Modifications P74 and P78: Price Equations Revisited – Equations and Implications

CONTENTS

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Introduction

This analysis is in two parts. In the first, the equations offered to PIMG are reviewed and partially explained. The intent is not that PIMG review these line by line but rather that they offer background to the second part of the analysis, which seeks to draw out the implications, which form the second part of this analysis.

It should be noted that these equations represent rational options for suppliers and generators in a generic world where there are two potential cash-out prices deriving from system balancing actions. There is also a spot price (PXP), which is impacted by expectations of these cash-out prices. This is a realistic description of the environment in which we are currently operating.

By expressing the analysis in equations, we are simply setting out the basic assumptions that we would, in any case be making in trying to assess the implications of a change to the cash-out regime. In many ways, the key advantage to this approach is that it explicitly sets out the assumptions being made and treats those assumptions consistently in the succeeding analysis.

The relevant equations to look at can be found on Page 12.

Supporting Analysis – Equations – Revised

Table 1: First-order factors in balancing decisions in a Settlement Period

Variable	Description	Assumptions
SP	Expected party's cash-out price	Probabilistic average of SP^- and SP^+
SP^+	The cash-out price when short	SBP now, national imbalance price P74, SBP or PXP P78
SP^-	The cash-out price when long	SSP now, national imbalance price P74, SSP or PXP P78
SBP	Predicted System Buy Price. Derived from BSAD and Offer Acceptances in the Balancing Mechanism.	Offer prices are independent of market balance position. Prediction based on history of prices.
SSP	Predicted System Sell Price. Derived from BSAD and Bid Acceptances in the Balancing Mechanism.	Bid prices are independent of market balance position. Prediction based on history of prices. Price relatively stable and associated with marginal fuel for generation.
PXP	Spot price available close to gate closure.	Liquid market. Visible price. Parties mark their contracts to market at this price.
Fuel	Generator Fuel Cost £/MWh	Revenue must exceed this cost
O	Offer price of a particular generator.	Not influenced by acceptance probability. (to be used in the generator equation).
B	Bid price of a particular generator.	Not influenced by acceptance probability. (to be used in the generator equation).
P^s	Cumulative probability of an individual supplier or generator being exposed to SP^+.	A function of the level of contract and, for suppliers, forecast error or, for generators, it is trip probability. Supplier forecast errors are assumed to be distributed normally around their central forecast of demand.
p^s	Probability density of the supplier being short	Function of m and C

Q^s	Cumulative probability of an individual supplier or generator being exposed to SP^-. $=1- P^s$	A function of the level of contract and, for suppliers, forecast error or, for generators, it is trip probability. Supplier forecast errors are assumed to be distributed normally around their central forecast of demand.
q^s	Probability density of the supplier being short	Function of m and C
m	The meter error from contact position	This is chosen rather than the meter error from expected demand as it makes the integration more straightforward
M^+	The mean shortfall of the supplier	Depends on contract level C Measured in standard deviations
M^-	The mean spill of the supplier	Depends on contract level C Measured in standard deviations
P^m	Cumulative probability of market being net short.	
P^o	Probability of generator's offer O being accepted by NGC	
P^b	Probability of generator's bid B being accepted by NGC	
C	Supplier contract offset from its expected demand level	if $C=0$ then $p^s = 0.5$ C is measured in standard deviations of supplier demand prediction error.

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1. Supplier Balance Equations

Equation 1.1 simply identifies the relationship between probabilities – i.e. if you have a certain probability of going short then your probability of going long is the reverse of that.

Equation 1.1: Probability equalities

Probability of supplier going long $= 1 - P^s = Q^s$	*(a)*
Probability of market going long $= 1 - P^m = Q^m$	*(b)*
$SP = P^s * SP^+ + Q^s * SP^-$	*(c)*

The suppliers expected cash-out price (SP) is the probability of being short times the short price plus the probability of being long times the long price.

