ATTACHMENT 1 – ANALYSIS FOR MODIFICATION P212

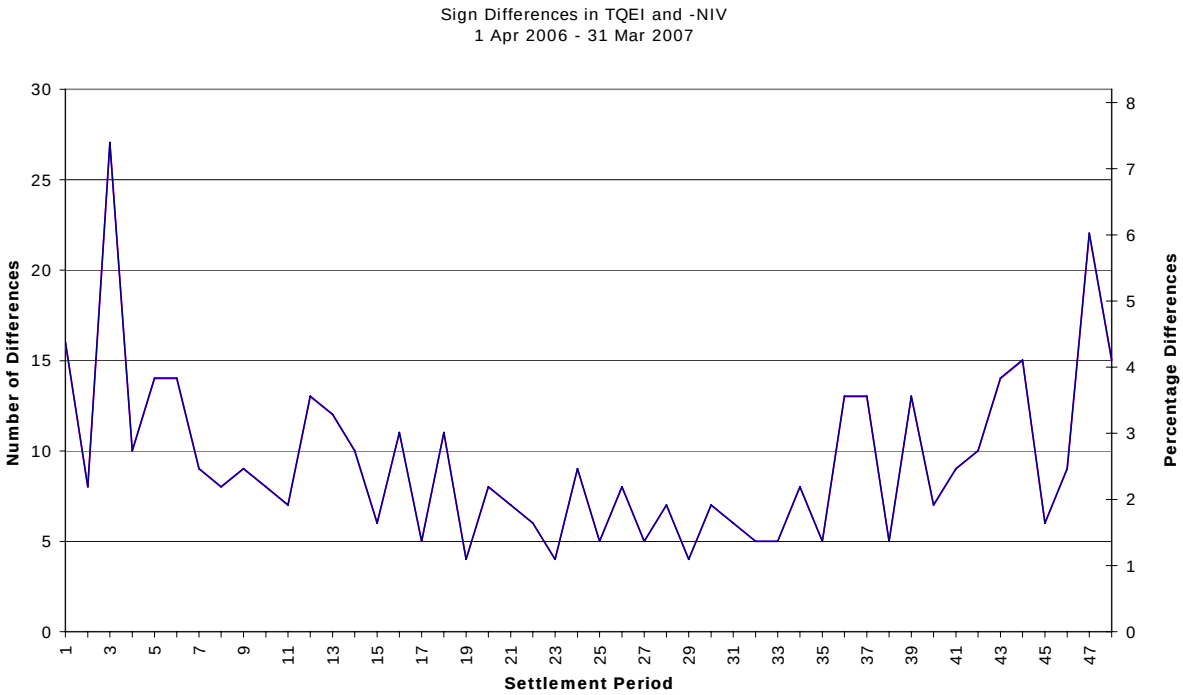
This attachment summarises the full set of analysis thus far undertaken by the P212 Modification Group to assess P212.

1. Net Imbalance Volume (NIV) vs Total System Energy Imbalance Volume (TQEI)

The Group compared NIV against TQEI to establish the degree to which NIV (as an estimation of system length) indicated the same system direction as TQEI. NIV indicates the system is short when NIV > 0 and long when NIV < 0. For the Period 1 April 2006 to 31 March 2007, Figure 1 (below) shows the number of occasions for each Settlement Period in which either:

- NIV indicated the system was short when TQEI indicated the system was long; or
- NIV indicated the system was long when TQEI indicated the system was short.

Figure 1. NIV vs TQEI



The data for this analysis indicated that 2.6% (452 out of 17520 Settlement Periods) have a different sign for NIV as for TQEI. Of the 452 Settlement Periods:

- 52% had a NIV under 10MWh;
- 3% had a NIV over 100MWh;
- 45% of the Settlement Periods were between 23:00 and 06:59;

2. System Spread

System spread was analysed for the year 1 April 2006 to 31 March 2007. The results of this analysis were:

When the System was long and SSP is the main price:

- SSP is on average 24% lower than Market Index Price[1] (MIP), (with a Standard Deviation of 15%);

[1] Note that this is the Market Index Price as provided by the Market Index Data Provider. It is not the Reverse Price as this will have had the default rules applied to it.

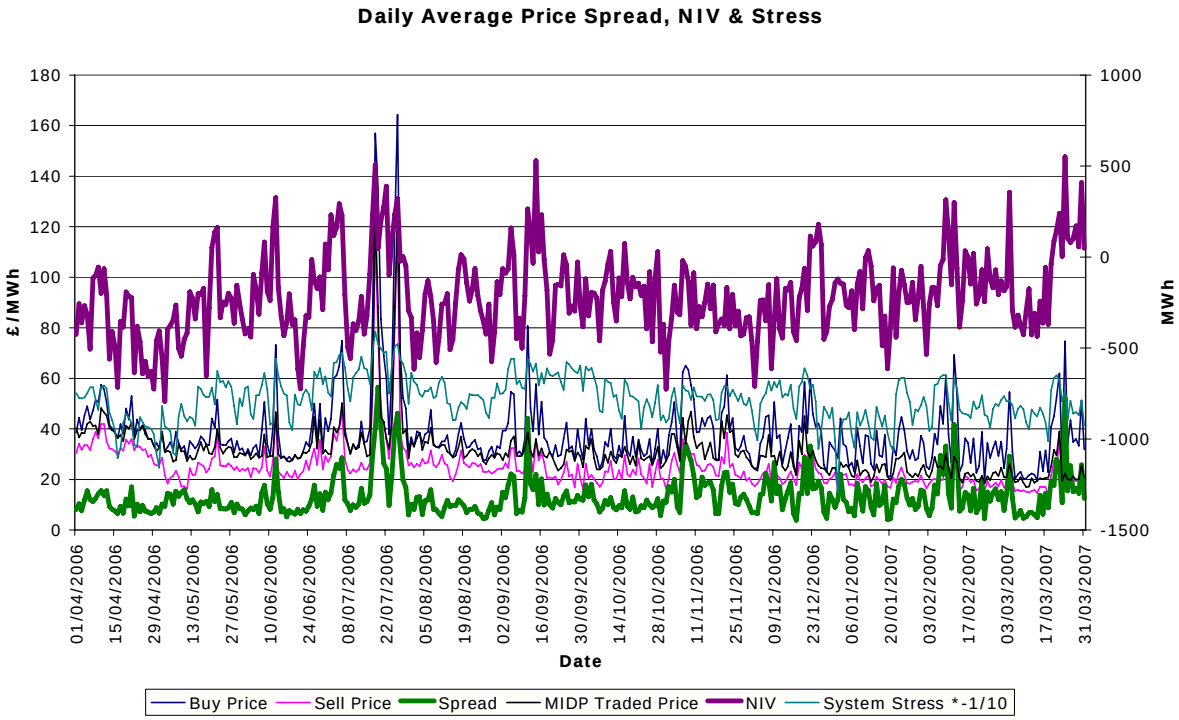
- The maximum decrease from MIP to SSP is 121% and the maximum increase is 77%[2]; and
- The average price decrease of SSP from MIP is £7.75 with a Standard Deviation of £8.33;
    - 69% of Settlement Period's lie within 1 Standard deviation of the average.

When the System is short and SBP is the main price:

- SBP is on average 86% greater than Market Index Price (with a Standard Deviation of 71%);
- The maximum increase from MIP to SBP is 743% and the maximum decrease is 52%;and
- The average price increase of SBP over MIP is £28.57 with a Standard Deviation of £28.95;
    - 67% of Settlement Period's lie within 1 Standard deviation of the average.

The Spread can be seen for the entire year in Figures 2 and 3 below. Figure 2 shows the daily average price spread against NIV and system stress[3]. Figure 3 shows the period averages for the year.

Figure 2. Daily average Price Spread

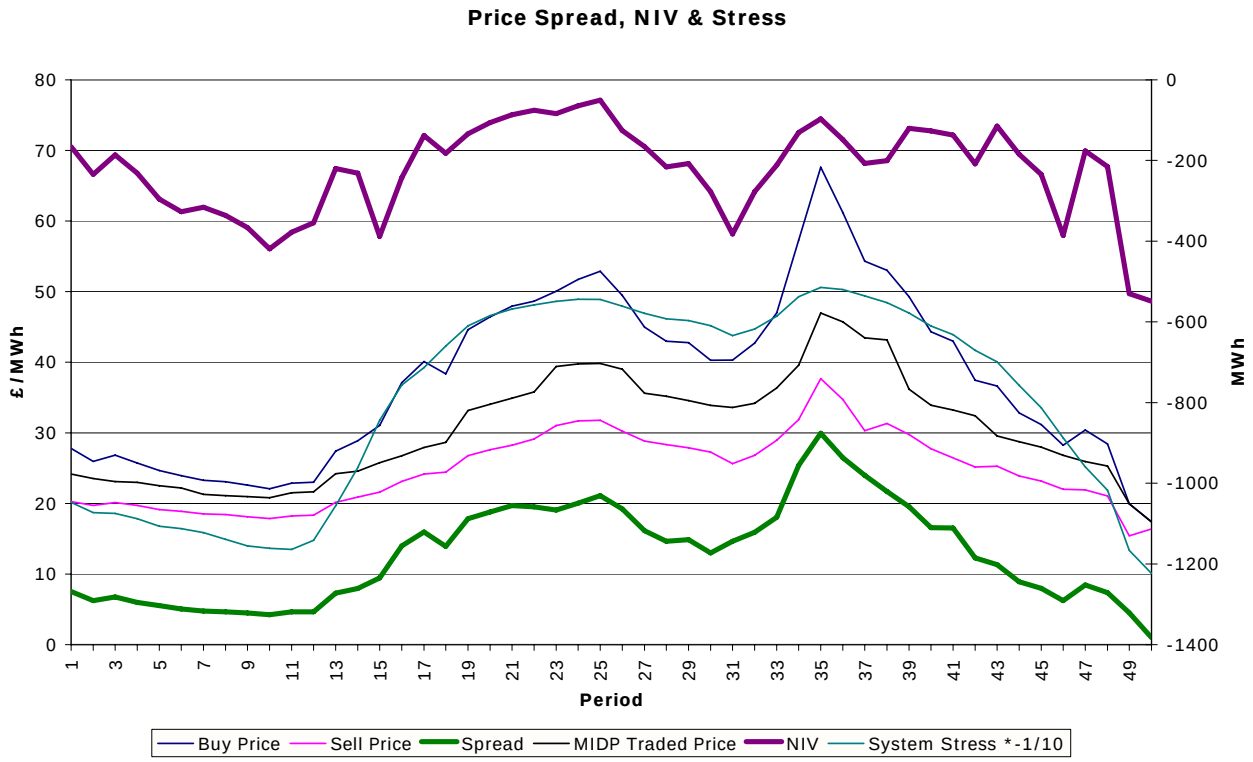


It is clear that, like the prices, the spread can be volatile even when averaged on a daily basis. Thus the spread is not indicative of any single percentage uplift or discount.

[2] This is due to the application of a default rule in the arrangements existing at the time in which SSP ≤ SBP (as defined in the BSC, T4.4.6(b)).

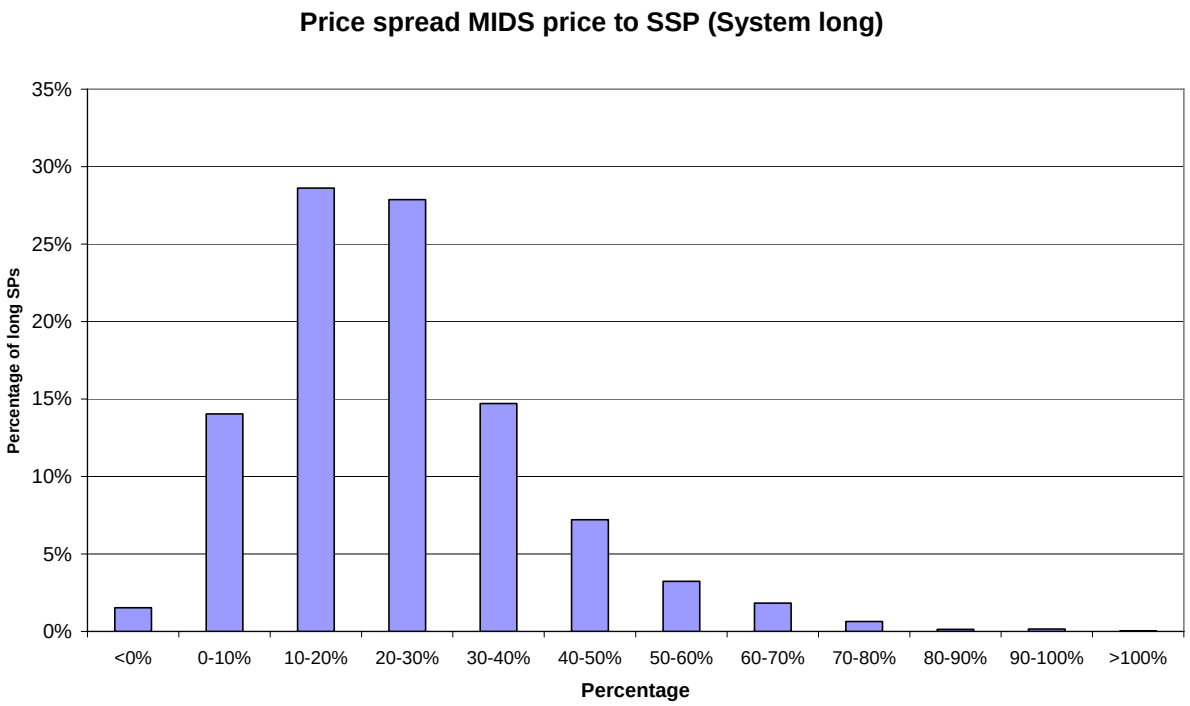
[3] Note that the measure of system stress used is the difference between metered demand volumes and total Maximum Export Limit (MEL). To get this on a scale comparable to NIV this has been multiplied by – (1/10). This measure of system stress does not differentiate between volumes already in the balancing mechanism and those brought to the market by the System Operator.

Figure 3. Daily average Price Spread



It can be seen that, whilst neither NIV or the measure of system stress correlate with SBP, average Settlement Period system stress follows the pattern of average Settlement Period Prices (and spread) more closely than NIV.

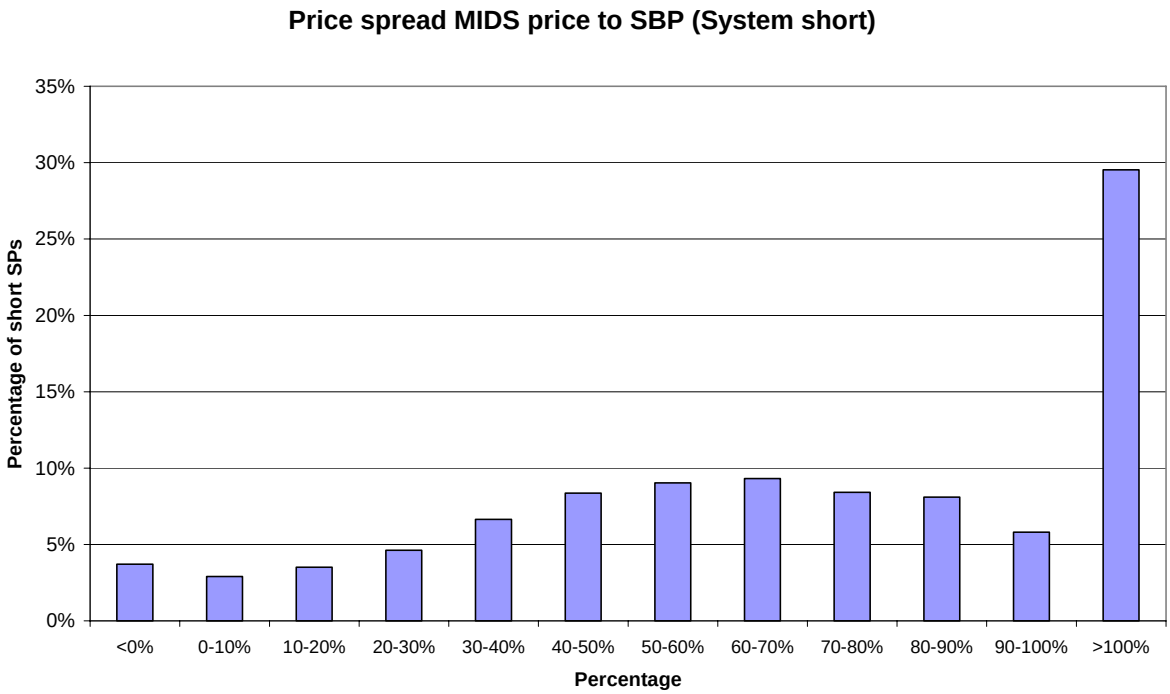
Figure 4. Distribution of Price Spreads when the System is Long



In both a long (NIV < 0) and a short (NIV > 0) market, the percentage of Settlement Periods in which the spread was within range's of 10% was analysed to gauge the distribution of the spread.

Figures 4 shows that, when the system is long, that the range of spread with the highest number of Settlement Period occurrences is the 20-30% spread. Figure 5 shows that, when the system is short, that the range of spread with the highest number of Settlement Period occurrences is the 60-70% spread. This highlights that under the current (and Pre PAR500) arrangements that, on average, the uplift to SBP when the system is short has been more extreme than the discount to SSP when the system is long.

Figure 5. Distribution of Price Spreads when the System is Short



As a day in which a High Risk of Demand Reduction (HRDR) notice published by the SO, the 18 July 2006 represents a day of system stress. Figure 6 shows the spread for this day in £/MWh with Figure 7 showing the spread in percentage terms (peaking at 170%).

