Status Quo Effects In Bargaining: An Empirical Analysis of OPEC

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Abstract

We conduct an event analysis on OPEC quota announcements to determine their impact on the stock returns in the oil industry. We find that announcements to reduce the quota are followed by positive excess returns over pre-announcement levels, announcements of no action are met with negative excess returns and announcements to increase the quota have no significant impact on stock market returns. This suggests that there is an asymmetric ability on the part of OPEC to secure agreements. In particular, when demand has increased, agreements are easily forthcoming, while when times are bad the probability of a disagreement is substantially higher. We present further empirical as well as anecdotal evidence to support our interpretation. Finally, we present two simple models of asymmetric information which make predictions consistent with our empirical findings. In the first model, disagreements arise due to a perceived lack of commitment to the agreed upon quota due to the possibility of random shocks. The second model takes a behavioural approach; in particular, disagreements arise because players place more emphasis on their individual quotas than strict profit maximisation dictates.
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1 Introduction

A number of papers, dating from Griffin [1985] to Ramcharran [2002] have tried to describe OPEC behaviour according to one of four competing hypotheses — a competitive model, a cartel model, a target revenue model or a property rights model. For the most part, these studies use OPEC production data to estimate a supply curve for OPEC oil. For example, support is given to the cartel model if a negative relationship is found between price and OPEC production, indicating a backward bending supply curve. Both the economics and politics of oil are much in the news lately, and given the continued importance that oil has in our economy, it is important to understand the behaviour of OPEC — in particular, what motivates its decisions.

The present paper strays from much of the previous literature examining OPEC. There is less to be gained from another study estimating the supply curves of OPEC members than other approaches. We take for granted that OPEC is a cartel that seeks to influence oil prices for the

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benefits of its members. However, we take seriously the fact that OPEC is not a monolithic body, but rather a collection of diverse interests which must negotiate any changes to its production schedule. To this end, there is much to be learned about OPEC through their announced decisions. We may then study how markets react to such announcements made by OPEC to glean relevant information about OPEC's decision-making capabilities. However, one will not find OPEC listed on any stock market. Therefore, in order to conduct such an analysis, we rely on the close relationship between OPEC and various groups of oil companies. We conduct an event study to analyse the impact that OPEC announcements have on the stock market returns of certain groups of oil companies. As is standard in event studies, we measure the impact of announcements by examining the pattern of abnormal returns in the days surrounding each event. More specifically, we divide OPEC announcements into three classes: (1) increases in the quota, (2) decreases in the quota and (3) no change in the quota. We then examine how the stock market indices of oil industry groups respond to each class of announcement. Upon presenting the results, we argue that they offer us interesting insights into the behaviour of OPEC and their decision-making apparatus — as the title of the paper suggests, we find evidence that the status quo is given extra significance in certain states of the world.

The paper presents two key results. Our first result is something of a negative result. In particular, we find no evidence of abnormal returns, either positive or negative, when OPEC announces an increase in the quota. Our second result is that significant abnormal returns do accrue following both status quo announcements and announcements of reductions in the quota. However, matters are not so simple. In the case of status quo announcements, we find significantly negative abnormal returns, while for quota reductions we find significantly positive abnormal returns. These results immediately suggest that the market is surprised by status quo announcements and quota reductions, but not by announcements of increases in the quota. Both of these results are quite consistent across the four sub-sectors of the oil industry that we consider.[1] However, why should status quo announcements lead to negative returns, while reductions lead to positive excess returns?

As we have said, our examination of OPEC behaviour is indirect, relying on an as yet unexplained relationship between OPEC and Western oil companies. Therefore, to put the results in the correct context and begin providing answers, we must explain this relationship. Of course all oil companies[2] are significantly dependent on the price of oil for their profitability. Thus by adjusting its production in an attempt to influence oil prices, OPEC affects the profitability of these oil companies. In particular, any action taken by OPEC that leads to higher revenues for it should be positively correlated with the profitability of oil companies. This relationship becomes even stronger if the company in question has operations in an OPEC-member country. This is because the typical arrangement between the two is rather similar to sharecropping.[3] Thus, if OPEC acts in a way to increase its profits, it should also increase the profits of the companies.

Let us consider the implications for each of the three possible announcements. To begin, consider status quo announcements; one can imagine three possible reasons for such announcement. First, neither demand nor supply conditions have changed substantially to require a change in production. This should not lead to any excess returns, positive or negative. Second, perhaps demand has gone up substantially so that production should be increased. Given the apparent positive correlation between oil prices and stock market returns, such a status quo announcement would surely lead to positive excess returns. Finally, perhaps demand has decreased so that the

[1] In particular, we conduct our event study on stock market indices for (1) the oil industry as a whole, (2) exploration and production companies, (3) service companies and (4) integrated oil companies.

[2] Specifically, those which drill, produce and/or explore for crude oil. Refiners or integrated companies with refining operations relying significantly on purchased oil will have a rather different relationship with OPEC.

[3] For example, Chevron-Texaco holds a 40 percent interest in oil fields offshore the Niger Delta. They note, "In addition, the Nigerian government levies taxes and royalties on Chevron's revenues and oil production, such that total Nigerian revenue from the partnership exceeds 85 percent. This is typical of overseas oil operations in which the government is the primary partner."

quota should be reduced. In this case a status quo announcement would lead to negative excess returns. But there is even more to consider. We should not witness *any* excess returns unless the market is taken by surprise by the announcement. Therefore, our result regarding status quo announcements indicates two things. First, status quo announcements are a surprise to the market and, second, they generally occur in periods of weak or falling demand.

Now consider announcements to reduce the quota. Our result is that these lead to positive abnormal returns. First, as above, given the presence of any abnormal returns, this must imply that the market is surprised by such announcements. Second, the fact that these excess returns are positive means that such announcements are typically also made during periods of weak or falling demand. In this case, any action by OPEC to raise the price of oil should provide a positive boost to the profitability of the oil companies we consider. Finally, consider announcements to increase the quota. Here we do not find any evidence of excess returns, either positive or negative. This suggests that the stock market accurately predicts such announcements and is not surprised when they finally come about.

Return now to the big picture and consider our empirical results as a whole. They suggest that we may consider a two state world — one state for good times and one for bad times. Our result of no excess returns suggests that agreements are easily forthcoming in the good state of the world. In contrast our dual result of negative abnormal returns following status quo announcements and positive abnormal returns following reductions indicates greater uncertainty regarding the probability of agreement in the bad state of the world. That is, suppose that demand has decreased so that the profitable thing for OPEC to do is lower the overall quota. The market sees the negative demand shock and then forms expectations on whether or not OPEC will agree to a reduction; however, these expectations are held more tentatively than in the case where demand has increased. Thus when the announcement is made, the market reacts to either outcome and abnormal returns of the kind we have discussed are likely to occur.

At a more abstract level, we have a situation in which a group of agents interact repeatedly through time in a constantly changing environment. Furthermore, their interaction is such that the probability of agreement is asymmetric with respect to the observed movement in demand. Our OPEC study provokes a more general theoretical point. Suppose that a group of agents is repeatedly attempting to write binding agreements in a constantly changing environment. It appears that *improvements* in the environment are more conducive to agreement: individual agents are happy enough with the improvement *per se* that they do not fight too hard over the precise division of the surplus. In contrast, a deterioration in the environment, one that calls for belt-tightening all around, will cause a greater outcry as agents are more inclined to contest the exact terms of the reduction.[4] Our analysis can be seen as providing substantive support for this sort of behaviour.

Standard theory, or variations thereof, do not seem to do very well in explaining this phenomenon. Indeed, when confronted with a situation such as the one we have described, one is immediately drawn to the works of Rotemberg and Saloner [1986] and Haltiwanger and Harrington [1991] as a potential explanation. These studies concluded that the maximal amount of sustainable collusion must vary over the business cycle. To see this, consider the iid demand case of Rotemberg and Saloner [1986] in which firms are Bertrand Competitors. Suppose that demand is high and the cartel seeks to implement the monopoly price. In this situation, the gain from undercutting the monopoly price is very high, and in fact, increasing with demand. Furthermore, next period demand is expected to be lower and so the punishments available to prevent deviations are weaker. Thus full collusion may not be possible when demand is high. However, as we will argue below, one cannot apply these authors' results. Neither model generates equilibrium path disagreements. Our results of significant abnormal returns indicate that the market is taken by surprise by certain announcements. Therefore, it is clear that any model without disagreements along the equilibrium path cannot explain completely our results.

What could be at play then which causes agreements to be more likely in good times than in

[4]For an academic example close to home, think of university budget cuts and the more intense scrutiny these receive from individual departments, relative to budget expansions.

bad times? For cartel members to refuse any reduction in their quotas when demand has fallen but accept an increase in their quota from a similar-sized increase in demand a wedge must be placed in such a way that there is a trade-off between the higher profits of an optimally set, but reduced, quota and the quota itself. Reference points seem particularly well-suited to this goal. Indeed, with some care one can write a reference point-based model which is capable of generating predictions consistent with our empirical findings and which is similar in spirit to some ideas found in the psychology and economics literature.[5]

The paper proceeds as follows. In the next section we briefly present the event study methodology, while in section 3 we provide the main empirical results and a more detailed interpretation than we have given thus far. We conclude section 3 with further empirical evidence in favour of our interpretation. In particular, for each status quo announcement we forecast the two-month forward price of oil using data up to the month of the OPEC meeting. The results obtained indicate that prices are predicted to fall, suggesting weak demand. Thus, as argued in our interpretation, status quo announcements overwhelmingly occur during bad times. In section 4 we take pains to demonstrate two things. First, we provide the results of some statistical tests which demonstrate that our empirical results are robust. Second, we present some anecdotal evidence which suggests that, as argued, OPEC finds it much more difficult to agree during bad times rather than in good times.[6]

In section 5 we turn to a more theoretical discussion. After arguing that standard models are incapable of predicting the appropriate pattern of agreements and disagreements, we present the first of two simple models which accurately predict our main empirical finding. In this model, with some probability, a cartel member may experience an adverse shock and lose the ability to commit not to deviate from the agreed upon quota. However, the cartel can still prevent deviations from the agreement through punishments which would be enforced upon seeing a deviation. Therefore, the cartel has two issues about which it must worry. The first is simply that it wants to sustain the highest possible level of profits for its members, while the second is that it wants to reduce the risk that a cartel member which experienced a shock will actually deviate. When demand increases it is clear that there is no trade-off between these two goals. Increasing the quota will raise the static profits of the cartel members *and* will lessen the static gain to be had from any deviation. In contrast, when demand decreases the cartel faces a trade-off. Reducing the quota increases the profits of the cartel members *but* also it increases the gains from a deviation. Therefore, if a cartel member has has strong enough beliefs that another member of the cartel has experienced a large shock, it will vote against any reduction in the quota.

We then proceed to a behavioural model which generates similar predictions regarding the nature of agreements, but which strays further from standard economic models. In the model considered there, disagreements arise because cartel members attach property rights to their quotas, so that the quota enters separately into the utility function. Then, following a decrease in demand, cartel members are willing to sacrifice efficiency for maintaining property rights. In contrast, when demand increases, there is no tradeoff between efficiency and property rights and so agreements can always be implemented. Moreover, by choosing the evolution of property rights, the model is capable of handling other issues which also seem empirically relevant — notable among them is the relative status of a cartel member. We find the intuition developed in this part of the paper quite attractive and rather more general than the specific example of OPEC considered here. After contrasting the models of sections 5, section 6 concludes the paper by arguing that a similar intuition can be found in many other situations such as labour negotiations. Relevant figures and tables are, for the most part, relegated to appendices.

[5]We refer the reader to Bazerman [1985], Bazerman and Carroll [1987], Zajac [1995] and to section 5.3 of the present paper for more details.

[6]In an appendix we also report the results of a similar event study where we consider the effect of the three announcements on oil prices and on a selection of refiners. We also try to eliminate the possibility that the results are driven by the behaviour of Saudi Arabia.

2 Empirical Methodology

Event studies have been a popular empirical tool in many fields for a great many years. A summary of the standard method can be found in Campbell *et al* [1997]; however, for completeness, we give a brief description. Initially, consider an event which occurred at time T^* and is believed to have an impact on the returns of stock i. We proceed in two steps. First, we must get an estimate of the normal returns of stock i. To do this we estimate:

$$R_{it} = \alpha + \beta R_{mt} + \epsilon_{it} \tag{1}$$

over the period $t = T^* - K - L_1, \ldots, T^* - L_1 - 1$, where L_1 is the number of days before the event in our window, K is the *normal returns* estimation period and R_{mt} denotes the market return at time t. In studies with stock prices, K is typically taken to be 250 or 150 (Campbell *et al* [1997]). Second, we calculate abnormal returns during the event window as:

$$\hat{\epsilon}^*_{it} = R_{it} - \hat{\alpha} - \hat{\beta} R_{mt} \tag{2}$$

where here $t = T^* - L_1, \ldots, T^* + L_2$, and L_2 is the number of days after the event.

