Impact "intuitive" patch on PRBs

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1 Introduction

CWE NRAs requested the project to study if implementing "intuitive" FB could adversely impact the paradoxically rejected blocks. This document provides an analysis of the PRBs obtained under both the FB "plain" and FB "intuitive" modes.

2 PRB definition

Before considering the statistics on PRBs it is important to have a common understanding of what a PRB is. This section introduces and defines PRBs.

A "paradoxically rejected block" is a block order that has not been matched by the matching algorithm, whereas the block is in-the-money. For a simple block order the existence of this situation can be attributed to the fill-or-kill nature of block orders: either the block is fully assigned, or it is not assigned at all.
An example is provided in Figure 1: a (sell) block is assumed to be OUT of the solution in the left hand picture, but IN the solution in the right hand picture. Evidently the added volume of the sell block causes the price to drop. If we assume that the limiting price of the block is between mcp^{OUT} and mcp^{IN}, it means the block should not be included, since it would lose money against mcp^{IN}. Consequently the block is rejected, so the market will settle against mcp^{OUT}. Against this price the block makes money. This creates the paradoxical situation where the block appears to be able to generate an income, but is rejected.

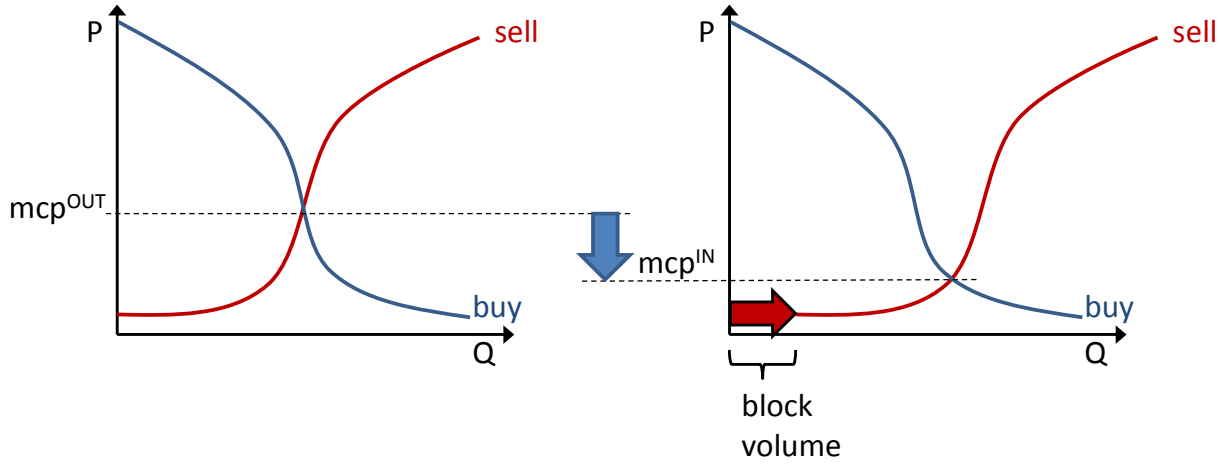

Figure 1 Illustration of effect the acceptance of a block order has on clearing price

The above example is a simple and mostly pedagogical example. In reality the PRB issue is further complicated by:

- the fact that block orders span multiple periods;
- the markets are coupled, so prices in neigbouring areas play a role;
- there is not just the single block of the example, but there are many block orders;

Especially the fact that there are many block orders, implies there are many combinations of block orders that can be accepted. Even though the matching algorithm is clev-

erer than enumerating all possibilities, there are no guarantees that a welfare optimal solution can be found in the finite time allocated to the algorithm.

Even though there are essentially two reasons for PRBs: either fundamental (cf. previous example), or due the inability of the algorithm to find a solution without the PRB, we have no way of distinguishing between these situations, hence we treat them the same. We can therefore define a PRB as:

PRB definition

A PRB is defined as a block order that is rejected, whereas the block is in-the-money:

- For a sell block: $\sum_{h \in hours\ of\ day} (mcp_h - P_h) Q_h > 0$
- For a buy block: $\sum_{h \in hours\ of\ day} (P_h - mcp_h) Q_h > 0$

With

mcp_h: the clearing price for hour h;

P_h: the block limit price for hour h;

Q_h: the block volume for hour h;

Important factors for paradoxical rejection are:

- The resilience of the market:
  - Either locally: to what extent can the market absorb the volume of the block;
  - Or regionally: to what extent does market coupling allow a market to lean on the resilience of adjacent markets. E.g. in a copperplate situation all markets experience the same resilience;
- The number and size of the block orders:
  - Sifting through many block orders will more likely be algorithmically challenging than relatively modest amounts of block orders. Here the number of block orders should be seen in the context of the full MRC scope;
  - The size of the block order: a small block order (little energy) is less likely to significantly impact the price, hence is less likely to become a PRB;
- Block and clearing price levels:
  - If block orders are priced at price levels close to the final clearing prices, a small change in price due to block acceptance is more likely to result in a PRB, than when block prices are further from final clearing prices.

2.1. PRB for smart orders

To complicate matters further CWE PXs offer so called "smart orders": block orders where some additional constraints can be imposed to allow more complex bidding strategies. The two types of supported smart orders are:

Linked block orders:

A block can be linked to another block, and the execution of this first block (child) is made conditional to the acceptance of the second block (parent). If a child's parent is not accepted, we do not consider the block a PRB, even if it is in the money. If a child's parent is accepted and the child makes money but is rejected, we consider this a PRB.

Exclusive groups:

A series of block orders can be added to an exclusive group. Of this series of block orders only one can be accepted. If one block of the series is accepted, whereas other (rejected) block orders in the group also make money, we do not consider these blocks PRB. If none of the blocks are accepted, but at least one of them makes money, we consider the exclusive group to be paradoxically rejected;

3 Analysis

3.1. Data

We looked at block order data from the parallel run during the period of 5 February 2014 (go-live NWE) to 31 October 2014. During this period there were 175426 block orders submitted in the CWE region. Of these blocks 8661 were accepted differently between the ATC/FB/FBI solutions. There were 567 blocks that were accepted differently between FB and FBI.

3.2. Transitional results

To assess the results of FB "plain" or FB "intuitive" on the PRB issue, we consider the different statuses a block order can have:

Status	Description
acc	The block order is accepted
rej	The block order is justifiably rejected: - The block order is out of the money; - The block order has a parent block that was rejected; - The block order is part of an exclusive group for which another block was already accepted;
PRB	The block is paradoxically rejected

- Either it is accepted;
- Or it is justifiably rejected: the block order is out of the money, or it has a parent block that was rejected, or it was part of an exclusive group of which another block was already accepted;
- Or it is paradoxically rejected;

We consider the transition matrices when moving from FB to FBI: the status under FB will change under FBI, and will this result in more, or less PRBs?

Erreur ! Source du renvoi introuvable. illustrates the transition table for each of the CWE areas. We discuss the results per area.

Belgium

The number of block orders that were accepted, rejected or PRB under FB and remain unchanged under FBI can be found in the green cells on the diagonal of the matrix. I.e. for 8985 + 19137 + 202 out of 28586 = 99.1% the block order statuses do not change. There are some previously rejected blocks that become accepted, and some previously accepted blocks that become rejected (i.e. the white cells). This is merely an effect of the changed price levels between the two FB modes, but does not aggravate the PRB issue.

Then there are the yellow cells: the PRBs that become (justifiably) rejected under FBI. This again is an effect of the changed price levels: at the price levels of FBI these blocks no longer are in-the-money. The reverse situation is where the (justifiably) rejected

blocks become PRB under FBI. The frequencies are 29 respectively 35. I.e. the figures do not suggest a systemic bias: roughly equal amounts move to PRBs from FB to FBI and from FBI to FB.

Finally there is the most problematic case where blocks that are accepted under FB become PRB under FBI (and vice versa). These cells are highlighted in red:

- 45 PRBs are accepted under FBI;
- 48 accepted blocks become PRB under FBI;

In aggregate under FBI there was an increase of PRBs from 276 to 285. To contrast: under ATC there were 501 PRBs, i.e. either FB mode brings a significant improvement.

Germany

The number of block orders that were accepted, rejected or PRB under FB and remain unchanged under FBI correspond to 99.8% of the block orders.

Transitions from PRB to rejected:

- 43 blocks were PRB under FB and become (justifiably) rejected under FBI.
- 41 blocks were (justifiably) rejected under FB and become PRB under FBI.
- I.e. the figures do not suggest a systemic bias: roughly equal amounts move to PRBs from FB to FBI and from FBI to FB.

