologies using abnormal returns, are the series of papers by Brown and Warner. The abnormal returns tested were the mean adjusted returns, markets adjusted returns, and risk adjusted returns (Brown & Warner, 1980). In Brown & Warner (1980), tests of these methodologies using monthly stock prices was made, whereas in Brown & Warner (1985), a similar procedure was applied to daily data. However, the implementation of these methods varies meaningfully between researchers, depending on their view of how the power of these types of tests are affected by a number of variables.

Commonly, event studies conduct statistical tests on so called abnormal returns – the difference between observed returns and expected returns according to some model – but the details of the methodology of event studies can vary drastically, depending on the assumption made by the author regarding the circumstances around the research question in focus. On such aspect is the whether to use parametric or non-parametric tests (Brown & Warner, 1980). A simple parametric t-test makes a strong assumption that the stock returns are normally distributed: if this assumption fails to hold, false inferences might be drawn. Non-parametric tests do not rely

on this assumption, which could make them more robust. However, Brown & Warner (1980) shows that the parametric tests are reasonably well specified for adequately sized samples.

One important aspect is the notion of clustering of events. When an event-study considers the effect of for example stock splits, stock dividends, etc., the data is collected from several temporally separated events: one for each stock. As the timing of these events are not related to each other, the event period for each stock is not taking place on the same dates. Therefore, external factors, such as political or economic events, will not influence the study in the same magnitude as if the event periods would be aligned with each other (Brown & Warner, 1980; Campbell et al., 1997). Therefore, if the study has event clustering, some adjustment of the methodology can be made to compensate for this (MacKinlay, 1997). Additionally, avoiding simple abnormal return models, such as mean adjusted returns, has a positive impact (Brown & Warner, 1980). However, regardless of such precautions, clustering does have a negative impact on the power of the employed tests, causing over-rejection of the null hypothesis (Kolari & Pynnönen, 2010).

2.2 EFFICIENT MARKETS HYPOTHESIS

That a market is efficient means that it will react to new information that was not available before, and adjust the prices of assets according to this infusion. For a perfectly efficient market, all actors have access to all available information without any time delay, meaning that asset prices always perfectly reflect available information. By extension, this leads to an impossibility of making any economic profit by trading on efficient markets, as all market participants always react to the same available information. The existence of trading profits can therefore be used as an indicator of market efficiency: as the trading profits increases, the efficiency of the market decreases. In the real world, there will rarely be perfect information available to all participants at every time instance. Some actors might also have private information, which is not shared with all other actors. Additionally, there will be a time lag between the release of information and the moment when a majority of the market actors are able to respond to novel information. (Campbell et al., 1997)

Therefore, the efficiency of a market is related to the information set available to the actors. Commonly, the three forms of market efficiency are: (i) weak-form efficiency, where the only information is the historic prices and returns; (ii) semistrong-form efficiency, where the information set includes all publicly available information; and (iii) strong-form efficiency, where the information set also includes private information. (Campbell et al., 1997)

3 METHODOLOGY

The methodology used to answer the purpose of this thesis is divided in two parts. These parts follow from the research questions used in this paper.

3.1 EVENT STUDY DETAILS

To be able to answer the second research question, an event study has been conducted. In short, the event-study tests for whether a specific event have led to any abnormal returns on security prices. In this context, *abnormal* means returns which differ significantly from what is normally expected, where the normality benchmark is determined by a certain model (Brown & Warner, 1980). In this chapter, the methodological choices related to the event study are outlined.

3.1.1 Time-windows used in the event study

Following the event-study methodology, a number of time-windows is to be specified. These include the estimation window, the event window, and the post-event window (Campbell et al., 1997). Figure 1 is adapted from Campbell et al. (1997) shows the relative positioning of these time-windows. The time windows used in this study can be seen in Table 1.

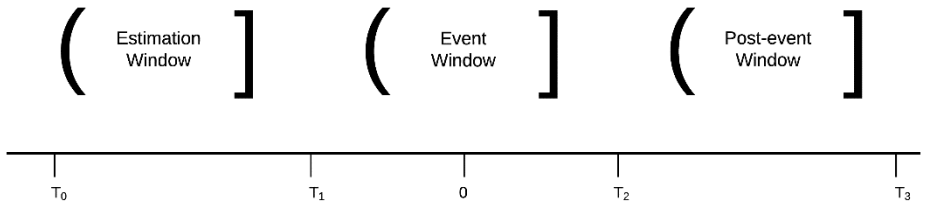

Figure 1 - Time-windows

The estimation window is used for determining the expected – or normal – returns for the securities. Two different estimation windows have been defined for this study: one long and one short. The long estimation window starts on 1st December 2008 and ends on 22nd October 2009. This longer estimation window included a gap between the start of the conference and the end of the estimation window. This is sometimes done to avoid the event itself from influencing the estimation of normal returns. The shorter estimation window starts on 15th July 2009 and ends 4th December 2009. This shorter estimation window has been selected so as to be as close as possible to the event itself. This shorter estimation window is included to – as

much as possible – reduce any confounding influence on the result from the 2008 financial collapse. In this study, the results of both these estimation windows will be reported.

Table 1 - Time-windows of this paper

	Start date	**End date**	**Calendar days**	**Weekdays**
Short Estimation Window	2009-07-15 (T_0)	2009-12-04 (T_1)	142 days	102 days
Long Estimation Window	2008-12-01 (T_0)	2009-10-22 (T_1)	325 days	233 days
Event Window	2009-12-07	2009-12-18 (T_2)	11 days	9 days
Post-event Window	2009-12-19	2010-02-01 (T_3)	44 days	30 days

Our event window follows the duration of the conference, which started 7th December 2009 and ended 18th December 2009. The day defined as T=0 is 18th December 2009, which is the last day of the conference and the day on which the Copenhagen Accord was presented.

3.1.2 Selection of securities

Four different portfolios have been constructed to examine the effect of the Copenhagen conference. The portfolios are created by combinations of two dimensions. The portfolios and their respective combinations, as well as the number of companies in each portfolio, are shown in Table 2.

The first dimension used for the portfolio construction is the country of incorporation. In this paper, the securities included are either incorporated in the United States of America or China. These two countries are chosen to be representative for developed and developing countries, respectively. The countries are also chosen because of the level of contribution to global emissions and because they are powerful actors on the global political scene.

The second dimension used to construct the portfolios is the industry: the securities chosen are either in the coal or solar market. We chose these markets since solar companies represent an industry which are predicted to be positively impacted by positive news from the Copenhagen conference, while the coal companies should get a positive effect if the conference failed to achieve any progress. Many listed companies have diversified revenue streams, stemming from

different industries. As an example, companies in the coal industry might also have investments and revenue from other mining operations – such as metal mining – which, in comparison to coal, should be comparatively less effected by happenings in the international climate change debate. Therefore, the portfolio companies have been chosen so that they had a majority of their revenue from either coal or solar in the year around the conference. In addition, companies with operations closer to manufacturing or raw material supply were preferred, as they were assumed to be more directly affected by events related to the industry, compared to companies further down in the value chain which can be more diversified. Following this reasoning, a choice was made to remove energy companies from either industry. Energy companies can adapt their energy generation procedure without affecting their core business of energy delivery. In comparison, coal mining companies and solar panel manufacturers are more exposed, as they are reliant on the underlying demand for their respective product.

Table 2 - Portfolio combinations

	United States of America	**China**
Coal	Portfolio US-C *12 companies*	Portfolio C-C *24 companies*
Solar	Portfolio US-S *9 companies*	Portfolio C-S *10 companies*

To find information about companies, we used the Bloomberg terminal in the finance lab at Handelshögskolan. In compiling a list of potential companies to include in each portfolio, we used a range of sources, including MarketLine Industry profiles of the coal and solar markets in the United States of America and China, published research, and online searches. However, most of the companies were found using the industry overview functions of the Bloomberg terminal. A list of the companies included in each portfolio can be found in Appendix I through IV.