Now consider a collection of events which occurred at times $t_1, \ldots, t_N$ and define ϵ^*_{ij} to be the vector of estimated abnormal returns for event j and stock i. Then define

$$\overline{\epsilon}^*_i = \frac{1}{N} \sum_{j=1}^{N} \epsilon^*_j$$

to be the sample average of abnormal returns for a sample of N events.Finally define the cumulative abnormal return (CAR) for stock i to be:

$$\overline{CAR}_i(t) = \sum_{k=T^*-L_1}^{t} \overline{\epsilon}^*_i(k)$$

where $t = T^* - L_1, \ldots, T^* + L_2$ and $\overline{\epsilon}^*_i(k)$ is the k^{th} element of the vector $\overline{\epsilon}^*_i$. Then, using standard techniques we can test for significance of abnormal returns and cumulative abnormal returns over the event window.

This method has been shown to be quite robust to certain deviations from the normality assumption on the errors but it still suffers from a number of drawbacks which we would like to remedy in the present analysis. As in most event studies, we have the problem of choosing the appropriate event window. We do not have a general data-driven method for calculating the window; instead, we conform to most event studies and experiment with windows of various length ranging from 1 to 20 days on either side of the event. Another concern is that the event window is chosen to be the same across all firms and all events in the study. While making the analysis tractable and easy to estimate, it is likely not true. One might believe that some firms have closer relations with OPEC and so information may leak out sooner than with other firms. To avoid issues such as this we prefer to use indices of energy companies (*e.g.,* service companies, exploration companies, *etc.*) rather than individual firms. Finally, the standard method has also been criticised because it does not account for changes in variance due to increased uncertainty during the event period (see Lockwood and Kadiyala [1988]). However, as reported in section 4 tests for changes in variance indicate that this is not a significant problem in the present setting.

3 Empirical Results

Our events are announcements by OPEC regarding their production quotas. Announcements are divided into three types — quota reductions, quota expansions and status quo announcements. We have data from 1986, when the current quota system was agreed upon, through to September

2002. As mentioned above, OPEC typically has between two and four regularly scheduled meetings but at times will announce *extraordinary* meetings if it believes market conditions are particularly uncertain.[7] Our sample contains 50 announcements by OPEC. 12 of these announcements are for reductions, 16 for increases and 22 maintain the status quo quota.[8] Our stock market data includes market indices for service companies, integrated companies, exploration & drilling companies as well as oil companies as a whole and we take as our market basket the S&P 500.[9] Daily data from 1 January 1986 to 30 September 2002 were obtained from Datastream.

In the main text, we restrict our attention to these groups of oil companies. However, it is intuitively clear that part of the influence OPEC announcements have on stock returns is via their effects on oil prices. In particular, higher oil prices should translate into greater profits for drilling and exploration companies since their output (and reserves) are more valuable. Higher prices should also, indirectly, benefit service companies which provide support to drilling and exploration firms. On the other hand, one might expect lower prices to be beneficial to refiners, since input costs are lower.[10] Therefore, to corroborate our findings, in Appendix 2, we report the results of a similar analysis on oil prices (both spot and two month forward prices). The results are largely consistent with those discussed in the main text.

3.1 Cumulative Abnormal Returns

In this subsection we report results using the traditional method of Campbell *et al* [1997]. We take as our event window 20 days before and after the date of the event and 150 days prior to the beginning of the event window as our normal returns estimation period.[11] For now we simply describe the results, which are reported in Tables 3 through 6 and can be seen graphically in Figure A-2; in the next subsection we will draw inferences from them.

For each index we find negative cumulative abnormal returns for status quo announcements which start to accrue in the days leading up to the announcement. Moreover, with the exception of the integrated companies sub-index, all of the cumulative abnormal returns are significantly less than zero at the 5% level (one-sided test) towards the end of the event window.[12] It is also important to note that these abnormal returns are quite large in percentage terms. After 20 days following the announcement, the cumulative abnormal returns are between -2.5 and -4.2%. Thus it appears that OPEC, by its inaction, has the ability to significantly alter stock returns in the days following such announcements.

Next consider reductions in the quota. The results are weaker, though still telling. Only in the case of exploration companies do the cumulative abnormal returns become significantly positive at the end of the event window. Indeed, here the effect is quite strong. 20 days following the event, the cumulative abnormal returns are approximately 6%. While the CAR function is significantly different from zero only in the case of exploration companies, if one looks more closely at the plot of the CAR functions, there is an interesting pattern which is consistent across all groups. In particular, in the days leading up to an announced reduction in the quota, positive abnormal returns accrue, peaking approximately 3 days before the announcement and then make a significant fall, only to recover again at the end of the window. Finally, after some

[7] These extraordinary meetings are typically announced at the conclusion of a regularly scheduled meeting and usually occur between one and three months later.

[8] The events were obtained from various issues of the New York Times and official OPEC press releases.

[9] In particular, we have the series OILEPAM, OILINAM, OILSVAM and OILGSAM from Datastream, which are indices of the exploration & production, integrated and services sub-sectors, and the energy sector as a whole for the Americas.

[10] This latter claim is not obvious. In particular see Lewis [2003] and Borenstein and Shepard [1996] for a discussion of tacit collusion in the retail gasoline market, which could invalidate the aforementioned claim.

[11] We experimented with various event window lengths and normal returns periods. The magnitude of some estimates vary a little; however, the pattern and significance, in general, do not.

[12] If one adopts an event window of 15 days before and 15 days after the event, then this too becomes significantly negative.

days and once OPEC's resolve becomes clear the markets reaction turns favourable — indeed, if one restricts analysis to days 12 through 20, significantly positive abnormal returns accrue over this time.[13] This finding is significant for all of the sub-indices at the 5% level.

What could be the cause of this? One might suspect that before the commencement of an OPEC meeting, the market is hopeful of an agreement and so positive returns accumulate. However, as the meetings begin, perhaps due to uncertainty or a profit-taking motive, prices decline significantly. Finally, after the announcement and in the days following, OPEC's resolve becomes more apparent and the positive effects of the quota reduction take hold.

One does wonder if there is a perverse explanation for this finding, unrelated to market fundamentals or expectations. However, the two events which had the biggest impact on oil company stock prices and oil prices (11 September 2001 and the Iraqi invasion of Kuwait) do not coincide properly with OPEC meetings (or their outcome) in order to generate such a result. Thus, one is tempted to believe that market psychology about OPEC's resolve is, in fact, generating the result. Furthermore, as with the finding for status quo announcements, the cumulative returns at the end of the window are between 2 and 6%. So again, the impact of such announcements by OPEC is rather large.

Finally we consider announcements of quota increases. Here the results fall into two different categories. For the oil sector as a whole and the exploration sub-sector, announcements of increases in the quota were met with no significant abnormal returns - either positive or negative. For integrated companies, the impact of a quota increase seems generally positive, though not significant.[14] On the other hand, for service companies the impact of an increase in the quota is met with negative cumulative abnormal returns which are significant.

Remark 1. It is important to note that although the CAR functions for quota reductions were not all significantly different from zero at the end of the event window, the difference between the CAR functions for reductions and status quo announcements for each index are significantly different from zero at the end of the window. Thus, the market reaction is very different for an announcement of a quota reduction than it is for a status quo announcement. We now turn to such issues.

3.2 Interpretation and Discussion

Let us now move to a discussion of the empirical results just presented. As alluded to in the introduction, the results indicate that OPEC has an asymmetric ability to secure agreements depending on whether the economy is in a good state or a bad state of the world. First, the fact that neither significantly positive nor significantly negative abnormal returns are associated with an increase in the quota implies that such events are anticipated by the stock market. Therefore, when such an announcement is made, say due to a positive demand shock, it does not come as a surprise. Second, the fact that abnormal returns do occur for the other announcements implies greater uncertainty in OPEC's ability to agree to a reduction following a negative shock. To see this, suppose that demand is lower and OPEC should reduce its quota. Given the realisation of demand, the market forms expectations about whether an agreement will occur or not; however, these beliefs are much more diffuse than the case of when demand has increased. Thus when the announcement is made, the market reacts to either announcement and abnormal returns of the kind reported above are quite likely to occur.

To us, this is an eminently reasonable explanation of what happens here and in many other bargaining situations. However, it is just one possible interpretation and so far rests only upon a logical argument. Thus, before we can be satisfied that it is the correct interpretation, we must provide further evidence. Before proceeding, we first dispel one alternative explanation. One may argue that an agreement to adjust the quota, either up or down, signals that OPEC as a cartel is strong but that status quo announcements signal weakness in the cartel. However, such

[13] Day 12 was chosen as it appeared to be a trough for all four sub-indices. Furthermore, in two cases there was a significantly negative return on day 11 (for a third sub-index the return was barely insignificant).

[14] However, the abnormal returns are significantly greater than those which accrue following inaction by OPEC.

an explanation cannot hold. To see this, suppose that it was true. Then we would not see an asymmetric pattern of abnormal returns; instead, we should observe positive abnormal returns for both increases and decreases in the quota. In the remainder of this section we attempt to give further support for our interpretation of the results by analysing status quo announcements more carefully.

In making its decisions, OPEC must form expectations about the expected path of demand for crude oil, supply by non-OPEC members and changes in inventories. Our strategy, therefore, is to forecast these variables for the quarter immediately following an OPEC meeting. With these forecasts, we can get some idea of the *oil market balance* and determine, in some sense, the *required* course of action by OPEC. We can then compare the required course of action with the actual outcome to determine any observable patterns of OPEC behaviour. We also consider forecasts of the two month forward price of West Texas Intermediate crude oil, which should act as a summary statistic of the oil market balance. In the next section we provide further robustness checks for both the empirical results and our interpretation. The data used for this analysis was provided by the Energy Information Agency of the U.S. Department of Energy.

Consider first oil prices. If one believes in an efficient market, then it should be the case that the price of oil acts as a summary statistic for the oil market balance. That is, if prices are expected to rise it should indicate tightness of the market, say because of strong demand growth. Thus if prices are expected to rise, this may indicate a need for OPEC to increase its quota, while if prices are expected to fall, it implies a need to reduce the quota.[15] This is our most convincing test. In 17 out of 21 cases, we found that the two-month forward price of West Texas Intermediate oil was expected to fall. Moreover, of the four cases in which the price was expected to rise, barring any action by OPEC, one coincided with the first Persian Gulf War and the remaining three were after the Asian Financial Crisis. As the reader shall presently see, this result is in line with the anecdotal evidence pointing to a shift in OPEC behaviour around the time of the Asian Crisis.

We now seek to disentangle some of the potentially different effects arising due to shocks to production, consumption and storage. For each of OECD crude oil consumption, non-OPEC production and OECD crude oil inventories we estimated a univariate time-series model using data up to the month of the OPEC meeting. We then used the estimated parameters of the model to obtain a forecast for each of the next three months.[16,17] One useful measure which captures part of the oil market balance is the difference between the expected change in OECD consumption and the expected change in non-OPEC production. If this number is positive, it suggests a role for OPEC to increase its quota, while if it is negative a reduction is more likely in order. For the 21 status quo announcements, between 8 and 12 (depending on the method of forecasting) of the announcements involved falling consumption.

Another measure which also captures part of the oil market balance is the expected change in inventories of crude oil held by OECD countries. Declining expected inventories indicate tightness in the market and a need for an increase in the quota, while the opposite result holds for an expected increase. Here, for over half of the status quo announcements, inventories were expected to increase, indicating little pressure on oil prices (see Kaufmann [2002]). Taken as a whole, our forecasts on oil prices as well as net consumption growth and inventories indicate that the underlying market conditions called, more often, for a reduction in the quota when the actual course taken by OPEC was to remain with the status quo.

The three measures reported above relate, in some way, to expectations about future developments in the oil market. However, it has often been argued in the popular press that OPEC

[15] Of course to some extent, even in the month prior to an OPEC meeting, the market may have already priced-in expectations of OPEC action. We ignore such difficulties in what follows.

[16] For OECD consumption we estimated an ARIMA(1,1,1) model and added both a quarterly autoregressive and moving average term to account for seasonal variation. The other two series were estimated as strictly ARIMA(1,1,1) models.

[17] We also estimated models which included seasonal dummy variables and U.S. industrial production as regressors. In all cases, the qualitative results were unchanged. Indeed, the predictions of our oil price forecasts are even stronger.

is influenced by past events. That this claim has merit is apparent given OPEC's price band mechanism whereby an automatic increase in production is to be implemented if prices become too high for a protracted period, while production is to be cut if prices are too low. Thus one may be tempted to examine the past market conditions as a guide for OPEC's action.