Figure 6. 18 July 2006 Price Spread

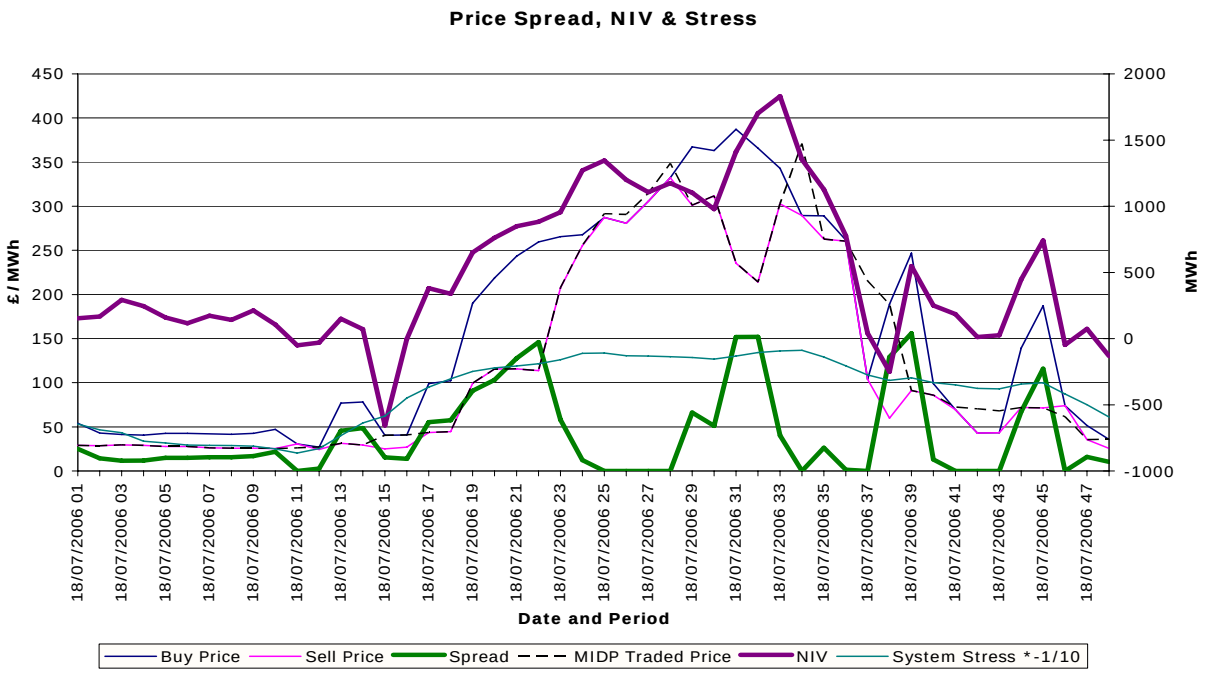
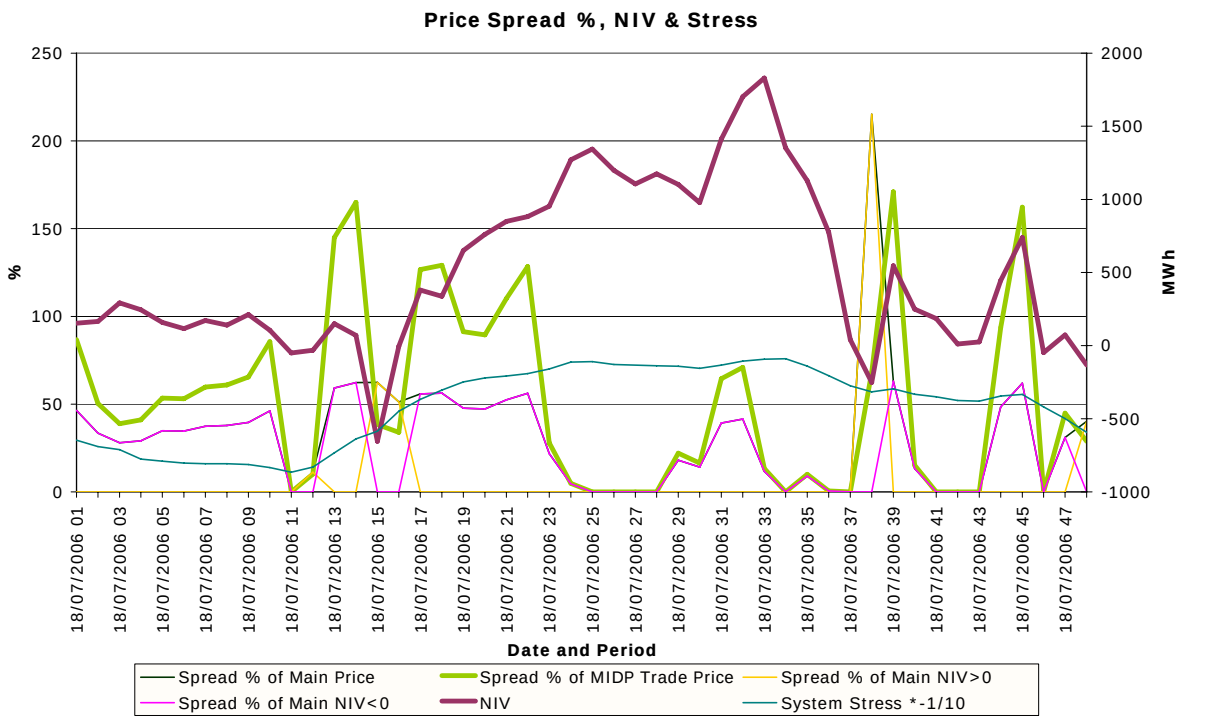


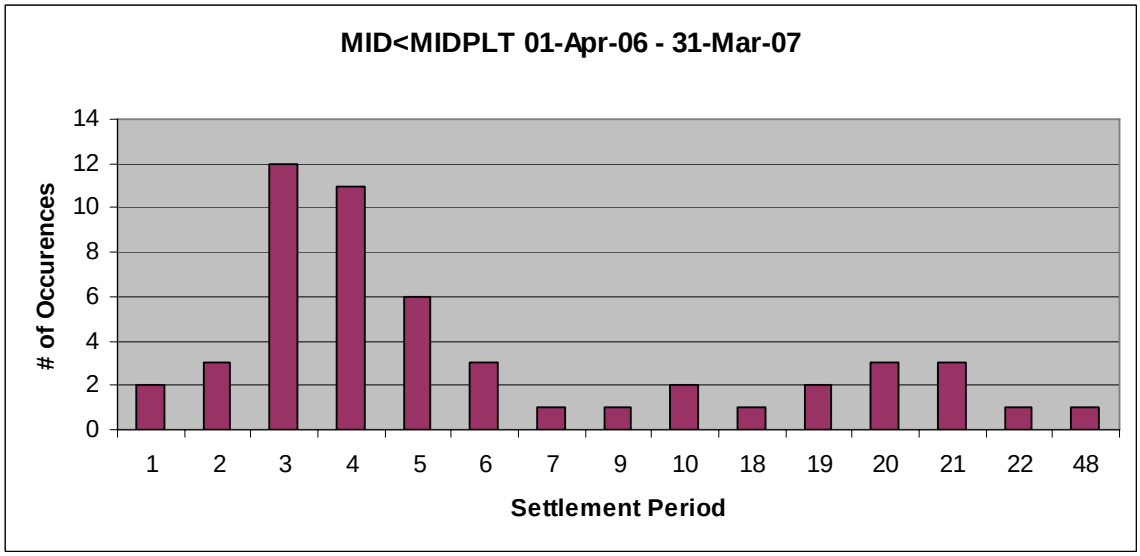
Figure 7. 18 July 2006 Percentage Price Spread



3. Market Index Definition Default

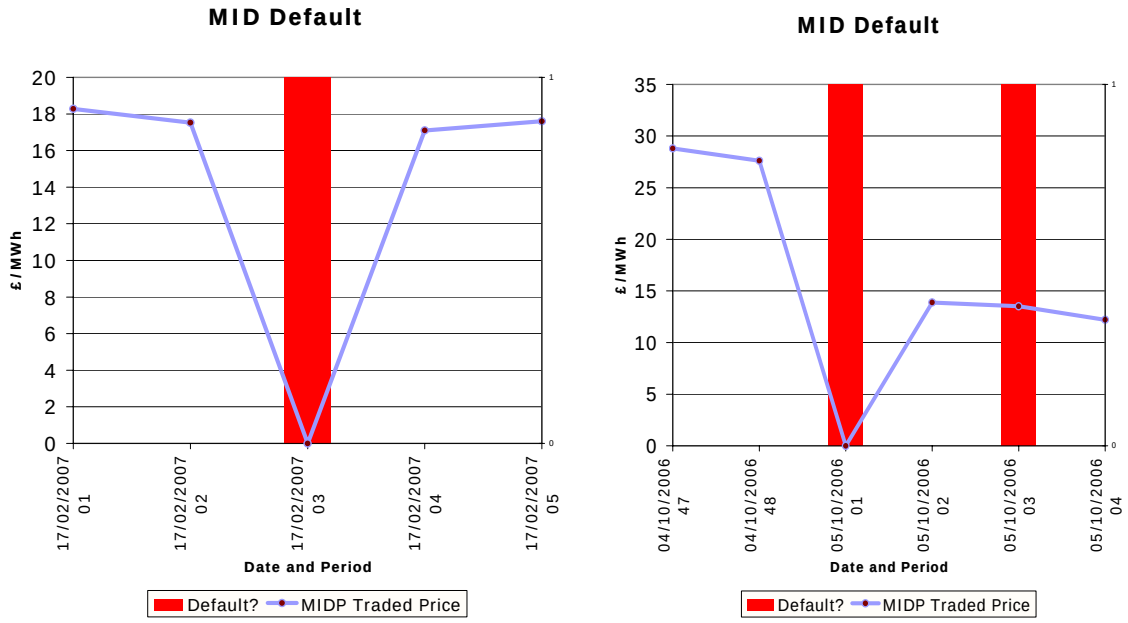
In the sample year of 1 April 2006 to 31 March 2007, there were 3 Settlement Periods in which there was no Market Index Definition (MID) data to calculate a price (occurring overnight (23:00 to 06:59)). There were 52 periods where the MID data was below the required 20MWh liquidity threshold. Figure 8 shows that most of these (42) occurred overnight.

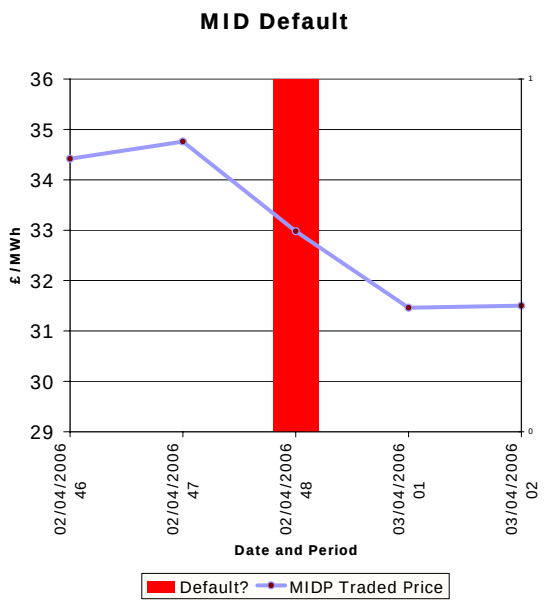
Figure 8. Settlement Periods in which MID did not meet the 20MWh liquidity threshold.

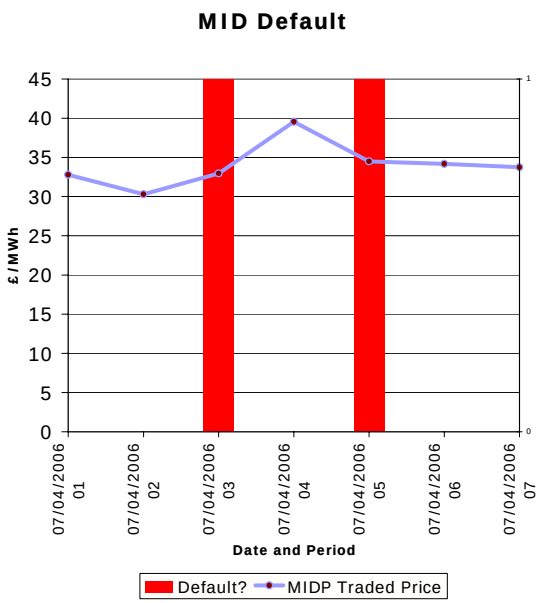


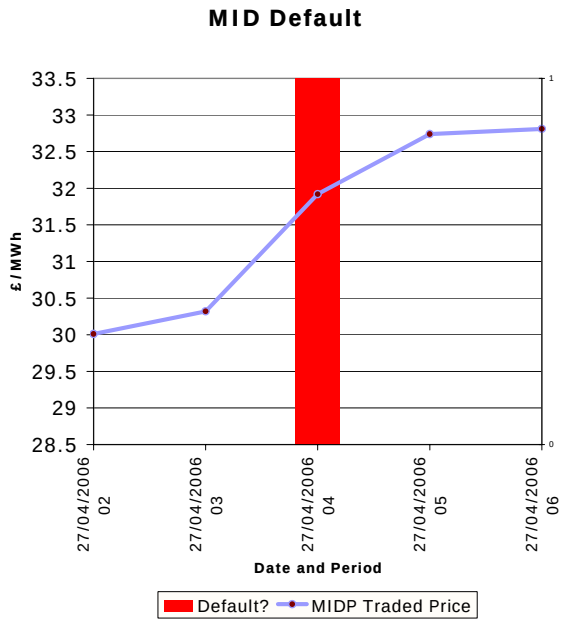
In order to understand how useful the previous Settlement Period might be as a proxy for a price for any Settlement Period in which default occurs, a sample of Settlement Periods in which default occurred are analysed here.

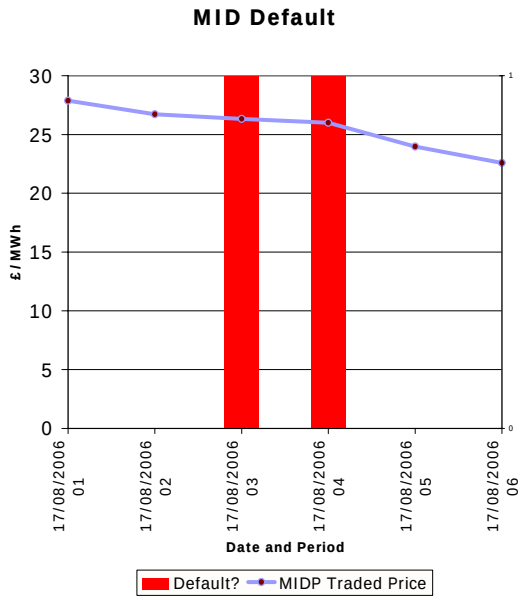
Figure 9. Settlement Periods of Default with MID Price recalculated with Liquidity Threshold removed











4. Price Analysis

Prices were recalculated under the P212 Proposed Option 1 **with a fixed percentage of 5%.** This section compares those P212 Option 1 prices with those that existed under the current (and pre-PAR500[4]) arrangements for the period 1 March 2006 to 31 March 2007[5].

Table 1 contains the average prices for the period for both the current ('live') and P212 fixed at 5% option. Note that the averages are first shown for the entire period (thus averaging SBP and SSP when these are both the main and reverse price) and then the averages for SBP when the system is short (and SBP is the main Energy Imbalance Price) and SSP when the system is long (and SSP is the main Energy Imbalance Price).

[4] PAR500 was introduced on 2 November 2006.
[5] Note that the 13 month period was chosen by the Group to include the Gas Balancing Alert on 13 March 2006 which was a day of system stress in the electricity market.

Table 1. P212 Proposed Option 1 – Fixed Percentage of 5% price comparison

	SBP (£/MWh)	SSP (£/MWh)	SBP when short (£/MWh)	SSP when long (£/MWh)
Live Average	£41.76	£27.31	£72.88	£21.72
P212 Average	£33.98	£32.31	£44.60	£28.47
Average Difference	£7.78	£5.00	£28.29	£6.74
% difference	18.63% decrease	18.29% increase	38.8% decrease	31% increase
Max difference	£351.9	£134.4		
Min difference	-£122.2	-£41.1		

When the system is short the P212 Proposed Option 1 SBP will, on average (in under otherwise identical conditions) lead to a 38.8% decrease in live SBP. Similarly, this will increase SSP by an average of 31% over live SSP.

The maximum difference in Table 1 indicates that for one individual Settlement Period, the P212 Proposed Option 1 SBP is £351.9/MWh below the live price SBP. Similarly the maximum difference for SSP indicates that the P212 Proposed Option 1 SSP is £134.4/MWh above the live SSP.

The minimum difference in Table 1 indicates that the P212 Proposed Option 1 SBP can be higher than the live price SBP (and that the P212 Proposed Option 1 SSP can be lower than the live SSP). This is primarily due to the current default rules where the reverse price is restricted to the level of the main price.

The Group also compare the P212 Proposed Option 1 price with that discovered under P211 Proposed. This can be seen in Table 2 below.

Table 2. P212 Proposed Option 1 – Fixed Percentage of 5% price comparison to P211

	SBP when short (£/MWh)	SSP when long (£/MWh)
Live Average	£64.13	£17.54
P212 Average	£31.85	£23.21
P211 Average	£53.88	£18.74

This shows that the P212 price would be significantly less than that of the P211 Proposed solution.

Daily and Period Averages

The Group also looked at daily and period averages for the time period 1 March 2006 to 31 March 2007. This can be seen in the Figures 10 to 13 below.

Figure 10 compares Proposed Option 1 SBP with live SBP when the system is short. This shows that the P212 daily average SBP is consistently below the live SBP. Additionally, whilst it follows the peaks in July, it does not reach the same level indicating less volatility. The Group noted that for the period in November and December 2006 it is significantly noticeable that the P212 SBP does not rise to the levels the live SBP. This indicates that the P212 price may be benign in signalling the costs to balancing the system on those days. The Group also noted that from December 2006, the divergence between the P212 and live SBP was more pronounced.

This pattern of more benign prices can also be seen in Figures 11 to 13. Figure 12 shows that, when the system is short in the peak Settlement Period 35 (17:00 -17:29), the P212 SBP is on average £45/MWh below the live SBP. The smallest difference is in Settlement Period 46 (22:30 – 22:59) of £12.6MWh. Whilst lower, the P212 SBP does follow a similar pattern to the live SBP throughout the day (on average).