For each potential company, the corresponding security ticker was investigated through Bloomberg. Three aspects were investigated for each security, before they were allowed to be included in any portfolio. Firstly, for each company, the country of incorporation, as well as which stock exchange the company was listed on, was collected. As previously mentioned, only Chinese and US companies were included in the study. Some Chinese companies included

are listed on a US stock exchange. Secondly, the security should have been actively traded in the period surrounding the COP15 conference. At minimum, each security should have had an initial public offering (IPO) before the start of the estimation window. Furthermore, the selected securities should be actively traded on the market during the period. No formal active-trading limit was used; instead, a visual inspection was done of the day-to-day security prices as reported by Bloomberg's graph function: securities with extended periods of stationary prices were excluded. Thirdly, each company's industry revenue was investigated. Using the *finance analysis* function in Bloomberg, the revenue of each company for 2009, along with the percentage of revenue stemming from the industry, was collected. For each included security, at least 60 percent of the revenue should originate from either solar or coal for the revenue year of 2009.

For each of the securities selected in this way, the last price trading data was collected for the period between 2008-12-01 and 2010-02-01. The last price is the closing price for the security for each day, i.e. the last price for which a security was traded during the day. In addition to the security last-price data, three market indices were collected for the same period. These indices were the Shanghai Stock Exchange Composite Index (SHCOMP), the Hong Kong Hang Seng Index (HSI) and the S&P 500 Index (SPX). These indexes were used to determine expected returns, where all securities were compared to the market where they were listed. Chinese companies listed in the United States were thus compared to the S&P 500 Index instead of one of the two Chinese indices. All security and index last-price data was extracted through Bloomberg. For the sake of brevity, the raw data will not be presented in this thesis.

3.1.3 Adjusting for missing returns

Not all securities included in our portfolios were traded on every day in our time windows. The intra-trade gaps that do exist are frequently only a day or two. However, there are methods available to adjust for such missing data points. The method used in this thesis is the lumped return procedure, as defined by Maynes & Rumsey (1993). This method works reasonably well for thickly and moderately thinly traded stocks (Maynes & Rumsey, 1993). The lumped return procedure works by distributing the returns of the next traded day over the non-trade days (Maynes & Rumsey, 1993).

Another point to take note of is that the data set is only adjusted for non-trading days when the corresponding stock market is open. That is, no adjustments are made over holidays and other times when the overall stock market is not trading.

3.1.4 Measuring abnormal returns

In the event-study in this paper, the market-adjusted returns model, as specified by Brown & Warner (1985), is used to determine the abnormal returns during the event window. In this method, an OLS regression is done for each individual security, where the day-to-day return of the security is regressed on the day-to-day return of the market.

In this study, the simple returns model is used to the day-to-day returns (see Equation 1). Some researchers chose to use logarithmic returns instead of simple returns. However, using this methodology in samples with high variance will reduce the expected returns (Hudson & Gregoriou, 2015). Generally, the choice of returns model is not critical, but comparisons across returns models should be done with caution (Hudson & Gregoriou, 2015).

Equation 1 - Simple returns

$$R_{it_1} = \frac{P_{it_1} - P_{it_0}}{P_{it_0}}$$

For each security, the market return is chosen to be a corresponding index of the stock market in which the security is listed. The alpha and beta estimators for each security is calculated according to Equation 2 and Equation 3, following the methodology of MacKinlay (1997). Note that these regressions are done on the returns in the estimation window.

Equation 2 - Beta estimator

$$\hat{\beta}_i = \frac{\sum_{\tau=T_0+1}^{T_1}(R_{i\tau} - \hat{\mu}_i)\,(R_{m\tau} - \hat{\mu}_m)}{\sum_{\tau=T_0+1}^{T_1}(R_{m\tau} - \hat{\mu}_m)^2}$$

Equation 3 - Alpha estimator

$$\hat{\alpha}_i = \hat{\mu}_i - \hat{\beta}_i\hat{\mu}_m$$

For each security, the abnormal returns are calculated based on the difference between the predicted day-to-day return – based on the regression model – and the observed day-to-day return. Because the event dates for all securities are the same, we have event date clustering. To adjust for this, the abnormal returns for all securities in each portfolio is summed to one aggregated portfolio return for each day (Equation 4). The variance of the abnormal returns is estimated using the unbiased estimator (Equation 5), where L_1 is the length of the estimation window.

Equation 4 - Portfolio return

$$\hat{\varepsilon}_{p\tau} = \sum_{i=1}^{N} \hat{\varepsilon}_{i\tau}$$

Equation 5 - Variance estimator

$$\hat{\sigma}^2_{\varepsilon_p} = \frac{1}{L_1 - 2} \sum_{\tau=T_0+1}^{T_1} \left| \hat{\varepsilon}_{p\tau} - \hat{\mu}_{\varepsilon_p} \right|^2$$

The variance of the abnormal returns can be approximated with Equation 5, as the variance introduced by the sampling error approaches zero asymptotically as the size of L_1 increases (MacKinlay, 1997).

3.1.5 Testing the null hypothesis

Under the null hypothesis, H_0, that there are no abnormal returns (neither positive nor negative), the distribution of abnormal returns is approximately normally distributed with parameters as in Equation 6 (MacKinlay, 1997).

Equation 6 - Distribution of abnormal returns

$$\varepsilon_{p\tau} \sim N\left(0, \sigma^2(\varepsilon_p)\right)$$

It can be difficult to pinpoint the exact date of an event when it comes to event studies (Brown & Warner, 1980). This is because it can be hard to know the precise moment when the information reached the market, i.e. when the price of the security adjusted to reflect the new situation. Furthermore, not all actors on the market receive information on the exact same time. Even though the internet has increased the speed of which information is spread, information might be released to a small sub-set of the population before it becomes public knowledge. Because of this, the abnormal returns of multi-day spans around an event are usually tested. The cumulative abnormal returns (CAR) between t_1 and t_2 is defined according to Equation 7 (MacKinlay, 1997). The variance of CAR_p approaches Equation 8 asymptotically as L_1 increases. In words, this expression is equal to the number of days in the event window multiplied by the variance of the abnormal returns, which we estimate from the estimation window portfolio abnormal returns.

Equation 7 - Cumulative Abnormal Return (of portfolio)

$$CAR_p(\tau_1, \tau_2) = \sum_{\tau=\tau_1}^{\tau_2} \varepsilon_{p\tau}$$

Equation 8 - Variance of Cumulative Abnormal Return

$$\sigma_p^2(\tau_1, \tau_2) = (\tau_2 - \tau_1 + 1)\sigma_{\varepsilon_p}^2$$

To test H_0, the crude dependency adjustment test is used. This test relates the cumulative abnormal return to the standard deviation of the abnormal return, as seen in Equation 9 (Campbell et al., 1997).

Equation 9 - Parametric test of H0

$$\theta = \frac{CAR_p(\tau_1, \tau_2)}{\sigma_p(\tau_1, \tau_2)} = \frac{\sum_{\tau=\tau_1}^{\tau_2} \varepsilon_{p\tau}}{\sqrt{N}\sigma_{\varepsilon_p}}$$

The distribution of the test statistic is also approximately normally distributed, as it approaches this distribution asymptotically with increasing length of L_1 (MacKinlay, 1997).

3.1.6 Selection of CAR-windows

Five CAR-windows have been chosen inside the event window, where the null hypothesis will be tested. The windows follow from the results of research questions II, which is presented in Chapter 4.2. The CAR-windows used are presented in Table 3. A justification for choosing these windows will now follow.