Equation 1.2 : Supplier marginal trade equation

Compare PXP with SP $(= P^s * SP^+ + Q^s * SP^-)$ *for small trades*	(a)
$PXP * \Delta C < P^s * SP^+ * \Delta C + Q^s * SP^- * \Delta C$ *: then buy*	(b)
$PXP * \Delta C > P^s * SP^+ * \Delta C + Q^s * SP^- * \Delta C$ *: then sell*	(c)
$PXP * \Delta C = P^s * SP^+ * \Delta C + Q^s * SP^- * \Delta C$ *: neutral to market*	(d)

If the supplier contracts more than a small amount ΔC then its probabilities of being long and short will change, also if it is a large supplier contracts more than ΔC the long and short prices may be affected by its actions.

$\boldsymbol{PXP = P^s * SP^+ + Q^s * SP^-}$	(e)

This is the suppliers neutral trade position. Other formulations are:

$PXP = Ps * SP^+ + (1 - P^s)*SP^-$	(f)
$\boldsymbol{PXP = SP^- + P^s * (SP^+ - SP^-)}$	(g)
$PXP - SP^- = P^s * (SP^+ - SP^-)$	(h)
$\boldsymbol{P^s = (PXP - SP^-) / (SP^+ - SP^-)}$	(i)

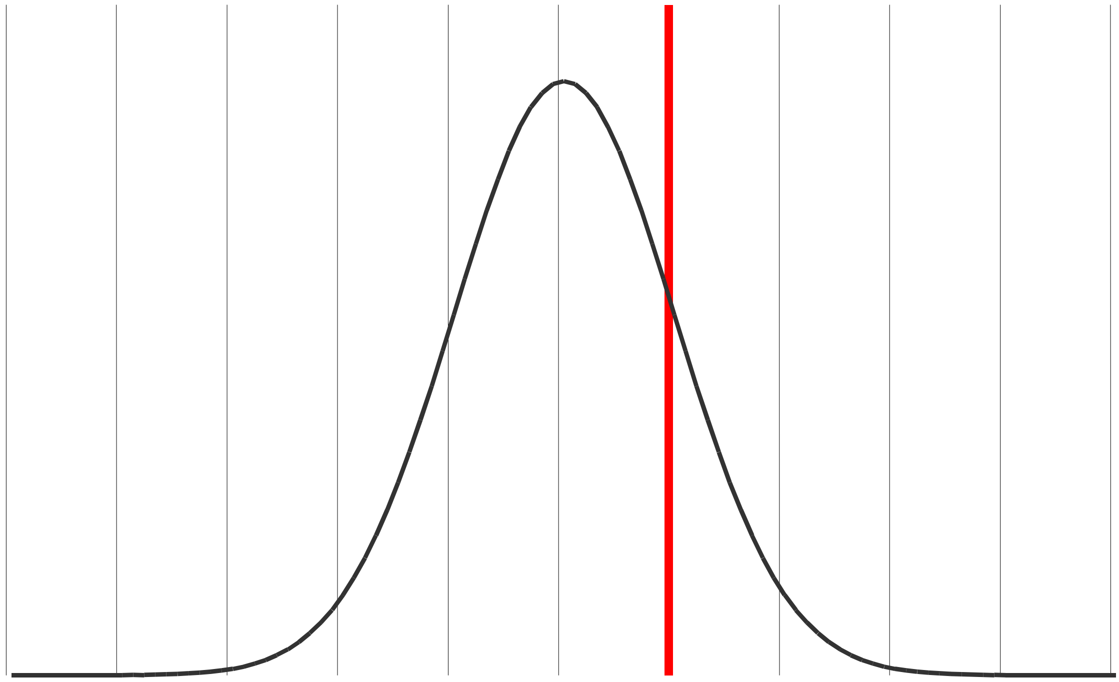
Given common access to PXP and similar views of long price and short price suppliers will trade to a similar probabilities of being short, hence a similar offset (in standard deviations of demand prediction error) from their expected demand.

National Balance versus Supplier balance

Let us consider a standard case where *$SP^-=10$, $SP^+=30$, $PXP=13.2$ this gives:*

$P^s=(13.2-10)/(30-10) = 0.16$	(j)

At a probability of being short of 0.16 a supplier would be contracted one standard deviation above its expected demand ($C = 1\sigma$).