For the red cells we have:

- 45 PRBs are accepted under FBI;
- 48 accepted blocks become PRB under FBI;
- I.e. the figures do not suggest a systemic bias: roughly equal amounts move from PRB to accepted and vice versa;

In aggregate under FBI there was a decrease of PRBs from 554 to 544. To contrast: under ATC there were 580 PRBs, i.e. either FB mode brings a small improvement.

France

The number of block orders that were accepted, rejected or PRB under FB and remain unchanged under FBI correspond to 99.6% of the block orders.

Transitions from PRB to rejected:

- 14 blocks were PRB under FB and become (justifiably) rejected under FBI.
- 22 blocks were (justifiably) rejected under FB and become PRB under FBI.
- I.e. the figures do not suggest a systemic bias: roughly equal amounts move to PRBs from FB to FBI and from FBI to FB.

For the red cells we have:

- 26 PRBs are accepted under FBI;
- 18 accepted blocks become PRB under FBI;
- I.e. the figures do not suggest a systemic bias: roughly equal amounts move from PRB to accepted and vice versa;

In aggregate both FB and FBI resulted in 196 PRBs. To contrast: under ATC there were 184 PRBs, i.e. either FB mode brings a small deterioration.

The Netherlands

The number of block orders that were accepted, rejected or PRB under FB and remain unchanged under FBI correspond to 99.1% of the block orders.

Transitions from PRB to rejected:

- 45 blocks were PRB under FB and become (justifiably) rejected under FBI.
- 47 blocks were (justifiably) rejected under FB and become PRB under FBI.

I.e. the figures do not suggest a systemic bias: roughly equal amounts move to PRBs from FB to FBI and from FBI to FB.

For the red cells we have:

- 22 PRBs are accepted under FBI;
- 44 accepted blocks become PRB under FBI;
- Here there might be more of a bias: the amount of blocks moving from PRB to accepted occurs only half the frequently as the reverse.

In aggregate under FBI there was a decrease of PRBs from 478 to 502. To contrast: under ATC there were 802 PRBs, i.e. either FB mode brings a significant improvement.

BE					
		FBI			
		acc	**rej**	**PRB**	**Σ**
FB	**acc**	8985	42	48	9075
	rej	63	19137	35	19235
	PRB	45	29	202	276
	Σ	9093	19208	285	28586
	ATC	8608	19477	501	

DE					
		FBI			
		acc	**rej**	**PRB**	**Σ**
FB	**acc**	17594	22	45	17661
	rej	34	78353	41	78428
	PRB	53	43	458	554
	Σ	17681	78418	544	96643
	ATC	17535	78528	580	

FR					
		FBI			
		acc	**rej**	**PRB**	**Σ**
FB	**acc**	8669	15	18	8702
	rej	8	14338	22	14368
	PRB	26	14	156	196
	Σ	8703	14367	196	23266
	ATC	8541	14541	184	

NL					
		FBI			
		acc	**rej**	**PRB**	**Σ**
FB	**acc**	6531	43	44	6618
	rej	39	19749	47	19835
	PRB	22	45	411	478
	Σ	6592	19837	502	26931
	ATC	6357	19772	802	

Table 1 block order status transition matrix per area

3.3. Observations on transitions

For the larger markets (DE and FR) the impact of FB on PRBs is relatively modest. The number of PRBs is comparable between the FB, FBI and ATC modes. Prices in the larger areas are more resilient against levels of cross border exchanges and against differences in block selection.

The smaller markets (BE and NL) are less resilient against the changes in cross border positions and changes in the block selection, hence the impact is more significant. The main effects is that the number of PRBs decreases under either FB mode compared to ATC for BE as well as NL. The number of PRBs is slightly higher under FBI compared to FB (+3.3% for BE and +5.0% for NL).

3.4. ΔP results

So far we considered the number of PRBs, but we have not yet considered the amount by which a PRB was in-the-money. We introduce an indicator ΔP, which indicated this amount. We define it as:

$$\Delta P = \begin{cases} \dfrac{\sum_{h \in hours\ of\ day} (mcp_h - P_h) Q_h}{\sum_{h \in hours\ of\ day} Q_h}, & for\ sell\ block\ orders \\ \dfrac{\sum_{h \in hours\ of\ day} (P_h - mcp_h) Q_h}{\sum_{h \in hours\ of\ day} Q_h}, & for\ buy\ block\ orders \end{cases}$$

For an exclusive group we have multiple block orders that all were rejected. We define its ΔP as the largest of the ΔP of its blocks.

