```
f[ϕ1_] := 1/(18*λ) * (3*λ + ϕ2 - ϕ1)^2
(*This corresponds to the payoff pi_i,
where we consider i to be insurer 1 and j to be insurer 2 without loss of generality *)
h[ϕ1_] := -(ϕ1 - ϕ2)^2/(6*λ) + (ϕ1 + ϕ2)/2
(*This corresponds to the payoff pi_h *)
g[ϕ1_] := (3*λ + ϕ1 - ϕ2)/(6*λ) * ϕ2
(*This corresponds to the payoff pi_h/i *)
Simplify[β * f[ϕ1]^-1 * D[f[ϕ1], ϕ1] * (h[ϕ1] - g[ϕ1]) + (1 - β) * (D[h[ϕ1], ϕ1] - γ)]
```

Out[•]= $\frac{\beta\,(-g[\phi_1] + h[\phi_1])\, f'[\phi_1]}{f[\phi_1]} + (-1+\beta)\,(\gamma - h'[\phi_1])$

```
In[•]:= (*Without pi_h (denoted pi_h) and pi_h\i (denoted pi_h hat) substituted,
we have the following where Gamma_h is the partial of pi_h
 wrt phi_i and Gamma_h hat is the partial of pi_h wrt phi_i*)
Simplify[β * (1/(18*λ) * (3*λ + ϕ2 - ϕ1)^2)^-1 * D[1/(18*λ) * (3*λ + ϕ2 - ϕ1)^2, ϕ1] * (πh - π̂h) +
   (1 - β) * (γh - γ̂h)]
(*The following are with pi_h and pi_h\i substituted.*)
```

Out[•]= $(-1+\beta)\,(\hat{\gamma}_h - \gamma_h) + \frac{2\,\beta\,(\hat{\pi}_h - \pi_h)}{3\,\lambda - \phi_1 + \phi_2}$

```
In[•]:= Simplify[β * (1/(18*λ) * (3*λ + ϕ2 - ϕ1)^2)^-1 * D[1/(18*λ) * (3*λ + ϕ2 - ϕ1)^2, ϕ1] *
    (-(ϕ1 - ϕ2)^2/(6*λ) + (ϕ1 + ϕ2)/2 - (3*λ + ϕ1 - ϕ2)/(6*λ) * ϕ2) + (1 - β) * (D[(3*λ + ϕ1 - ϕ2)/(6*λ) * ϕ2, ϕ1] - γ)]
```

Out[•]= $\frac{-2\,\beta\,\phi_1 + (-1+\beta)\,(6\,\gamma\,\lambda - \phi_2)}{6\,\lambda}$

```
In[•]:= (*This is the NIN FOC,
before symmetry is considered and where \Gamma is the partial of \pi_h *)
(*We then introduce the symmetry and let phi_1=phi_2.*)
Simplify[(-2*β*ϕ + (-1 + β) * (6*γ*λ - ϕ))/(6*λ)]
```

Out[•]= $\frac{6\,(-1+\beta)\,\gamma\,\lambda + \phi - 3\,\beta\,\phi}{6\,\lambda}$

```
In[•]:= (*Without any simplification we can proceed to solve
 for phi by setting the above expression equal to zero.*)
Solve[(6 (-1 + β) γ λ + ϕ - 3 β ϕ)/(6 λ) == 0, ϕ]
```

In[∘]:= $\left\{\left\{\phi \to \frac{6\,(-1+\beta)\,\gamma\,\lambda}{-1+3\,\beta}\right\}\right\}$

```
(*Trying this again with only pi_h\i and partial
 pi_h\i not being subbed in with their functional forms.*)
```

$$\text{Simplify}\left[\beta * \left(\frac{1}{18*\lambda} * \left(3*\lambda+\phi_j-\phi_i\right)^2\right)^{-1} * \text{D}\left[\frac{1}{18*\lambda} * \left(3*\lambda+\phi_j-\phi_i\right)^2, \phi_i\right] * \left(\left(\frac{-(\phi_i-\phi_j)^2}{6*\lambda}+\frac{\phi_i+\phi_j}{2}\right)-(\gamma_1)\right) + (1-\beta) * \left(\text{D}\left[\frac{-(\phi_i-\phi_j)^2}{6*\lambda}+\frac{\phi_i+\phi_j}{2}, \phi_i\right]-\gamma_2\right)\right]$$

Out[∘]= $\left\{\left\{\phi \to \frac{6\,(-1+\beta)\,\gamma\,\lambda}{-1+3\,\beta}\right\}\right\}$

Out[∘]= $$\frac{(-1+\beta)\,(-3\,\lambda+6\,\lambda\,\gamma_2+2\,\phi_i-2\,\phi_j)}{6\,\lambda} - \frac{2\,\beta\left(-\gamma_1-\frac{(\phi_i-\phi_j)^2}{6\,\lambda}+\frac{1}{2}\,(\phi_i+\phi_j)\right)}{3\,\lambda-\phi_i+\phi_j}$$

In[∘]:= $$\text{Simplify}\left[\beta * \left(\frac{1}{18*\lambda} * \left(3*\lambda+\phi_j-\phi_i\right)^2\right)^{-1} * \text{D}\left[\frac{1}{18*\lambda} * \left(3*\lambda+\phi_j-\phi_i\right)^2, \phi_i\right] * \left(\left(\frac{-(\phi_i-\phi_j)^2}{6*\lambda}+\frac{\phi_i+\phi_j}{2}\right)-(\gamma_1)\right) + (1-\beta) * \left(\text{D}\left[\frac{-(\phi_i-\phi_j)^2}{6*\lambda}+\frac{\phi_i+\phi_j}{2}, \phi_i\right]-\gamma_2\right)\right]$$

Out[∘]= $$\frac{(-1+\beta)\,(-3\,\lambda+6\,\lambda\,\gamma_2+2\,\phi_i-2\,\phi_j)}{6\,\lambda} - \frac{2\,\beta\left(-\gamma_1-\frac{(\phi_i-\phi_j)^2}{6\,\lambda}+\frac{1}{2}\,(\phi_i+\phi_j)\right)}{3\,\lambda-\phi_i+\phi_j}$$

In[∘]:=
```
(*We can then go about our symmetry argument. When we let phi_i =
 phi_j = phi we have a fair amount of simplification. *)
```

$$\text{Simplify}\left[\frac{(-1+\beta)\,(-3\,\lambda+6\,\lambda\,\gamma_2+2\,\phi-2\,\phi)}{6\,\lambda} - \frac{2\,\beta\left(-\gamma_1-\frac{(\phi-\phi)^2}{6\,\lambda}+\frac{1}{2}\,(\phi+\phi)\right)}{3\,\lambda-\phi+\phi}\right]$$

Out[∘]= $$\frac{3\,\lambda-3\,\beta\,\lambda-4\,\beta\,\phi+4\,\beta\,\gamma_1+6\,(-1+\beta)\,\lambda\,\gamma_2}{6\,\lambda}$$

In[∘]:=
```
(*We can then solve for phi. *)
```

$$\text{Solve}\left[\frac{3\,\lambda-3\,\beta\,\lambda-4\,\beta\,\phi+4\,\beta\,\gamma_1+6\,(-1+\beta)\,\lambda\,\gamma_2}{6\,\lambda} == 0, \phi\right]$$

Out[∘]= $$\left\{\left\{\phi \to \frac{3\,\lambda-3\,\beta\,\lambda+4\,\beta\,\gamma_1-6\,\lambda\,\gamma_2+6\,\beta\,\lambda\,\gamma_2}{4\,\beta}\right\}\right\}$$