If you sum together a set of normal distributions (μ_n , σ_n) then a normal distribution (μ , σ) results. The relationship between the means is:

$\mu = \Sigma\mu_n$	(k)

And the relationship between the standard deviations is:

$\sigma^2 = \Sigma(\sigma_n)^2$ *hence*	(l)
$\sigma = \sqrt{\Sigma(\sigma_n)^2}$	(m)

There are 8 large suppliers assume they are all equal size with a national demand 40GW (i.e. 5GW each) and that each suppliers demand error σ = 3% = 150MW then:

$\sigma^2 = \Sigma(\sigma_n)^2 = 8 * 150^2$	(n)
$\sigma = 150 * \sqrt{8} = 150 * 2.8 = 424MW$	(o)
*Net supplier contract position = 8 *150 = 1200MW = 2.8σ*	(p)
Probability of suppliers as a whole being short = 0.00234	(q)

(Note that if we had started with a PXP closer to SBP as would happen in a short market (e.g. $SP^-=10$, $SP^+=30$, *PXP=26.8) then suppliers would go short and the nation even shorter)*

Equation 1.3: Supplier Current

Under the current price structure:

$SP^- = SSP$ *and* $SP^+ = SBP$ *; hence*	(f)
$\mathbf{PXP = SSP + P^s * (SBP - SSP)}$ *; and*	(g)
$\mathbf{P^s = (PXP - SSP) / (SBP - SSP)}$	(i)

Equation 1.4: Supplier – P74

Under the single price mod the supplier cash-out prices are independent of whether it is long or short they only depend upon the market being long or short, hence:

$SP = P^m * SBP + (1 - P^m) * SSP = SP^+ = SP^-$

you can substitute into Equation 2 and cancel out P^s terms but it is easier to start from scratch:

$PXP = SP = SP = P^m * SBP + (1 - P^m) * SSP$; *so*
$\mathbf{PXP = SSP + P^m * (SBP - SSP)}$ *; and*
$\mathbf{P^m = (PXP - SSP) / (SBP - SSP)}$

These last two equations show the fixed relationship between PXP, the expectation of the market being short P^s, and the expectations of SSP and SBP.

Equation 1.5: P78 expected prices

$SP^{-} = P^m * PXP + Q^m * SSP$	
$SP^{+} = P^m * SBP + Q^m * PXP$	
$SP = P^s * SP^{+} + Q^s * SP^{-}$	
$SP = P^s * (P^m * SBP + Q^m * PXP) + Q^s *(P^m * PXP + Q^m * SSP)$	
$SP = P^s * P^m * SBP + P^s * Q^m * PXP + Q^s * P^m * PXP + Q^s * Q^m * SSP$	
But for contract neutrality SP = PXP	
$PXP = P^s * P^m * SBP + P^s * Q^m * PXP + Q^s * P^m * PXP + Q^s * Q^m * SSP$	
$PXP - P^s * Q^m * PXP - Q^s * P^m * PXP = P^s * P^m * SBP + Q^s * Q^m * SSP$	
$PXP *(1 - P^s * Q^m - Q^s * P^m) = Q^s * Q^m * SSP + P^s * P^m * SBP$	
$PXP *(1 - P^s * (1-P^m) - Q^s * (1-Q^m)) = Q^s * Q^m * SSP + P^s * P^m * SBP$	
$PXP *(1 - P^s + P^s * P^m - Q^s + Q^s * Q^m) = Q^s * Q^m * SSP + P^s * P^m * SBP$	
$PXP *(Q^s * Q^m + P^s * P^m) = Q^s * Q^m * SSP + P^s * P^m * SBP$	
$PXP *(Q^s * Q^m + P^s * P^m) = Q^s * Q^m * SSP + P^s * P^m * SSP + P^s * P^m * SBP - P^s * P^m * SSP$	
$PXP *(Q^s * Q^m + P^s * P^m) = (Q^s * Q^m + P^s * P^m)* SSP + P^s * P^m * (SBP-SSP)$	
$PXP = SSP + (SBP - SSP) * P^s * P^m /(Q^s * Q^m + P^s * P^m)$ – P78 – *note:*	
$PXP = SSP + (SBP - SSP) * P^m /(Q^m + P^m)$ – **P74**	
$PXP = SSP + (SBP - SSP) * P^s /(Q^s + P^s)$ - **now**	

2. Generator contract equation – general

In deciding whether to sell ahead or to wait and trade in the balancing mechanism the generator will consider the net sale benefit and compare it with the net non-sale benefit. If the net sale benefit does not exceed the net non-sale benefit the generator will not trade ahead.

