Calculating the field delivered citygate price differential

The price difference between the field price delivered to the citygate and purchases at the citygate can be written as follows:

$$\Delta P_t = P_t^d - P_t^{CG}$$

where: P_t^d = the delivered price from the field to Chicago
P_t^{CG} = the citygate price.

The delivered price is actually the weighted average of prices from all the field zones. In my analysis the weights are the pipeline capacities leased by Peoples Gas from the particular field location to the Chicago citygate. For each location, i we have the field price

$$P_{it} = P_t^H + b_{it}$$

where: bit = basis from the Henry Hub to location I,
P_t^H = the Henry Hub price.

The delivered price for a given field location is the field price plus fuel and variable pipeline charges. We can write the delivered price, for location i as

$$P_{it}^d = P_{it}\left(1 + \frac{f_i}{1 - f_i}\right) + TV_i = P_{it}\left(\frac{1}{1 - f_i}\right) + TV_i$$

where: fi = fuel percentage that the pipeline takes, and
TVi = the variable transport charges.

The weighted average delivered price over all locations is

$$P_t^d = \sum_i \alpha_{it}\left(P_{it}\left(\frac{1}{1 - f_i}\right) + TV_i\right).$$

If we substitute in the expression for the field price we have

$$P_t^d = \sum \alpha_{it}\left(\frac{P_t^H + b_{it}}{1 - f_i} + TV_i\right).$$

The citygate price is simply

$$P_t^{CG} = P_t^H + b_{CG,t},$$

where: $b_{CG,t}$ = the Henry Hub-Chicago basis.

Now we can find the expression for the difference in prices as

$$\Delta P_t = P_t^H\left(\sum_i\left(\frac{\alpha_{it}}{(1-f_i)}\right)-1\right)-b_{CG,t}+\sum_i\frac{\alpha_{it}b_{it}}{(1-f_i)}+\sum_i\alpha_{it}TV_i$$

Rearranging terms a bit provides a convenient way to show the differences.

$$\Delta P_t = P_t^H\left(\sum_i\left(\frac{\alpha_{it}}{(1-f_i)}\right)-1\right)+\sum_i\alpha_{it}TV_i+\sum_i\frac{\alpha_{it}b_{it}}{(1-f_i)}-b_{CG,t}\,.$$

The first two terms are (most of) the difference to cost to transport field gas compared to buying at the citygate. The second two terms represent the difference in price between the field location and the citygate.[1]

Now set $\Delta P_t = 0$, and solve for the third term in the expression above. We have

$$\sum_i\frac{\alpha_{it}b_{it}}{(1-f_i)} = b_{CG,t}-P_t^H\left(\sum_i\left(\frac{\alpha_{it}}{(1-f_i)}\right)-1\right)-\sum_i\alpha_{it}TV_i\,,$$

or

$$\sum_i\frac{\alpha_{it}b_{it}}{(1-f_i)} = b_{CG,t}-P_t^H(f-1)-\sum_i\alpha_{it}TV_i\,.$$

[1] The complicating factor here is that the field basis is inflated to account for the fuel that is turned over to the pipeline.