MODELO DE EQUILIBRIO DE MERCADOS

Variables:

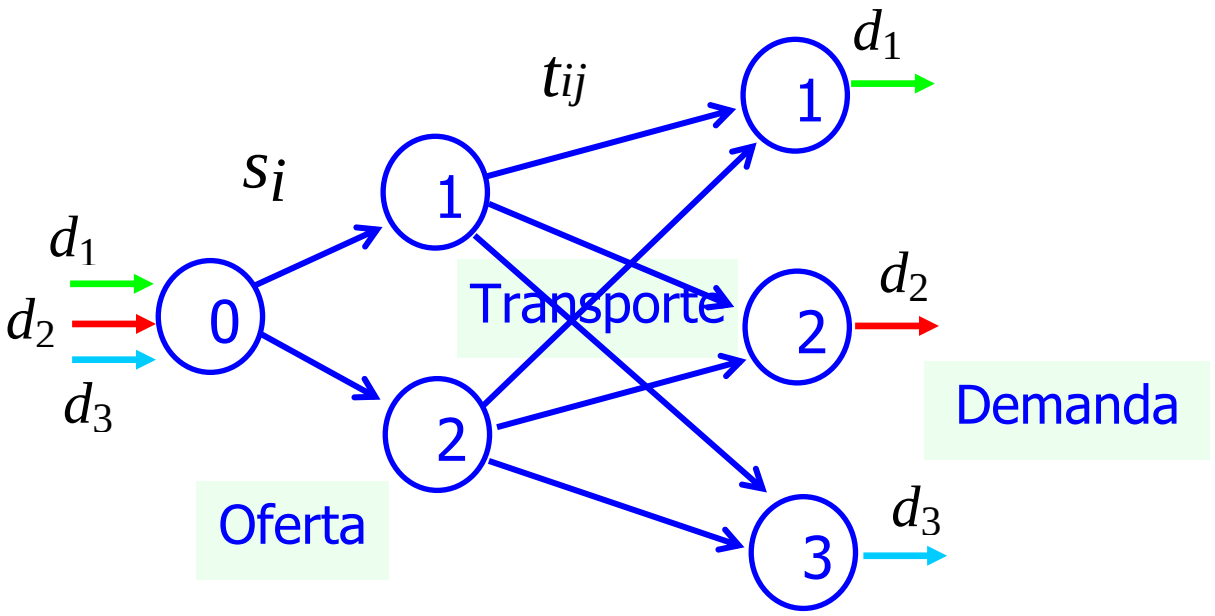
s_i: Cantidad producida por el centro i.

t_{ij}: Cantidad transportada desde $i \longrightarrow j$.

$c_{ij}(t_{ij})$ Coste unitario de transporte de $i \longrightarrow j$ de t_{ij} unidades.

$\pi_i(s_i)$ Coste unitario de producir s_i unidades.

Restricciones:



$$
\begin{aligned}
t_{11} + t_{21} &= d_1 \\
t_{12} + t_{22} &= d_2 \\
t_{13} + t_{23} &= d_3 \\
s_1 + s_2 &= d_1 + d_2 + d_3 \\
s_1 - t_{11} - t_{12} - t_{13} &= 0 \\
s_2 - t_{21} - t_{22} - t_{23} &= 0 \\
s_i \geq 0,\ t_{ij} &\geq 0
\end{aligned}
$$

MODELO DE EQUILIBRIO DE MERCADOS

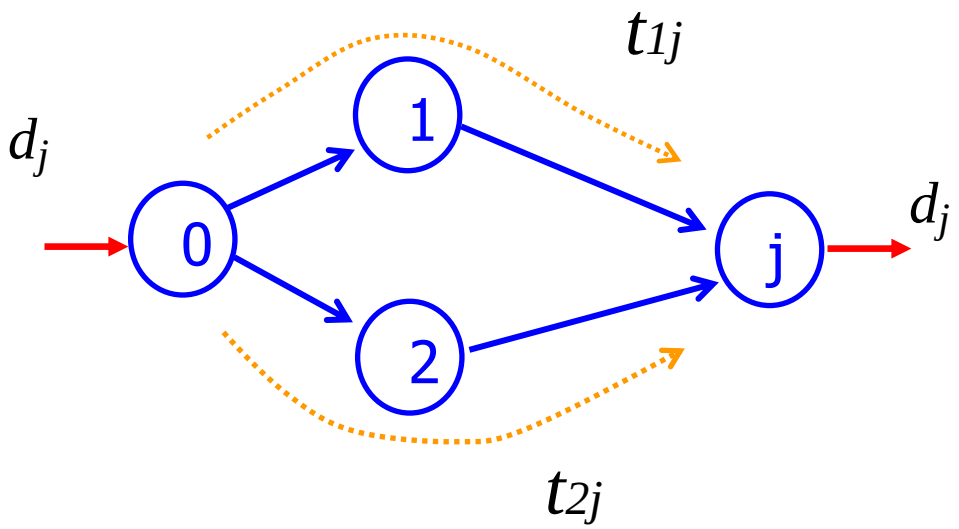
$$\pi_1(s_1) + c_{1j}(t_{1j}) = \pi_2(s_2) + c_{2j}(t_{2j})$$