Figure 13 shows that P212 SSP and live SSP when the system is long do not follow a similar pattern throughout the day (on average). Settlement Period 37 (18:00-18:29) shows that on average P212 SSP is £17 above the live SSP.

Figure 10. Daily Average SBP when Short

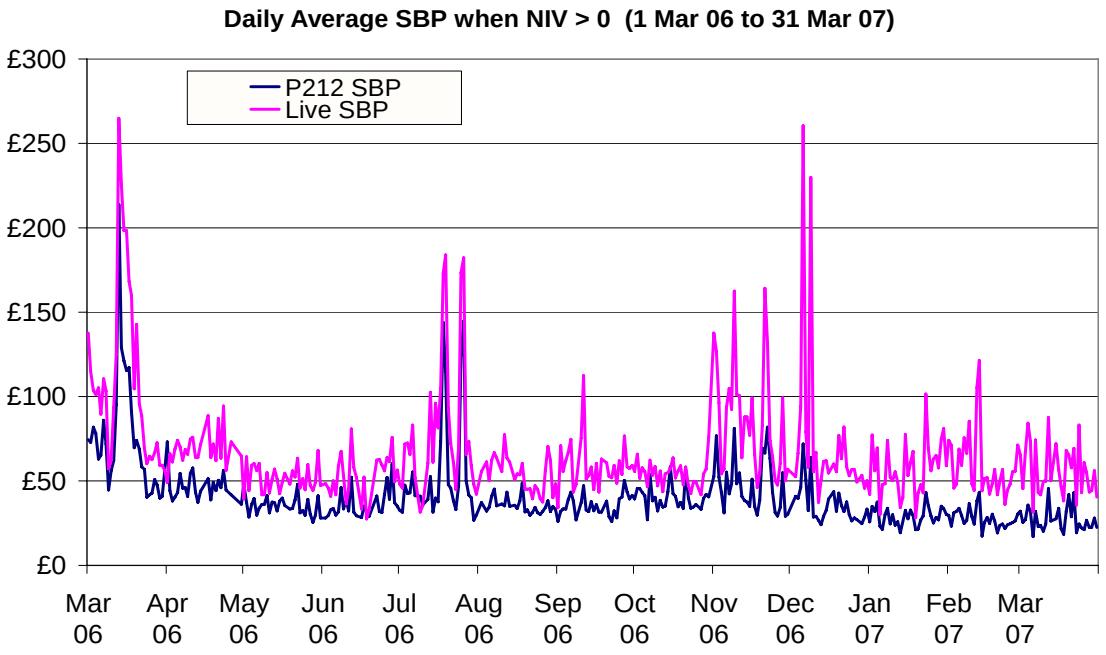


Figure 11. Daily Average SSP when Long

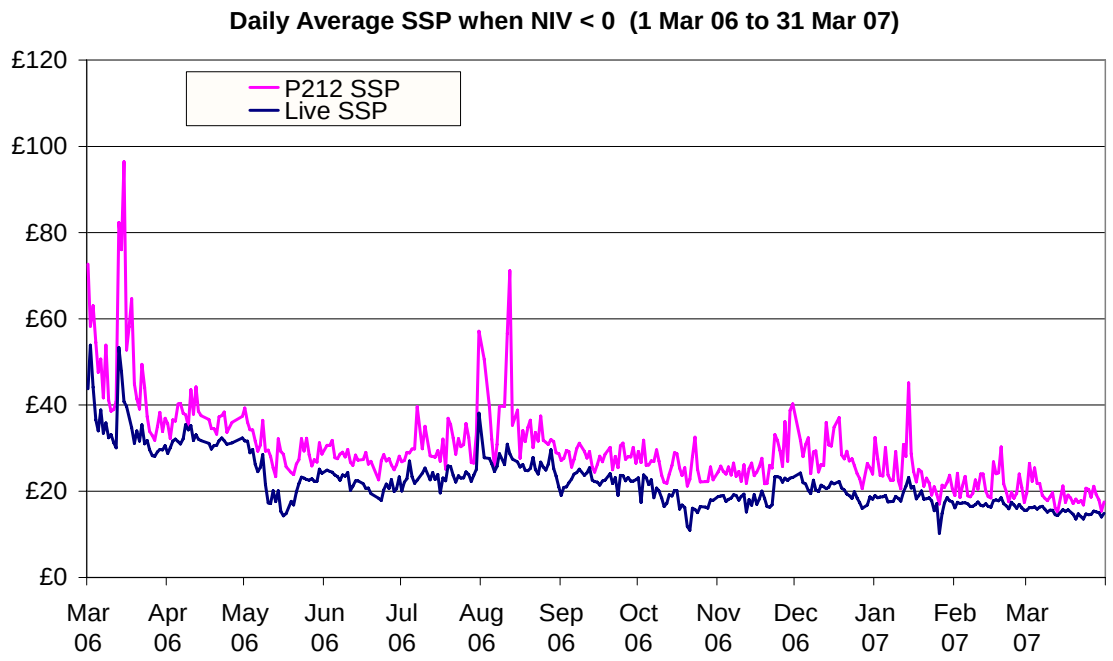


Figure 12. Period Average SBP when Short

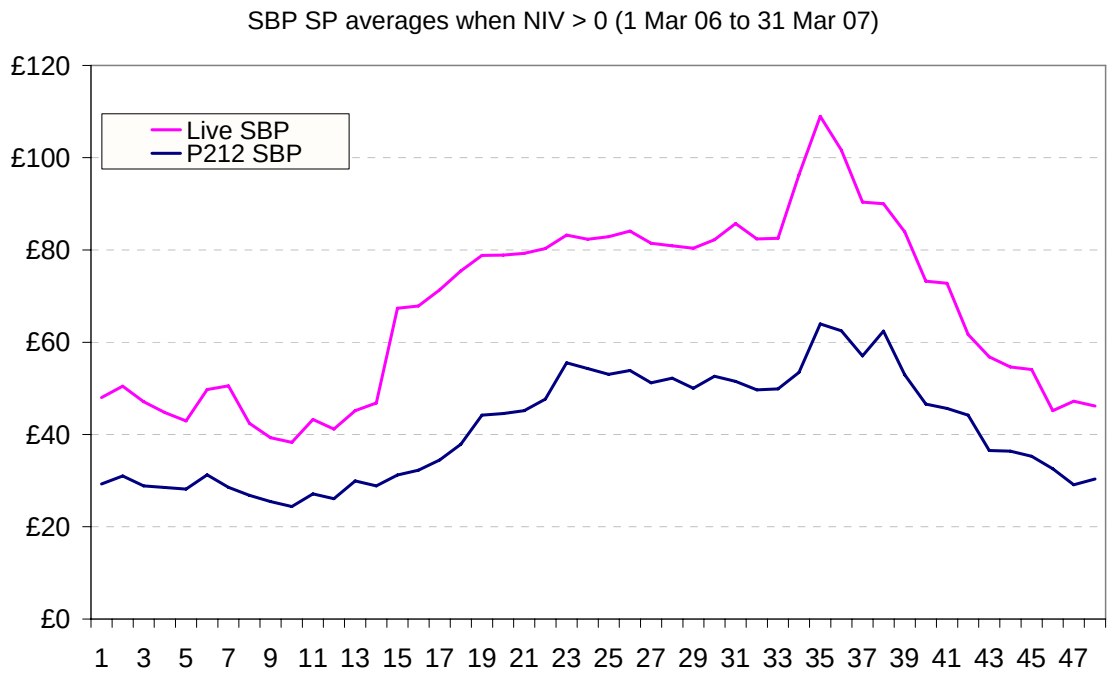
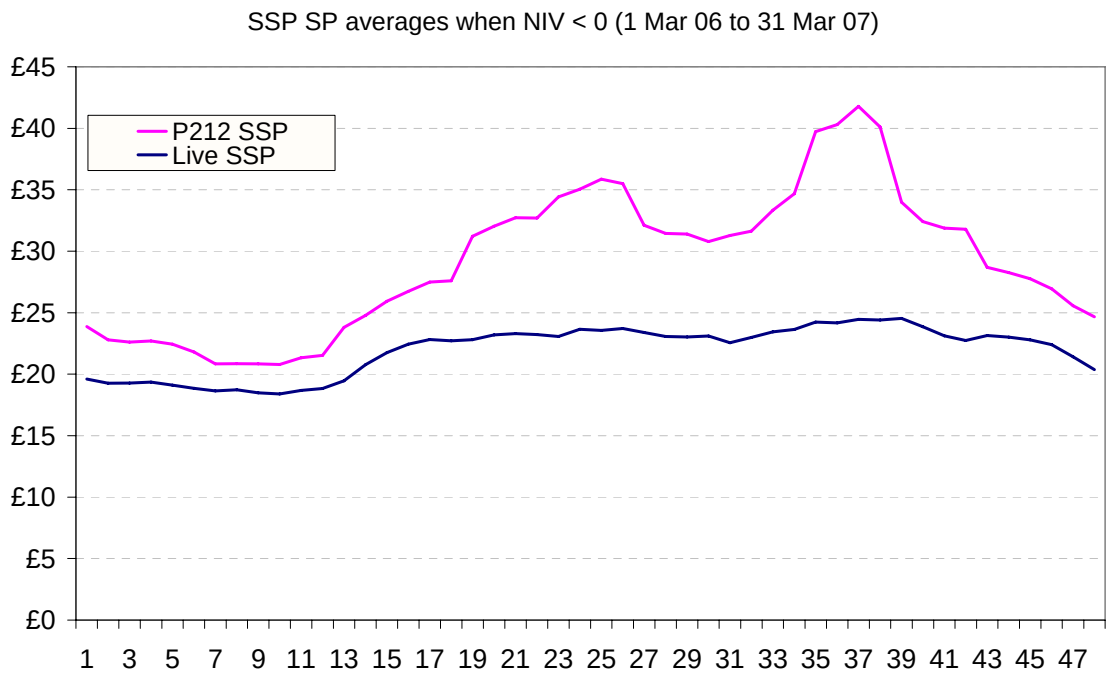
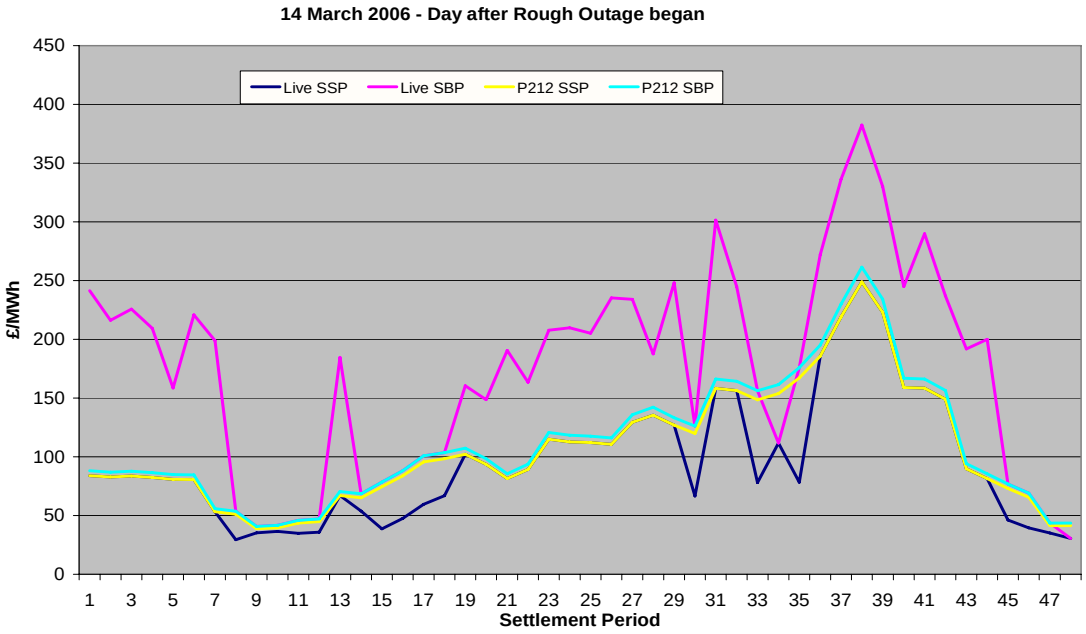


Figure 12. Period Average SSP when Long



The 14th March 2006, which was the day following the Gas balancing Alert, was selected as a day of system stress. This can be seen in Figure 14. It can be seen that whilst the P212 SBP does increase throughout the day toward the peak it does not reflect the stress on the system to the same degree as the live SBP. The difference being up to £120/MWh.

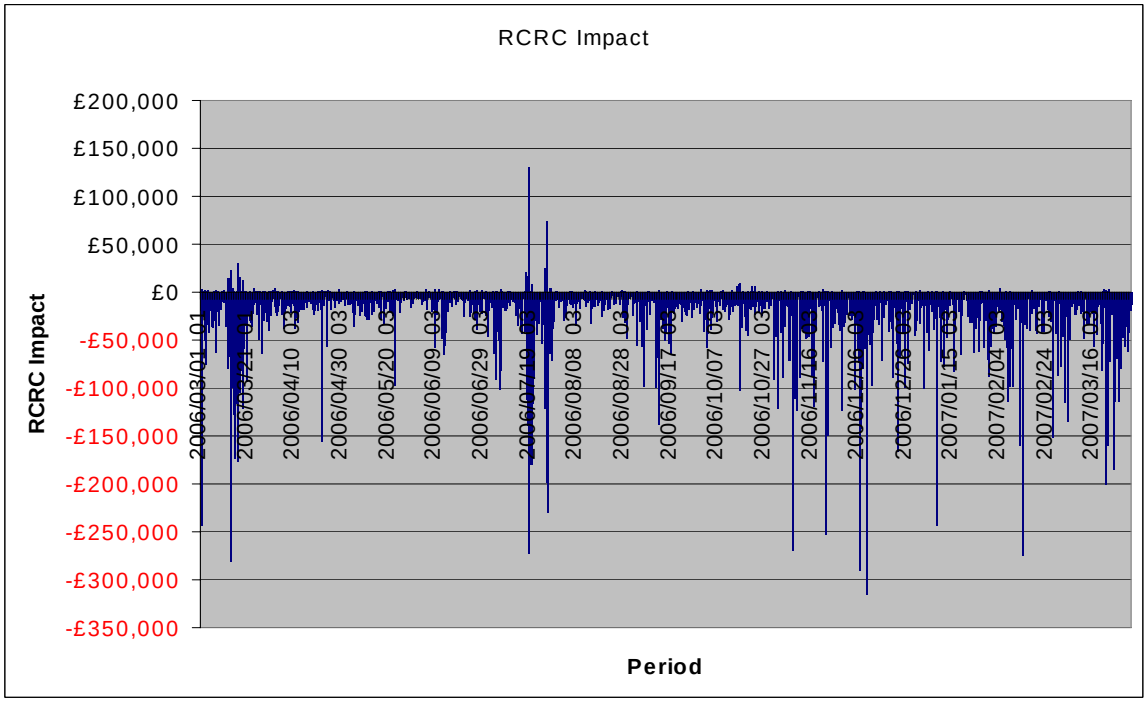
Figure 14. Day of System Stress – 14 March 2006



5. RCRC Analysis

RCRC was recalculated based on the P212 prices for Proposed Option 1 (fixed percentage uplift and discount of 5%) and this can be seen in Figure 15. The graph shows that RCRC under the P212 Proposed Option 1 was, on average, significantly lower than the actual historic RCRC. For the entire period 1 March 2006 to 31 March 2007, the P212 recalculated RCRC would have been £158m less than the actual historic RCRC. The largest decrease in an individual Settlement Period was £315,000 (SP36 on 9 December 2006) with the largest increase being £131,000 (SP34 on 18 July 2006).

Figure 15. RCRC impact by Settlement Period (P212 Proposed Option 1 less Historic RCRC).



6. APX Data

In order to have a better understanding of when trades are made on the power exchanges, the Group investigated APX trades. Figure 16 shows the total volume of trades (in MWh) that were made in March 2007 against the time (before the start of the Settlement Period) in which those trades were made.