Note that a positive value of ΔP corresponds to a situation where the block is in-the-money, whereas a negative value corresponds to a situation where it is out-of-the-money. PRBs and accepted blocks therefore must have positive ΔP values, whereas rejected blocks must have negative ΔP values.

We restrict our analysis to hours for which either FB or FBI resulted in a PRB. We therefore only have transitions from FB to FBI that are move:

- From PRB to acc;
- From PRB to rej;
- From PRB to PRB;
- From acc to PRB;
- From rej to PRB;

In Figure 2, Figure 3, Figure 4 and Figure 5 the ΔP values are scattered for each area: on the horizontal axis the value under FB, on the vertical axis the value under FBI.

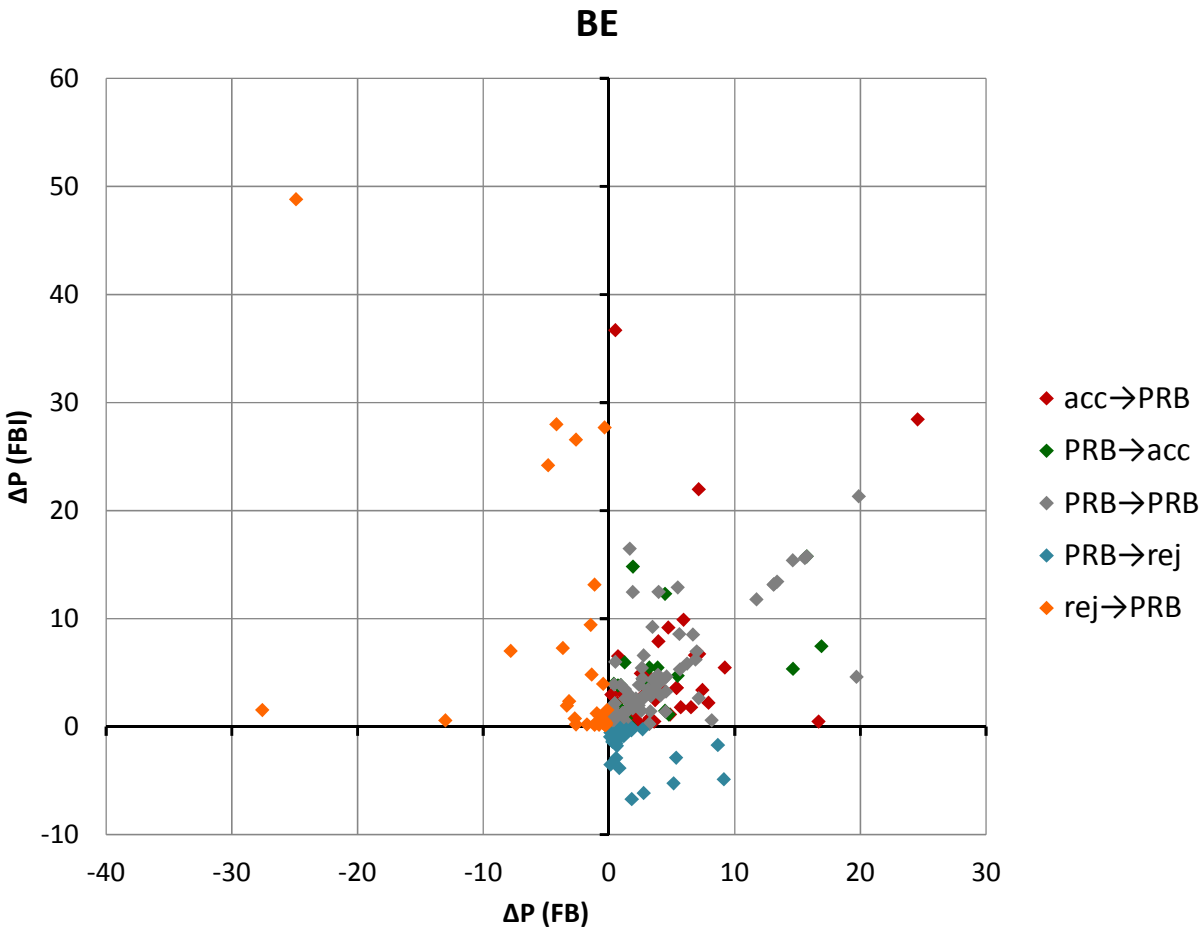

Figure 2 Scatter of ΔP values of blocks that were PRB in either of the FB or FBI simulations for the BE market.