o

$$\pi_1(s_1) + c_{1j}(t_{1j}) > \pi_2(s_2) + c_{2j}(t_{2j})$$

$$\Downarrow$$

$$t_{1j} = 0$$



$$\Pi_i(s_i) = \int_0^{s_i} \pi_i(x)dx, \quad \Pi_i'(s_i) = \pi(s_i), \ i = 1, 2$$

$$C_{ij}(t_{ij}) = \int_0^{s_i} c_{ij}(x)dx, \quad C_{ij}'(t_{ij}) = c_{ij}(t_{ij}), \quad i = 1, 2, \ j = 1, 2, 3$$

$$Min_{\ s,t}\ F(s,t) = \sum_i \Pi_i(s_i) + \sum_{i,j} C_{ij}(t_{ij})$$

$$\begin{array}{l} \text{Oferta 1} \\ \text{Oferta 2} \\ \text{Dem. 1} \\ \text{Dem. 2} \\ \text{Dem. 3} \\ \text{Nodo 0} \end{array} \begin{pmatrix} -1 & 0 & 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & -1 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 0 & -1 \\ 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} s_1 \\ s_2 \\ t_{11} \\ t_{12} \\ t_{13} \\ t_{21} \\ t_{22} \\ t_{23} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ -d_1 \\ -d_2 \\ -d_3 \\ d_1 + d_2 + d_3 \end{pmatrix}$$

$$s \geq 0, \ t \geq 0$$

$$Min_t\, G(t) = F(s(t),t) = \Pi_1(t_{11}+t_{12}+t_{13}) + \Pi_2(t_{21}+t_{22}+t_{23}) + \Sigma_{i,j}\, C_{ij}(t_{ij})$$

$$\begin{array}{rcl|l} t_{11}+t_{21} & = & d_1 & \lambda_1 \\ t_{12}+t_{22} & = & d_2 & \lambda_2 \\ t_{13}+t_{23} & = & d_3 & \lambda_3 \\ t_{ij} & \geq & 0 & \mu_{ij} \end{array}$$

Condiciones de Karush-Kuhn-Tucker

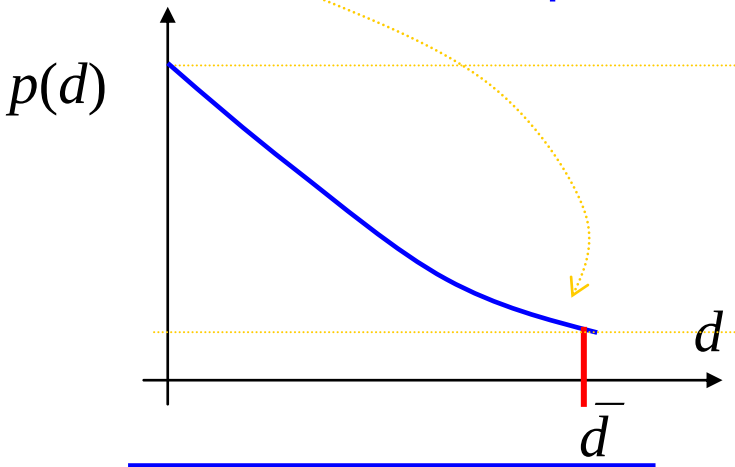
$$\frac{\partial G}{\partial t_{ij}} = \pi_i(s_i) + c_{ij}(t_{ij}) = \lambda_j + \mu_{ij}, \quad \mu_{ij} \geq 0,\ t_{ij} \geq 0, \quad \mu_{ij} \cdot t_{ij} = 0$$

$$u_{0j} = Min_{\ i=1,2}\ \{\ \pi_i(s_i) + c_{ij}(t_{ij})\ \} = \lambda_j = \underline{\text{Precio en mercado } j}$$