Firstly, the last day of the conference is a natural inclusion (defined as day 0 in our results). This was the final day of negotiation, and when the Copenhagen Accord was presented. As it might have taken the markets some time to interpret the results of the conference, the following trading day is included in this time window. As the 18th is a Friday, the following trading day is on the Monday 21st December. This will leave the markets ample time to digest the unexpected nature of the outcome.

Secondly, a CAR-window covering the entire conference period is included. The test statistic continues to be well-specified even under such longer time-windows (Brown & Warner, 1985). However, the power of the test is reduced when longer time-periods are used (Brown & Warner, 1985).

Thirdly, the leak of *The Danish Text* during the opening days of the conference is an early indicator that there were conflicts already going into the conference. The text further emphasised the fault lines which existed between the developed and developing countries, right at the start of the negotiations (Christoff, 2010). Therefore, the leak of this document, as well as the following trading day, is of interest.

Fourthly, there were a number of protests marches in Copenhagen (van der Zee & McKie, 2009). The public pressure was substantial before the conference (Kunelius & Eide, 2012), so large and visible protests might have served to pressure the representatives to sign a binding agreement. A large protest on 12th December, gathering approximately 100,000 protesters, as well as the large number of arrests on the 14th December are chosen as indicators of the people's impatience.

Lastly, in the final days of the conference, it was becoming clear that the elevated expectations going into the conference were not to be fulfilled. A CAR window covering these last trading days are therefore of interest.

In addition to the multi-day CAR windows, the one-day CAR values were also calculated for all days of the conference, as well as the post-event window. Inflections based on these results should be made with caution, as one cannot be certain that the information of an event has disseminated thoroughly. Therefore, these results carry less weight in our analysis compared to the multi-day results. The results of the one-day CAR windows are presented in Chapter 4.1.3, except the one-day CAR values in the post-event window, which are presented in Appendix V through VIII.

Table 3 - Chosen CAR windows

Event	**Start day***	**End day***	**Start-date**	**End-date**
Copenhagen Accord released	0	1	2009-12-18	2009-12-21
Entire Copenhagen Summit	-9	0	2009-12-07	2009-12-18
Leak of the Danish Text	-8	-7	2009-12-08	2009-12-09
Public protests	-5	-3	2009-12-11	2009-12-15
Final days of the conference	-3	0	2009-12-15	2009-12-18

*) Relative to the last day of the Conference

3.2 Analysis of major happenings during the Copenhagen Conference

Information about the events during the Copenhagen conference were gathered through peer-reviewed papers, as well as through newspaper articles. The peer-reviewed articles reflect the post-conference perception, whereas the newspaper articles capture the day-to-day developments. The newspaper articles were found by searching the webpage of *The Guardian* (theguardian.com) via a tailored google search. In this thesis, the stock markets in China and the United States of America are assumed to follow the semistrong-form market efficiency, i.e. reacting to publicly available information. *The Guardian* was chosen as an indicator of the available information set, as the newspaper had sufficient journalistic resources to cover the conference proceedings, and a worldwide audience.

The search term included "Copenhagen" and "conference", and was limited to the days of the conference (7th December to 18th December). The search method returned a total of 91 newspaper articles. From this sample, articles relevant to the purpose of this thesis were selected and summarised. After this, a list of notable events was compiled for each day of the conference. The events deemed by the authors to carry the highest importance are presented in Chapter 4.2 of this paper.

4 RESULTS

In this chapter, the results stemming from the thesis's methodology is included. First, an overview of notable events during the COP15 conference is presented, followed by the results of the event study.

4.1 STATISTICAL RESULTS

In this chapter, our results of our industry-country portfolios will be presented. The results for all five CAR windows are represented, as well as their respective significance levels. For all portfolios, both the 233-days estimation window and the 102-days estimation window results are reported. In addition to this, the one-day CAR-windows are reported for each day of the event, i.e. from 7th December to 21st December. The results for the post-event period are presented in Appendix V through VIII.

4.1.1 Results with short estimation window

The sum of the cumulative abnormal return for each portfolio, using the short estimation window, can be seen in Table 4.

Table 4 - CAR values with short estimation window

CAR	Portfolio US-C	Portfolio US-S	Portfolio C-C	Portfolio C-S
(0, 1)	-0.189	0.301	-0.477	-0.024
(-9, 0)	0.831	0.872	-0.345	0.359
(-8,-7)	0.116	0.139	0.129	-0.135
(-5,-3)	0.367	0.032	-0.188	0.678*
(-3, 0)	0.459	0.099	0.352	0.035

* 10% significance level, ** 5% significance level, *** 1% significance level

The test statistic, along with the corresponding p-value, for each portfolio and CAR-window, using the short estimation window, can be seen in Table 5.

Table 5 - Test statistics with short estimation window

	Portfolio US-C		Portfolio US-S		Portfolio C-C		Portfolio C-S	
CAR	t-value	p-value	t-value	p-value	t-value	p-value	t-value	p-value
(0, 1)	-0.773	0.440	1.056	0.291	-1.246	0.213	-0.080	0.936
(-9, 0)	1.518	0.129	1.369	0.171	-0.403	0.687	0.545	0.586
(-8,-7)	0.475	0.635	0.488	0.626	0.337	0.736	-0.458	0.647
(-5,-3)	1.225	0.221	0.091	0.927	-0.401	0.689	1.883	0.060*
(-3, 0)	1.327	0.184	0.246	0.806	0.650	0.516	0.085	0.932

* 10% significance level, ** 5% significance level, *** 1% significance level

4.1.2 Results with long estimation window

The sum of the cumulative abnormal return for each portfolio, using the long estimation window, can be seen in Table 6.

Table 6 - CAR values with long estimation window

CAR	Portfolio US-C	Portfolio US-S	Portfolio C-C	Portfolio C-S
(0, 1)	-0.213	0.280	-0.545	-0.071
(-9, 0)	0.631	0.743	-0.658	0.015
(-8,-7)	0.071	0.129	0.047	-0.206
(-5,-3)	0.313	-0.032	-0.251	0.575
(-3, 0)	0.371	0.081	0.179	-0.107

* 10% significance level, ** 5% significance level, *** 1% significance level

The test statistic, along with the corresponding p-value, for each portfolio and CAR-window, using the long estimation window, can be seen in Table 7.

Table 7 - Test statistics with long estimation window

	Portfolio US-C		Portfolio US-S		Portfolio C-C		Portfolio C-S	
CAR	t-value	p-value	t-value	p-value	t-value	p-value	t-value	p-value
(0, 1)	-0.493	0.622	0.622	0.534	-1.061	0.289	-0.147	0.883
(-9, 0)	0.653	0.514	0.737	0.461	-0.573	0.566	0.014	0.989
(-8,-7)	0.163	0.870	0.286	0.775	0.092	0.927	-0.424	0.672
(-5,-3)	0.592	0.554	-0.058	0.954	-0.399	0.690	0.968	0.333
(-3, 0)	0.607	0.544	0.127	0.899	0.246	0.805	-0.156	0.876

* 10% significance level, ** 5% significance level, *** 1% significance level

4.1.3 One-day CAR windows

In addition to the tests conducted on the specified CAR-windows, the one-day car windows for each day of the event is also reported. The corresponding values and significance levels for each portfolio can be seen in Table 8, Table 9, Table 10, and Table 11.