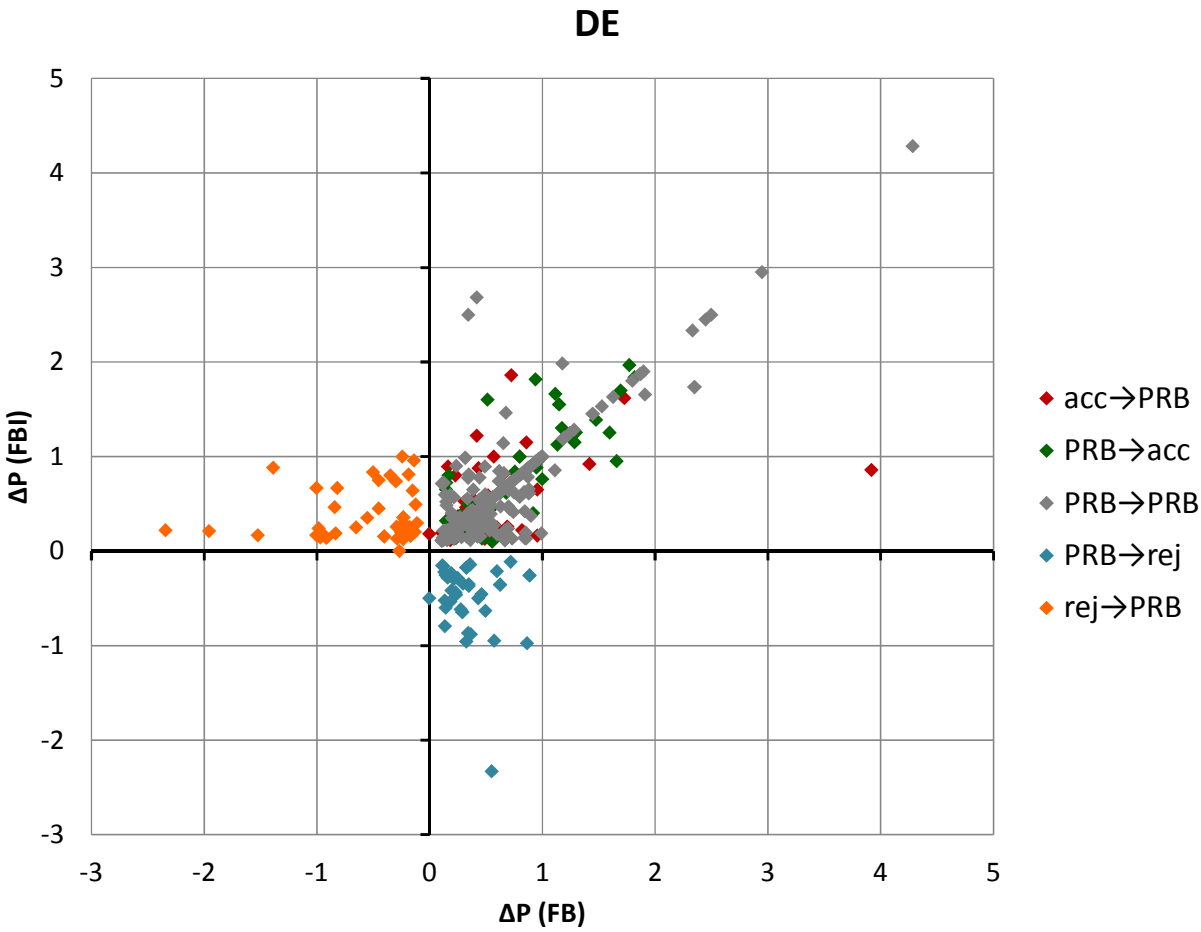

Figure 3 Scatter of ΔP values of blocks that were PRB in either of the FB or FBI simulations for the DE market.