Figure 16. APX data

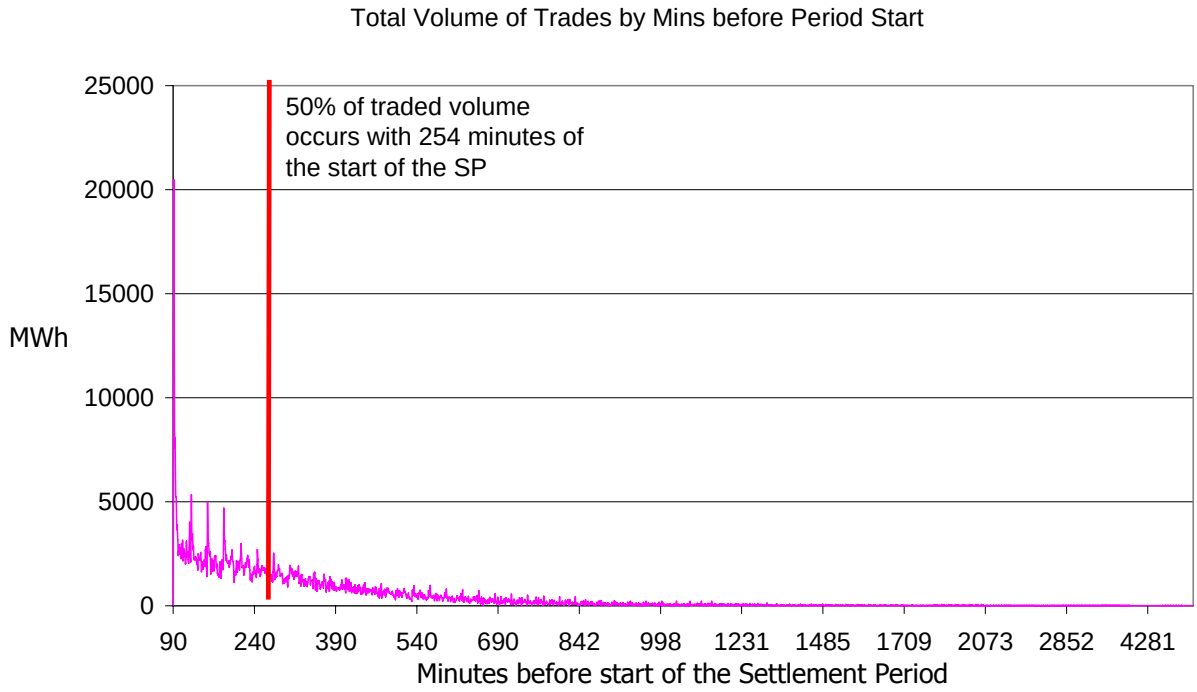
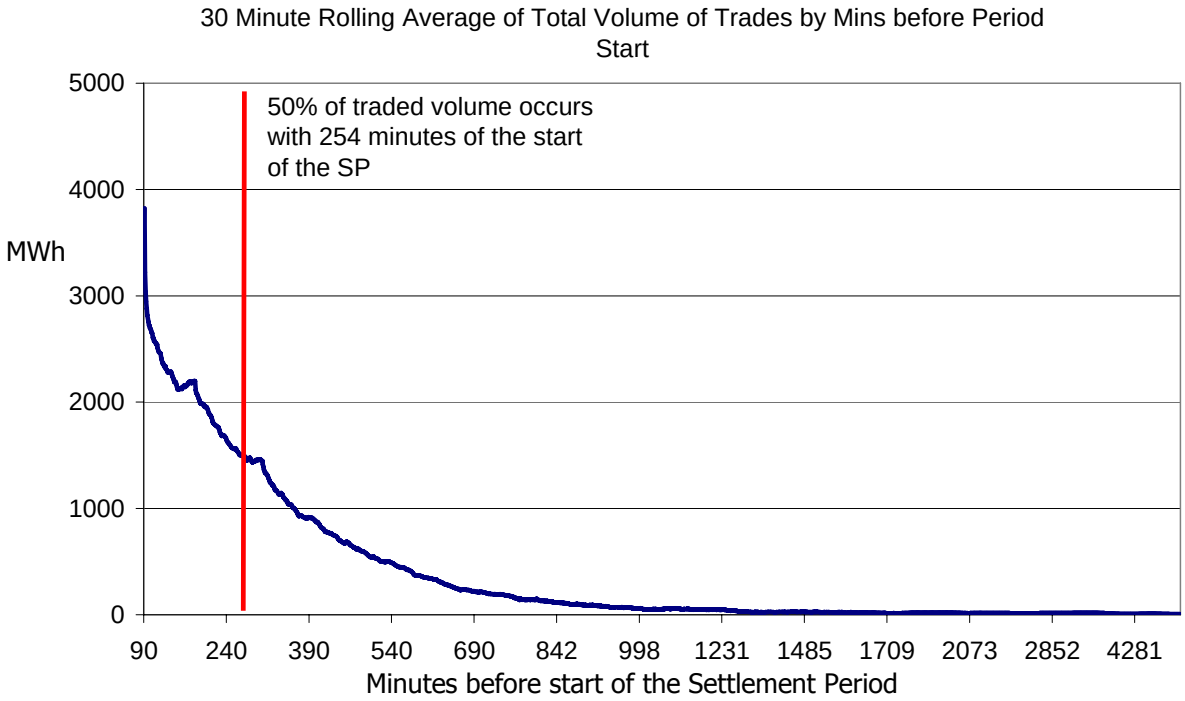


Figure 17 shows the same information but presents a 30 minute rolling average of the volumes rather than the volumes for each individual minute.

Figure 17. APX data



The Group also chose to look at nine individual Settlement Periods of APX data. The Group chose to select three Settlement Periods of system stress, three Settlement Periods that were benign and three randomly chosen Settlement Periods. The Settlement Periods selected were:

- SP 36 on 29 Dec 05 (stress - NISM)
- SP 35 on 13 March 2006 (stress - Rough outage)
- SP 31 on 18 July 2006 (stress - HRDR)
- SP 31 on 16 July 2006 (benign – Low NIV)
- SP 27 on 23 August 2006 (benign).
- SP 24 on 1 October 2006 (benign – Winter Low NIV)
- SP 13 on 3 April 2006 (Computer generated random)
- SP 24 on 5 July 2006 (Computer generated random)
- SP 45 on 20 September 2006 (Computer generated random)

For each Settlement Period, there are four graphs. These are shown in Figures 18 to 53.

- The first plots the price of each trade against the minutes before the start of the Settlement Period;
- The second plots the differential from one trade to the next. Thus if,
  - Trade 1 Gate Closure (GC) - 20 hours[6], £30, 20MWh
  - Trade 2 GC - 15 hours, £20, 20MWh
  - Trade 3 GC - 13 hours, £15, 100MWh

  Then plot:
  - 20 hours, 0
  - 15 hours, -£10
  - 13 Hours, -£5
- The third plots trades that enter the market price calculation (according to the Market Index Definition Statement (MIDS)[7]) against an expected market index price (E(MIP)). Thus from 20 hours prior to GC, for every new trade, recalculate expected market index price based on info available (and assuming no further trades before GC). This is to enable to track what might be considered rational behaviour under P212 by a trader when compared to the subsequent trades actually struck (shown in graph 1 for each of the 9 Settlement Periods). Thus whenever a trade is struck that enters the MIP, there will be an updated E(MIP) associated with that. From the example above, at:
  - 20 hours, E(MIP) = £20/MWh
  - 15 hours, E(MIP) = £25/MWh
  - 13 hours, E(MIP) = £17.86/MWh

  where E represents the expectation based on no further trades before GC.
- The fourth graph plots the percentage differential between the trade actually struck and the E(MIP) as you get closer to the start of the Settlement Period. This indicates that, under a P212 Proposed Option 1 or 2 arrangement, in order to trade, the percentage uplift or discount would have to be in excess of this differential[8].

E(MIP) assumptions:

- The trades that actually occurred were the least expensive available;
- Parties would chose to trade under the P212 arrangements based on their rational expectation of what market price would be;
- Expected Market Index Price (E(MIP)) is calculated at the point in which each actual trade was made. It is based on all trades for the Settlement Period in question that had occurred (under the current arrangements) at a moment in time before Gate Closure <u>and</u> that are currently included in the market price according to the MIDS; and

[6] 20 hours before Gate closure for the relevant Settlement Period.
[7] The MIDS can be found on Elexon's website at: http://www.elexon.co.uk/bscrelateddocs/default.aspx
[8] Assuming the expectation of no further trades before Gate Closure is correct.

- At any point in time when E(MIP) is calculated, a Party would have the expectation that there are no future trades.

Included on the fourth graph for each of the nine Settlement Periods is a brief commentary on whether, under the assumptions of using E(MIP) and Proposed Option 1 (fixed at 5%), it would have been rational to have actually made the trades that were struck under the current arrangements.