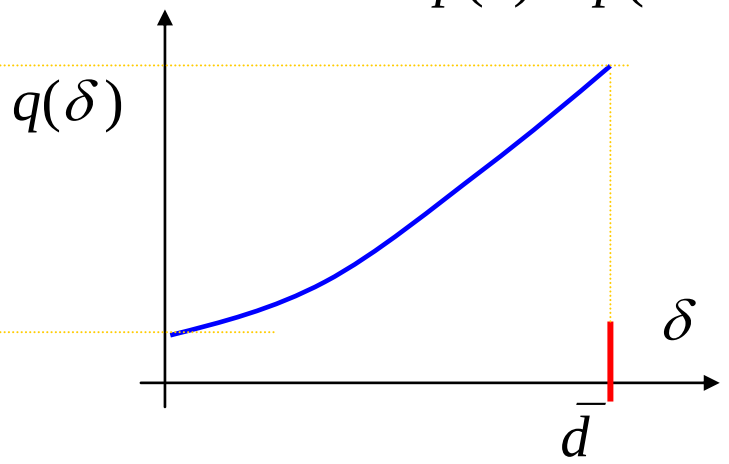
$$[\pi_i(s_i) + c_{ij}(t_{ij}) - u_{0j}] \cdot t_{ij} = 0$$

$$\begin{array}{rcl} t_{ij} > 0 & \Rightarrow & \pi_i(s_i) + c_{ij}(t_{ij}) - u_{ij} = 0 \\ \pi_i(s_i) + c_{ij}(t_{ij}) - u_{ij} > 0 & \Rightarrow & t_{ij} = 0 \end{array}$$

$\bar{d}$ = Cota superior de la demanda



$p(d) = p(\ \bar{d} - \delta\ ) = q(\delta)$

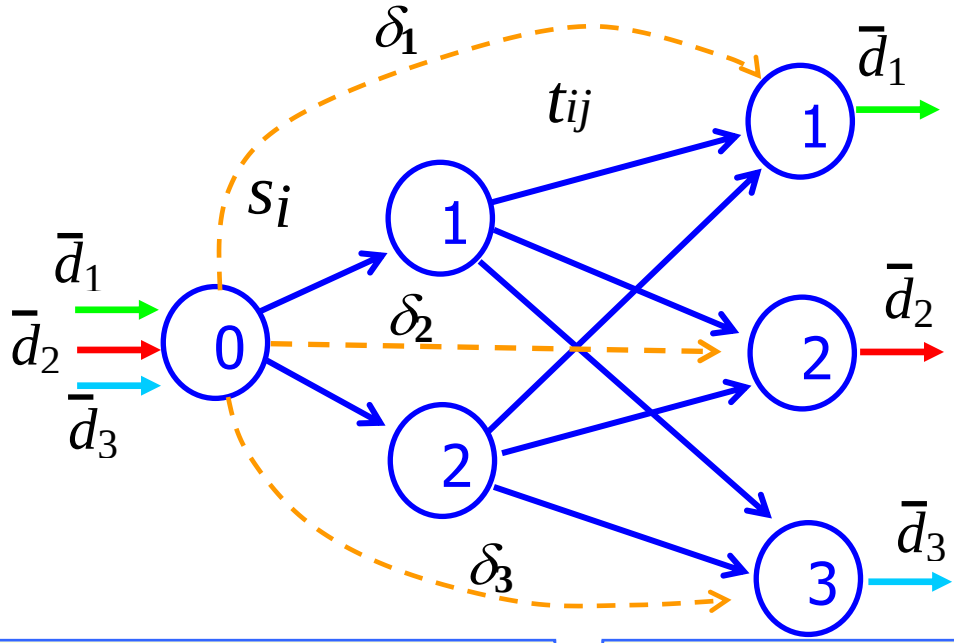


Precio = p(demanda)