With the data available to us, we must disentangle shifts in demand from movement along the demand curve for OPEC oil. A rather crude identification strategy is to use the elasticity of demand and revenues to identify shifts in demand. For example, if the demand function is unit elastic then changes in revenue are equivalent to changes in demand. We can extend this to the case in which demand is not unit elastic and calculate the implied change in revenue and then use this to identify shifts in demand. In this situation, the implied change in revenue is:

$$\Delta^I R = Q \cdot (1 + \epsilon) \cdot \Delta P$$

where ϵ is the elasticity of demand. Then, if the implied change in revenue is less than the actual change in revenue we have identified, if only very crudely, an increase in demand. Typical estimates for the price elasticity of demand range between -0.2 and -0.6. Using an X-11 seasonal adjustment for OECD consumption, we find that the difference between the implied and actual change in revenues indicates negative demand shocks in 14 of 21 status quo announcements.[18] Thus, well over half of the status quo announcements come during times of falling demand for OPEC oil.

4 Robustness Checks

This short section has two purposes. The first is to subject our empirical results to further robustness checks. In particular, we report a number of non-parametric tests on the nature of abnormal returns and measures of variance. After arguing that the empirical results survive this analysis, we then provide further, mainly anecdotal, evidence in favour of our interpretation.

4.1 Non-Parametric Tests

Even though the (cumulative) abnormal returns may not be significant in any time period, we are still able to say something about their nature. Specifically, a Wilcoxon signed rank test tests for whether or not more than half of the abnormal returns are of a particular sign. For each of the four sub-indices we test the null hypothesis that 50% of the returns are positive for each class of event. Considering status quo announcements, with the exception of the integrated companies sub-index, we are able to reject this hypothesis in favour of the alternative that more than 50% of the abnormal returns are negative.[19] This result strengthens the event analysis above which says that announcements of inaction by OPEC lead to significantly lower stock returns.

In only one other instance - for the service companies sub-index - do we find a moderately significant result. Here we find weak evidence that increasing the quota is more likely to generate a negative return than a positive return. This finding, too, is also consistent with the event analysis presented above.

[Table 1 Here]

In criticising the standard event study techniques Lockwood and Kadiyala [1988] and Cyree and Degennaro [2002] hint that changes in variance during the event window may be important. For each event in the data we can conduct a simple F-test, where the null hypothesis is that the variance term σ^2 is the same during the normal returns period and during the event window. For the oil sub-index we estimated that for 7 of the 50 events the variance was different during the

[18]The precise method of seasonal adjustment made little difference in the qualitative results.
[19]The result for integrated companies is only mildly insignificant.

two periods. The corresponding number for the integrated companies, exploration companies and service companies sub-indices is 5, 3 and 3 respectively. This suggests that changes in variance are not as important as one might think. Furthermore, a non-parametric test similar in spirit to the Wilcoxon signed rank test never rejects the null hypothesis that variance is constant for each of the three different classes of event.

4.2 Anecdotal Evidence

We now return to issues related to our interpretation of the results. The forecasts of the last section and the non-parametric tests just reported support our argument that status quo announcements typically arise when demand is falling or otherwise sluggish. Figure 1, below, gives some indication as to the relationship between OECD crude oil consumption and OPEC's quota. Especially prior to 1995, it seems that increases in OECD consumption have typically been met with OPEC quota increases.[20]

However, just looking at Figure 1 cannot give us a complete picture and, indeed, one must be careful in drawing conclusions from it since it cannot distinguish between shifts in demand and movement along the demand curve. Continuing with our intuitive discussion we now turn to the published New York Times reports which contained news of OPEC's decision. There is plenty of anecdotal evidence which suggests that OPEC is a good test of our intuition that agreements are more difficult when times are bad rather than when times are good. For instance, discord among OPEC members is quite common. For example, in its June 1988 production announcement maintaining the status quo, the New York Times reports that both Iraq and the United Arab Emirates exempted themselves from the quota. This happened despite the fact that oil prices were low and overproduction was widely noted. Again, in 1993, Kuwait held up an agreement that would have lowered production in an attempt to strengthen weak oil prices with its demands for even more production. With varying intensities, such a pattern has continued until this day. In recent years, disagreement has often circled around how best to bring Iraq back into the quota system. The active members appeared unwilling to accommodate Iraqi production, leaving analysts expecting huge gluts of oil and fearing a market collapse. Notice that, this anecdotal evidence also indicates that such disagreements are more probable during bad times (for OPEC) rather than good.

A more detailed analysis of these reports can also provide further insight into the market psychology following OPEC's decision not to change the quota. Similarly to the graphical analysis above, we find some evidence of a *structural break* occurring around the time of the Asian Financial Crisis. Specifically, from December 1987 to June 1997 there were 16 status quo announcements made by OPEC. In only two of these events could one unambiguously make the case that the alternative choice on the table was an increase in production.[21] In some cases the status quo appeared to be the decision that was called for, while in the majority of others, the published news reports cite disagreement in being able to reduce the quota or that OPEC's actions signal an even higher likelihood of cheating.

In contrast, after the Asian Financial Crisis, a shift in OPEC philosophy seems to have occurred. In the eight status quo announcements between July 1997 and September 2002, in only one case can it be read as a failure of OPEC to reduce the quota to induce a price increase, while in three cases the action appears to have been taken to drive prices up even further. One wonders whether this is due to caution on OPEC's part or a result of the tense political situation in the Middle-East. Indeed, despite the weak economy of 2002, oil prices remained high because of uncertainty over the situation in Iraq - something which is still felt in the current oil market. According to published statements by OPEC, the cartel appears loathe to change its quota due to these political uncertainties. Having left its quota unchanged in March, June and September 2002, OPEC justified its decision stating that "the relative strength in current market prices is

[20]Note that the scale for the quota is on the right-hand side, while that for OECD consumption is on the left-hand side.

[21]These two events were the announcements of November 1994 and November 1996.

partially a reflection of the prevailing political situation rather than solely the consequence of market fundamentals."

5 Theoretical Discussion

In this section we turn to a theoretical discussion of the empirical results. As we have often mentioned, the results indicate an asymmetry in OPEC's internal bargaining structure. In particular, there must be something which makes agreements more likely to occur when the quota should be relaxed and less likely to occur when the quota should be tightened. Thus when the market believes the quota should be relaxed, it will be priced into stock prices and any resulting increase in the quota will not be met with further movement in the stock prices. On the other hand, when the market has the opposite beliefs, then there is room for a strong positive or negative reaction *ex post* to any OPEC announcement because, though it sees a need for a change in policy, the market believes an agreement much less likely.

5.1 Problems With Standard Theory

In an attempt to come up with a reasonable theoretical explanation for our results, the first thing to notice is that standard repeated game arguments necessarily fail if we are willing to assume an efficient stock market. Rotemberg and Saloner [1986] and Haltiwanger and Harrington [1991] develop models of repeated collusive interaction and examine the properties of the *most collusive* equilibrium. The latter predicts that cooperation will be the most difficult to sustain when demand is decreasing. The reason that collusion is difficult to sustain during periods of falling demand is because the future punishments available to prevent deviations are much weaker.

It is true that our empirical findings indicate that collusion is more difficult to sustain during bad times. However, to say that our findings are consistent with the aforementioned theories would be a mistake. In both the models of Rotemberg and Saloner [1986] and Haltiwanger and Harrington [1991], no place is allowed for surprise. Again consider the latter model and suppose that a negative demand shock has just been observed. How would an efficient market react? It would recognise that full collusion is no longer possible; therefore, the stock price would immediately adjust downwards to its new level. When an announcement is finally made concerning the new quota, there would be no reaction since the impact would already be priced into the stock. A similar adjustment, though in the opposite direction, would occur if a positive demand shock was realised. What is missing then from these models is the possibility that the market can be *surprised* by some announcements and not by others; indeed, the market will *never* be surprised in either model.

The next place in the existing literature that one is drawn towards is that of bargaining with incomplete information. However, as we now argue, this literature also has little to offer in the way of explaining our empirical findings. Much of it is concerned with negotiations between a single buyer and seller in which the valuation of the buyer is not known rather than splitting a pie (see *e.g.,* Schmidt [1993] and Hart and Tirole [1988]). It is difficult to think of a natural way to extend such models to the current setting. A more fundamental problem, beyond simply finding a convenient way to extend the models, is that their main predictions are inconsistent with our empirical findings. In particular, many of the models predict that the seller sets price equal to the lowest possible valuation buyer for all but the last periods. Thus very little information is revealed. This stands in sharp contrast to our empirical findings in which significant information is revealed at each meeting — especially in periods of weak demand.

Let us examine the standard two player Cournot game with linear inverse demand given by $P(Q_t) = A_t - Q_t$, where Q_t is the agreed upon *total* quota to see if any mileage can be obtained from incomplete information. If the quota is optimally set, then total profits are given by $\frac{A_t^2}{4}$. Now suppose that a demand shock has occurred; demand is now $\bar{A}_t$ and the quota is initially left unchanged at Q_t. Then we can define the bargaining space as the extra profits to be had by adjusting the quota to its optimal level; denote the bargaining space by $B_t \equiv \frac{\bar{A}_t^2}{4} - (\bar{A}_t - Q_t)Q_t$ and note that $B_t \geq 0$. Thus we see that whether demand has gone up or down, we always have a non-negative bargaining space.

It is clear that incomplete information must be carefully placed into the model to generate consistent predictions. For example, cost uncertainties will not do. Their influence on the model would be entirely symmetric with respect to positive and negative demand shocks. As we have alluded to earlier, a wedge must be placed in such a way that, with some probability, the bargaining space, B_t, is negative following a decrease in demand. Moreover, the bargaining space should remain positive following an increase in demand. In what follows we present two very simple ways to introduce incomplete information, which can generate predictions consistent with those that we have reported above. The first introduces a probability that a cartel member cannot commit to produce only its quota. Another way, which we discuss in Section 5.3, is the introduction of behavioural types.

5.2 Disagreement As A Perceived Lack Of Commitment

The situation we have in mind is a cartel of $n > 2$ members which meets every period to decide upon the quota for the current period given the realisation of demand. We take a very simple view of the cartel. In particular, membership in the cartel implies a high degree of commitment not to produce more than the allocated quota. However, we allow for the possibility that at most one country will periodically experience a random shock.[22] In what follows we will assume that the random shock is private information but that all cartel members receive a signal which is correlated to the true realisation of the random shock. When a country experiences a shock then we assume that it loses the ability to commit to its agreed upon quota. The country may, therefore, be tempted to deviate from the cartel agreement. Whether it does deviate depends on two things — the magnitude of the shock and the punishment that the other cartel members can impose upon the deviator.

We then adopt a very simple rule about how the quota is adjusted. In particular, we assume that the cartel is constrained between two choices; when demand has increased, it can either increase the quota by some fixed positive amount or maintain the status quo, while when demand has decreased, it can either decrease the quota by some fixed amount or maintain the status quo. Upon observing demand information and private signals regarding the true realisation of the shock, cartel members vote on the proposals for the quota. Voting is by majority rule, though we do not model this stage formally.

Given these assumptions, the model predicts quite nicely the empirical result that we have discussed throughout the paper. The reason is very simple. When demand increases, profit maximisation dictates that the quota should be increased. Moreover, doing so also lessens the static gain to a deviation and, therefore, makes such deviations less likely to occur. However, when demand has decreased, we have a tension. Profit maximisation dictates that the quota should be reduced, but doing so increases the static gain to a deviation and, therefore, makes such a deviation more likely. Therefore, cartel members may be tempted to vote against a reduction in the quota, especially if their signal regarding the true realisation of the random shock is strong enough.

With this intuition in mind, let us now proceed with a more formal discussion of the model. Note that everything could be embedded in the frame work of a repeated game with incomplete information. However, in the interests of clarity and simplicity, we present, instead, its static equivalent. Suppose that there are $n > 2$ *ex ante* identical members of a cartel who meet each period to decide upon a quota for the current period. Suppose that the inverse demand function is given by $P(A_t, Q_t)$, where A_t is a measure of demand at time t and $Q_t = \sum_i q_{it}$ is the total production of the cartel at time t. Given demand and the production decisions of each cartel member, let $\pi_{it}(P(A_t, Q_t), q_{it})$ denote the profits of country i at time t. Our point of departure from the standard model is the following. Write the per-period utility function of country i

[22] This assumption is not necessary but it serves to greatly simplify things; see Remark 4 below.

as $u(\theta_{it}, \pi_{it}(P(A_t, Q_t), q_{it}))$ and assume that $\frac{\partial^2 u}{\partial\theta\partial\pi} > 0$ so that the marginal utility of profits is increasing in θ_{it}.[23] We assume that θ_{it} is private information and a new realisation is drawn each period for each cartel member.[24] Given our assumption regarding how θ enters the utility function, it can be thought of as the importance, relative to other activities, of profits generated from the cartel. For example, suppose that country i experienced a severe natural disaster at time t; then it will have strong needs for revenues in order to pay for relief and reconstruction efforts. In our view, we would interpret this as a high realisation of θ_{it}.