Figure 18. 29 December 2005 – SP 36 (Stress) – Graph 1

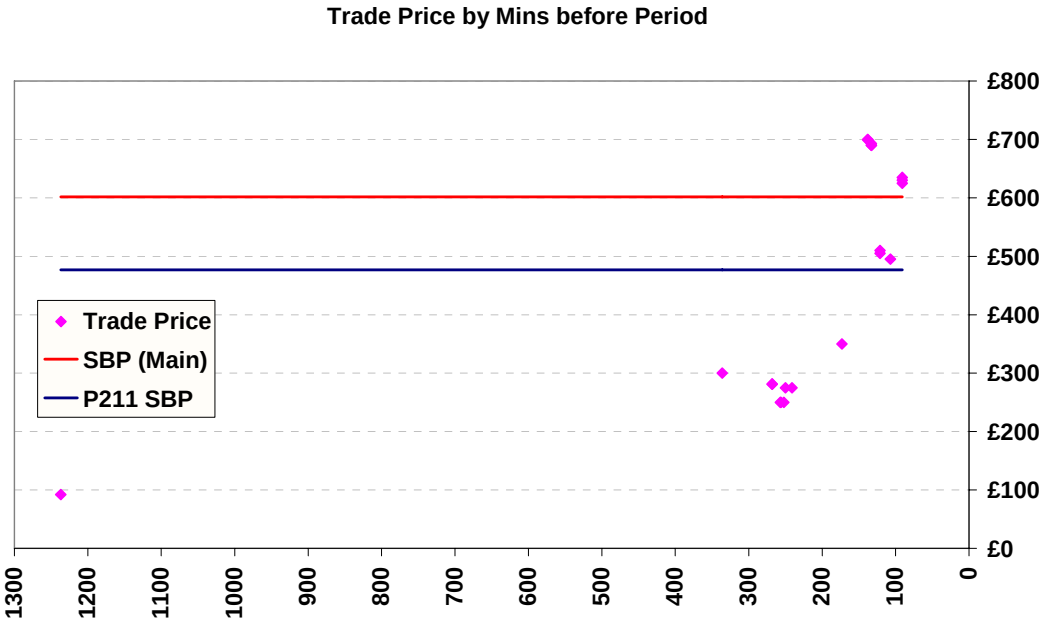


Figure 19. 29 December 2005 – SP 36 (Stress) – Graph 2

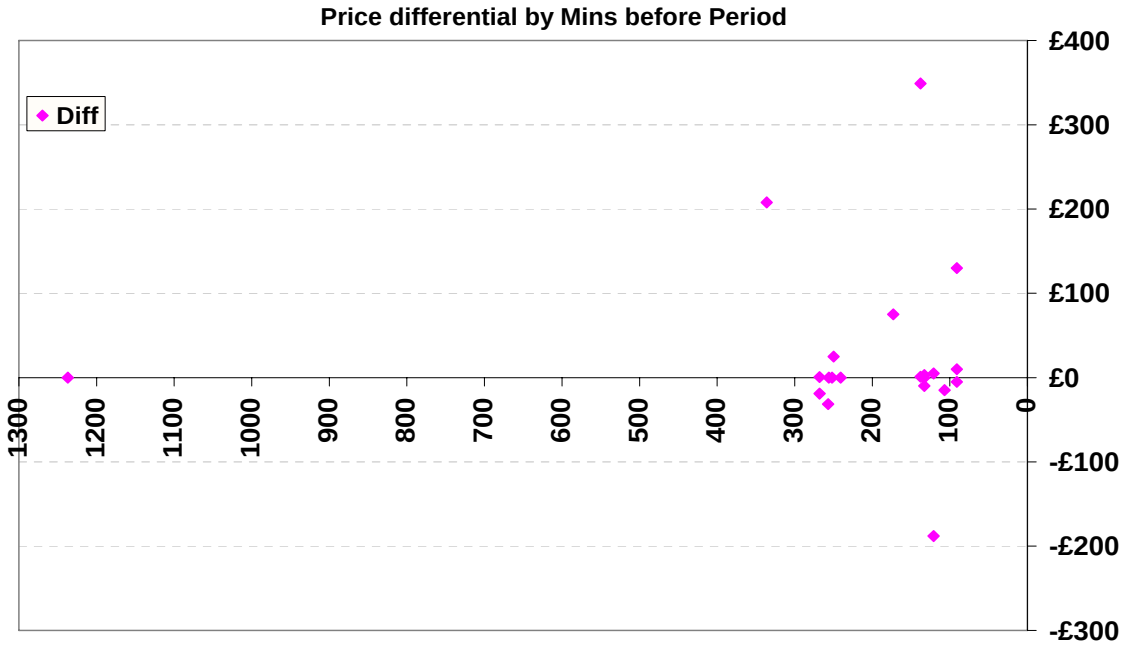


Figure 20. 29 December 2005 – SP 36 (Stress) – Graph 3

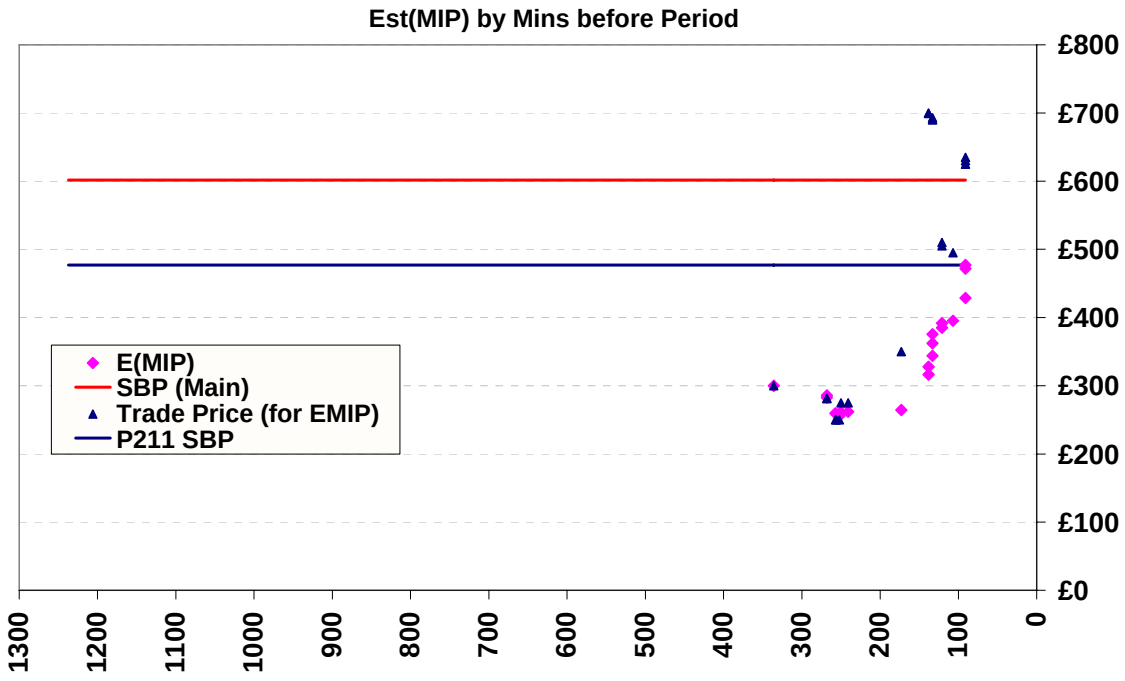


Figure 21. 29 December 2005 – SP 36 (Stress) – Graph 4

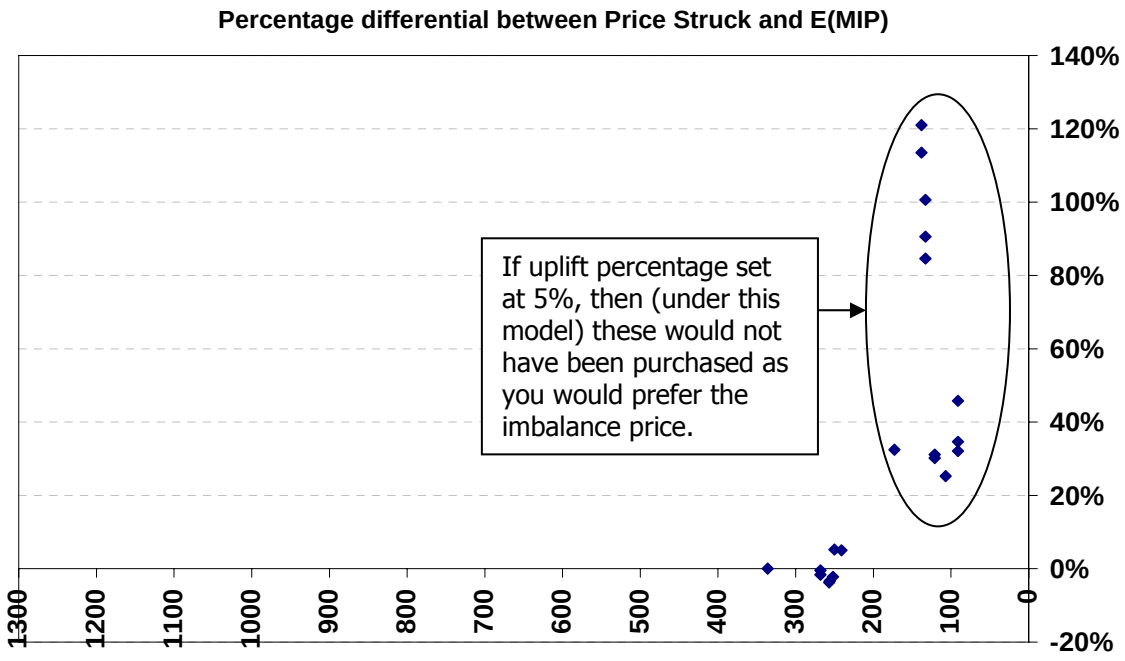


Figure 22. 13 March 2006 – SP 35 (Stress) - Graph 1

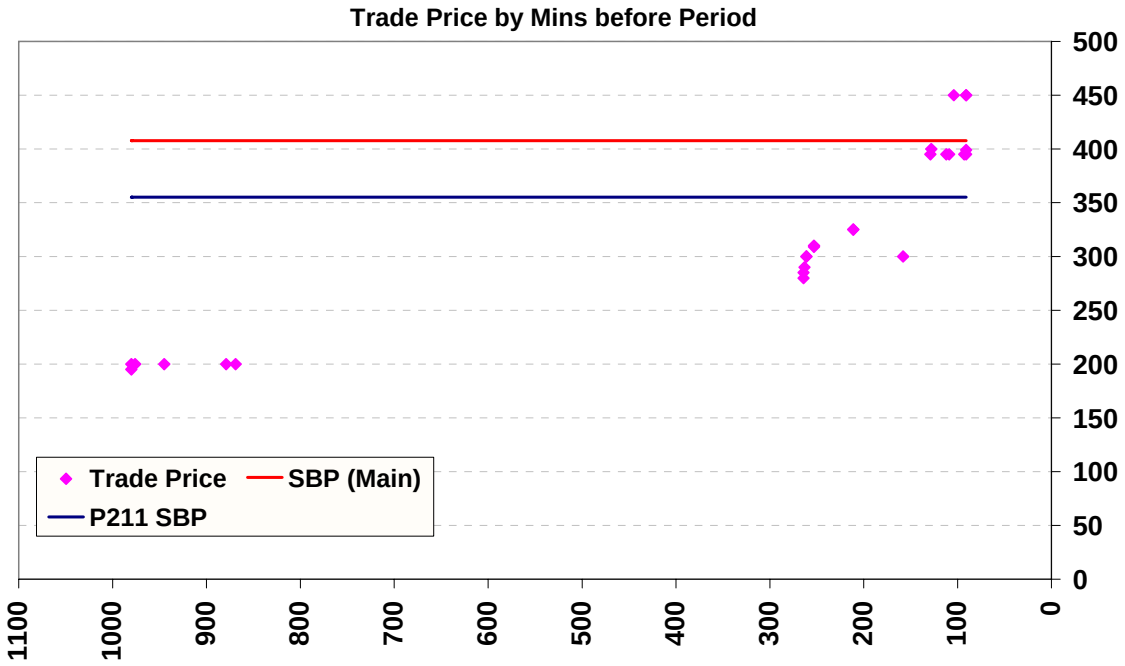


Figure 23. 13 March 2006 – SP 35 (Stress) – Graph 2

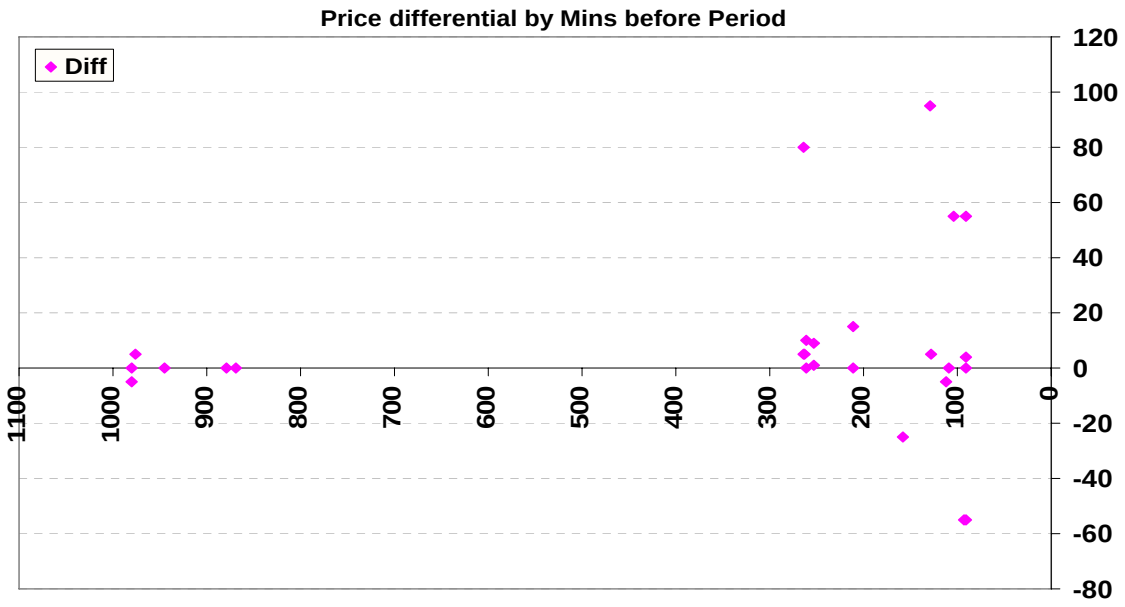


Figure 24. 13 March 2006 – SP 35 (Stress) – Graph 3

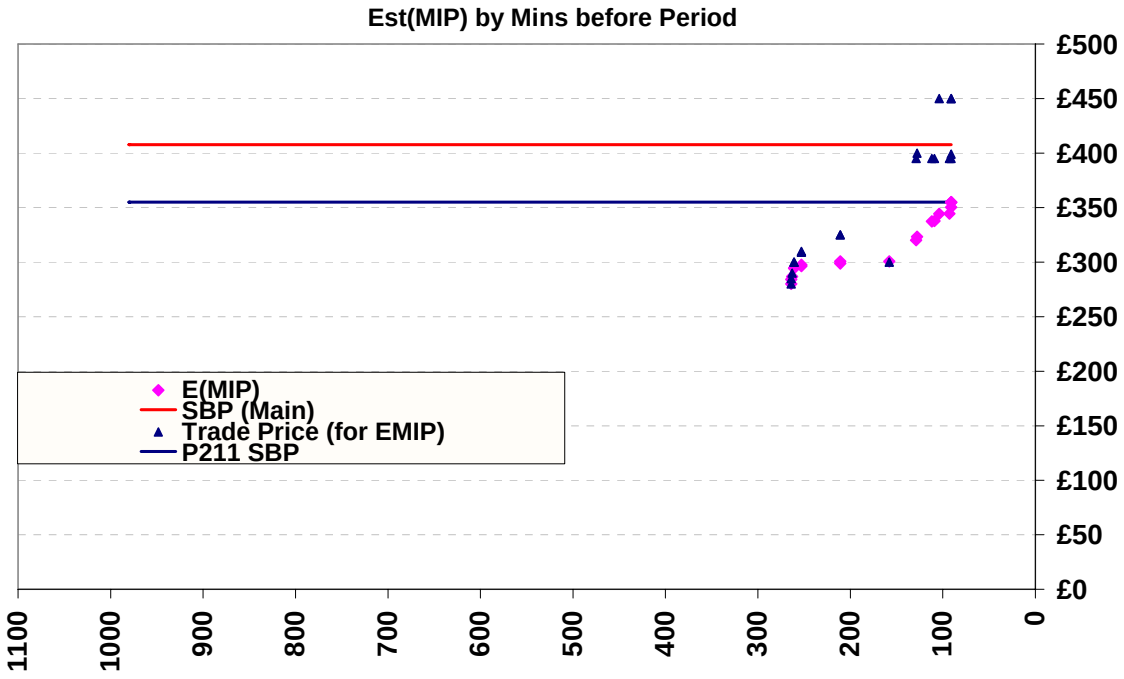


Figure 25. 13 March 2006 – SP 35 (Stress) - Graph 4

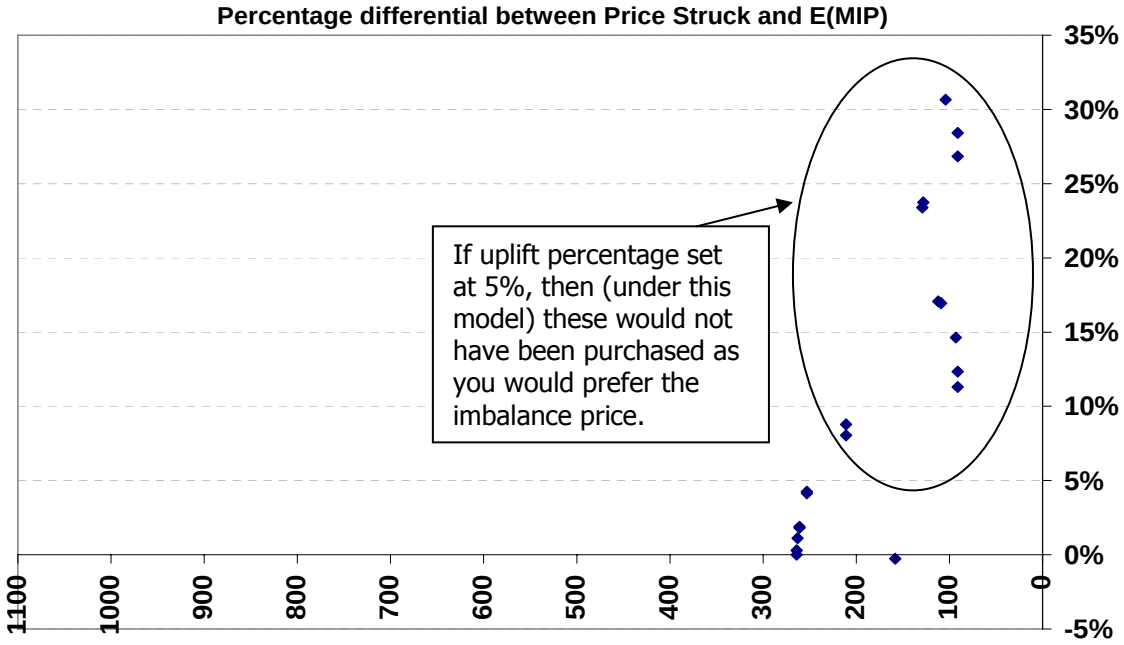


Figure 26. 18 July 2006 – SP 31 (Stress) – Graph 1