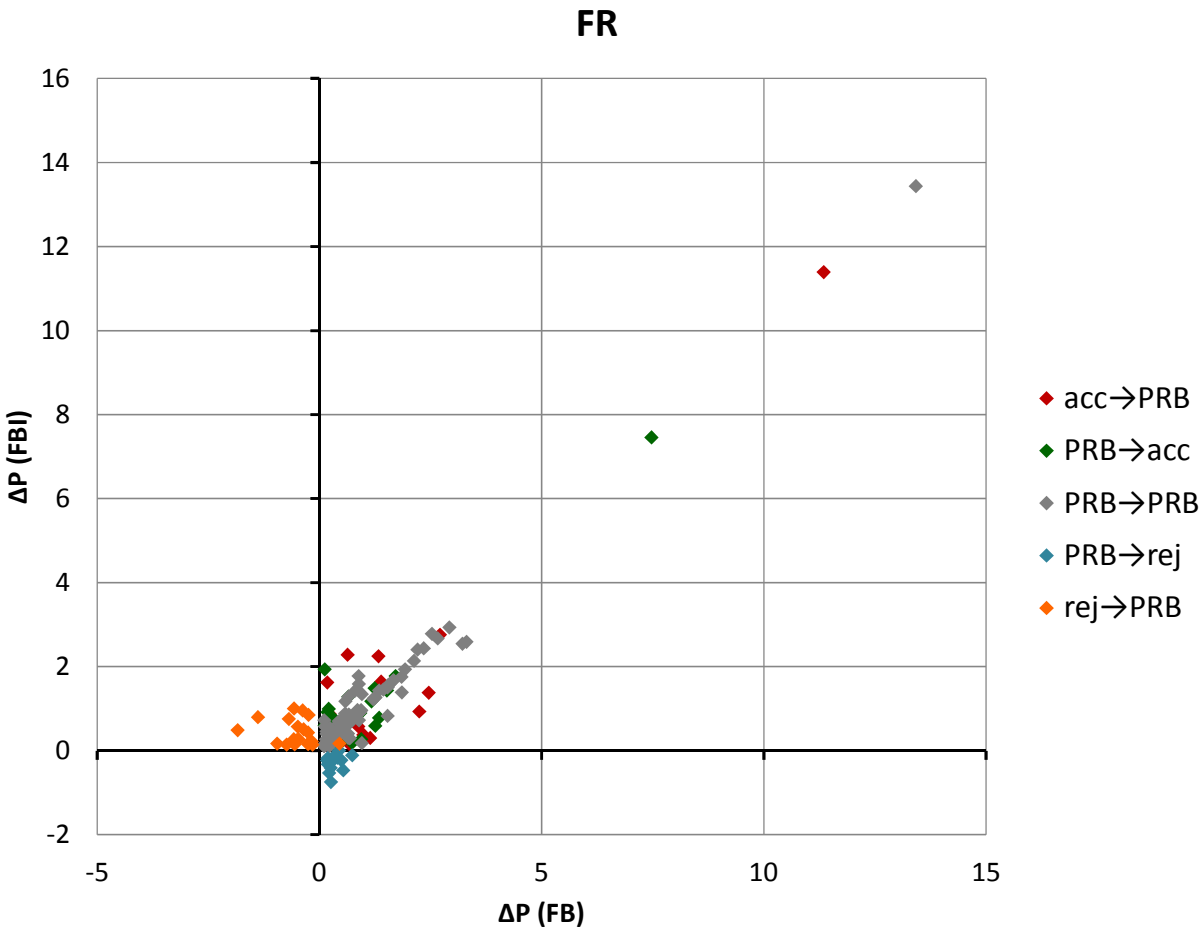

Figure 4 Scatter of ΔP values of blocks that were PRB in either of the FB or FBI simulations for the FR market.