Equation 2.1: Net Sale Benefit for Generators

When a contract is sold from a genset the benefit is: sale price minus fuel, minus trip risk (noting that fuel is saved), plus bid benefit (again noting that fuel is saved).

$\text{Net Sale Benefit} = (PXP - Fuel) - P^s * (SP^+ - Fuel) * (1 - P^b) + P^b * (Fuel - B)$	(a)
$\text{Net Sale Benefit} = PXP - Fuel - P^s * SP^+ * (1 - P^b) + P^s * Fuel * (1 - P^b) + P^b * Fuel - P^b * B$	(b)
$\text{Net Sale Benefit} = PXP - Fuel - P^s * SP^+ * (1 - P^b) + P^s * Fuel * (1 - P^b) + P^b * Fuel - P^b * B$	(c)
$\text{Net Sale Benefit} = PXP - P^s * SP^+ * (1 - P^b) - P^b * B - Fuel + P^s * Fuel * (1 - P^b) + P^b * Fuel$	(d)
$\text{Net Sale Benefit} = PXP - P^s * SP^+ * (1 - P^b) - P^b * B - (1 - P^b) * Fuel + P^s * Fuel * (1 - P^b)$	(e)
$\text{Net Sale Benefit} = PXP - P^s * SP^+ * (1 - P^b) - P^b * B - (1-P^b) * (1 - P^s) * Fuel$	(f)

The four elements of the above equation are: contract sale; the trip cost (only if the bid is not accepted hence the genset still runs); the benefit if a bid is accepted; and the fuel cost (which only applies when there is no bid accepted and no trip).

If the generator is not in the balancing mechanism then it cannot bid so the bid probability is 0, hence the equation simplifies to:

$\text{Net Sale Benefit} = PXP - P^s * SP^+ - (1 - P^s) * Fuel$	(g)

Equation 2.2: Net Non-Sale Benefit for Generators

If the generator does not sell ahead then it can either spill into the balancing mechanism by putting in an FPN greater than contract, or it can wait and offer into the balancing mechanism. Clearly it will choose the option with maximum benefit, hence:

$\text{Net non-sale Benefit} = Max((SP^- - Fuel) * (1 - P^s), P^o * ((O - Fuel) * (1 - P^s) - P^s * SP^+))$	(h)

This is a simplified equation which assumes: PXP>Fuel or there would be no trade; SP^->Fuel or there would be no spill; O>Fuel or there would be no offer; and B<Fuel or there would be no bid.

If the generator is not in the balancing mechanism then it cannot offer so the offer probability is 0, hence the equation simplifies to:

$\text{Net non-sale Benefit} = (SP^- - Fuel) * (1 - P^s)$	(i)
$\text{Net non-sale Benefit} = SP^- * (1 - P^s) - Fuel * (1 - P^s)$	(j)

Equation 2.3: Generator bottom stop sale price

If the net sale benefit does not exceed the net non-sale benefit the generator will not trade ahead, the inequality is:

$PXP - P^s * SP^+ * (1 – P^b) - P^b * B – (1-P^b) *(1 - P^s) * Fuel > Max ((SP^- – Fuel) * (1 – P^s), P^o * ((O – Fuel) * (1 – P^s) – P^s * SP^+));$	(k)
$\mathbf{PXP > P^b * B + (1-P^b) * P^s * SP^+ + (1-P^b) *(1 - P^s) * Fuel + Max ((SP^- – Fuel) * (1 – P^s), P^o * ((O – Fuel) * (1 – P^s) – P^s * SP^+));}$	(l)

There is not a lot you can do with this equation (as is) beyond filling in numbers and seeing what you get.