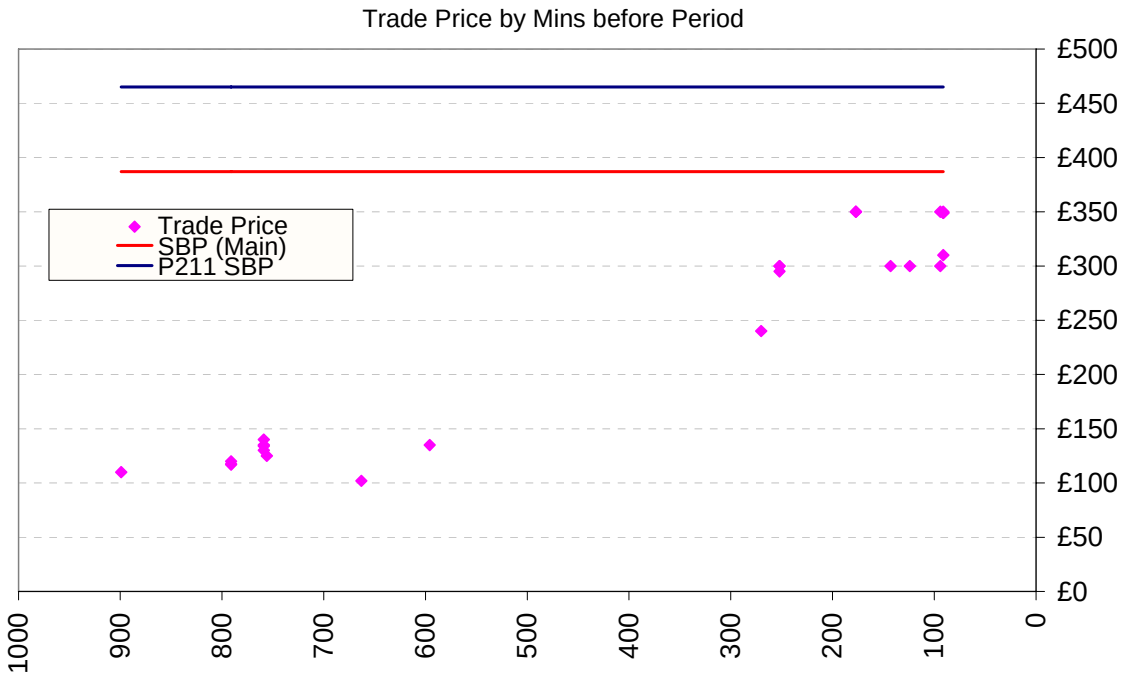


Figure 27. 18 July 2006 – SP 31 (Stress) – Graph 2

Figure 28. 18 July 2006 – SP 31 (Stress) – Graph 3

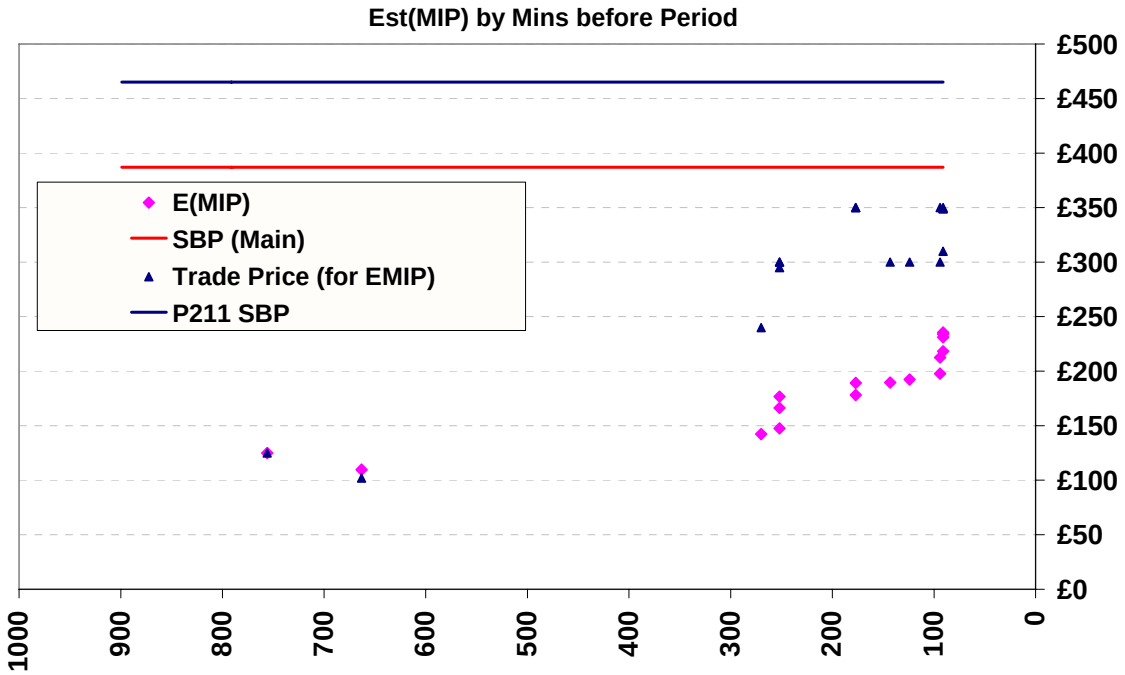


Figure 29. 18 July 2006 – SP 31 (Stress) – Graph 4

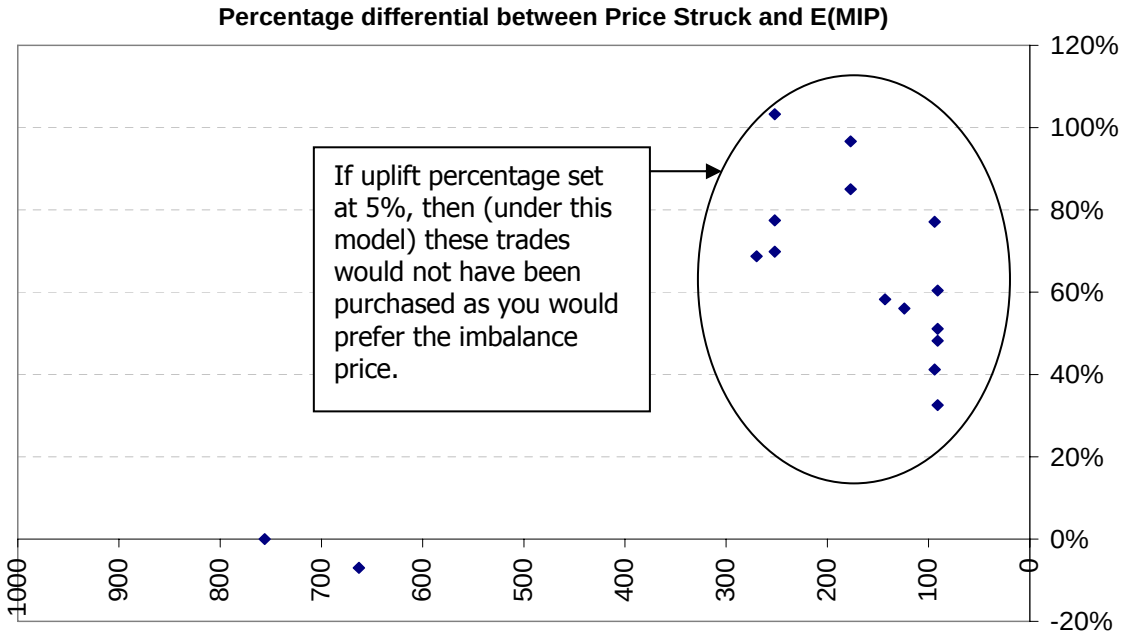


Figure 30. 16 July 2006 – SP 31 (Benign) – Graph 1

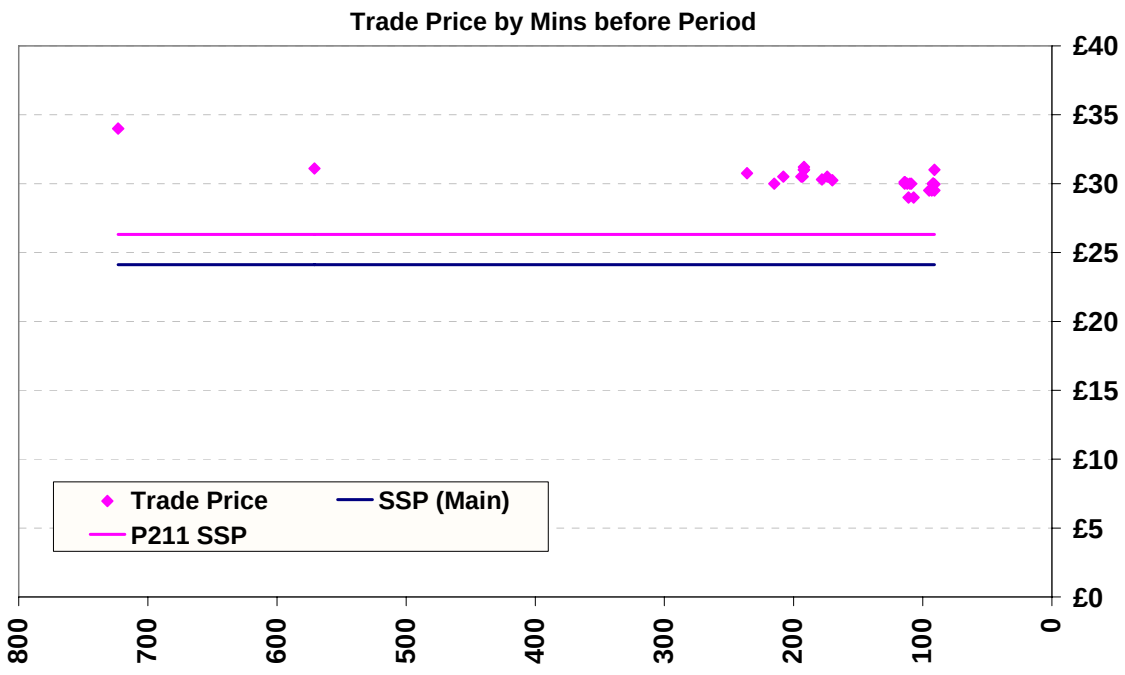


Figure 31. 16 July 2006 – SP 31 (Benign) – Graph 2

Figure 32. 16 July 2006 – SP 31 (Benign) – Graph 3

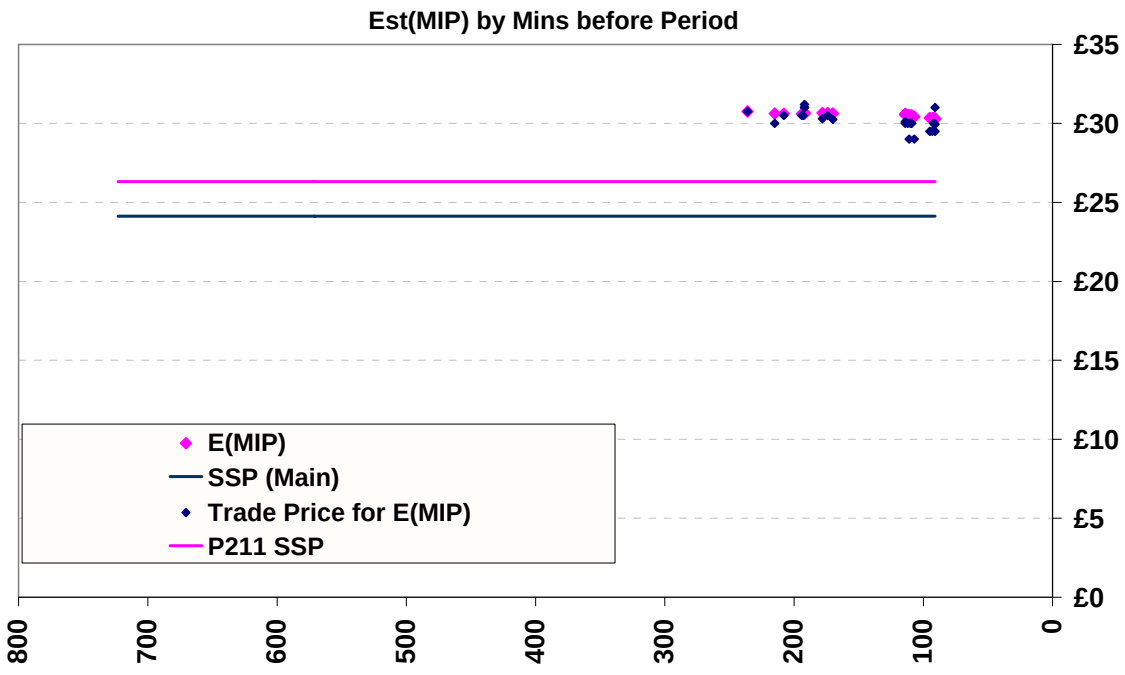


Figure 33. 16 July 2006 – SP 31 (Benign) – Graph 4

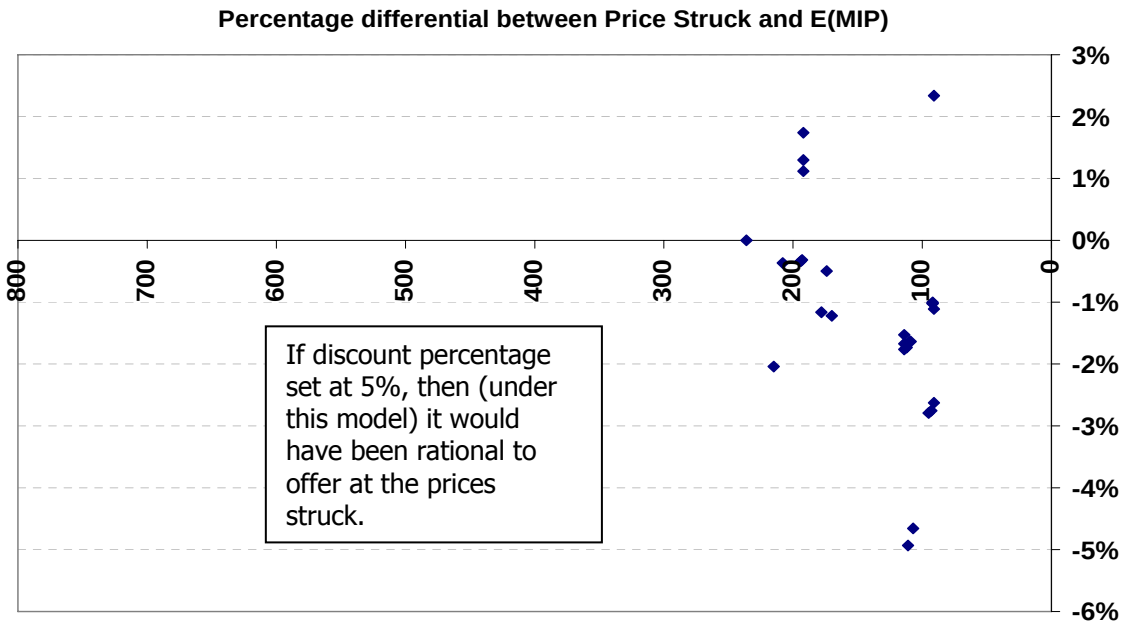


Figure 34. 23 August 2006 – SP 27 (Benign) – Graph 1

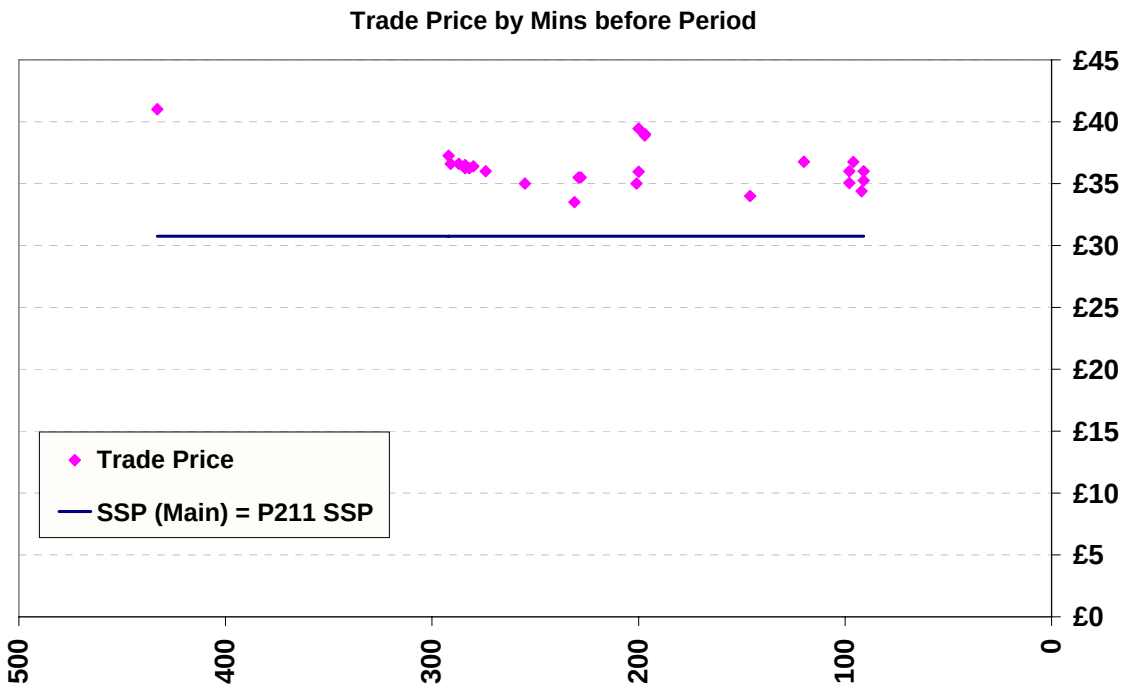


Figure 35. 23 August 2006 – SP 27 (Benign) – Graph 2

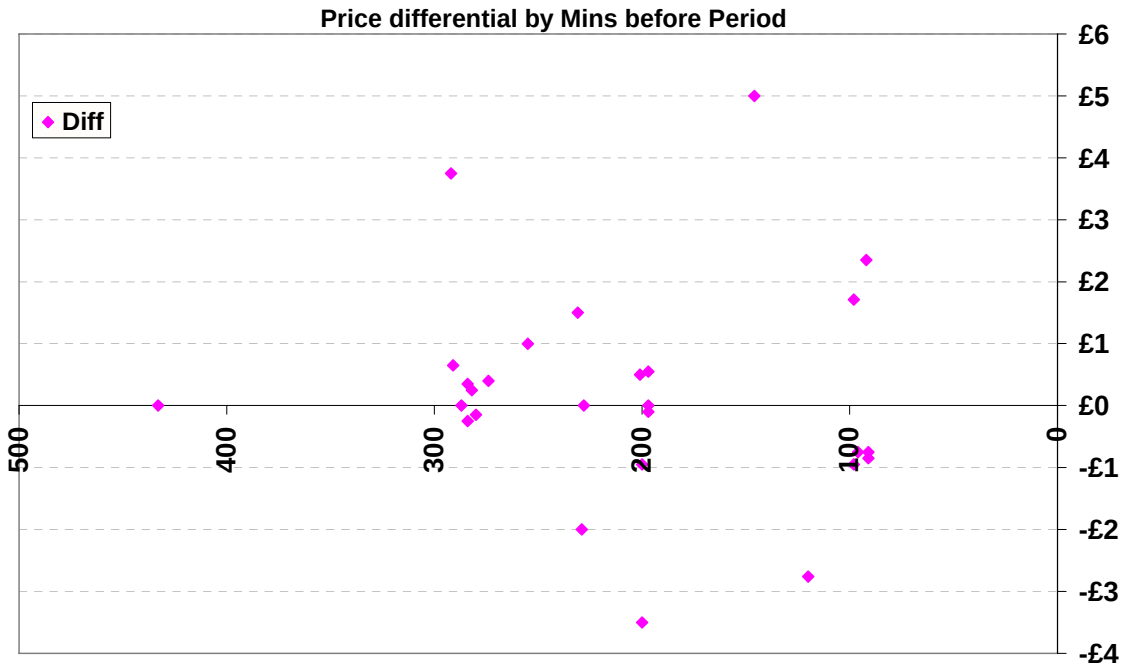