We now describe the process by which random shocks occur. As we have said above, we assume that at most one country may experience a random shock to θ. That is, let $\bar{\theta}_t \equiv \max\{\theta_{it}\}$ and assume that $\bar{\theta}_t \sim F$, where F is a distribution with support on $[a, b]$, $0 \leq a < b \leq \infty$. This implies that if $\bar{\theta}_t = \theta_{it}$ for some $i \in \{1, \ldots, n\}$, then $\theta_{jt} = a$ for all $j \neq i$. The specific interpretation of θ_{jt} is the following. When $\theta_{jt} = a$, then everything is *normal* for country j; however, if $\theta_{jt} > a$, then country j has experienced some adverse shock to its economy and places greater significance on revenues from the cartelised industry. As we have said, at most one country may experience a shock at any time period. However, it may be the case that *normal* times prevail for all countries. To capture this, assume that $F(a) = p \in (0, 1)$ and that this is the only mass point in the distribution function, F.

With these preliminaries in mind, let us now describe the mechanism by which cartel members set the quota. Assume that each period, demand is realised and publicly observed by all cartel members. Next assume that each cartel member learns its particular realisation θ_{it}; moreover, suppose that each country obtains an informative signal $\tilde{\theta}_{it}$ from some conditional distribution $G(\tilde{\theta}|\bar{\theta})$ regarding realised value of $\bar{\theta}_t = \max\{\theta_{it}\}$. Given the realisation of $\tilde{\theta}$, cartel members update their beliefs about the true state of the world using Bayes' Rule. Let $F(\bar{\theta}|\tilde{\theta}_j)$ denote j's posterior distribution over the true state, $\bar{\theta}$. As we said above in our intuitive discussion, we adopt a simple voting procedure for implementing changes in the quota. In particular, when demand has increased, the cartel can either increase its quota by some discrete, positive amount, $\Delta\hat{Q}_I(A_t, \hat{Q}_{t-1})$ or remain with the status quo, where $\hat{Q}_{t-1}$ is the quota that prevailed in the previous period. On the other hand, if demand has decreased, the cartel can either decrease the quota by a discrete, negative amount, $\Delta\hat{Q}_D(A_t, \hat{Q}_{t-1})$ or remain at the status quo. Each member votes either in favour of the proscribed change or in favour of the status quo.

It should be clear that when demand has increased, it will be a dominant strategy for all players, except possibly the one which received a positive shock to θ, to vote in favour of an increase in the quota. The reason is that by voting in favour of the increase in the quota, it is increasing its profits (since an increase in the quota is what is called for) *and* it is lowering the probability that a potential deviant will defect from the cartel agreement because an increase in the quota lowers the static gain from a deviation.

However, when demand has gone down, voting in favour of reducing the quota is no longer a dominant strategy. To be sure, a reduction in the quota will increase a cartel member's profits so long as (a) no countries receive a shock to θ or (b) a country receives a shock, and, therefore, loses the ability to commit, but is prevented from deviating for fear of the future punishment $\Lambda(A_t)$. However, by voting to reduce the quota by $\Delta\hat{Q}_D(A_t, \hat{Q}_{t-1})$, the cartel is *increasing* the gains from a potential deviator, and, therefore, increasing the likelihood of a deviation. Suppose that country i realised $\theta_{it} > a$. We know that it will deviate if and only if $u(\theta_{it}, \pi_t(P_t^{br}, q_{it}^{br})) - u(\theta_{it}, \pi_t(P_t, q_{it})) > \Lambda(A_t)$; therefore, there is some critical value $\theta^*(\hat{Q}_t)$, which depends on the current quota, $\hat{Q}_t$, such that i deviates if and only if $\bar{\theta}_t = \theta_{it} \geq \theta^*(\hat{Q}_t)$.

Given a signal $\tilde{\theta}_j$ for player j, we obtain the posterior distribution, $F(\bar{\theta}|\tilde{\theta}_j)$ and are in a position to calculate the expected utility of player j, first under the scenario in which the quota is reduced to $\hat{Q}_t^l = \hat{Q}_{t-1} + \Delta\hat{Q}_D(A_t, \hat{Q}_{t-1})$ and second when the status quo is maintained. We

[23] For example, suppose that $u(\theta, \pi) = \theta \cdot \pi$.

[24] In particular, assume that the draws are *i.i.d.* over time.

calculate this former expected utility as:

$$\begin{aligned} V_j^l(A_t,\hat{Q}_t^l) &= F(\theta^*(\hat{Q}_t^l)|\tilde{\theta}_j)\cdot\Big[u(a,\pi(P_t,q_{jt}^l))+\delta\mathbb{E}V_j(A_{t+1},\hat{Q}_{t+1})\Big] \\ &+ (1-F(\theta^*(\hat{Q}_t^l)|\tilde{\theta}_j))\cdot\big[u(a,\pi(P_t^{br},q_{jt}^l))+\delta\mathbb{E}V_j(\Lambda(A_t))\big] \end{aligned} \quad (3)$$

where the first square-bracketed term represents the expected utility provided that there is no deviation, which, player j believes will occur with probability $F(\theta^*(\hat{Q}_t^l)|\tilde{\theta}_j)$. The second square-bracketed term represents the expected utility in the situation in which a country deviates, which, player j believes will occur with probability $1-F(\theta^*(\hat{Q}_t^l)|\tilde{\theta}_j)$. The term $V_j(\Lambda(A_t))$ is the continuation value of player j under the situation in which a deviation has occurred and the cartel moves to punish the deviator. In a similar manner, we may calculate the expected utility under the scenario in which the quota is left unchanged at $\hat{Q}_{t-1}$:

$$\begin{aligned} V_j(A_t,\hat{Q}_{t-1}) &= F(\theta^*(\hat{Q}_{t-1})|\tilde{\theta}_j)\cdot\Big[u(a,\pi(P_t,q_{jt}))+\delta\mathbb{E}V_j(A_{t+1},\hat{Q}_{t+1})\Big] \\ &+ (1-F(\theta^*(\hat{Q}_{t-1})|\tilde{\theta}_j))\cdot\big[u(a,\pi(P_t^{br},q_{jt}))+\delta\mathbb{E}V_j(\Lambda(A_t))\big] \end{aligned} \quad (4)$$

The same interpretation applies to the two-square bracketed terms.

It is clear that player j will vote in favour of a reduction in the quota if and only if $V_j^l(A_t,\hat{Q}_t^l)\geq V_j(A_t,\hat{Q}_{t-1})$. The tension is clearly visible in (3) and (4). Given our assumptions, we have that $\theta^*(x)$ is an increasing function of x. Therefore, $F(\theta^*(\hat{Q}_{t-1})|\tilde{\theta}_j)>F(\theta^*(\hat{Q}_t^l)|\tilde{\theta}_j)$ and so country j believes a deviation to be more likely if the quota is reduced than if the status quo is maintained. Thus, for a fixed $\tilde{\theta}_{jt}$, player j is more likely to vote in favour of the status quo. However, working in the opposite direction we also have, $u(a,\pi(P_t(\hat{Q}_t^l),q_{jt}^l))-u(a,\pi(P_t(\hat{Q}_{t-1}),q_{jt}))>0$; the bigger this difference, the more likely is country j to vote in favour of a reduction in the quota. Clearly then, under appropriate regularity conditions on F and G, we will have the existence of a threshold, θ_j^*, such that j votes against a reduction in the quota if and only if $\tilde{\theta}_j\geq\theta_j^*$.[25] A similar analysis can be conducted for all cartel members $j\neq i$, where i denotes the country, if any, which experienced a realisation $\theta_i>a$.

We can summarise with the following result:

Proposition 1. *Given the assumptions of the model, the cartel will always vote to increase the quota following a positive demand shock, while if demand has decreased, the cartel will vote against the proposed decrease if a majority of cartel members receive signals, $\tilde{\theta}_j$, high enough.*

Proof. This follows immediately from the discussion above. □

Remark 2. We can cite at least one example consistent with the model that we have just presented. In 1992 OPEC met with the wish to lower its total production quota. However, it was dissuaded from doing so because of Kuwaiti demands that it be able to produce as much oil as it could in order to generate revenues necessary to pay for its restoration as a result of damage sustained from the first Persian Gulf War. While it was quite clear that Kuwait suffered a great deal of damage and was in need of oil revenues, it is reasonable to argue that nobody knew the exact extent of this damage. To a lesser extent, it has been noted (see Mabro [2001], in particular) that uncertainty regarding the political situation in Venezuela prevented OPEC from acting many times in the mid-1990s.

Remark 3. As we mentioned above, the model could be embedded within the framework of repeated games; however, we believe that this will not alter the main predictions of the model. The main difficulty in transforming our model into a repeated game would be to endogenise the available punishments, $\Lambda(A_t)$. Consider the approach of Haltiwanger and Harrington [1991] in which demand follows a deterministic process. Now suppose that demand has decreased and

[25]Of course, this threshold will depend on the parameters of the model. In particular, it will depend upon the *strength* of the signal as well as on $\hat{Q}_{t-1}$ and $\hat{Q}_t^l$.

consider the identical thought experiment as above — reducing the quota still increases the static gain to a deviation but because demand has, in any case, decreased, this gain may still be smaller than the corresponding gain to deviation when demand was A_{t-1} and the quota $\hat{Q}_{t-1}$. If this were the only effect, then our result would be destabilised; however, we must also analyse the punishments. In a Haltiwanger and Harrington setting, since demand has decreased, it is more likely that demand will be lower next period; therefore, $\Lambda(A_t)$ is also smaller, and so, the available punishments are weaker, making deviations potentially more likely. Thus there is still a tension which occurs in the minds of a cartel member when deciding whether or not to vote in favour of a quota reduction.

Remark 4. We can relax the assumption that at most one cartel member receives a negative shock in each period. The key insight to doing so it to note that a cartel member which received a shock may still vote in favour of an increase in the quota (if demand has increased) or against a reduction in the quota (if demand has decreased), provided that the size of its shock is not too great. For example, suppose that demand has decreased and country i has received a small shock; that is, $\theta_{it} \approx a$. Because the shock is small, i is unlikely to gain from a deviation, even if the quota is reduced. However, suppose that i received a signal, $\tilde{\theta}_{it}^{j} \approx b$, regarding the realisation of j's shock. In this case, i believes that j has very strong incentives to deviate and so will vote against any reduction in the quota. A similar thought experiment can be conducted for the case in which demand increases. Hence the main intuition follows and we can expect disagreements to be much more likely following a decrease in demand rather than an increase.

5.3 A Behavioural Approach

The model presented above is very intuitive and cleanly predicts our empirical finding that agreements are less likely to arise in bad times. While it was without loss of generality to consider a static equivalent of the dynamic game, our restriction that the cartel could only choose between changing the quota in the direction of the demand change and the status quo was not. We believe that the assumption is a reasonable approximation of OPEC behaviour at any point in time, we note it as a potential drawback.

The behavioural model to which we turn has proposals which are endogenously determined by the players and, therefore, does not suffer from such criticism. Moreover, the special way in which reference points enter into the utility function allows us to generate virtually identical predictions regarding the exact nature of agreements. In particular, disagreements will never occur when demand has increased but will probabilistically occur following a negative demand shock. As the reader shall see, the model is also more faithful to the intuition given by a number of authors in the experimental economics as well as organisational behaviour literature. Indeed, Bazerman and Carroll [1987] argued that the likelihood of disagreements is much greater when participants frame negotiations in terms of losses, rather than the overall gains of a successful agreement. One can see a clear role for reference points — when times are prosperous all participants are more likely to view negotiations in a positive frame than they would when times are bad.

To understand this intuition better, let us return to an example considered earlier — that of a university deciding how to allocate funds to its various departments. Each department enters into the discussions with a status quo level of funding. If times are prosperous, the university can easily increase funding to each department. Thus, one might imagine an agreement to be easily forthcoming since the gains from the status quo are easily visible. However, now suppose that times are not good. In this situation, cuts are necessary and it is much more difficult to view negotiations in terms of gains rather than losses. Therefore, we may except that each department vehemently opposes any cuts to its status quo level of funding. Thus, we may view the status quo as the moral or emotional equivalent of a *property right* held by the department heads. The unique aspect of this status quo is that it only bites when property rights must be taken away.