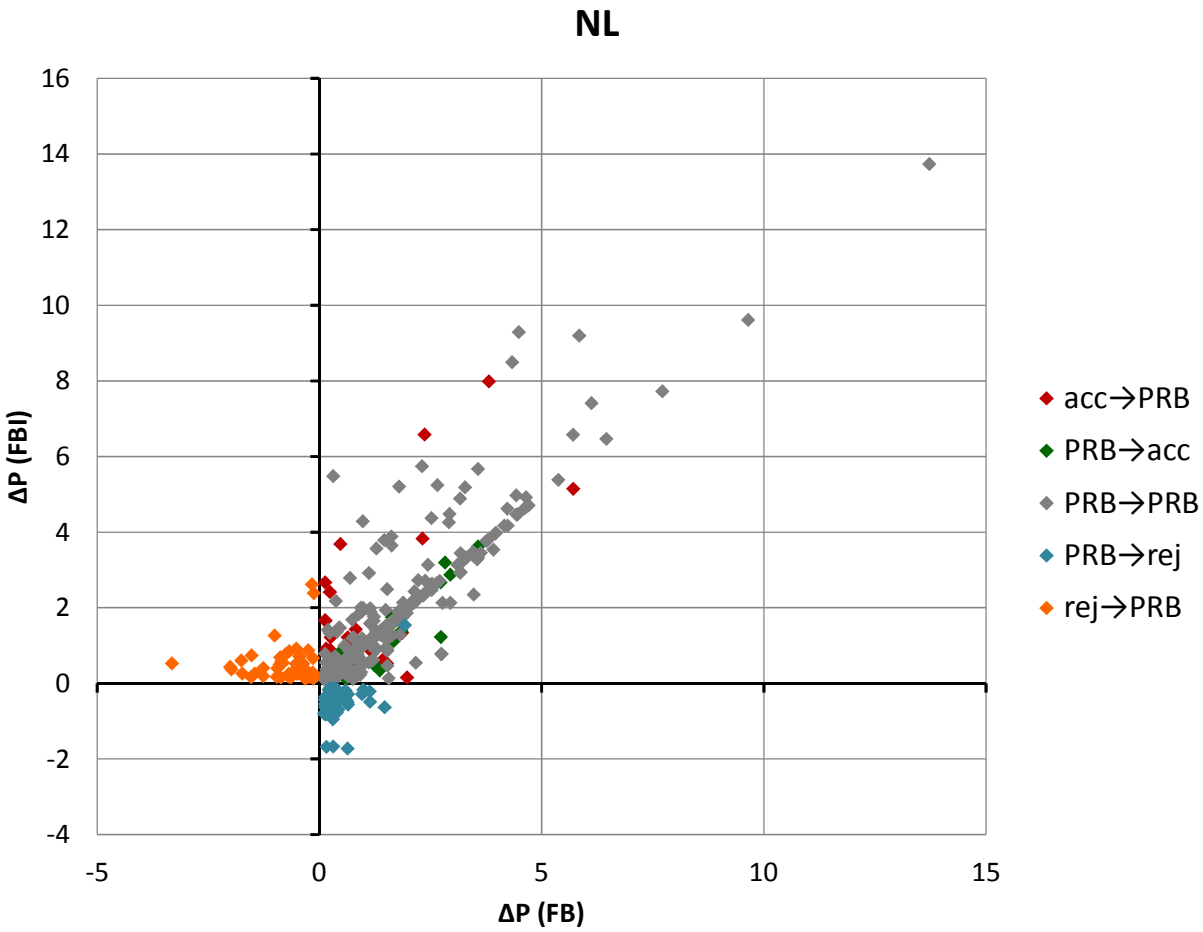

Figure 5 Scatter of ΔP values of blocks that were PRB in either of the FB or FBI simulations for the NL market.

3.5. Observations on ΔP

The most extreme situations are found for the Belgian market, with extremes of PRBs being in the money up to almost 50€/MWh for delivery day 11 April 2014. Focussing on Figure 2 for BE we note that this extreme for a 50€ PRB occurs under FBI, but not under FB. However this does not mean that problems under FBI are worse than under FB: for this specific instance the prices under FB happened to be such that this block was out-of-the-money. I.e. the block was rejected for both the FB and FBI results, however under FBI it was labelled "PRB", whereas under FB it was "rejected".

One more outlier can be spotted resulting in a ~37€ PRB under FBI, which was accepted under FB. Like the previous PRB this one corresponds to 11 April 2014 too, which appears to have been a particularly stressed day with regards to PRBs.

For the remaining points in the scatter a more even picture between FB and FBI results is depicted.

4 Conclusions

The issue of the PRBs exists today under ATC MC and will continue to exist under FB MC. Results suggest that the severity of this issue actually will be reduced when FB is introduced.

Comparing the FB and FBI results a small difference in favour of FB can be observed. However even FBI results in less PRBs than would be found under ATC.