Figure 36. 23 August 2006 – SP 27 (Benign) – Graph 3

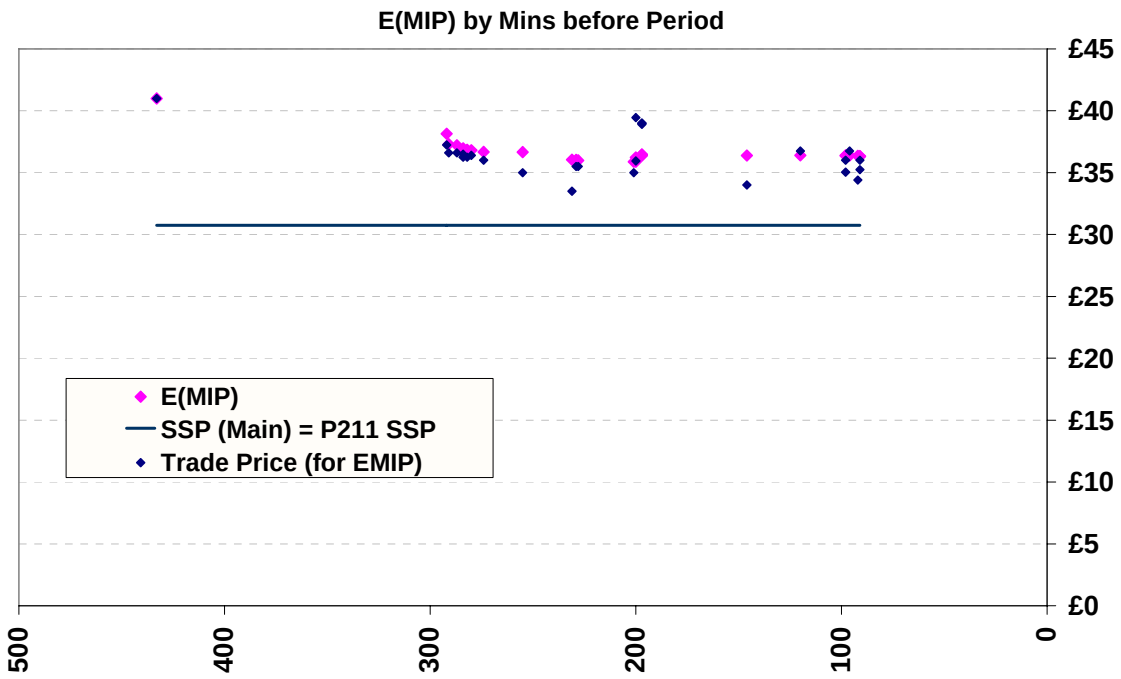


Figure 37. 23 August 2006 – SP 27 (Benign) – Graph 4

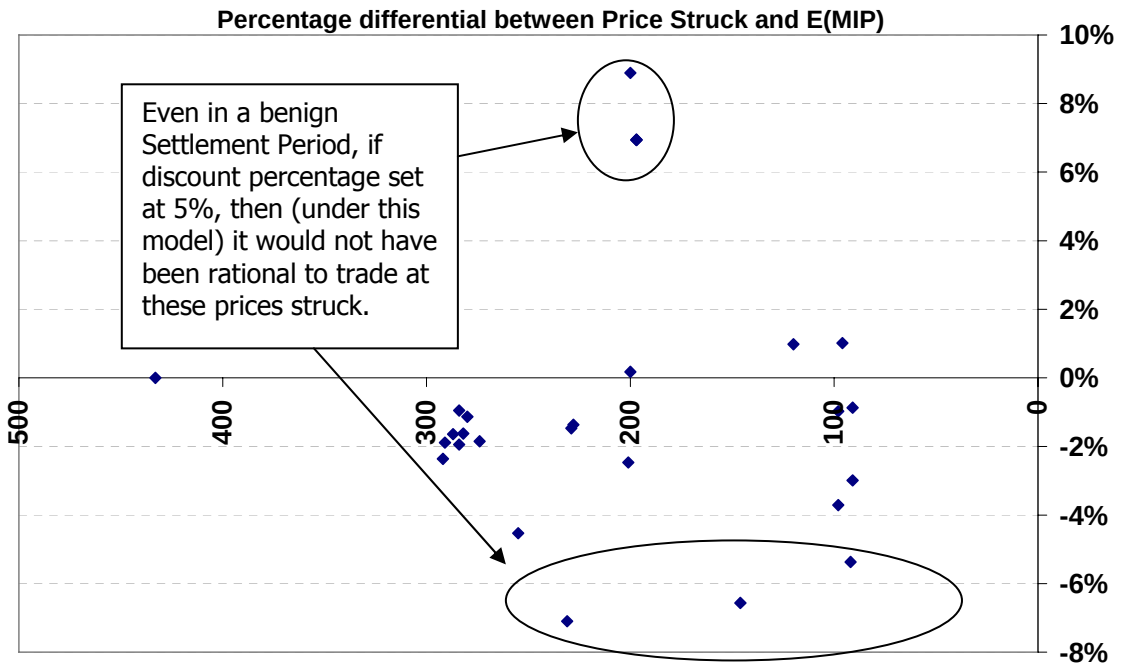


Figure 38. 1 October 2006 – SP 24 (Benign) – Graph 1

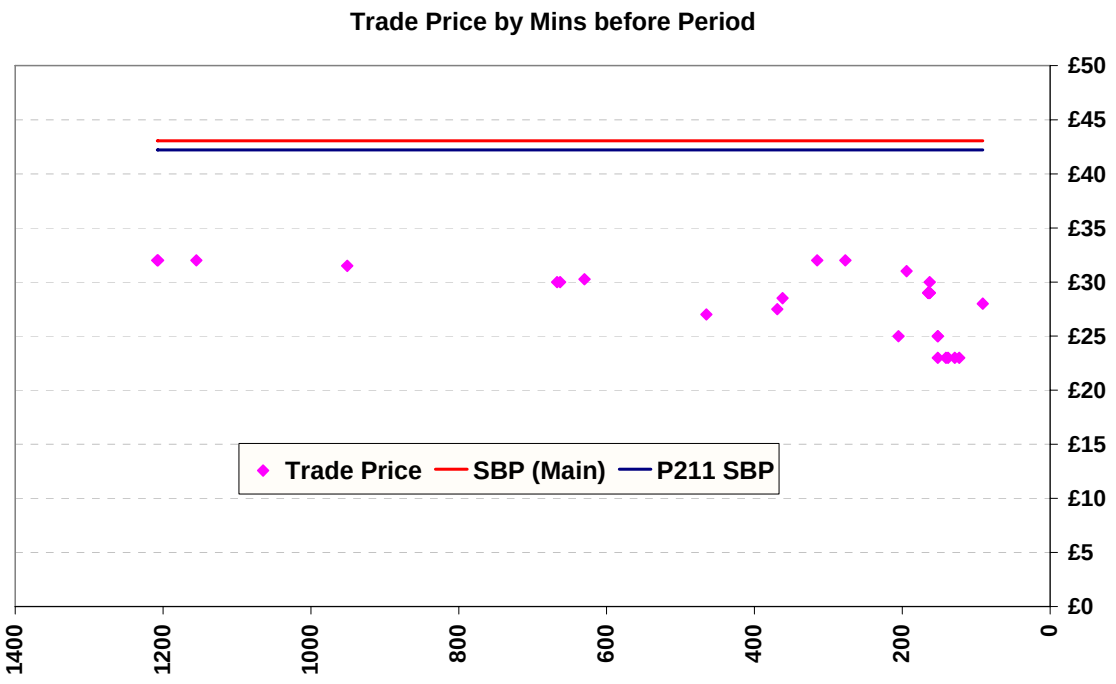


Figure 39. 1 October 2006 – SP 24– (Benign) Graph 2

Figure 40. 1 October 2006 – SP 24 (Benign) – Graph 3

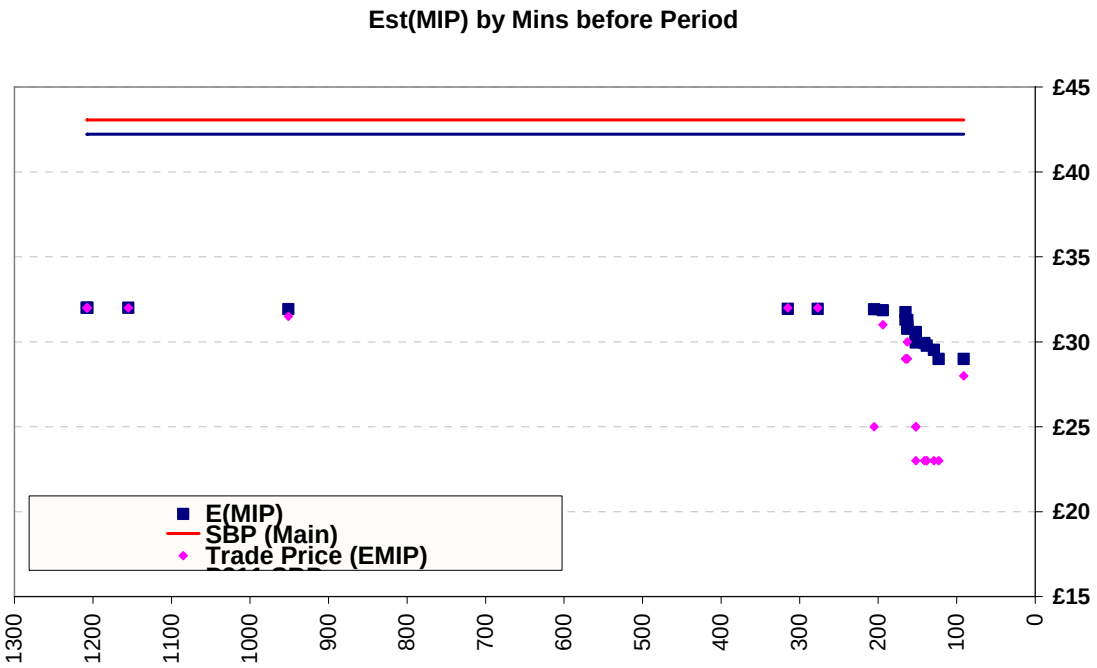


Figure 41. 1 October 2006 – SP 24 (Benign) – Graph 4

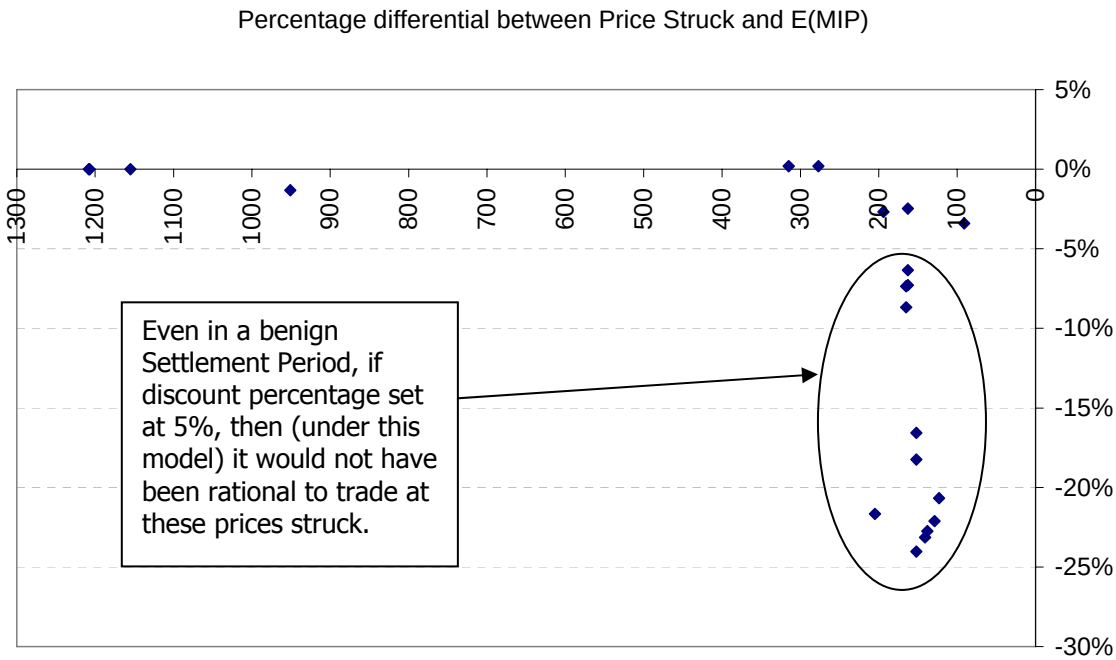


Figure 42. 3 April 2006 – SP 13 (Random) – Graph 1

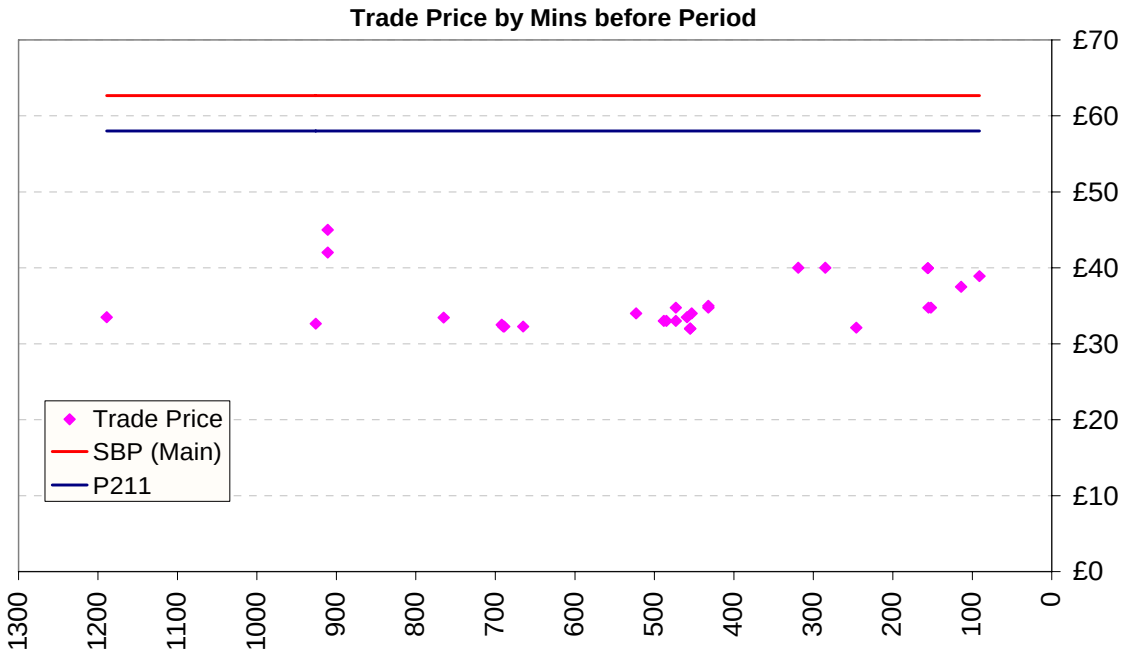


Figure 43. 3 April 2006 – SP 13 (Random) – Graph 2

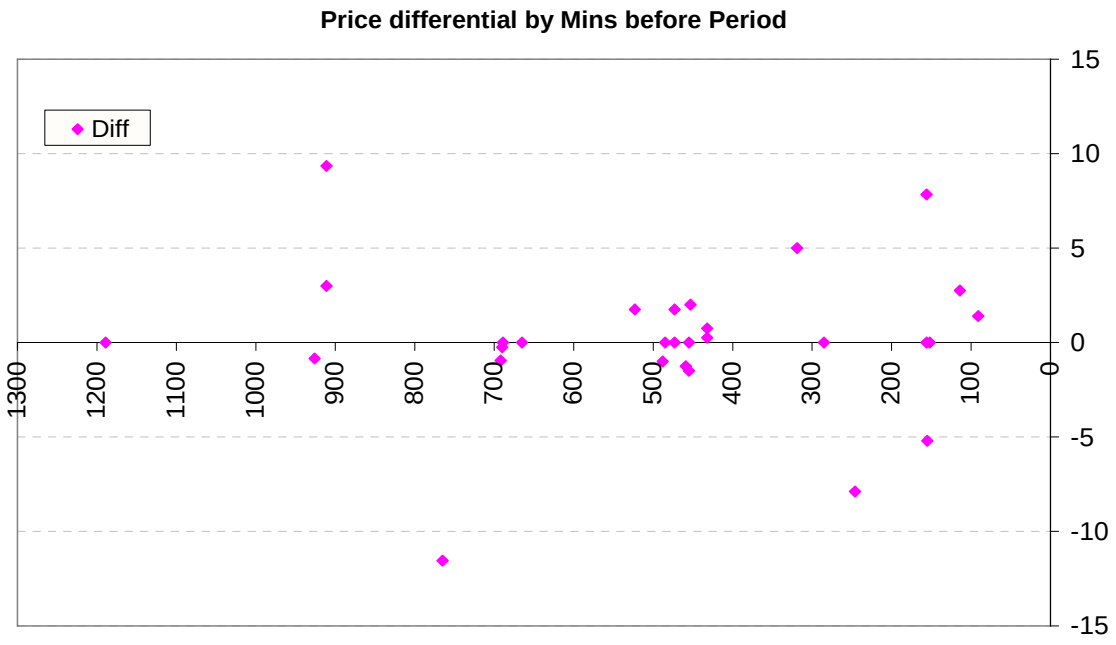


Figure 44. 3 April 2006 – SP 13 (Random) – Graph 3

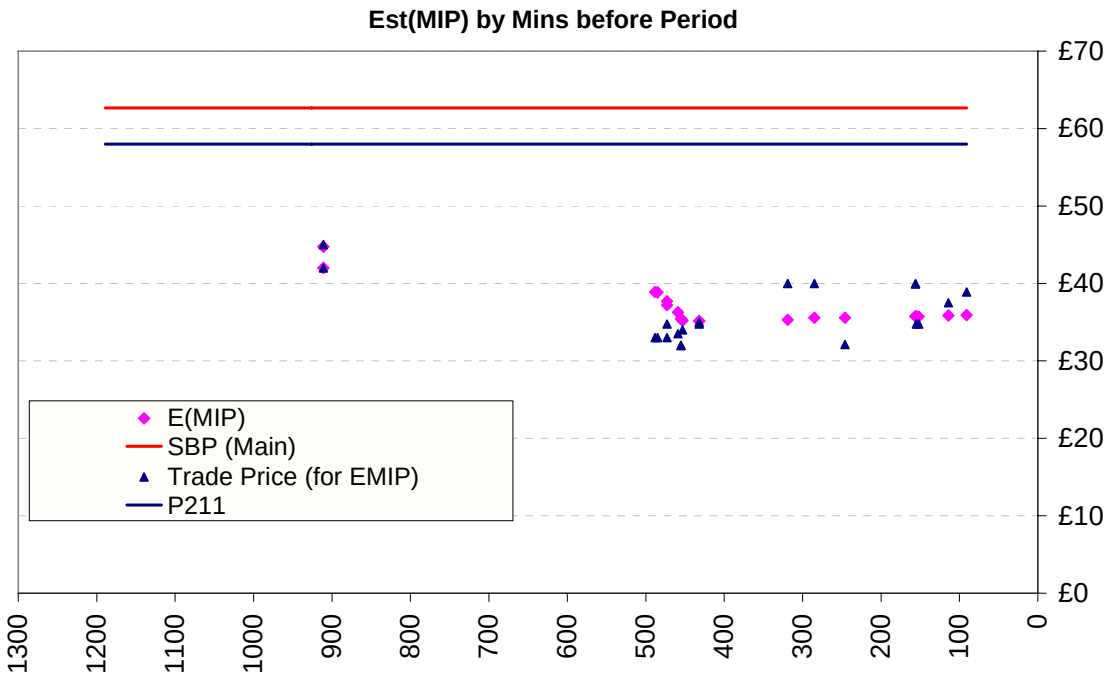


Figure 45. 3 April 2006 – SP 13 (Random) – Graph 4