This intuition has recently been demonstrated to have force in an experimental work by

Gächter and Riedl [2003]. In this paper they coin the term *moral property right* to describe a claim held by a person even though the claim has no legal basis and is "often [rooted] in historical claims, custom or the status quo." Specifically, they consider a bargaining situation in which the *moral property rights* are no longer feasible.[26] It was shown that bargaining was significantly affected by the presence of *moral property rights*. In particular, opening offers were strongly correlated with perceived rights and, more importantly, the outcome was very close to the focal point predicted under the hypothesis that moral property rights significantly affect behaviour.

It is not difficult to imagine that the logic of Gächter and Riedl [2003] and Bazerman and Carroll [1987] extends much more generally. We, therefore, turn our attention to such issues. Indeed, return to our setting and suppose that demand has increased, then property rights (*i.e.,* quotas) of all can be expanded and there is no conflict since property rights increase with profits in this case. However, if demand has decreased, then the status quo quotas bite; this is because to increase profits, property rights must be taken away. This may cause cartel members to view the negotiations, at least partly, in terms of lost property rights, rather than higher profits. Therefore, disagreement becomes considerably more likely as each cartel member fights to maintain property rights. In what follows we present a rudimentary analysis of this intuition and demonstrate that such a model can explain the main empirical findings.

5.3.1 A Simple Model

The following two person example guides us throughout the formal analysis. There is a linear inverse demand function given by:

$$P(Q^t, A^t) = A^t - Q^t$$

where $Q^t = q_1^t + q_2^t$ denotes total production at time t and A^t represents the state of demand. In each period the players play the Cournot equilibrium with quota $(\bar{q}_1^t, \bar{q}_2^t)$ where it is assumed that players sign binding contracts not to produce more than their quota. We assume that cartel members do not experience any direct utility from their quota but experience a psychological loss in utility if their quota is reduced from the period before. Thus the utility of player i is given by:

$$U_i(q_i^t, q_j^t, A^t, \bar{q}_i^{t-1}, \bar{q}_i^t) = u_i(q_i^t, q_j^t, \bar{q}_i^t, \bar{q}_j^t, A^t) + \alpha(\bar{q}_i^t - \bar{q}_i^{t-1}) \cdot \mathbb{I}[\bar{q}_i^{t-1} \geq \bar{q}_i^t] \tag{5}$$

where $\alpha > 0$ represents the psychological cost of losing property rights to produce $\bar{q}_i^{t-1}$ and u_i is the utility arising from the Cournot game given demand and quotas. Notice that this is not the standard loss-averse utility function in two respects. First, we assume that u_i is a standard utility function. Second, we assume that increasing the quota beyond the status quo does not provide any extra utility. Suppose we had a term, $\alpha_1(q_i^t - q_i^{t-1}) \cdot \mathbb{I}[q_i^{t-1} < q_i^t]$, in the utility function with $0 < \alpha_1 < \alpha$ to give us a more standard representation of loss aversion. In this situation, it would always be optimal to have an infinite quota. To avoid this triviality we set $\alpha_1 = 0$.

Let α_{it} denote the realised psychological cost for player i at time t and suppose first that it is private information and second that α_{it} is iid across time and across players with some distribution $F : \mathbb{R}_+ \mapsto [0, 1]$. Now suppose that in each period demand is realised and the players meet to discuss the quota for the observed demand. To keep things simple, assume that bargaining is of the ultimatum type in which player 1 proposes a quota in odd periods and player 2 proposes a quota in even periods.

Imagine a situation in which demand increases so that $\bar{q}_1^{t-1} + \bar{q}_2^{t-1} < \frac{A^t}{2}$. Then there is a surplus of $\frac{A^t}{2} - \bar{q}_1^{t-1} - \bar{q}_2^{t-1}$ and no need to worry about costs associated with losing property

[26] By this we mean that the sum of the claims is larger than the size of the pie. Historical claims for a two-thirds share of a pie of size 2490 were allocated by means of a competitive task.

rights. However, if we are in the opposite situation in which $\bar{q}_1^{t-1} + \bar{q}_2^{t-1} > \frac{A^t}{2}$ then the quota must be reduced in order to increase profits. Conditional on his realisation, the proposer must choose an allocation $\mathbf{q}_t$ to maximise his expected profits. Then following a decrease in demand, two things work to make disagreements a distinct possibility. First, if the realisation of the proposer is *high enough*, he may be unwilling to make an offer which involves the quota being reduced. Second, given the offer of the proposer, if the responder's cost realisation is *high enough*, she may rather reject so that the psychological cost is not incurred. Thus to be reasonably sure of agreements, both players must have low psychological cost realisations. Of course, if demand increases the players need not worry about the psychological cost parameter of the other player; therefore, agreements will always be forthcoming.

5.3.2 Extensions

Of course one must ask why a cartel member's utility function would give such weight to the cartel, beyond its role in determining revenues. One might relate this to status - the higher the quota the more status within the cartel a member has. This idea has some merits; indeed, competitions for status may take place in which one member refuses to agree unless he or she is given comparable status to another member. For example, during the Iran-Iraq war, Iraq was often exempted from its quota obligations and refused to rejoin the quota system unless it was given an equal quota to that of Iran. This is despite the fact that Iran is both geographically larger and more populous than Iraq. Moreover, status can be seen at play in other situations. After the first Persian Gulf War, Saudi Arabia was able to increase its share of OPEC production quite dramatically and has resisted attempts to relinquish this higher share. Today, Nigeria also seems concerned about its status within OPEC arguing that its current share of production is not in line with either its population or its proven reserves.

However, if we are to take status seriously, we must allow for the reference point to be something other than last period's quota. Instead, denote by a_i^t the reference point of player i at time t. We can allow for status by assuming that $a_i^t > q_i^{t-1}$ - that is, player i demands an increased quota.[27] Surely if demand has decreased then this makes agreements even less likely to occur. On the other hand, if demand has increased then player i will just as surely not reject an offer which simultaneously increases his revenues and his quota, even if the new quota falls short of his aspiration level. The reason is that rejecting would lead to the status quo which is even worse. This model would then predict that changes in status occur when demand has decreased rather than when it has increased.

Furthermore, we can allow property rights to evolve over time in a more general fashion. That is, let a_i^t denote the perceived *property right* by player i at time t and suppose that $a_i^{t+1} = \lambda a_i^t + (1-\lambda)q_i^t$. Then it becomes interesting to know whether λ is closer to 0 or to 1. The latter indicates very slow adjustments of property rights, while the former very fast adjustments. One might think that the more quickly property rights evolve then the more difficult agreements are when the size of the pie shrinks. This follows because the players very quickly become accustomed to a higher quota and are then loathe to give it up if demand then decreases. On the other hand, if property rights evolve more slowly, then disagreements will be less likely to occur because each player has some *slack* in his property rights or aspirations that he can give up before incurring any psychological costs.

This would be an interesting exercise because over time, the original reason for the unequal split fades away from the memories of the players but last period's split of the pie is still fresh in the memory. Thus, once property rights are attained through a competitive process does the inequality still remain through time? An exercise as outlined above will also shed some light on whether or not agreements do come about more easily, or more quickly when the size of the pie has increased.

[27] There is also nothing preventing $a_i^t = q_j^t$ so that player i aspires, or feels entitled to, equal treatment with regard to player j.

6 Concluding Remarks

In this paper we have presented the results of an event study analysis of OPEC behaviour and its effects on the stock returns in the energy sector. The results are quite clear. When OPEC reduces the quota, positive and often significant abnormal returns accrue in the four sub-sectors considered. Next, when the quota is increased, there is no significant pattern of abnormal returns. Finally, when OPEC takes no action negative and significant abnormal return accrue across all sectors. Moreover, these abnormal returns appear to be economically meaningful, accumulating in some cases to ±5% by the end of the event window.

We believe strongly that these results offer us an interesting insight into OPEC's decision-making behaviour. Specifically, we think the results indicate an asymmetric ability of OPEC to secure agreements. That is, when demand is increasing, OPEC is far more likely to increase the quota than they are to decrease it when demand is decreasing. In part, this interpretation is confirmed when one examines the news reports surrounding these status quo announcements. However, there appears to be a shift in behaviour since the Asian Financial Crisis. In support of our interpretation we went back to the news reports and found convincing evidence that most status quo announcements prior to the Asian Crisis were in periods of falling demand. This anecdotal evidence was further supported through forecasts of oil prices. Overwhelmingly, the forecasts implied falling prices for the following quarter.

Both of the models considered in Section 5 explain, though in different ways, the main empirical finding of this paper — namely, that disagreements are more likely during poor economic times. In the first model the possibility of random shocks serves to generate the result. In particular, a country which experiences a random shock, loses its ability to commit not to deviate. Deviations can still be deterred via the threat of punishments. Moreover, when demand increases, the cartel can increase the static profits of its members *and* reduce the static gain to any deviation. However, when demand has decreased a tension between current profits and the incentives of a firm to deviate arises. If beliefs of the cartel members are strong enough, they will vote against a proposal to lower the quota. In contrast, the latter model takes a slightly more direct approach by assuming that cartel members face a psychological cost to having their quotas reduced because of perceived property rights. Then in a simple bargaining model, the result readily follows.

To conclude the paper, we argue that the story we have told throughout the paper is part of a seemingly more general phenomenon. As discussed in the introduction, the current paper has given an interesting example of an asymmetric reaction to news. In particular, we argued that the primary reason for this result is because bargaining behaviour is influenced by the business cycle. From this standpoint, our analysis shares some similarities with the literature on union-firm negotiations and strikes. Indeed, there are many studies which point to more frequent strikes during economic booms but with a significantly shorter duration than during recessions; see for example Kennan [1985], Kennan and Wilson [1989], Harrison and Stewart [1989] and Card [1988, 1990], among others. However, as in the present paper, this literature has also not provided a satisfactory theoretical explanation of the data. In our minds, the nicest explanation makes use of the Coase conjecture. However, even this explanation relies on the assumption that commitment is more difficult when demand is high.

Finally, if one takes our behavioural model as an accurate description of OPEC, one can also see similar examples of entitlement effects distorting bargaining outcomes. For example, Bazerman [1985] has argued that reference points play an important role in wage arbitration. Zajac [1995] also argues that the status quo is a strong reference point in certain situations and that feelings of entitlement to the status quo are often more important than notions of fairness. Entitlements are also at play in issues of taxation and the provisions of the welfare state. It is not often that a politician will win an election promising to scale back health-care, pensions and other social programmes while at the same time raising taxes. However, as Romer [1996] and Boeri, Börsch-Supan, and Tabellini [2001] economics and demographics may soon require such changes. These authors also argue that a strong preference for the status quo has held up major reforms, which though not Pareto superior, would be more efficient and sustainable.