Table 8 - One-day car windows for US Coal

Portfolio US-C		**Short est. Window**			**Long est. Window**		
Date	Event day	CAR	T-value	P-value	CAR	T-value	P-value
2009-12-21	1	-0.113	-0.653	0.514	-0.123	-0.402	0.688
2009-12-18	0	-0.076	-0.440	0.660	-0.090	-0.296	0.767
2009-12-17	-1	0.121	0.698	0.485	0.090	0.295	0.768
2009-12-16	-2	0.200	1.155	0.248	0.181	0.595	0.552
2009-12-15	-3	0.215	1.241	0.214	0.190	0.623	0.533
2009-12-14	-4	0.241	1.390	0.164	0.228	0.747	0.455
2009-12-11	-5	-0.088	-0.510	0.610	-0.104	-0.343	0.732
2009-12-10	-6	0.099	0.572	0.567	0.085	0.279	0.780
2009-12-09	-7	0.109	0.628	0.530	0.093	0.304	0.761
2009-12-08	-8	0.008	0.044	0.965	-0.022	-0.072	0.943
2009-12-07	-9	0.004	0.021	0.983	-0.018	-0.061	0.952

* 10% significance level, ** 5% significance level, *** 1% significance level

Table 9 - One-day car windows for US Solar

Portfolio US-S		**Short est. Window**			**Long est. Window**		
Date	Event day	CAR	T-value	P-value	CAR	T-value	P-value
2009-12-21	1	0.292	1.448	0.148	0.270	0.848	0.396
2009-12-18	0	0.009	0.046	0.963	0.011	0.034	0.973
2009-12-17	-1	0.002	0.008	0.994	0.006	0.018	0.985
2009-12-16	-2	-0.009	-0.043	0.966	-0.022	-0.069	0.945
2009-12-15	-3	0.097	0.482	0.630	0.086	0.272	0.786
2009-12-14	-4	0.032	0.159	0.874	-0.004	-0.013	0.989
2009-12-11	-5	-0.097	-0.482	0.630	-0.114	-0.359	0.719
2009-12-10	-6	0.419	2.079	0.038**	0.395	1.243	0.214
2009-12-09	-7	0.182	0.901	0.367	0.180	0.566	0.572
2009-12-08	-8	-0.043	-0.212	0.832	-0.051	-0.161	0.872
2009-12-07	-9	0.280	1.390	0.165	0.256	0.806	0.420

* 10% significance level, ** 5% significance level, *** 1% significance level

Table 10 - One-day car windows for Chinese Coal

Portfolio C-C		**Short est. Window**			**Long est. Window**		
Date	Event day	CAR	T-value	P-value	CAR	T-value	P-value
2009-12-21	1	-0.171	-0.632	0.527	-0.185	-0.511	0.609
2009-12-18	0	-0.306	-1.130	0.258	-0.360	-0.992	0.321
2009-12-17	-1	0.105	0.387	0.699	0.048	0.132	0.895
2009-12-16	-2	0.156	0.577	0.564	0.127	0.349	0.727
2009-12-15	-3	0.397	1.467	0.142	0.364	1.005	0.315
2009-12-14	-4	-0.631	-2.334	0.020**	-0.631	-1.740	0.082*
2009-12-11	-5	0.047	0.173	0.862	0.016	0.043	0.966
2009-12-10	-6	-0.114	-0.421	0.674	-0.129	-0.357	0.721
2009-12-09	-7	0.131	0.486	0.627	0.086	0.236	0.813
2009-12-08	-8	-0.002	-0.009	0.993	-0.038	-0.106	0.916
2009-12-07	-9	-0.127	-0.470	0.638	-0.140	-0.387	0.699

* 10% significance level, ** 5% significance level, *** 1% significance level

Table 11 - One-day CAR windows for Chinese Solar

Portfolio C-S		**Short est. Window**			**Long est. Window**		
Date	Event day	CAR	T-value	P-value	CAR	T-value	P-value
2009-12-21	1	0.139	0.669	0.504	0.119	0.347	0.728
2009-12-18	0	-0.163	-0.782	0.434	-0.190	-0.556	0.579
2009-12-17	-1	-0.081	-0.391	0.696	-0.127	-0.371	0.711
2009-12-16	-2	-0.043	-0.204	0.838	-0.074	-0.217	0.829
2009-12-15	-3	0.322	1.547	0.122	0.284	0.830	0.407
2009-12-14	-4	0.365	1.752	0.080*	0.334	0.977	0.329
2009-12-11	-5	-0.008	-0.038	0.970	-0.043	-0.126	0.900
2009-12-10	-6	-0.345	-1.657	0.098*	-0.373	-1.091	0.275
2009-12-09	-7	-0.097	-0.465	0.642	-0.124	-0.363	0.717
2009-12-08	-8	-0.038	-0.183	0.855	-0.082	-0.238	0.812
2009-12-07	-9	0.446	2.144	0.032**	0.410	1.199	0.230

* 10% significance level, ** 5% significance level, *** 1% significance level

4.2 Overview of events during the Copenhagen Summit

As previously mentioned, the COP15 conference in Copenhagen carried with it high hopes of substantial progress in the battle against climate change (Christoff, 2010; Daniel, 2010). However, despite the media focus and political posturing, the conference failed to produce the planned outcome (Christoff, 2010). There were events leading up to, as well as during, the conference, which lead to this unexpected outcome.

On 7th December, the first day of the conference, a shared editorial was published in 56 newspapers from around the world, outlining why it was important that the conference produced an agreement. The editorial states that few believe that the COP15 can actually produce such an agreement, and discusses the environmental implications the world is and will be facing, highlighting problems such as ever-cheaper flights and the developing world having to increase their emissions to increase their wealth. The editorial also urges the politicians to dedicate themselves to the task of getting to an agreement, wanting them to understand the importance and criticality of the task at hand. (The Guardian, 2009a)

On 8th December, a text called *The Danish text* was leaked. This text outlined how the organisers should try to make the developing countries accept more responsibility for global emissions, and adapt higher emission reductions. This was very controversial, since the Kyoto protocol – which only included targets for developed countries – put emphasis on the historic responsibility the developed countries had for the cumulated environmental damages: these countries had caused large amount of the aggregated pollutions and should therefore be burdened with most of the immediate mitigation actions. The developing countries had permission to continue increasing their emissions, since they needed to expand their economy and quality-of-life of their citizens. (Vidal, 2009a)

Vidal (2009a) summarizes *The Danish text* thusly:

1. "Force developing countries to agree to specific emission cuts and measures that were not part of the original UN agreement"
2. "Divide poor countries further by creating a new category of developing countries called 'the most vulnerable'"
3. "Weaken the UN's role in handling climate finance"
4. "Not allow poor countries to emit more than 1.44 tonnes of carbon per person by 2050, while allowing rich countries to emit 2.67 tonnes"

Allegedly, the text was supposed to be used as a guideline in negotiation and work sessions at the start of the conference. Afterwards, when the higher-level political leaders joined the conference, they would finalize the agreement. The text also includes numbers on emission reduction targets how much the developing countries should get in subsidies from the richer countries to help them with their reductions. (Vidal, 2009a)

On the 9th of December, an article where Lumumba Di-Aping, who is the chairman for G77 which is a group of 132 developing countries, was interviewed by The Guardian. In this article, he spoke out about *The Danish Text* and how unfair it is to developing countries. He said "The text robs developing countries of their just and equitable and fair share of the atmospheric space. It tries to treat rich and poor countries as equal." (Vidal, 2009b)

On the 12th of December, a large Protest took place in Copenhagen, where the protesters wanted to urge the politicians to reach an agreement. The Danish police estimated that 30 000 people joined the protest. But around 700 of the protesters were arrested by the police for either throwing rocks or masking their faces, both actions which are in violation of Danish law. At the same time the biggest political figures were about to join the conference – now on its last part – such as Barack Obama, Gordon Brown and Wen Jiabao. Even after the rocky start of the conference, they were able to release a document with different reductions for the developed and developing countries. Just as the Kyoto Protocol the developed countries are supposed to take the largest share of reduction and the developing countries a smaller one. Unfortunately, there is nothing written about the actual quantity of subsidies the developed countries are supposed to give to the developing countries to help them with their emission reductions. (van der Zee & McKie, 2009)