Where the generator is not in the Balancing Mechanism the trade-ahead decision is:

$(PXP - P^s * SP^+) - (1 - P^s) * (Fuel) > (SP^- – Fuel) * (1 – P^s)$	(r)
$PXP - P^s * SP^+ > SP^- * (1 – P^s)$	(s)
$PXP > SP^- * (1 – P^s) + P^s * SP^+$	(t)
$\mathbf{PXP > SP^- + P^s * (SP^+ - SP^-)}$	(u)

This states that a generator not in the balancing mechanism is willing to sell ahead if the power exchange price is greater than spill price plus its own trip risk. Note that this is in the same form as the supplier equation(with inequality replacing equality); **hence all passive parties have a similar price attitude.**

Given the complication of equation 2(l) some simplification is called for firstly we will assume that P^S (the very low probability of the generator tripping) is zero:

$PXP > P^b * B + (1-P^b) * P^s * SP^+ + (1-P^b) *(1 - P^s) * Fuel + Max ((SP^- – Fuel) * (1 – P^s), P^o * ((O – Fuel) * (1 – P^s) – P^s * SP^+));$	(l)
$PXP > P^b * B + (1-P^b) * Fuel + Max ((SP^- – Fuel), P^o * (O – Fuel));$	(v)

We may also make the simplifying assumption the Fuel = SP^- this is not always reasonable, a better assumption is that Fuel = SSP; i.e. the generator we are considering is marginal. We will apply this assumption in each price case individually.

Equation 2.5: Generator contract equation – current

Current two price generator case SP^+ =SBP and SP^- = SSP

$PXP > P^b * B + (1-P^b) * Fuel + Max ((SSP – Fuel), P^o * (O – Fuel));$	(w)

Assume marginal so Fuel = SSP

$\mathbf{PXP > P^b * B + (1-P^b) * SSP + Max (P^o * (O – SSP), 0)}$	**(x)**

Noting that the offer price will almost always be above SSP

$PXP > P^b * B + (1-P^b) * SSP + P^o * (O – SSP)$	(y)
$PXP > SSP - P^b *(SSP - B) + P^o * (O – SSP)$	(z)

PXP must be greater than spill price discounted by bid benefit and increased by offer benefit.

Equation 2.6: Generator contract equation – P74

For a single price $SP^- = SP^+ = SP = P^m * SBP + (1 - P^m) * SSP$ *hence:*

$PXP > P^b * B + (1-P^b) * Fuel + Max((SP^- - Fuel), P^o * (O - Fuel));$	(v)
$PXP > P^b * B + (1-P^b) * Fuel + Max(((P^m * SBP + (1 - P^m) * SSP) - Fuel), P^o * (O - Fuel))$	(aa)

Assume marginal so Fuel = SSP

$PXP > P^b * B + (1-P^b) * SSP + Max(((P^m * SBP + (1 - P^m) * SSP) - SSP), P^o * (O - SSP))$	(bb)
$PXP > P^b * B + (1-P^b) * SSP + Max((P^m * (SBP - SSP), P^o * (O - SSP))$	(cc)
$\mathbf{PXP > SSP - P^b * (SSP - B) + Max(P^o * (O - SSP), P^m * (SBP - SSP))}$	(dd)

PXP must be greater than spill price discounted by bid benefit and increased by the maximum of offer benefit and spill benefit.

Equation 2.7: Generator contract equation – P78

For P78 the prices are:

$SP^- = P^m * PXP + Q^m * SSP$	
$SP^+ = P^m * SBP + Q^m * PXP$	
$PXP > P^b * B + (1-P^b) * Fuel + Max((SP^- - Fuel), P^o * (O - Fuel));$	(v)
$PXP > P^b * B + (1-P^b) * Fuel + Max((P^m * PXP + Q^m * SSP - Fuel), P^o * (O - Fuel));$	(ee)

Assume marginal so Fuel = SSP

$PXP > P^b * B + (1-P^b) * SSP + Max((P^m * PXP + Q^m * SSP - SSP), P^o * (O - SSP));$	(ff)
$PXP > P^b * B + (1-P^b) * SSP + Max((P^m * PXP + (1 - P^m) * SSP - SSP), P^o * (O - SSP));$	(gg)
$PXP > SSP - P^b * (SSP - B) + Max((P^m * (PXP - SSP), P^o * (O - SSP));$	(hh)
$\mathbf{PXP > SSP - P^b * (SSP - B) + Max((P^o * (O - SSP), P^m * (PXP - SSP));}$	(ii)