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Appendix 1 - Figures

Figure A-1: Oil Price Fluctuations

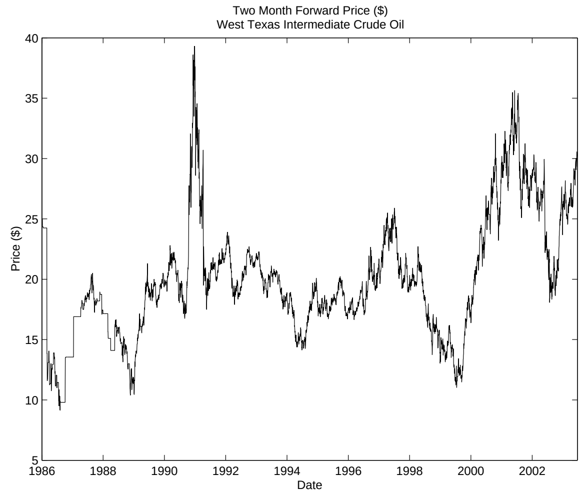


Figure A-2: Cumulative Abnormal Returns - Sub-Indices

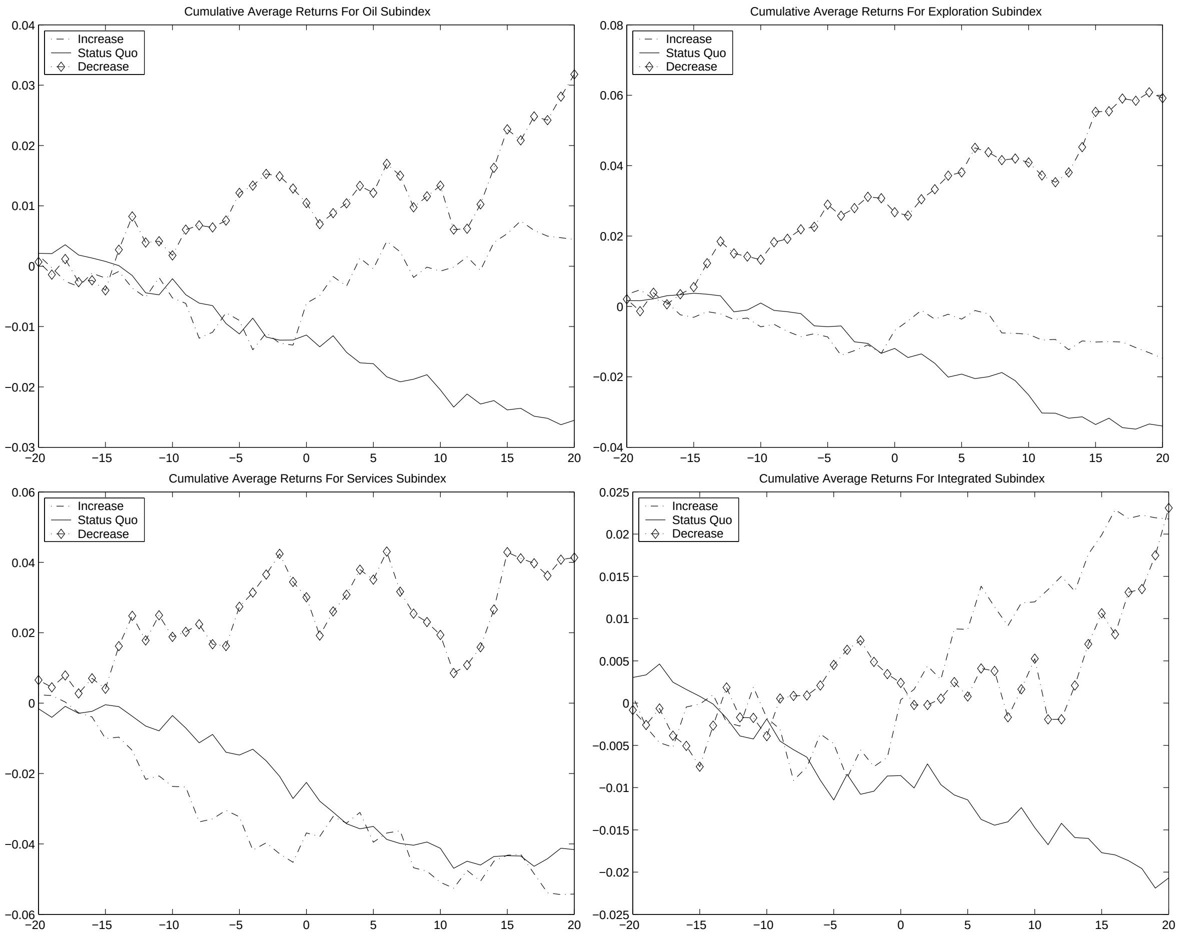


Figure A-3: Quota Shares Within OPEC

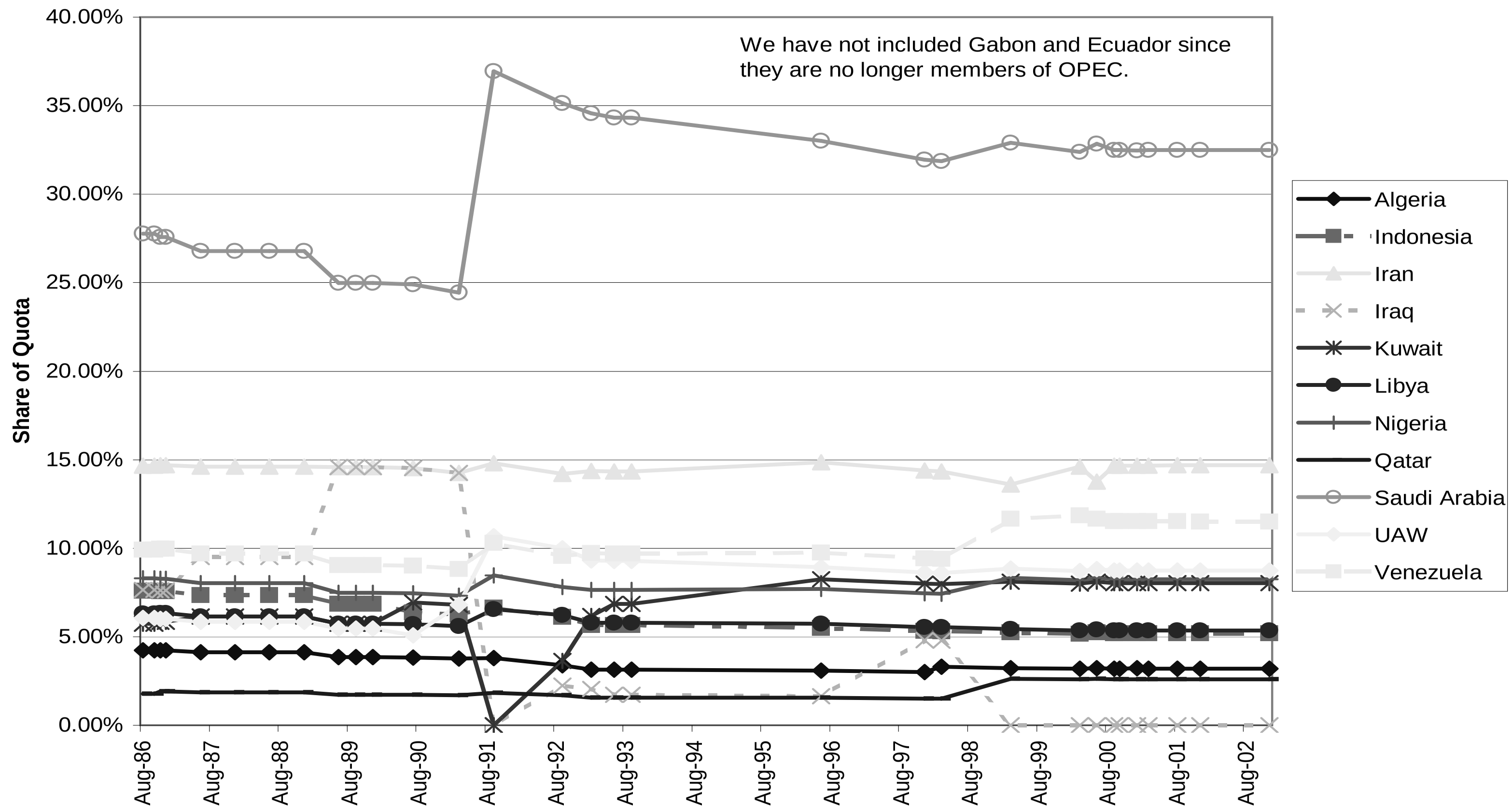


Figure A-4: Saudi Arabia - OPEC Comparison (SHARE for Saudi Arabia)

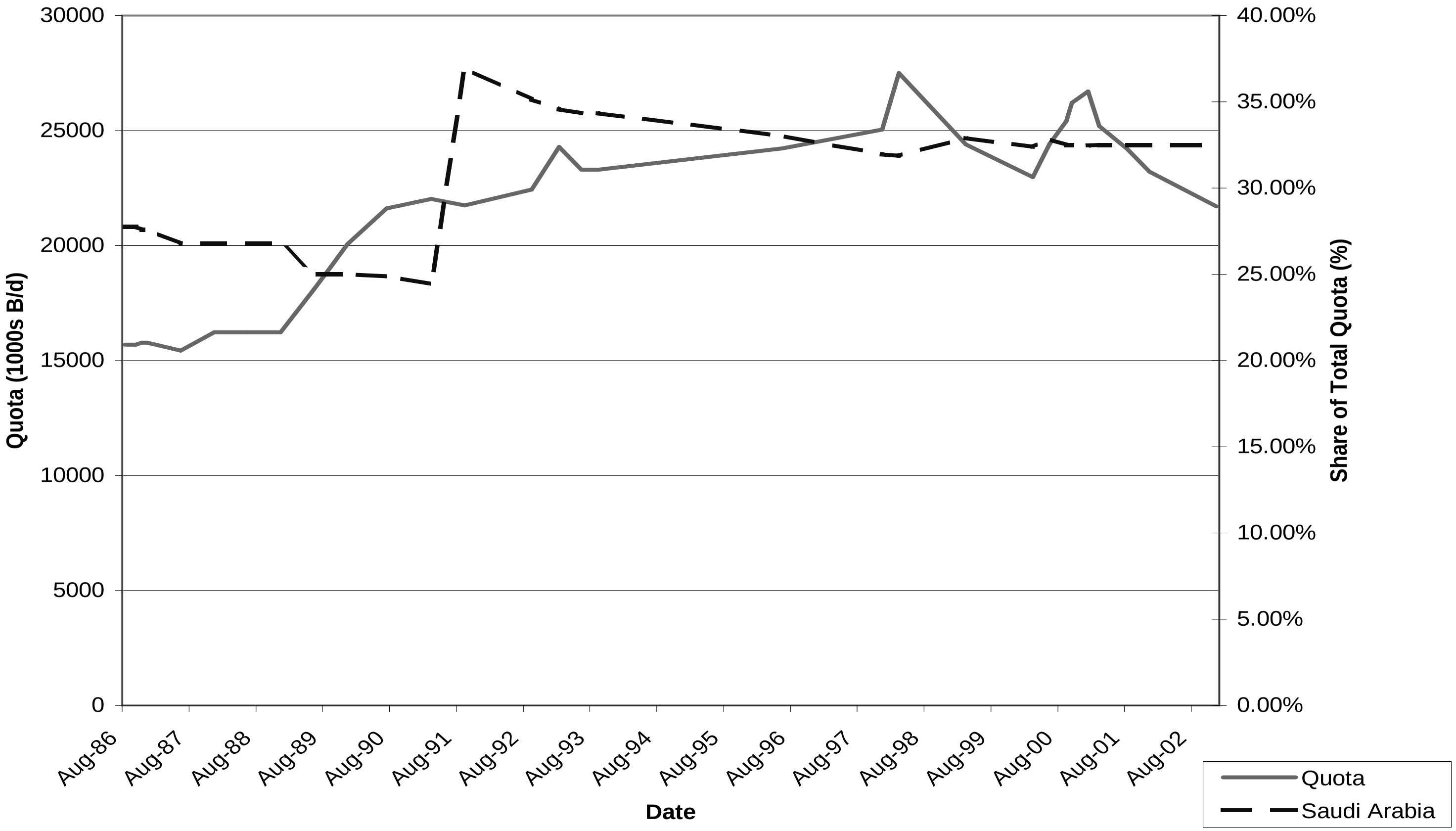
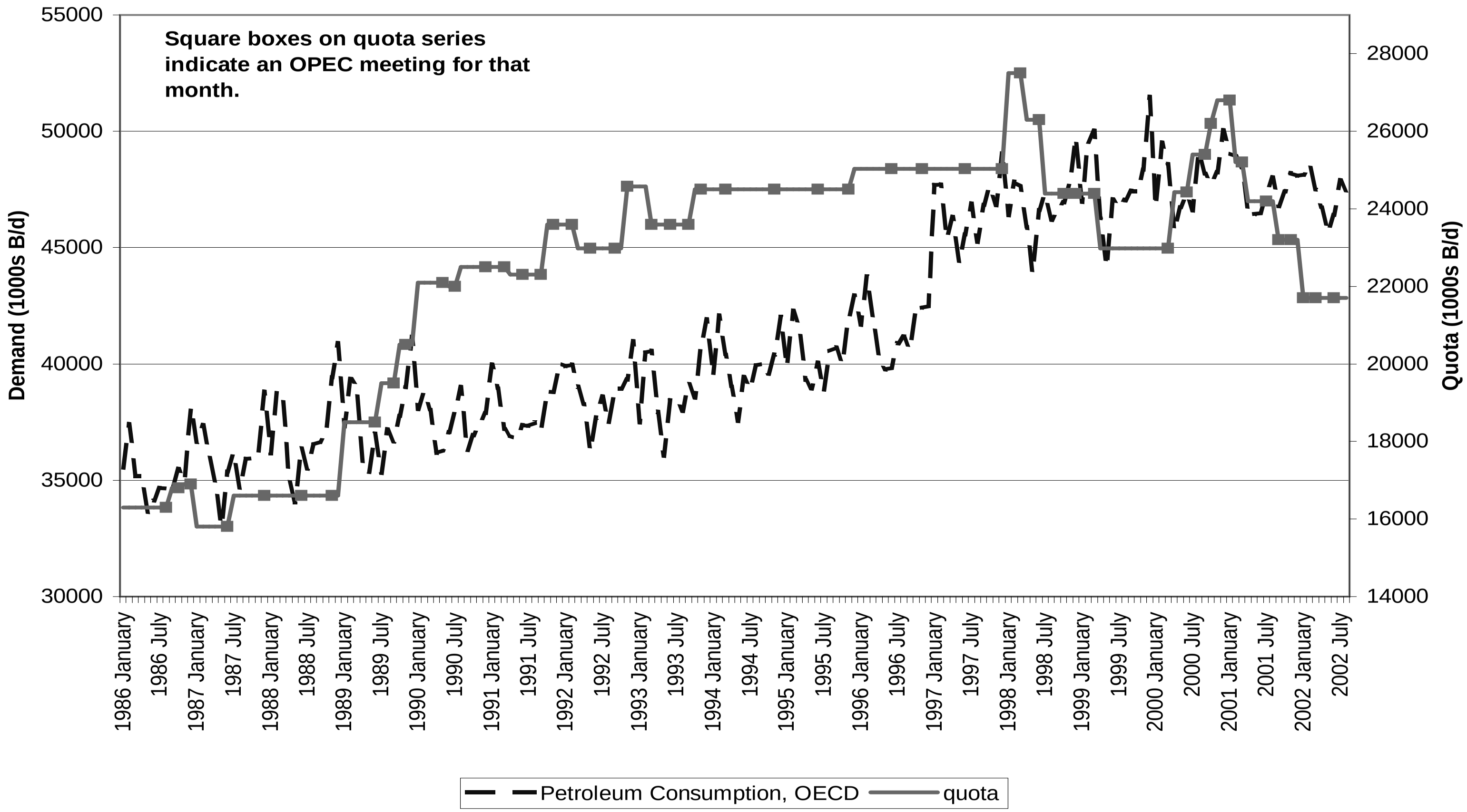