On the 15th of December, another protest happened and 194 protesters were arrested, they had set fire to barricades and thrown fire bombs. To handle this situation the riot police used tear gas. Since the conference started over 1500 arrests had been done and the Danish police has gotten a lot of complaints from how they have handled the situation. (van der Zee, 2009)

Also on the 15th of December, there was a setback in the conference, where about five hours were lost when a group of African developing countries accused the developed countries for trying to get rid of their obligations to the Kyoto protocol. The developed countries on the other hand wants the developing countries to be responsible, mainly China and India both whose greenhouse emissions have steadily grown. The conference now had two drafts, one that is more aligned with the Kyoto protocol the other is more of a break away. Su Wei that is one of

China's negotiator said that: “Developed nations won't come to the table with real numbers. That is the main obstacle preventing progress”, the rift between the developed and developing countries has widened. At the same time the Obama administrations has both given a promise of funding for green technology and they sent more people to negotiate an agreement. (Vidal et al., 2009a)

On the 16th of December, the conference had met many set-backs and was said to be 18 hours behind schedule, as the world leaders were about to arrive. After two years of planning and being such an important event, people all around the globe were concerned that the conference was heading for a failure. It appeared that there was still a big rift between the developed and developing countries that was halting the process, with the developed countries arguing that China and India needs to take responsibility for their emissions. They also argue that the world was not the same as in 1997, when the Kyoto Protocol was signed. (Vidal & Stratton, 2009)

On the 18th of December, the last day of the conference, Obama made a speech at the morning before the last discussions, where he spoke about how the world’s countries needed to come to an agreement, how the US needs to take their responsibility for being the second largest emitter, and that managing the environmental damages that had already been done was a big challenge. He ended his speech with: “We must choose action over inaction; the future over the past – with courage and faith, let us meet our responsibility to our people, and to the future of our planet.” (The Guardian, 2009b)

On the 18th of December, right after the conference were finished, it was said that this was a vital step towards the future and even if it was a difficult conference, it was still a good start. Lumamba Di-Aping did not agree with this and said: “The lowest level of ambition you can imagine. It's nothing short of climate change scepticism in action. It locks countries into a cycle of poverty for ever. Obama has eliminated any difference between him and Bush.” The head of Greenpeace in the UK stated: “The city of Copenhagen is a crime scene tonight, with the guilty men and women fleeing to the airport. (…) It is now evident that mitigating global warming will require a radically different model of politics than the one on display here in Copenhagen.” Lastly Lydia Baker from *Save the Children* claimed that the world leaders “effectively signed a death warrant for many of the world's poorest children. Up to 250,000 children from poor communities could die before the next major meeting in Mexico at the end of next year.” It is quite clear that there was a clear difference between the two groups’ experience of the conference. (Vidal et al., 2009b)

5 ANALYSIS

In the analysis, we will analyse our statistical findings and the different events during the COP15 conference and how we think they effected the conference.

5.1 STATISTICAL FINDINGS

In *Table 4 - CAR values with short estimation window* and *Table 5 - Test statistics with short estimation window*, we can see that the CAR-value of the protest is significant at the ten percent level when it comes to the Chinese solar market under the short estimation window. This date is included in the CAR-window covered by the "public protests". Looking closer at the one-day CAR values, we can see that both Chinese solar and Chinese coal have significant effects on 14th December. To see if there were any confounding events taking place in China at the same time, a search of *The Guardian* was done for the dates between 12th and 14th December with the search terms *china*, *solar*, *coal*, and *energy*. We were unable to find any information which would explain any changes based on this search method. The sign of the coal portfolio is negative, while the sign of the solar portfolio is positive. Looking on the corresponding values of the US portfolios under the short estimation window, we can see no effect for the solar industry (with a p-value of 0.927). The effect on the coal market is more pronounced, albeit not significant at the ten percent level, and carries a positive sign.

Other events in Table 4 and Table 5 show no significant effects for any of the portfolios. The lack of significant effects continues in *Table 6 - CAR values with long estimation window* and *Table 7 - Test statistics with long estimation window*, which show results under the long estimation window: there are no significant effect in either market or industry. The one-day cars under the long estimation window only have a significant effect on 14th December: Chinese coal.

Lastly, we can look at Table 8 through Table 11, where we can see if we have any significant effects on each day for our four portfolios. If we start by exanimating the first table that contains data about the US coal market, there are no significant effects on any day. Then we can look at Table 9 and see that we have one significant effect at the five percent level in the US solar, the date is 10th December. We cannot find anything major happening during this date. If we now look at Table 10 and Table 11, which contains information about the Chinese coal and solar respectively, we can observe three significant days. In Table 10, there are significant effects on 14th of December for both the short and long estimation windows, at five percent significance

level with the short and ten percent level with the long estimation window. Lastly, in Table 11, three significant effect were found: the 14th, the 10th and the 7th, the first two in the ten percent level and the last one in the five percent level. These dates are only significant when useing the short estimation window.

5.2 EVENTS EFFECTING THE CONFERENCE

If we start from the beginning when discussing the event, the expectations was high and many wanted the event to be a success, we can just look at the editorial. Many different new papers from different political backgrounds and countries all stood together to show that the world leaders that this is what the people wanted, a united force against climate change. This could have made it more possible for an agreement to be made.

When the event started, it did not take long before the first setback. When *the Danish text* was leaked, the conference had hardly started and the divide between the developing countries and developed countries had become even more pronounced. This could easily be the start towards them not reaching an agreement since the text had a strong contrast if you compare it to the Kyoto protocol.

The next notable event was when Lumumba Di-Aping spoke out against the organizers and developed countries about *The Danish text.* Since he is a big role-model for many developing countries, him speaking out against the conference probably made the divide bigger between the rich and poor countries and that probably made it more difficult to reach an agreement.

After this there was the start of the biggest protest around the event and many of the protesters was arrested by the police. The protest was as stated before meant to urge the politicians to come to an agreement. We hope that a protest as big as this one would help the politicians to reach an agreement.

Another problem for the conference was when the debate was delayed by five hours when a group of developing countries claimed that the developed countries wanted to get rid of the Kyoto protocol. This and the fact that two drafts were being made, one more in line with the Kyoto protocol and one more aligned with *The Danish text.* All of this effected the discussions negatively and made the divide between richer and poorer countries bigger which could stop an agreement from being made.

When the world leaders were about to join the conference, they were 16 hours after schedule in the discussions and we believe that it is impossible to come to an agreement with that little time left and especially with the giant gap between the developed and developing countries.

Before the last day Obama had a speech about how the world needs to stand together and come to an agreement and that the US will and needs to take their responsibility. Even if this speech would help them to get the agreement needed we think that it was too late in to the conference and that it was impossible to take the next step towards a green future.

6 DISCUSSION

We will now discuss our findings in relation to the two research questions, as well as outline potential issues concerning the chosen methodology. Additionally, ideas for future research are also presented.

6.1 EVENT-STUDY RESULTS

When we chose the CARs to investigate we wanted events were the new information that got released to the public would affect how the participants act on the market. For example, we thought that when *The Danish text* was leaked some participants would sell their solar stocks. This is because we assume that the market is efficient, and that the solar portfolios would react negatively to a decreased probability of a successful agreement of the conference. Conversely, our expectation was that a failure of the conference would be reflected positively in the valuation of the coal portfolios.