In Conclusion

For suppliers and other non bid/offer gens

$PXP = SSP + (SBP - SSP) * P^s * P^m / (Q^s * Q^m + P^s * P^m)$	P78
$PXP = SSP + (SBP - SSP) * P^m / (Q^m + P^m)$	P74
$PXP = SSP + (SBP - SSP) * P^s / (Q^s + P^s)$	now

For marginal (Fuel = SSP) bid/offer gensets their ***bottom stop price is:***

$PXP > SSP - P^b * (SSP - B) + Max(P^o * (O - SSP), P^m * (PXP - SSP))$	P78
$PXP > SSP - P^b * (SSP - B) + Max(P^o * (O - SSP), P^m * (SBP - SSP))$	P74
$PXP > SSP - P^b * (SSP - B) + Max(P^o * (O - SSP), 0)$	now

Hence P78 potentially increases the bottom stop price and P74 potentially increases it more.

Note that there is no point in offering unless it is better than spill so

$P^o * (O - SSP) > P^m * (PXP - SSP)$	P78
$P^o * O - P^o * SSP > P^m * PXP - P^m * SSP$	P78
$P^o * O > P^m * PXP - P^m * SSP + P^o * SSP$	P78
$O > SSP + (P^m / P^o) * (PXP - SSP)$ *: similarly*	**P78**
$O > SSP + (P^m / P^o) * (SBP - SSP)$	**P74**

Supporting Analysis – Implications

The implications derive form the conclusions in the preceding section.

1. Supplier balance

The following conclusions can be derived from the supplier balance equations:

a. In the current mechanism, the sole determinant of the relationship between the spot price and expected system prices is the expectation of the individual supplier's exposure to those system prices.

   i. Because supplier contract positions have tended to be correlated with each other, the net system balance will be the sum imbalances largely in the same direction, which leads to excess spill.

b. Under P74, the sole determinant of the relationship between PXP and expected system prices is the extent of market imbalance.

   i. A pure spill strategy by all suppliers would lead to the same outcome as the present system.

   ii. However, if all suppliers seem to be spilling, then the risk of exposure to a high buy price becomes negligible, reducing the incentive to spill so much.

c. P78 offers a more complex relationship whereby both market length and individual length impact. Table 2 gives a representation of the implications of this.

Table 2: P78 probabilities and prices

Probability matrix

	Ps	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
Pm	**0.1**	**0.01**	0.03	0.05	0.07	0.10	0.14	0.21	0.31	0.50
	0.2	0.03	**0.06**	0.10	0.14	0.20	0.27	0.37	0.50	0.69
	0.3	0.05	0.10	**0.16**	0.22	0.30	0.39	0.50	0.63	0.79
	0.4	0.07	0.14	0.22	**0.31**	0.40	0.50	0.61	0.73	0.86
	0.5	0.10	0.20	0.30	0.40	**0.50**	0.60	0.70	0.80	0.90
	0.6	0.14	0.27	0.39	0.50	0.60	**0.69**	0.78	0.86	0.93
	0.7	0.21	0.37	0.50	0.61	0.70	0.78	**0.84**	0.90	0.95
	0.8	0.31	0.50	0.63	0.73	0.80	0.86	0.90	**0.94**	0.97
	0.9	0.50	0.69	0.79	0.86	0.90	0.93	0.95	0.97	**0.99**

SSP	**10**
SBP	**30**

PXP based on probability matrix and given expected system prices

	Ps	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
Pm	**0.1**	**10.24**	10.54	10.91	11.38	12.00	12.86	14.12	16.15	20.00
	0.2	10.54	**11.18**	11.94	12.86	14.00	15.45	17.37	20.00	23.85
	0.3	10.91	11.94	**13.10**	14.44	16.00	17.83	20.00	22.63	25.88
	0.4	11.38	12.86	14.44	**16.15**	18.00	20.00	22.17	24.55	27.14
	0.5	12.00	14.00	16.00	18.00	**20.00**	22.00	24.00	26.00	28.00
	0.6	12.86	15.45	17.83	20.00	22.00	**23.85**	25.56	27.14	28.62
	0.7	14.12	17.37	20.00	22.17	24.00	25.56	**26.90**	28.06	29.09
	0.8	16.15	20.00	22.63	24.55	26.00	27.14	28.06	**28.82**	29.46
	0.9	20.00	23.85	25.88	27.14	28.00	28.62	29.09	29.46	**29.76**