Figure 1: OPEC Quota and OECD Oil Demand



Appendix 2

The purpose of this appendix is two-fold. We first conduct another robustness check. In particular, we use our empirical methodology to briefly examine the impact that OPEC announcements have on oil prices and refiners. The idea is the following - first, we should see a similar pattern of abnormal returns when studying oil prices as we do in our analysis of oil companies. Second, regarding refiners, we should see a weaker effect, and, moreover, reductions in the quota should no longer lead to positive abnormal returns. We then proceed to discuss Saudi Arabia's role within OPEC. Its prominence within OPEC and its vast reserves means we should take small pause to analyse it.

2.1 Oil Prices and Refiners

Oil Prices

As we have emphasised in the main text, the relationship between oil companies and OPEC is largely through oil prices. That is, OPEC's actions influence the price of oil, which, in turn affects the profitability of an oil company. We expect a similar pattern of cumulative abnormal returns, though the effect need not be the same.[28] In particular, crude oil is a storable resource; thus when information arrives which would tend to push up oil prices, firms may have the incentive to draw down on their stocks, thus muting any price increase to some extent. Similarly, when information pointing to lower prices arrives, firms may take it as an opportunity to build up stocks, with a similar dampening effect. Thus, although we expect a similar pattern, it would not be surprising if the magnitude and significance of any events is somewhat weaker.

Our analysis is for the spot price and the two-month forward price of West Texas Intermediate crude oil. As can be seen in the figures below, we have a virtually identical pattern of abnormal returns. Towards the end of the event window, we have positive cumulative abnormal returns for quota reductions, and these are significant for the two-month forward price. While the CAR functions for status quo announcements are not significantly negative, in both cases, we are able to say that they are significantly below the CAR functions for reductions in the quota. Finally, the CAR function for announcements of increases in the quota is never significantly different from zero. Thus we have that the pattern of returns follows closely to that reported in the main text, though with somewhat weaker effects.

[Figure A2-1 Here]

Refiners

We also consider the impact of OPEC announcements on refiners. For lack of an index of all refiners, we consider instead two of the larger North American refiners - Valero and Sunoco. Importantly, these companies also have a significant retail marketing business and so we must be careful in our analysis. We might expect status quo announcements to be the best news. That is, the market calls for a reduction in crude oil production but OPEC fails to accommodate, leading to a reduction in prices. First, the status quo announcement will put downward pressure on their input prices, which should increase profitability. Second, to the extent that these companies have retail marketing operations the work of Borenstein and Shepard [1996] and Lewis [2003] pointing to asymmetric price movements may come into play, leading to even higher profits from lower prices.

As can be seen from the figures, we have positive abnormal returns for quota reductions and negative abnormal returns for status quo announcements. This is consistent with our interpretation that the market is surprised by such announcements. However, it seems contrary

[28] We modify the estimation a little here. In particular, we consider $R_{it} = \alpha + \epsilon_{it}$ as our normal returns model (see Campbell *et al* [1997] for more details). In addition our normal returns estimation period is taken to be 150 days and the event window is 15 days before and after the event date.

to the predicted pattern of returns. Indeed, the figures for Valero look much the same as for the oil indices considered in the main body. The pattern of returns for Sunoco is more consistent with our predictions. In particular, quota reductions seem to be met somewhat negatively. Importantly, however, none of the CAR functions are significantly different from zero for both firms.

[Figure A2-2 Here]

2.2 Insurance

It has been suggested that Saudi Arabia acts as a *swing* producer and, in some sense, insures other OPEC members against large swings in demand. Indeed, given Saudi Arabia's prominence within OPEC we feel it important to take a separate look at it. Attention in the popular press would seem to indicate that insurance is the first place one should look. However, under the hypothesis that Saudi Arabia insures OPEC members, it would appear that disagreement is not due to rent-seeking but rather the belligerence of Saudi Arabia. Thus let us dispel these concerns. Assume that Saudi Arabia does, in fact, insure other OPEC members. Then we would expect to find a positive correlation between the quota and Saudi Arabia's share of the quota.

With the data at hand, it is a simple enough task to obtain such correlations. However, we must proceed cautiously since Saudi Arabia was able to increase dramatically its share of the quota during the first Persian Gulf War because it was the only OPEC member with adequate spare capacity. Thus, we divide our sample into two separate periods. The first includes the period up to and including 1990, while the second includes the period from 1992 until 2002. Visually, one can see in Figure A-4 how Saudi Arabia's share of the quota moves with the overall quota. From the graph, it does not appear that the correct, under the null hypothesis, correlation emerges. However, we endeavour to be slightly more formal. In the table below we report the results of two regressions of Saudi Arabia's share on the total OPEC quota.

[Table 2 Here]

As the reader can see, for each time period, we are able to reject the null hypothesis of zero correlation in favour of the hypothesis of *negative* correlation between the quota and Saudi Arabia's share at least at the 5% level of significance. Thus we can reject the hypothesis that Saudi Arabia acts as an insurer and can be much more satisfied with the first of our models in Section 5. Note also that the negative correlation also holds if we run the regressions in terms of first differences, though the t-statistics drop slightly.

Figure A2-1: CAR Function For Oil Prices

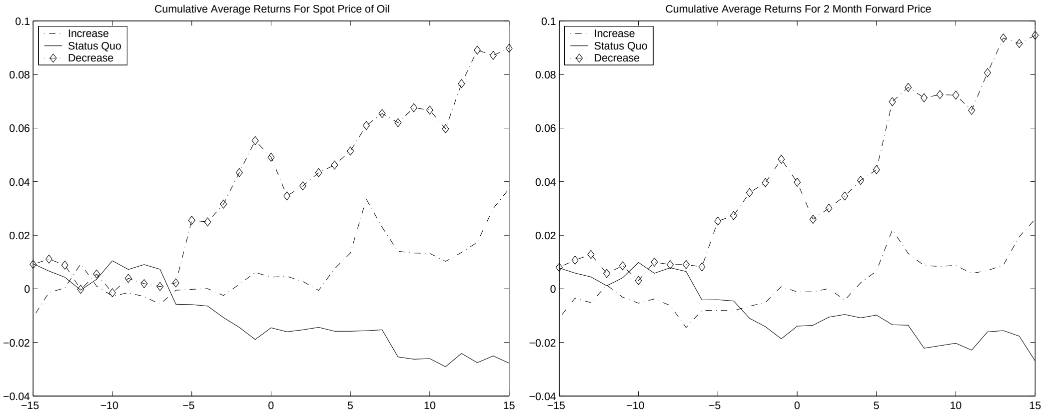
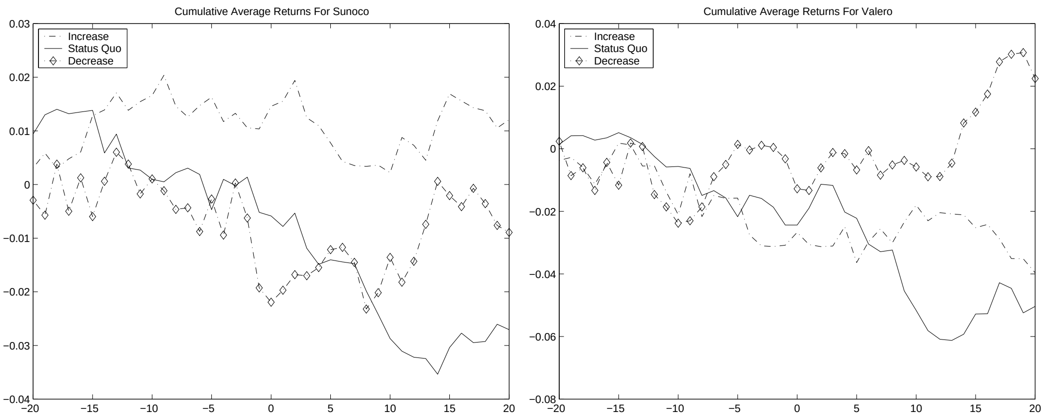


Figure A2-2: CAR Function For Refiners



Appendix 3 - Tables

Table 1: **Wilcoxon Signed Rank Tests**

Index	Q↑	Q↔	Q↓
Oil Companies	0.1328	-2.3357	0.2365
Integrated Companies	0.9492	-1.8174	0.4438
Service Companies	-1.8433	-2.1414	0.1587
Exploration Companies	-1.1954	-1.9988	0.6706

Table 2: **Test of Insurance Hypothesis**

Regressors	1986-1990	1992-2002
Total OPEC Quota	-0.000281 (-5.80)**	-0.0003122 (-2.87)*
Constant	33.62	40.60
Number of Observations	12	17
R-Square	0.77	0.24

* — significant at 5%
** — significant at 1%

Table 3: **Abnormal Returns For Oil Companies Sub-Index**

Event Day	Q↑ $\bar{\epsilon}^*$	Q↑ $\overline{CAR}$	Q↔ $\bar{\epsilon}^*$	Q↔ $\overline{CAR}$	Q↓ $\bar{\epsilon}^*$	Q↓ $\overline{CAR}$
-20	0.0018	0.0018	0.0021	0.0021	0.0007	0.0007
-19	-0.0021	-0.0002	-0.0001	0.0021	-0.0021	-0.0014
-18	-0.0023	-0.0025	0.0015	0.0036	0.0026	0.0012
-17	-0.0008	-0.0034	-0.0017	0.0018	-0.0038	-0.0026
-16	0.0022	-0.0012	-0.0005	0.0014	0.0003	-0.0023
-15	-0.0008	-0.002	-0.0006	0.0008	-0.0017	-0.004
-14	0.0011	-0.0009	-0.0007	0.0001	0.0067	0.0027
-13	-0.0027	-0.0036	-0.0016	-0.0016	0.0055	0.0082
-12	-0.0016	-0.0052	-0.0029	-0.0044	-0.0043	0.0039
-11	0.0033	-0.0019	-0.0003	-0.0047	0.0002	0.0041
-10	-0.0034	-0.0053	0.0027	-0.0021	-0.0024	0.0018
-9	-0.0009	-0.0062	-0.0026	-0.0047	0.0043	0.0061
-8	-0.0058	-0.0119	-0.0014	-0.0061	0.0007	0.0068
-7	0.001	-0.0109	-0.0004	-0.0065	-0.0003	0.0064
-6	0.0032	-0.0077	-0.003	-0.0095	0.0011	0.0076
-5	-0.0013	-0.009	-0.0017	-0.0112	0.0046	0.0122
-4	-0.0049	-0.0139	0.0026	-0.0086	0.0012	0.0134
-3	0.0028	-0.0111	-0.0031	-0.0117	0.0019	0.0153
-2	-0.0017	-0.0128	-0.0005	-0.0122	-0.0004	0.0149
-1	-0.0003	-0.0131	0	-0.0122	-0.002	0.0129
0	0.0069	-0.0061	0.0008	-0.0114	-0.0024	0.0105
1	0.0013	-0.0049	-0.002	-0.0134	-0.0035	0.007
2	0.0032	-0.0017	0.0018	-0.0115	0.0018	0.0088
3	-0.0016	-0.0033	-0.0028	-0.0143	0.0016	0.0104
4	0.0047	0.0014	-0.0017	-0.016	0.0029	0.0133
5	-0.0018	-0.0004	-0.0001	-0.0162	-0.0011	0.0122
6	0.0046	0.0041	-0.0022	-0.0183	0.0048	0.017
7	-0.0018	0.0024	-0.0008	-0.0192	-0.0019	0.015
8	-0.0042	-0.0019	0.0004	-0.0187	-0.0053	0.0097
9	0.0017	-0.0002	0.0007	-0.018	0.0018	0.0116
10	-0.0007	-0.0008	-0.0025	-0.0205	0.0018	0.0134
11	0.0007	-0.0001	-0.0029	-0.0233	-0.0073	0.0061
12	0.0017	0.0016	0.0022	-0.0212	0.0001	0.0062
13	-0.0022	-0.0007	-0.0017	-0.0228	0.004	0.0102
14	0.0046	0.0039	0.0006	-0.0223	0.006	0.0163
15	0.0015	0.0054	-0.0016	-0.0238	0.0064	0.0227
16	0.0021	0.0075	0.0003	-0.0235	-0.0018	0.0209
17	-0.0016	0.0059	-0.0013	-0.0249	0.004	0.0248
18	-0.0009	0.005	-0.0004	-0.0252	-0.0006	0.0242
19	-0.0003	0.0047	-0.001	-0.0263	0.0039	0.0281
20	-0.0003	0.0044	0.0007	-0.0255	0.0037	0.0318