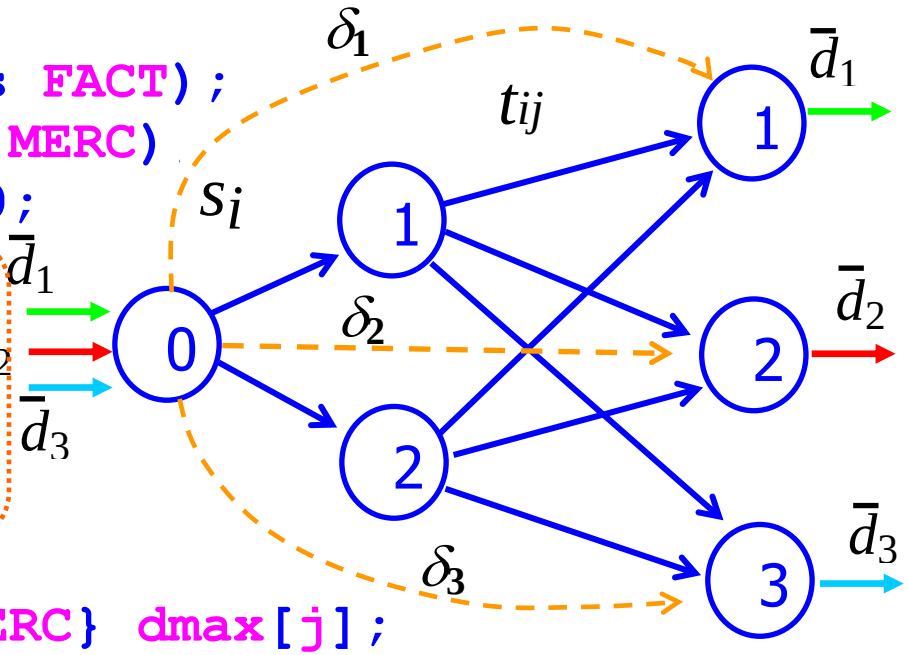
$\bar{d} = d + \delta$

Exceso de demanda

Demanda absorbida por el mercado

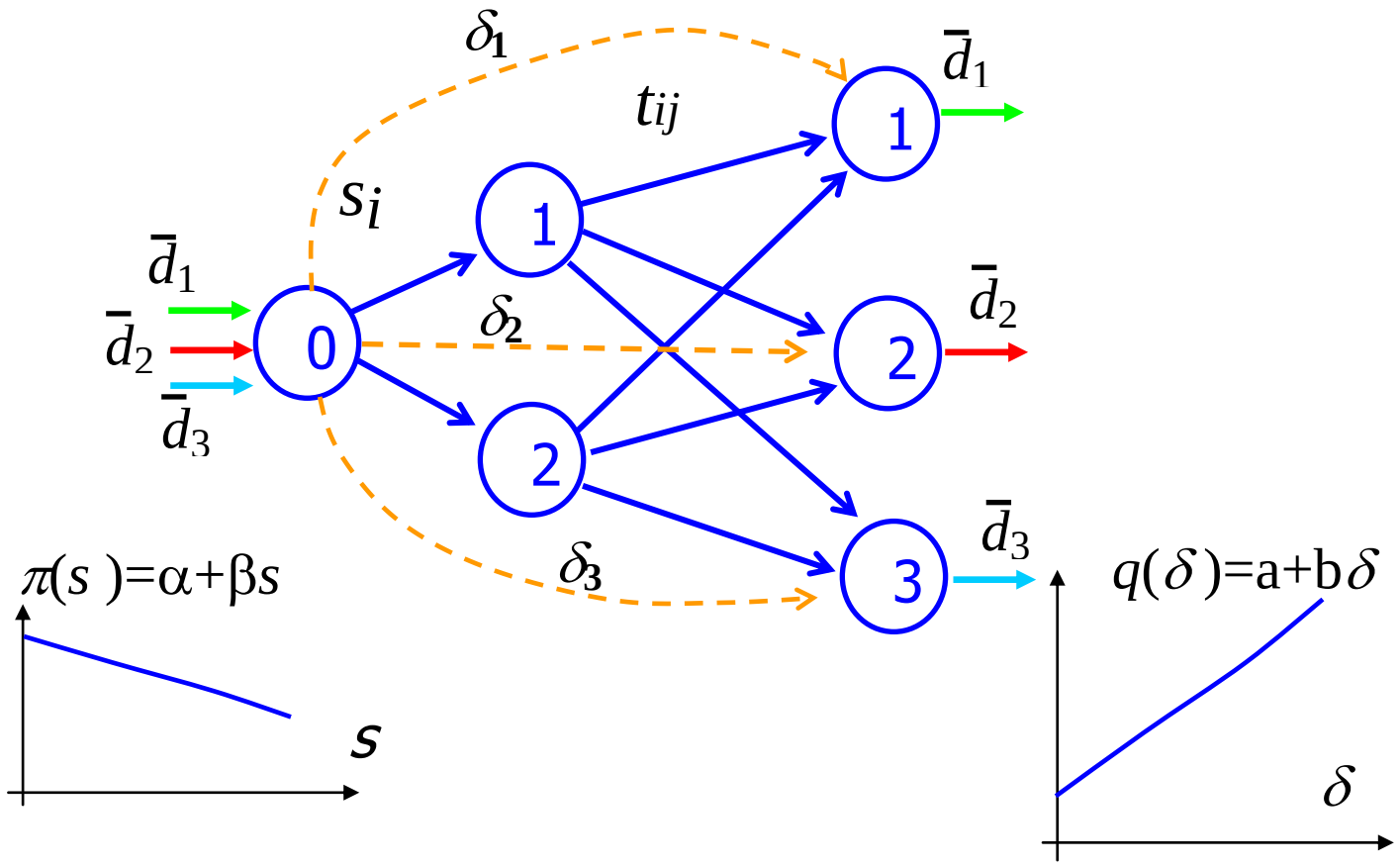


```
set FACT;
set MERC;
set ARCTR within (FACT cross MERC);
set ORIGEN;
set ARC_FACT within (ORIGEN cross FACT);
set ARC_EXC within (ORIGEN cross MERC)
param CTRANS {(i,j) in ARCTR} >=0;
param a {(i,j) in ARC_EXC}>=0;
param b {(i,j) in ARC_EXC};
param dmax {j in MERC}>0;
param alfa {(i,j) in ARC_FACT}>0;
param beta {(i,j) in ARC_FACT };
```




```
param dtotal default sum {j in MERC} dmax[j];
node O_R {l in ORIGEN} net_out = dtotal;
node P {i in FACT};
node MR {j in MERC} net_in = dmax[j];
arc fict {(l,j) in ARC_EXC} >= 0,
      from O_R[l], to MR[j];
arc xij {(i,j) in ARCTR} >= 0,
      from P[i], to MR[j];
arc si {(i,j) in ARC_FACT} >=0,
      from O_R[i], to P[j];
```

```
minimize F:
sum{(i,j) in ARC_FACT}
    alfa[i,j]*si[i,j]+0,5*beta[i,j]*si[i,j]^2+
sum{(p,q) in ARCTR} CTRANS[p,q]*xij[p,q]+
sum{(r,s) in ARC_EXC}a[r,s]*fict[r,s]+0,5*b[r,s]*fict[r,s]^2;
```



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TRESMES.MOD

```
set MERC;
set ARCTR within (FACT cross MERC);
set ORIGEN;
set ARC_FACT within (ORIGEN cross FACT);
set ARC_EXC within (ORIGEN cross MERC);
param CTRANS {(i,j) in ARCTR} >=0;
param a {(i,j) in ARC_EXC}>=0;
param b {(i,j) in ARC_EXC};
param dmax {j in MERC}>0;
```

TRESMES.DAT

```
 ARCTR:= (P1,M1) (P1,M2) (P1,M3) (P2,M1) (P2,M2) (P2,M3);
 ORIGEN:= O;
 ARC_FACT:= (O,P1) (O,P2);
 ARC_EXC:= (O,M1) (O,M2) (O,M3);
am CTRANS:= P1 M1 1   P1 M2 2   P1 M3 1.5
            P2 M1 3   P2 M2 2   P2 M3 2.5;
am a:=     O M1 10    O M2 12   O M3 9;
am b:=     O M1 3     O M2 2    O M3 4;
am dmax:= M1 200 M2 200 M3 200;
```