As we stated in our analysis we have only one significant CAR-value, which concerns Chinese solar during the period coinciding with a period of public protests during COP15. However, we are uncertain if we can attribute this effect directly to the protests, since no other portfolio show any significant change. The sign of the change for Chinese solar is negative, meaning that, if causality is assumed, the protests would have had a negative effect on the valuation on the portfolio. The authors believe that a show of popular support for getting to a binding agreement should have led to an increase in the value of the solar portfolio. If the protests put more pressure on the politicians – increasing the likelihood of an agreement – the expectation is that renewable energy sources would be benefitted. From our results, it appears that the opposite is true. If we consider the protest to be the only event that would influence the portfolio's value during this period, this means that either (i) the public show of support was interpreted being a negative contribution to getting an agreement, or (ii) that an agreement would be a negative outcome for solar companies in China. Neither of these alternatives are very attractive. Therefore, we are hesitant to attribute the change of the portfolios valuation to the public protests during COP15. Other confounding events, external to the environment presented in this thesis, are likely to have a been a driver of the change.

Our one day CARs had some significant effect but we cannot say if they are reliable since we are not sure when the information becomes public and the event takes place. It is also possible that something affected the markets those days and which had nothing to do with the climate

conference. Therefore, we cannot be certain that these observed market effects stem from the COP15 conference.

We think that it could be that these conferences are not the clearest sign that the international society are making progress towards climate change mitigation. Perhaps the markets are moving towards more sustainable operations on their own: as demand solar increases and demand for coal declines, the rent-bearing opportunities of each industry become more respectively less attractive. The companies may not have time to wait for politicians to come to an agreement before the time for action has already passed. Political actions and negotiations, such as the COP15 conference has a role to play, but the immediate day-to-day impacts of such multilateral negotiations are perhaps too indistinct to be measurable through the event-study methodology. That the world is moving towards climate change mitigation is not something that is determined solely through Conference of the Parties, but something that is inherent to modern society. To quote Kunelius & Eide (2012): "[Climate change] has emerged as an essential discursive element of the global environment in which people, institutions and nations act."

6.2 EVENTS SELECTED DURING THE COP15 CONFERENCE

The selection of events for the CAR-windows are largely subjective, as they are chosen based on what was believed to be impactful events which would affect the stock market. There could be other events that could have had a part in why the conference failed. For example, there could have been events prior to the conference starting signalling that the conference was poorly planned or prepared, which could have reduced the confidence in the conference's ability to reach an agreement. However, if there were events during the conference which were not included in the study, we do not believe that those events would lead to more significant results than the ones presented in this thesis. There were many factors that affected the outcome, and we believe that it was not just one specific day that solidified the outcome of the conference.

6.3 EVENT-STUDY METHODOLOGY

Event studies does not have a clear and fixed methodology, differing significantly from author to author. There is continuous argumentation for why one method should be picked above another. However, we have found that minor alterations seem to have a low effect on the end results. We decided to use the market adjusted returns to calculate the predicted values of our

stocks instead of using the mean adjusted returns mostly because what we have found the market adjusted model produces more powerful results. We have also had trouble finding literature that use event studies the same way we intend to, i.e. to analyse the effect on a temporally limited political event.

To ensure that the test has sufficient power to find abnormal effect, the number of securities included in the portfolios should be quite high. However, our search for companies to include in the four portfolios did not produce a large sample size. Either our methodology for finding the companies were flawed, or the number of companies in these industries are too limited. For the solar portfolios, the difficulty of finding a sufficient number of companies could also stem from the industry being fairly new, especially in 2009 when the COP15 conference took place. Equally, the coal industry might also have some factors which limits the number of available companies. In the United States of America, the market is mature, where smaller coal producers have been acquired by larger ones. Thus, the number of available companies for us to study are reduced. In China, we did find a decent number of companies through our methodology. However, the issue in this market is that some of the largest companies are state-owned, which disqualifies them from being included in this study.

Another instance which reduces the power of our test is the presence of event clustering. In event studies, such clustering reduces the power of the test. Clustering is when you have events which affect all securities of the portfolio at the same time. Since we look at the same event but for different stocks, clustering is unavoidable. Unfortunately, we cannot escape this: even if we use more stocks the clustering will still be there and effect our tests' power. Some authors suggest using non-parametric tests, or making other more advanced adjustments as a way to increase the power of the event study.

Initially, we only had the longer estimation window. However, the proximity of the 2007–2008 financial crash caused uncertainty whether this longer estimation window would include too many negative effects which could depress the normal returns during the event window. Therefore, we elected to include a shorter estimation window as well, positioning this as close as possible to the event itself. Comparing the results from the two estimation windows, we can see that we have more significant results from the short estimation window. Attributing this to either the financial crash, or to the lesser number of days included to form a benchmark, is not trivial.

Because of the fact that we assume that the stock market has Semistrong-form of efficiency, every participant will know and act as best as possible with the information they have and everyone knows the public information. Unfortunately, some participants will have obtained private information which they can act on: they could for example have a source at the conference that tells them what is going on before the media has reported it to the public. To observe this, we added one day before the events we wanted to examine in our CARs just to catch the leaked information. We also wanted to add a couple of days after the events since it could take some time before the participants understand the information i.e. it takes some time before the information is public.

6.4 FUTURE RESEARCH

In the future, we think it would have been interesting to see if our results match those from other countries or regions. We would have liked to see how other developed countries' markets behaved. Markets in Europe would have been interesting to observe, as these countries often try to position themselves as progressive in relation to issues about climate change. In addition, Germany would be interesting to include for its historic reliance on coal, but current leadership in solar power deployment. In addition, aggregating securities across

the EU can potentially provide many separate securities. Other countries that would have been rewarding to observe could be other developing countries, such as Brazil, Russia, and perhaps in particular India. We also believe that this type of research can be expanded to other industries beyond solar and coal. Some examples could be wind-energy, hydro-power, oil or natural gas.

Lastly studying other climate conferences would be very rewarding, if there was research observing the Paris Agreement or the Kyoto Protocol or just other days in this conference it could be possible to understand how these conferences effect the market.

7 CONCLUSION

The purpose of this thesis was: *To investigate if the 2009 United Nations Climate Change Conference had any noticeable impact on the valuation of companies in the coal & solar industries in China and the United States of America*.

None of the four portfolios we chose to investigate yielded any significant results that can be used to support the claim that the outcome of the 2009 United Nations Climate Change Conference had an effect on the markets. One significant effect (at the ten percent level) was found with a negative effect for the Chinese solar portfolio during the period of heavy protest during the conference. However, the effects were contrary to what the authors believe intuitive: clear public support for climate change mitigation action would be a positive effect for renewable energy industries. Therefore, we are hesitant in attributing the effect to the studied events during COP15. When controlling for the effect, this study could not find any colluding effects during the same time period.

The authors believe that the results of large multilateral negotiation on climate change has little direct impact on the valuation of companies in the industries assumed related to climate change. These conferences do play a role in the long term, but the changes are likely very granular when looking at the day-to-day valuation of companies. It seems more plausible that the growing demand for cleaner products & energy sources is exerting pressure on the industries, establishing a momentum of change.

It seems as it was not just one major singular event during the 2009 United Nations Climate Change Conference that to led to the politicians not coming to a binding agreement. We believe that a series of unfortunate events, combined with poor planning and preparatory work, all lead to the conference ending without an agreement, and thus being described to be a failure.