Table 4: **Abnormal Returns For Exploration Companies Sub-Index**

Event Day	Q↑ $\overline{\epsilon}^*$	Q↑ $\overline{CAR}$	Q↔ $\overline{\epsilon}^*$	Q↔ $\overline{CAR}$	Q↓ $\overline{\epsilon}^*$	Q↓ $\overline{CAR}$
-20	0.0034	0.0034	0.0016	0.0016	0.002	0.002
-19	0.0013	0.0047	0	0.0016	-0.0034	-0.0014
-18	-0.0026	0.0021	0.0005	0.0022	0.0053	0.0039
-17	-0.001	0.0012	0.0009	0.003	-0.0033	0.0006
-16	-0.0036	-0.0024	0.0003	0.0033	0.0029	0.0035
-15	-0.0007	-0.0031	0.0004	0.0037	0.002	0.0055
-14	0.0016	-0.0015	-0.0003	0.0035	0.0068	0.0123
-13	-0.0006	-0.0021	-0.0004	0.003	0.0062	0.0185
-12	-0.0016	-0.0037	-0.0046	-0.0015	-0.0034	0.015
-11	0.0004	-0.0033	0.0005	-0.001	-0.0009	0.0142
-10	-0.0025	-0.0058	0.002	0.001	-0.0009	0.0133
-9	0.0007	-0.0051	-0.0021	-0.0011	0.0049	0.0182
-8	-0.002	-0.0071	-0.0004	-0.0015	0.001	0.0192
-7	-0.0015	-0.0086	-0.0005	-0.002	0.0027	0.0219
-6	0.0008	-0.0078	-0.0035	-0.0055	0.0007	0.0226
-5	-0.0009	-0.0087	-0.0003	-0.0058	0.0063	0.0289
-4	-0.0052	-0.0139	0.0002	-0.0055	-0.0031	0.0258
-3	0.0013	-0.0126	-0.0045	-0.0101	0.0021	0.0279
-2	0.0016	-0.0109	-0.0005	-0.0105	0.0032	0.0311
-1	-0.0024	-0.0133	-0.0028	-0.0133	-0.0004	0.0307
0	0.0065	-0.0068	0.0014	-0.0119	-0.004	0.0268
1	0.0027	-0.0041	-0.0026	-0.0145	-0.0009	0.0258
2	0.003	-0.0011	0.001	-0.0135	0.0046	0.0305
3	-0.0025	-0.0036	-0.0027	-0.0162	0.0028	0.0333
4	0.0014	-0.0022	-0.0039	-0.0201	0.0039	0.0372
5	-0.0014	-0.0036	0.0008	-0.0192	0.0009	0.0381
6	0.0024	-0.0012	-0.0013	-0.0205	0.007	0.0451
7	-0.0009	-0.0021	0.0005	-0.02	-0.0013	0.0438
8	-0.0054	-0.0075	0.0012	-0.0188	-0.0022	0.0416
9	-0.0001	-0.0076	-0.0023	-0.0211	0.0005	0.042
10	-0.0003	-0.0079	-0.0041	-0.0251	-0.0011	0.0409
11	-0.0016	-0.0095	-0.0051	-0.0303	-0.0037	0.0372
12	0.0002	-0.0094	-0.0001	-0.0303	-0.0019	0.0353
13	-0.0029	-0.0123	-0.0014	-0.0318	0.0028	0.0381
14	0.0025	-0.0098	0.0004	-0.0314	0.0072	0.0453
15	-0.0003	-0.0101	-0.0022	-0.0335	0.01	0.0553
16	0.0001	-0.01	0.0018	-0.0318	0.0002	0.0554
17	-0.0001	-0.0101	-0.0027	-0.0344	0.0036	0.0591
18	-0.0016	-0.0117	-0.0004	-0.0349	-0.0006	0.0584
19	-0.0014	-0.0131	0.0014	-0.0334	0.0024	0.0608
20	-0.0016	-0.0147	-0.0005	-0.034	-0.0016	0.0592

Table 5: **Abnormal Returns For Service Companies Sub-Index**

Event Day	Q↑ $\overline{\epsilon}^*$	Q↑ $\overline{CAR}$	Q↔ $\overline{\epsilon}^*$	Q↔ $\overline{CAR}$	Q↓ $\overline{\epsilon}^*$	Q↓ $\overline{CAR}$
-20	0.0023	0.0023	-0.0016	-0.0016	0.0066	0.0066
-19	-0.0002	0.0022	-0.0024	-0.004	-0.0021	0.0045
-18	-0.0019	0.0003	0.0031	-0.0009	0.0034	0.0079
-17	-0.0031	-0.0028	-0.002	-0.0029	-0.0051	0.0027
-16	-0.0012	-0.0039	0.0006	-0.0023	0.0043	0.007
-15	-0.0061	-0.0101	0.0019	-0.0005	-0.0029	0.0041
-14	0.0004	-0.0096	-0.0005	-0.001	0.0121	0.0162
-13	-0.0038	-0.0134	-0.0027	-0.0037	0.0086	0.0248
-12	-0.0082	-0.0216	-0.0028	-0.0065	-0.007	0.0178
-11	0.001	-0.0207	-0.0014	-0.0079	0.0072	0.025
-10	-0.003	-0.0237	0.0044	-0.0035	-0.0061	0.0188
-9	-0.0002	-0.0238	-0.0036	-0.0071	0.0014	0.0202
-8	-0.0099	-0.0337	-0.0042	-0.0113	0.0022	0.0224
-7	0.0009	-0.0329	0.0024	-0.0089	-0.0057	0.0167
-6	0.0024	-0.0304	-0.005	-0.0139	-0.0005	0.0162
-5	-0.0018	-0.0323	-0.0008	-0.0147	0.0112	0.0274
-4	-0.0095	-0.0418	0.0016	-0.0131	0.004	0.0314
-3	0.0021	-0.0397	-0.0033	-0.0164	0.0051	0.0365
-2	-0.0031	-0.0428	-0.0044	-0.0208	0.0059	0.0424
-1	-0.0024	-0.0452	-0.0063	-0.0271	-0.008	0.0344
0	0.0084	-0.0369	0.0046	-0.0225	-0.0044	0.0301
1	-0.001	-0.0379	-0.0053	-0.0278	-0.0109	0.0192
2	0.0057	-0.0322	-0.0031	-0.031	0.0068	0.0261
3	-0.0019	-0.0341	-0.0033	-0.0343	0.0047	0.0308
4	0.003	-0.0311	-0.0014	-0.0357	0.0071	0.0379
5	-0.0085	-0.0395	0.0007	-0.035	-0.0029	0.0351
6	0.0026	-0.0369	-0.0037	-0.0387	0.008	0.0431
7	0.0006	-0.0363	-0.0012	-0.0399	-0.0114	0.0317
8	-0.0105	-0.0467	-0.0005	-0.0404	-0.0062	0.0254
9	-0.001	-0.0477	0.0009	-0.0394	-0.0024	0.023
10	-0.0031	-0.0509	-0.0018	-0.0413	-0.0037	0.0194
11	-0.0017	-0.0526	-0.0057	-0.0469	-0.0108	0.0085
12	0.0051	-0.0475	0.002	-0.0449	0.0023	0.0108
13	-0.0031	-0.0506	-0.0011	-0.046	0.0051	0.0159
14	0.0057	-0.0449	0.0024	-0.0436	0.0107	0.0266
15	0.0017	-0.0432	0.0002	-0.0433	0.0163	0.0429
16	0.0003	-0.0429	-0.0001	-0.0434	-0.0018	0.0411
17	-0.0055	-0.0485	-0.0029	-0.0464	-0.0014	0.0397
18	-0.0054	-0.0539	0.0022	-0.0442	-0.0035	0.0362
19	-0.0005	-0.0544	0.003	-0.0412	0.0046	0.0408
20	0.0002	-0.0542	-0.0004	-0.0416	0.0006	0.0413

Table 6: **Abnormal Returns For Integrated Companies Sub-Index**

Event Day	Q↑ $\overline{\epsilon}^*$	Q↑ $\overline{CAR}$	Q↔ $\overline{\epsilon}^*$	Q↔ $\overline{CAR}$	Q↓ $\overline{\epsilon}^*$	Q↓ $\overline{CAR}$
-20	0.0009	0.0009	0.003	0.003	-0.0008	-0.0008
-19	-0.0037	-0.0028	0.0003	0.0033	-0.0018	-0.0026
-18	-0.0019	-0.0047	0.0013	0.0046	0.002	-0.0006
-17	-0.0005	-0.0052	-0.0022	0.0025	-0.0032	-0.0039
-16	0.0048	-0.0005	-0.0009	0.0016	-0.0012	-0.0051
-15	0.0003	-0.0001	-0.0008	0.0008	-0.0025	-0.0075
-14	0.0011	0.001	-0.0009	-0.0001	0.0049	-0.0027
-13	-0.0033	-0.0023	-0.0017	-0.0018	0.0045	0.0018
-12	-0.0004	-0.0027	-0.0021	-0.0039	-0.0035	-0.0017
-11	0.0046	0.0019	-0.0004	-0.0042	-0.0001	-0.0018
-10	-0.0036	-0.0017	0.0024	-0.0019	-0.0022	-0.0039
-9	-0.0014	-0.0031	-0.0026	-0.0045	0.0045	0.0005
-8	-0.006	-0.0091	-0.001	-0.0055	0.0003	0.0009
-7	0.0016	-0.0076	-0.0009	-0.0064	0.0001	0.0009
-6	0.0039	-0.0037	-0.0027	-0.0091	0.0012	0.0021
-5	-0.0011	-0.0048	-0.0023	-0.0115	0.0024	0.0045
-4	-0.0041	-0.0089	0.003	-0.0084	0.0018	0.0063
-3	0.0033	-0.0055	-0.0024	-0.0108	0.0011	0.0074
-2	-0.002	-0.0075	0.0004	-0.0104	-0.0025	0.0049
-1	0.0011	-0.0064	0.0018	-0.0086	-0.0014	0.0034
0	0.0068	0.0004	0	-0.0086	-0.001	0.0024
1	0.0012	0.0016	-0.0015	-0.01	-0.0026	-0.0002
2	0.0028	0.0044	0.0029	-0.0072	0	-0.0002
3	-0.0016	0.0028	-0.0025	-0.0097	0.0007	0.0005
4	0.006	0.0088	-0.0012	-0.0109	0.002	0.0025
5	-0.0001	0.0087	-0.0006	-0.0115	-0.0017	0.0008
6	0.0051	0.0138	-0.0023	-0.0138	0.0033	0.0041
7	-0.0024	0.0114	-0.0007	-0.0144	-0.0003	0.0038
8	-0.0022	0.0091	0.0004	-0.0141	-0.0055	-0.0017
9	0.0027	0.0118	0.0017	-0.0124	0.0033	0.0016
10	0.0001	0.012	-0.0024	-0.0147	0.0036	0.0053
11	0.0015	0.0134	-0.002	-0.0168	-0.0072	-0.0019
12	0.0016	0.015	0.0025	-0.0142	0	-0.0019
13	-0.0018	0.0132	-0.0017	-0.0159	0.004	0.0021
14	0.0044	0.0176	-0.0001	-0.016	0.0049	0.007
15	0.0023	0.0199	-0.0017	-0.0177	0.0036	0.0106
16	0.003	0.0229	-0.0003	-0.018	-0.0025	0.0081
17	-0.001	0.0218	-0.0007	-0.0186	0.005	0.0131
18	0.0004	0.0222	-0.0009	-0.0196	0.0004	0.0135
19	-0.0003	0.0219	-0.0023	-0.0219	0.004	0.0175
20	-0.0001	0.0218	0.0012	-0.0207	0.0056	0.0231