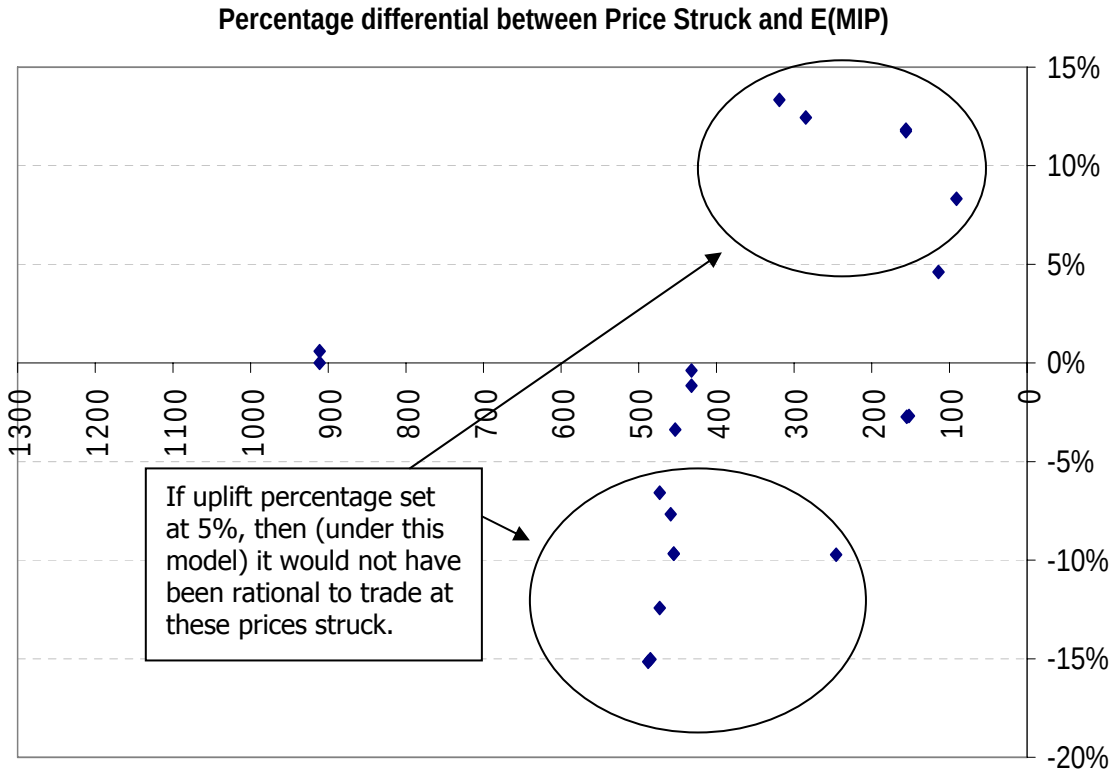


Figure 46. 5 July 2006 – SP 24 (Random) – Graph 1

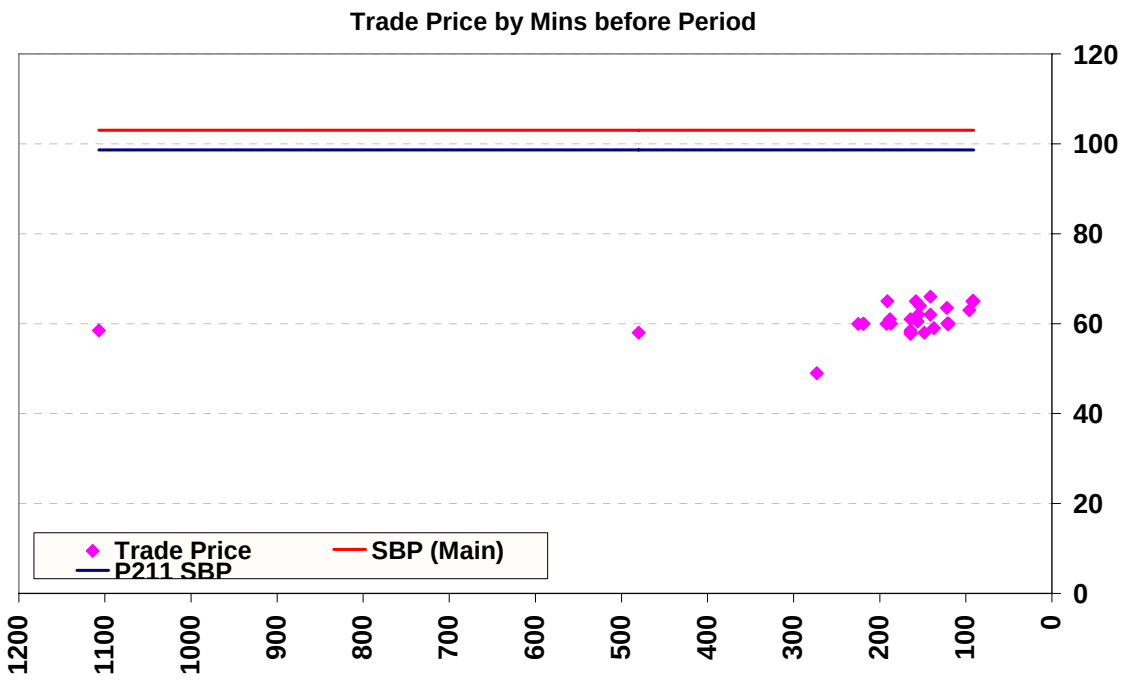


Figure 47. 5 July 2006 – SP 24 (Random) – Graph 2

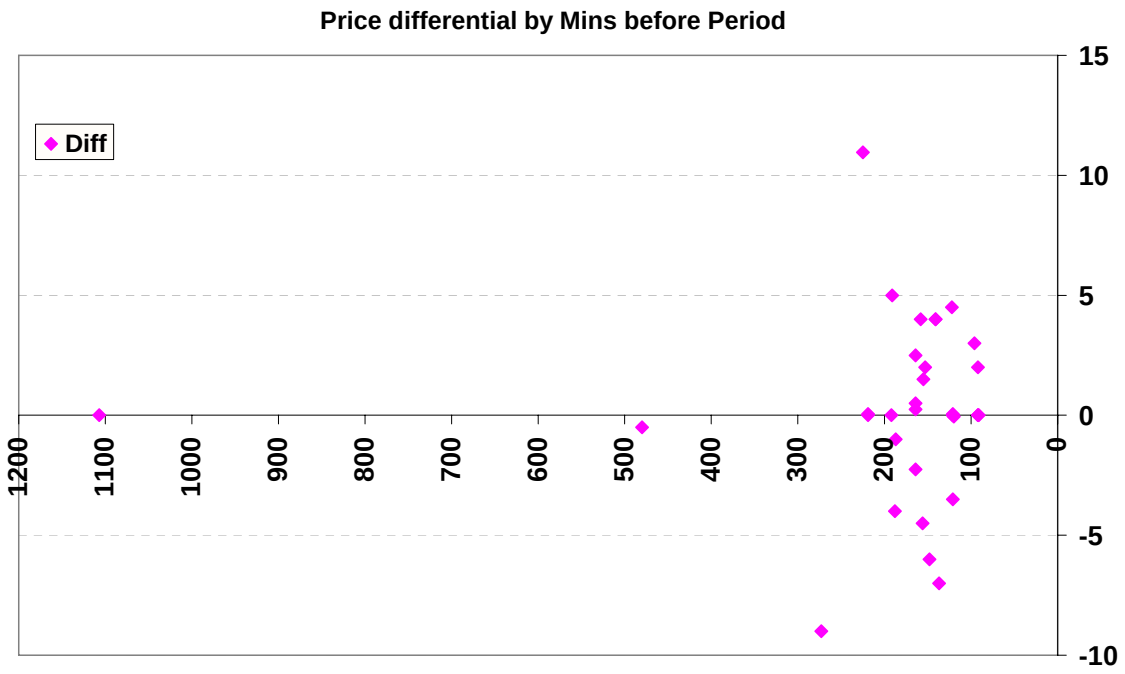


Figure 48. 5 July 2006 – SP 24 (Random) – Graph 3

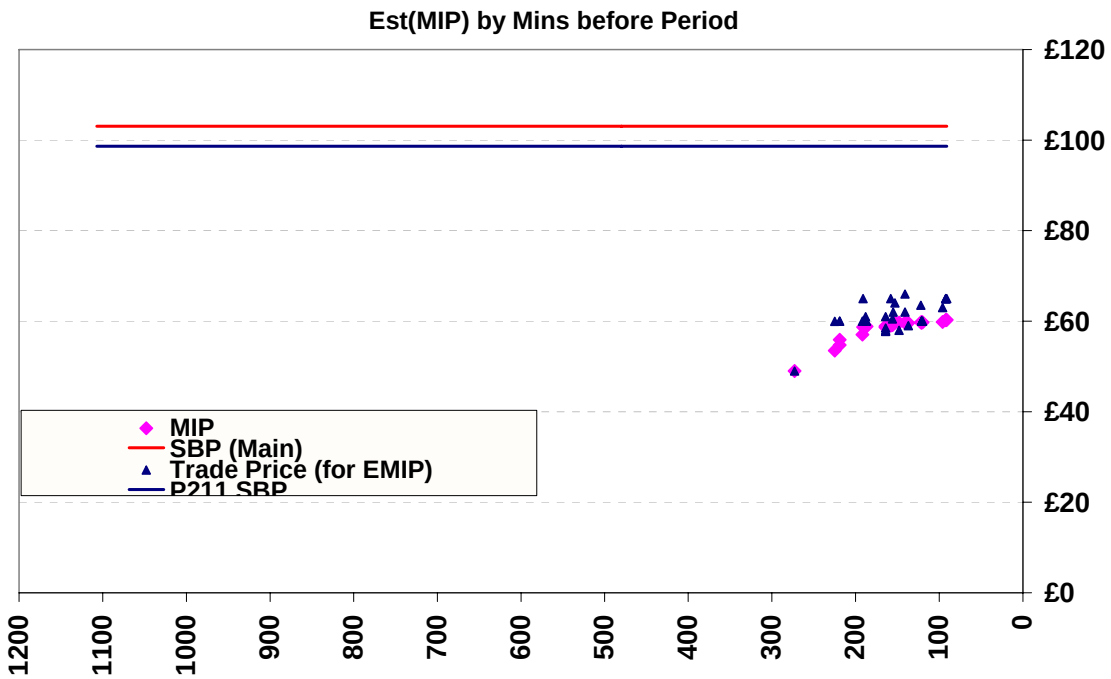


Figure 49. 5 July 2006 – SP 24 (Random) – Graph 4

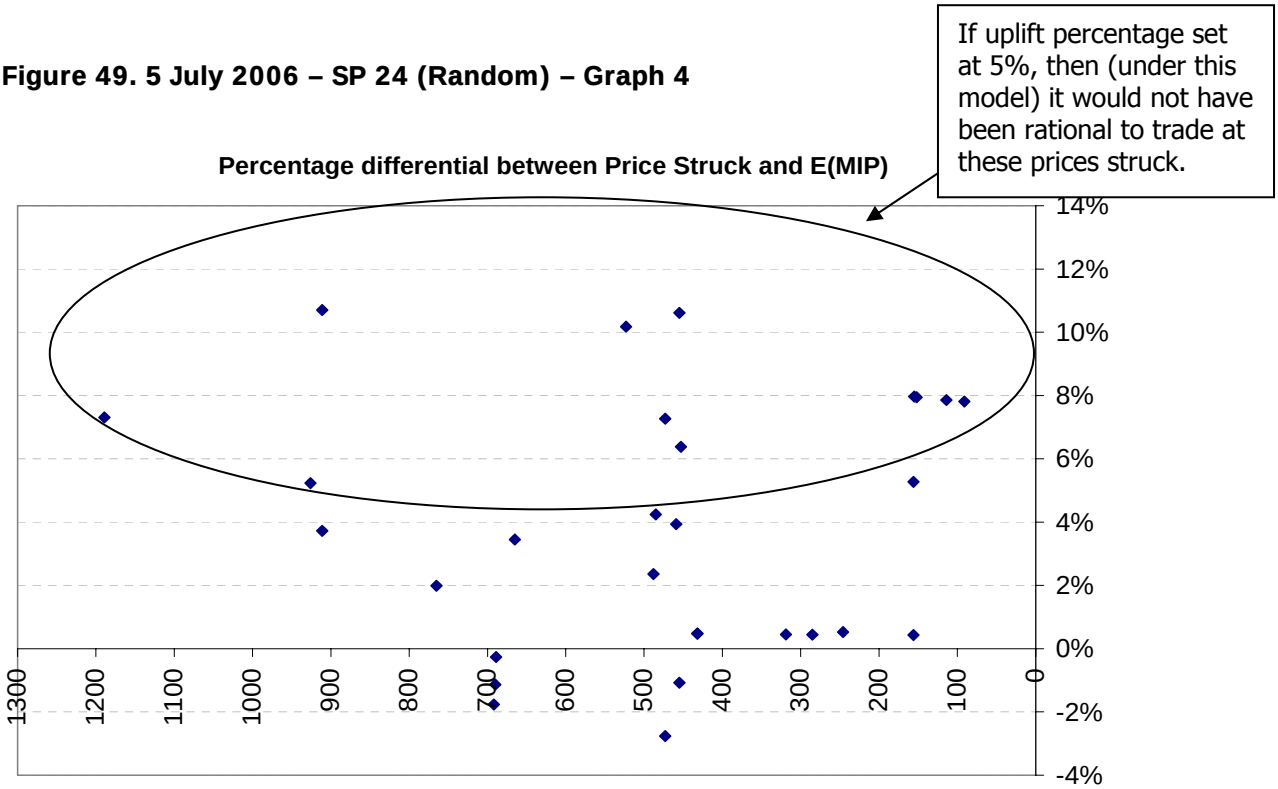


Figure 50. 20 September 2006 – SP 45 (Random) – Graph 1

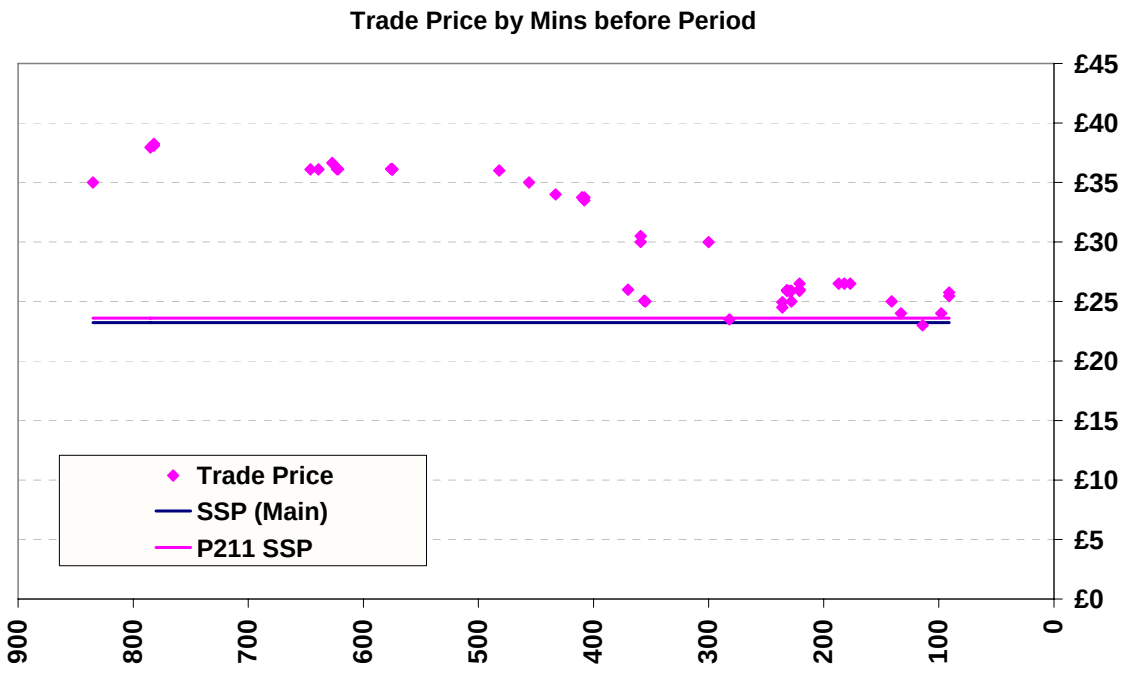


Figure 51. 20 September 2006 – SP 45 (Random) – Graph 2

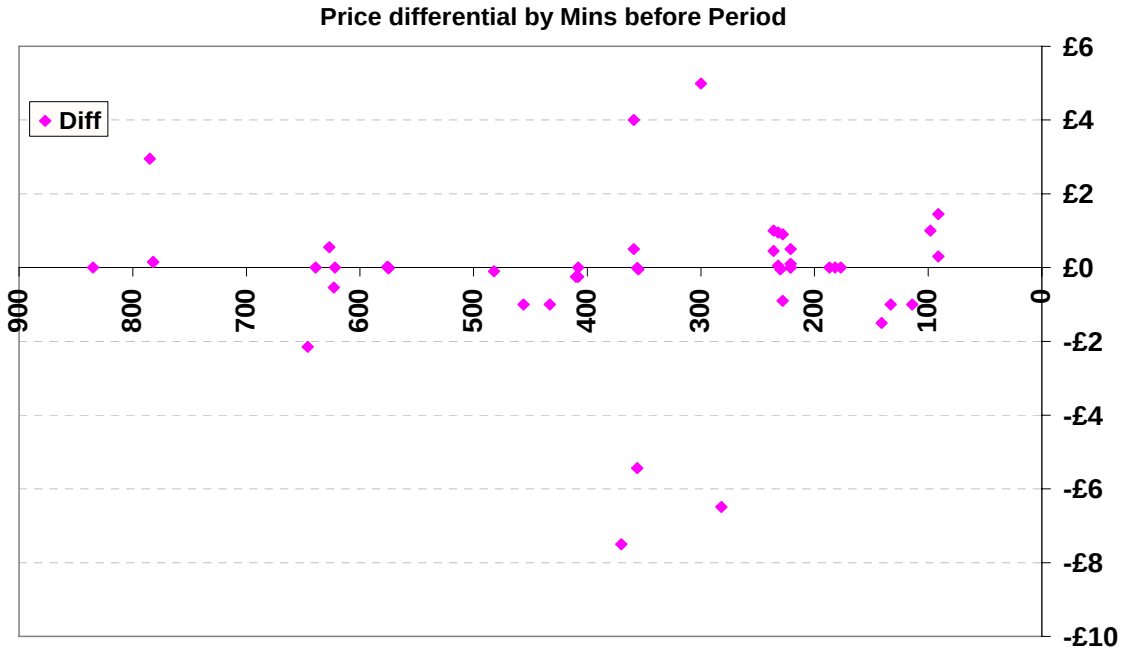


Figure 52. 20 September 2006 – SP 45 (Random) – Graph 3

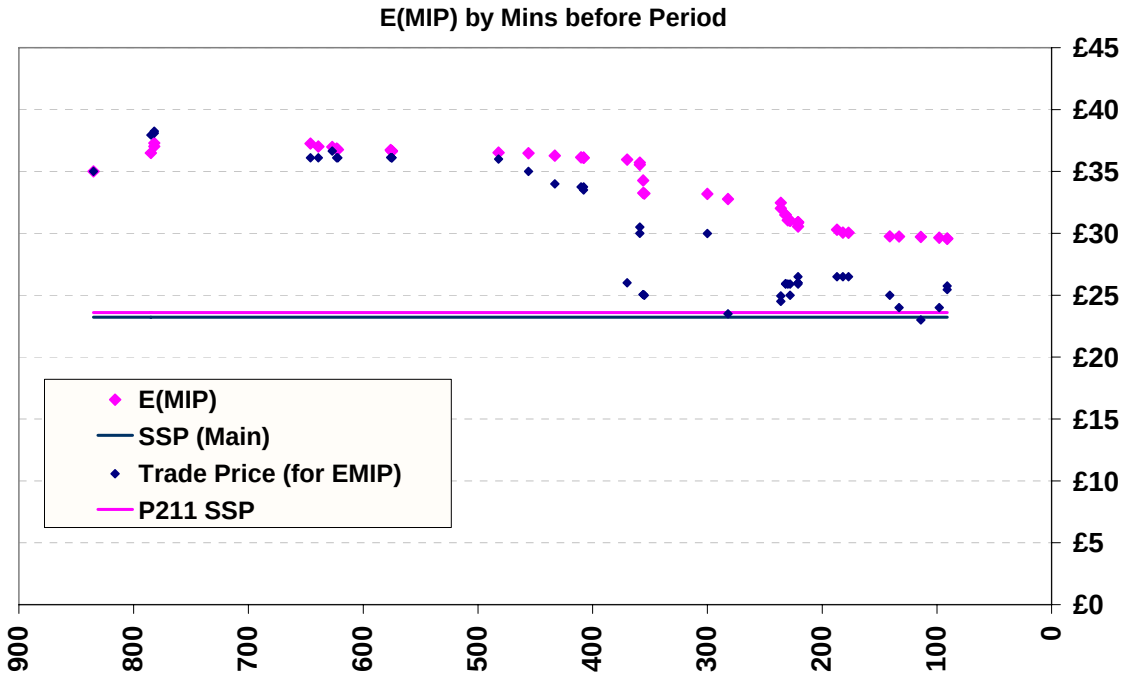
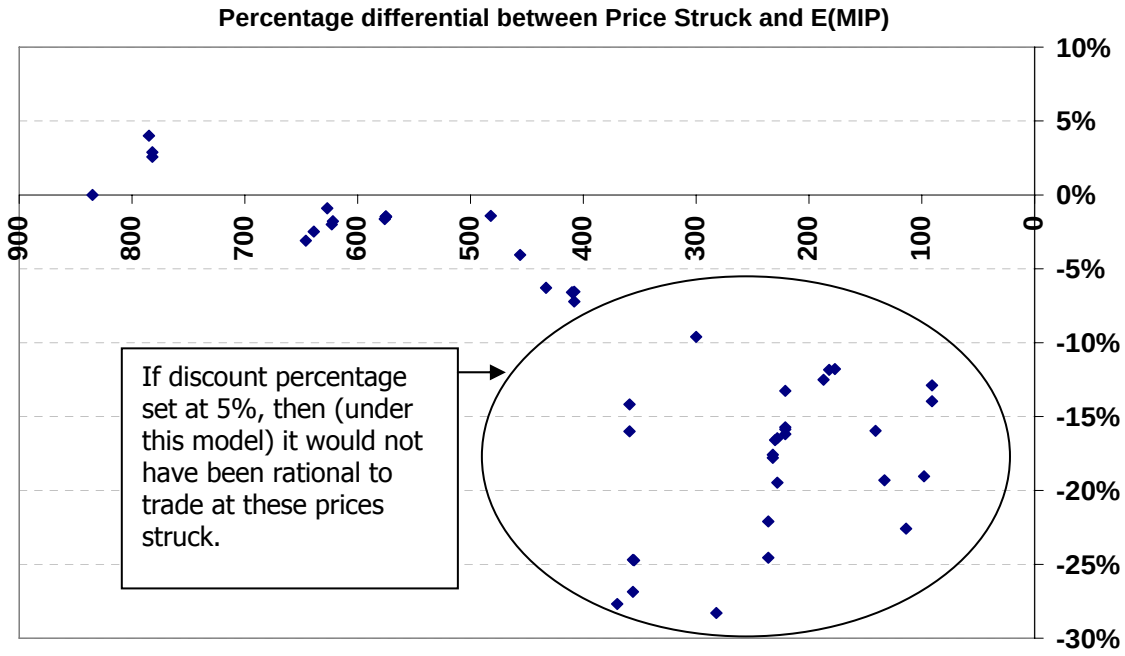



Figure 53. 20 September 2006 – SP 45 (Random) – Graph 4