In Table 2:

Ps is the probability of the supplier being short

Pm is the probability of the market being short

i. In the table, the diagonal in bold is the line at which the suppliers probability of being short is fully correlated with the markets probability of being short. There is likely to be a positive correlation between the two although it is to be expected that, if all suppliers seek to go 1 standard deviation long (Ps about 0.4) then the market will be considerably longer. This means that the equilibrium will not necessarily be stable.

2. Generator Reserve prices

a. Under the current regime, the generator reserve price is mainly determined by the probability of an Offer being accepted.

$$PXP - SSP + P^b * (SSP - B) > Max (P^o * (O - SSP), 0)$$

i. In a spill market, this becomes very low.

ii. In a market tending to be short this rises considerably.

iii. This is not necessarily economically inefficient but there is no value of lost load coming into the mechanism other than through the market mechanism, which is likely to contribute to the spikiness of SBP because low probabilities of acceptance will lead to offer price mark-ups.

b. Under P74, the driving factor is the expected market length and expected SBP.

$$PXP - SSP + P^b * (SSP - B) > Max (P^o * (O - SSP), P^m * (SBP - SSP))$$

i. A high buy-sell spread will increase the generator reserve price, increasing PXP.

ii. This feeds through into the supplier equation because a higher PXP raises the cost of spill – so parties will be less long.

iii. There is a feedback loop into Offer prices and into the SBP based on them, which is explored below.

c. Under P78, the driving factor is the market length and the spread between the power exchange price and SSP.

$$PXP - SSP + P^b * (SSP - B) > Max (P^o * (O - SSP), P^m * (PXP - SSP))$$

i. The reserve price will be lower as there is a smaller spread.

ii. This makes the likely market length greater.

iii. The feedback loop mentioned above needs to be explored.

3. Generator Offer prices

a. The current mechanism offers no direct link between Offer price and market length. However,

$$PXP - SSP + P^b * (SSP - B) > Max (P^o * (O - SSP), 0)$$

i. In a long market, P^o is very low.

ii. Pricing is dominated by P^b. This tends to bring the PXP reserve price below SSP, especially as pre-gate closure transactions by NGC (based on the certainty of a long market) will have raised SSP.

b. Under P74, the probabilities of Offer Acceptance and market length act on the buy-sell spread to set reserve prices for Offers.

$$O > SSP + (P^m /P^o) * (SBP - SSP)$$

i. Note that P^m and P^o are positively correlated. The probability of the market being short is likely to be larger than the probability of a particular offer being accepted (although this is not fully the case).

ii. However, as the market goes shorter, the probability of Offer acceptance is likely to increase at a greater rate because the population of available Offers (those not already accepted) will reduce.

iii. P^o is also inversely correlated with the Offer Price O. This will tend to cap the Offer price as being not too far above the reserve price.

iv. In a market going shorter, NGC has an incentive to reduce the spread by buying in the forward market. This reduces the spread by bringing SBP down but it also reduces SSP because fewer NGC sells will come through BSAD.

v. If SSP comes down but SBP comes down further through NGC actions in the market, then this will put a downward pressure on PXP, incentivising suppliers to go longer, which reduces the probabilities of Offer acceptance and market length.

vi. This suggests that the outcome will be towards a stable equilibrium.

c. Under P78, the same probabilities apply but related to a spread between PXP and SSP.

$O > SSP + (P^m / P^o) * (PXP - SSP)$

i. Offer reserve prices are likely to be lower than under P74 but similar in nature.

ii. In a shorter market, with NGC buying in the forward market, this will only influence Offer prices to the extent that SSP is moved.

iii. However, in comparing Offer prices under P74 and P78, the primary driver is likely to be market length.