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APPENDIX

I. COMPANIES IN PORTFOLIO: US COAL

Table 12 - Companies in portfolio: US Coal

Country	Industry	Ticker	Name
US	Coal	ACIIQ / ARCH / ACI	Arch Coal INC
US	Coal	ANRZQ (Delisted)	Alpha Natural resources INC
US	Coal	ARLP	Alliance resource Partners LP
US	Coal	BTUUQ (Delisted)	Peabody energy
US	Coal	CNX	Consol energy INC.
US	Coal	ICO US	International Coal Group Inc
US	Coal	JRCCQ US	James River Coal Company
US	Coal	MEE US	Massey Energy Company
US	Coal	NRP US	Natural resource partners
US	Coal	PCXCQ	Patriot Coal Corporation
US	Coal	WLB US	Dakota Westmoreland corp
US	Coal	WLTGQ US	Walter energy

II. COMPANIES IN PORTFOLIO: US SOLAR

Table 13 - Companies in portfolio: US Solar

Country	Industry	Ticker	Name
US	Solar	ASTI US	Ascent Solar Technologies
US	Solar	FSLR US	First Solar Inc.
US	Solar	GTATQ US	GT Advanced Tech
US	Solar	RGSE US	Real Goods Solar (RGS) Energy
US	Solar	RNWEF US	REC Silicon ASA
US	Solar	SPIR US Equity	Spire US Equity
US	Solar	SPWR US	SunPower
US	Solar	SUNEQ	SunEdison INC
US	Solar	WEST US Equity	ANDALAY SOLAR Inc

III. COMPANIES IN PORTFOLIO: CHINESE COAL

Table 14 - Companies in portfolio: Chinese Coal

Country	Industry	Ticker	Name
China	Coal	000552 CH	Gansu Jingyuan
China	Coal	000723 CH	Shanxi Meijin
China	Coal	000780 CH	Inner Mongolia Pingzhuang Energy Co Ltd
China	Coal	000937 CH	Jizhong Energy Resources Co Ltd
China	Coal	000968 CH	Taiyuan Coal gasification
China	Coal	000983 CH	Shanxi Xishan
China	Coal	002128 CH	Huolinhe opencut coal industry
China	Coal	1088 HK	China Shenhua Energy
China	Coal	1171 HK	Yanzhuo Coal mining
China	Coal	1898 HK	China Coal energy company
China	Coal	600098 CH	Guangzhou Development Group Inc
China	Coal	600121 CH	Zhangzhou Coal Industry & Electric Power Co Ltd
China	Coal	600348 CH	Yang Quan Coal Industry
China	Coal	600395 CH	Guizhuo Panjia
China	Coal	600397 CH	Anyuan Coal Industry Group Co Ltd
China	Coal	600508 CH	Shanghai Datun Energy Resources Co Ltd
China	Coal	600546 CH	Shanxi coal international energy group
China	Coal	600971 CH	Anhui Hengyuan-A
China	Coal	600997 CH	Kailuan energy-A
China	Coal	601001 CH	Datong Coal Industry
China	Coal	601666 CH	Pingdingshan
China	Coal	601699 CH	Shanxi Lu'an Environmental Energy Development
China	Coal	601918 CH	China Coal Xinji Energy
China	Coal	900948 CH	Inner Mongolia Yitai Coal Co ltd

IV. COMPANIES IN PORTFOLIO: CHINESE SOLAR

Table 15 - Companies in portfolio: Chinese Solar

Country	Industry	Ticker	Name
China	Solar	002218 CH	Shenzhen Topra
China	Solar	155 HK	China solar energy holdings limited
China	Solar	3800 HK	GCL Poly Energy
China	Solar	757 HK	Solargiga Energy Holdings Ltd
China	Solar	CSUNY US	China Sunergy
China	Solar	JASO US	JA Solar Holdings Co Ltd
China	Solar	LDKYQ US	LDK Solar CO
China	Solar	SOL US	Renesola LTD
China	Solar	TSL US	Trina Solar Ltd
China	Solar	YGE US	Yingli Green Energy

V. POST-EVENT ONE-DAY CAR VALUES, US COAL

Table 16 - Post-event one-day CAR values, US Coal

Portfolio US-C		**Short est. Window**			**Long est. Window**		
Date	Event day	CAR	T-value	P-value	CAR	T-value	P-value
2010-02-01	31	0.227	1.31	0.190	0.22	0.72	0.469
2010-01-29	30	-0.513	-2.96	0.003***	-0.54	-1.78	0.075*
2010-01-28	29	0.198	1.14	0.253	0.17	0.55	0.584
2010-01-27	28	-0.181	-1.04	0.296	-0.20	-0.64	0.521
2010-01-26	27	0.079	0.46	0.646	0.06	0.18	0.855
2010-01-25	26	0.052	0.30	0.763	0.04	0.12	0.904
2010-01-22	25	0.163	0.94	0.345	0.12	0.40	0.688
2010-01-21	24	-0.208	-1.20	0.228	-0.25	-0.81	0.419
2010-01-20	23	-0.007	-0.04	0.966	-0.04	-0.12	0.903
2010-01-19	22	-0.005	-0.03	0.978	-0.01	-0.04	0.967
2010-01-18	21	N/A	N/A	N/A	N/A	N/A	N/A
2010-01-15	20	-0.007	-0.04	0.967	-0.04	-0.12	0.903
2010-01-14	19	-0.169	-0.98	0.328	-0.19	-0.61	0.540
2010-01-13	18	-0.074	-0.43	0.667	-0.09	-0.28	0.778
2010-01-12	17	0.172	0.99	0.321	0.14	0.47	0.638
2010-01-11	16	-0.121	-0.70	0.484	-0.14	-0.46	0.648
2010-01-08	15	0.188	1.08	0.278	0.17	0.56	0.575
2010-01-07	14	-0.107	-0.62	0.538	-0.12	-0.40	0.688
2010-01-06	13	0.412	2.38	0.017**	0.39	1.29	0.198
2010-01-05	12	0.274	1.58	0.114	0.26	0.84	0.399
2010-01-04	11	0.265	1.53	0.126	0.26	0.86	0.392
2010-01-01	10	N/A	N/A	N/A	N/A	N/A	N/A
2009-12-31	9	0.071	0.41	0.680	0.04	0.14	0.891
2009-12-30	8	-0.075	-0.43	0.666	-0.09	-0.31	0.757
2009-12-29	7	-0.111	-0.64	0.523	-0.13	-0.43	0.666
2009-12-28	6	-0.068	-0.39	0.696	-0.09	-0.28	0.777
2009-12-25	5	N/A	N/A	N/A	N/A	N/A	N/A
2009-12-24	4	-0.055	-0.32	0.749	-0.07	-0.23	0.819
2009-12-23	3	0.341	1.97	0.049**	0.32	1.06	0.289
2009-12-22	2	0.205	1.19	0.236	0.19	0.62	0.535
2009-12-21	1	-0.113	-0.65	0.514	-0.12	-0.40	0.688

* 10% significance level, ** 5% significance level, *** 1% significance level

VI. POST-EVENT ONE-DAY CAR VALUES, US SOLAR

Table 17 - Post-event one-day CAR values, US Solar

Portfolio US-S		**Short est. Window**			**Long est. Window**		
Date	Event day	CAR	T-value	P-value	CAR	T-value	P-value
2010-02-01	31	N/A	N/A	N/A	N/A	N/A	N/A
2010-01-29	30	-0.041	-0.20	0.838	-0.06	-0.18	0.853
2010-01-28	29	-0.164	-0.82	0.414	-0.19	-0.59	0.558
2010-01-27	28	-0.063	-0.31	0.755	-0.07	-0.22	0.823
2010-01-26	27	0.081	0.40	0.686	0.09	0.27	0.786
2010-01-25	26	0.021	0.11	0.915	0.01	0.04	0.967
2010-01-22	25	-0.445	-2.21	0.027**	-0.45	-1.43	0.152
2010-01-21	24	-0.105	-0.52	0.601	-0.13	-0.40	0.690
2010-01-20	23	-0.175	-0.87	0.386	-0.16	-0.52	0.605
2010-01-19	22	0.034	0.17	0.865	0.01	0.04	0.970
2010-01-18	21	0.032	0.16	0.872	0.01	0.03	0.977
2010-01-15	20	-0.229	-1.13	0.256	-0.25	-0.79	0.431
2010-01-14	19	-0.164	-0.81	0.416	-0.20	-0.62	0.536
2010-01-13	18	-0.018	-0.09	0.927	-0.01	-0.02	0.984
2010-01-12	17	-0.348	-1.73	0.084*	-0.39	-1.21	0.225
2010-01-11	16	0.051	0.25	0.799	0.03	0.08	0.933
2010-01-08	15	0.050	0.25	0.805	0.03	0.09	0.926
2010-01-07	14	-0.058	-0.29	0.774	-0.06	-0.18	0.855
2010-01-06	13	0.170	0.84	0.398	0.16	0.50	0.616
2010-01-05	12	0.285	1.41	0.158	0.25	0.80	0.425
2010-01-04	11	0.260	1.29	0.197	0.25	0.79	0.430
2010-01-01	10	N/A	N/A	N/A	N/A	N/A	N/A
2009-12-31	9	-0.059	-0.29	0.771	-0.08	-0.26	0.796
2009-12-30	8	-0.117	-0.58	0.560	-0.15	-0.48	0.632
2009-12-29	7	0.317	1.58	0.115	0.29	0.92	0.360
2009-12-28	6	-0.080	-0.40	0.691	-0.11	-0.36	0.719
2009-12-25	5	-0.047	-0.24	0.814	-0.06	-0.20	0.844
2009-12-24	4	-0.050	-0.25	0.803	-0.10	-0.30	0.764
2009-12-23	3	0.010	0.05	0.960	-0.02	-0.05	0.958
2009-12-22	2	0.173	0.86	0.390	0.18	0.56	0.577
2009-12-21	1	0.292	1.45	0.148	0.27	0.85	0.396

* 10% significance level, ** 5% significance level, *** 1% significance level

VII. POST-EVENT ONE-DAY CAR VALUES, CHINESE COAL

Table 18 - Post-event one-day CAR values, Chinese Coal

Portfolio C-C		**Short est. Window**			**Long est. Window**		
Date	Event day	CAR	T-value	P-value	CAR	T-value	P-value
2010-02-01	31	-0.443	-1.64	0.101	-0.496	-1.37	0.171
2010-01-29	30	-0.171	-0.63	0.528	-0.192	-0.53	0.596
2010-01-28	29	0.061	0.23	0.822	0.034	0.09	0.924
2010-01-27	28	0.315	1.17	0.244	0.275	0.76	0.448
2010-01-26	27	-0.233	-0.86	0.389	-0.286	-0.79	0.429
2010-01-25	26	0.087	0.32	0.748	0.048	0.13	0.895
2010-01-22	25	-0.372	-1.38	0.169	-0.409	-1.13	0.259
2010-01-21	24	-0.513	-1.90	0.058*	-0.525	-1.45	0.147
2010-01-20	23	-0.038	-0.14	0.888	-0.102	-0.28	0.778
2010-01-19	22	0.079	0.29	0.771	0.055	0.15	0.878
2010-01-18	21	-0.188	-0.69	0.487	-0.201	-0.55	0.579
2010-01-15	20	-0.093	-0.34	0.732	-0.111	-0.31	0.760
2010-01-14	19	-0.270	-1.00	0.318	-0.271	-0.75	0.455
2010-01-13	18	-0.102	-0.38	0.707	-0.165	-0.46	0.649
2010-01-12	17	-0.439	-1.62	0.105	-0.430	-1.19	0.236
2010-01-11	16	-0.333	-1.23	0.218	-0.351	-0.97	0.333
2010-01-08	15	-0.366	-1.35	0.176	-0.389	-1.07	0.284
2010-01-07	14	0.092	0.34	0.734	0.040	0.11	0.912
2010-01-06	13	0.305	1.13	0.260	0.264	0.73	0.466
2010-01-05	12	0.412	1.52	0.127	0.399	1.10	0.271
2010-01-04	11	0.159	0.59	0.558	0.119	0.33	0.742
2010-01-01	10	N/A	N/A	N/A	N/A	N/A	N/A
2009-12-31	9	-0.230	-0.85	0.394	-0.254	-0.70	0.483
2009-12-30	8	-0.503	-1.86	0.063*	-0.501	-1.38	0.167
2009-12-29	7	-0.150	-0.55	0.580	-0.162	-0.45	0.655
2009-12-28	6	-0.134	-0.50	0.620	-0.132	-0.36	0.715
2009-12-25	5	-0.023	-0.08	0.933	-0.054	-0.15	0.882
2009-12-24	4	0.422	1.56	0.119	0.437	1.21	0.228
2009-12-23	3	0.049	0.18	0.856	0.033	0.09	0.927
2009-12-22	2	-0.444	-1.64	0.101	-0.509	-1.40	0.161
2009-12-21	1	-0.171	-0.63	0.527	-0.185	-0.51	0.609

* 10% significance level, ** 5% significance level, *** 1% significance level

VIII. POST-EVENT ONE-DAY CAR VALUES, CHINESE SOLAR

Table 19 - Post-event one-day CAR values, Chinese Solar

Portfolio C-S		**Short est. Window**			**Long est. Window**		
Date	Event day	CAR	T-value	P-value	CAR	T-value	P-value
2010-02-01	31	0.169	0.81	0.416	0.15	0.43	0.669
2010-01-29	30	-0.052	-0.25	0.801	-0.10	-0.28	0.781
2010-01-28	29	0.046	0.22	0.826	-0.01	-0.03	0.979
2010-01-27	28	-0.299	-1.44	0.150	-0.33	-0.96	0.336
2010-01-26	27	0.169	0.81	0.418	0.14	0.40	0.692
2010-01-25	26	0.180	0.86	0.387	0.15	0.44	0.659
2010-01-22	25	-0.260	-1.25	0.211	-0.32	-0.93	0.351
2010-01-21	24	-0.056	-0.27	0.787	-0.11	-0.31	0.756
2010-01-20	23	0.052	0.25	0.802	0.01	0.03	0.978
2010-01-19	22	-0.203	-0.97	0.330	-0.23	-0.67	0.505
2010-01-18	21	-0.032	-0.16	0.876	-0.05	-0.13	0.894
2010-01-15	20	-0.164	-0.79	0.429	-0.21	-0.62	0.537
2010-01-14	19	-0.394	-1.90	0.058*	-0.43	-1.25	0.213
2010-01-13	18	-0.147	-0.71	0.478	-0.17	-0.49	0.627
2010-01-12	17	-0.158	-0.76	0.449	-0.20	-0.59	0.555
2010-01-11	16	0.135	0.65	0.517	0.10	0.29	0.772
2010-01-08	15	0.079	0.38	0.705	0.05	0.13	0.894
2010-01-07	14	-0.120	-0.58	0.563	-0.15	-0.44	0.661
2010-01-06	13	0.222	1.07	0.286	0.18	0.54	0.591
2010-01-05	12	0.315	1.51	0.130	0.28	0.81	0.421
2010-01-04	11	0.162	0.78	0.437	0.14	0.42	0.673
2010-01-01	10	N/A	N/A	N/A	N/A	N/A	N/A
2009-12-31	9	0.010	0.05	0.960	-0.04	-0.13	0.900
2009-12-30	8	-0.093	-0.45	0.655	-0.13	-0.37	0.709
2009-12-29	7	-0.026	-0.12	0.902	-0.06	-0.18	0.854
2009-12-28	6	0.105	0.50	0.615	0.07	0.21	0.835
2009-12-25	5	-0.001	-0.01	0.996	-0.01	-0.02	0.986
2009-12-24	4	-0.057	-0.28	0.783	-0.09	-0.26	0.793
2009-12-23	3	0.077	0.37	0.710	0.04	0.12	0.906
2009-12-22	2	-0.085	-0.41	0.682	-0.12	-0.35	0.724
2009-12-21	1	0.139	0.67	0.504	0.12	0.35	0.728

* 10% significance level, ** 5% significance level, *** 1% significance level