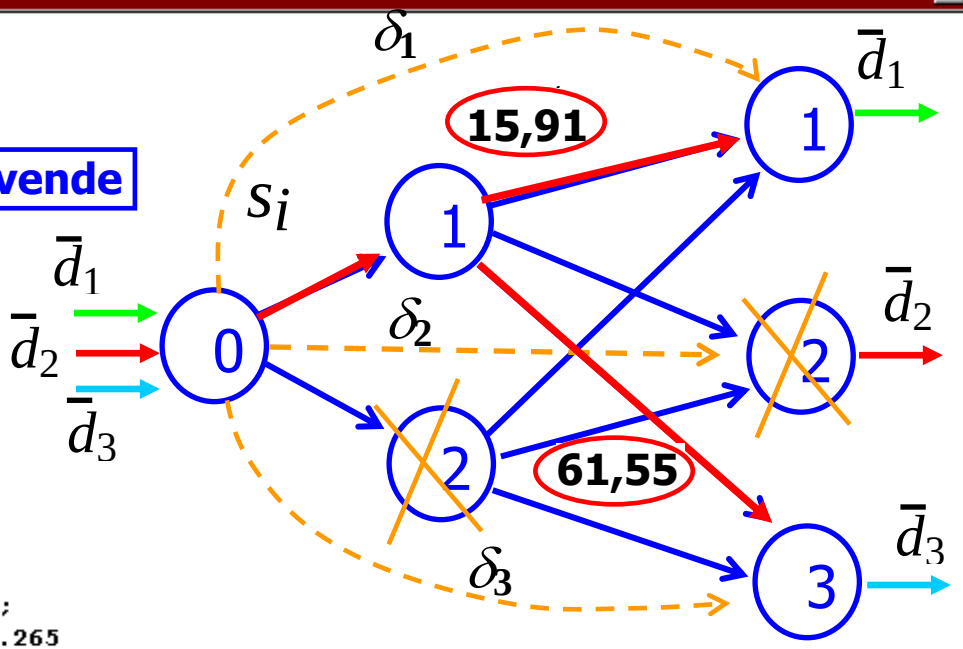
Commands

```
display {(i,j) in ARC_EXC} MR[j]-0_R[i];
MR[j] - 0_R[i] :=
O M1    562.265
O M2    412
O M3    562.765
;

display xij;
xij :=
P1 M1    15.9118
P1 M2     0
P1 M3    61.5588
P2 M1     0
P2 M2     0
P2 M3     0
;

display alfa['O','P1']+beta['O','P1']*s_i['O','P1'];
alfa['O','P1'] + beta['O','P1']*s_i['O','P1'] = 561.265
```

Precio en M1

Precio en M2; no se vende

Precio en M3



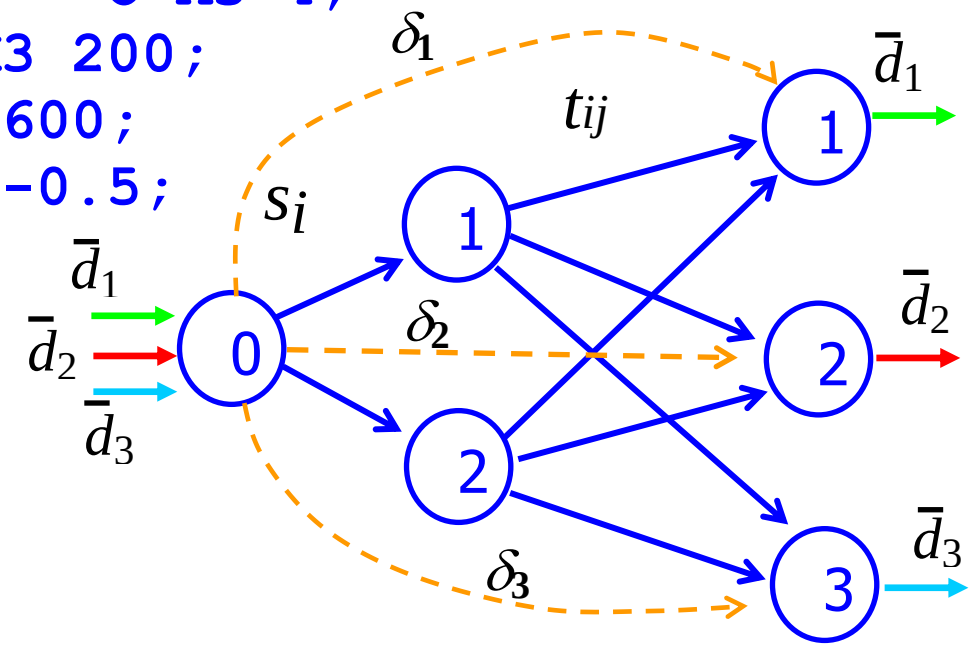
ampl:

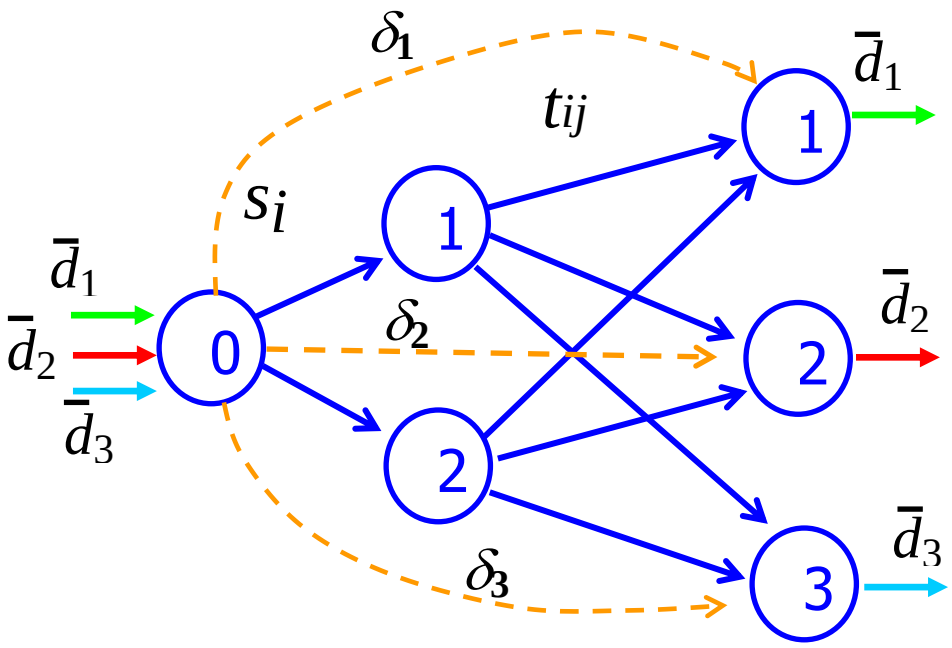
Model PPRUX.RUN

Solver Finished.

13:14

```
set FACT:= P1 P2;
set MERC:= M1 M2 M3;
set ARCTR:= (P1,M1) (P1,M2) (P1,M3) (P2,M1) (P2,M2)
(P2,M3);
set ORIGEN:= O;
set ARC_FACT:= (O,P1) (O,P2);
set ARC_EXC:= (O,M1) (O,M2) (O,M3);
param CTRANS:= P1 M1 1   P1 M2 2   P1 M3 1.5
               P2 M1 3   P2 M2 2   P2 M3 2.5;
param a:=     O M1 10   O M2 12   O M3 9;
param b:=     O M1 3    O M2 2    O M3 4;
param dmax:= M1 200 M2 200 M3 200;
param alfa:= O P1 600   O P2 600;
param beta:= O P1 -0.5 O P2 -0.5;
```





$$\Pi_i(s_i) = \int_0^{s_i} \pi_i(x)dx, \;\; \Pi_i'(s_i) = \pi_i(s_i), \;\; i = 1, 2$$

$$Q_j(\delta_j) = \int_0^{\delta_j} q_j(x)dx, \;\; Q_j'(\delta_j) = q_j(\delta_j), \;\; j = 1, 2, 3$$

$$C_{ij}(t_{ij}) = \int_0^{s_i} c_{ij}(x)dx, \;\; C_{ij}'(t_{ij}) = c_{ij}(t_{ij}), \;\; i = 1, 2, \;\; j = 1, 2, 3$$

$$Min_{\,s,t}\; F(s,t) = \sum_i \Pi_i(s_i) + \sum_{i,j} C_{ij}(t_{ij}) + \sum_j Q_j(\delta_j)$$

$$\begin{aligned}
&t_{11} + t_{21} + \delta_1 = \bar{d}_1 \\
&t_{12} + t_{22} + \delta_2 = \bar{d}_2 \\
&t_{13} + t_{23} + \delta_3 = \bar{d}_3 \\
&s_1 + s_2 + \delta_1 + \delta_2 + \delta_3 = \bar{d}_1 + \bar{d}_2 + \bar{d}_3 \\
&s_1 - t_{11} - t_{12} - t_{13} = 0 \\
&s_2 - t_{21} - t_{22} - t_{23} = 0 \\
&s_i \geq 0, \;\; \delta_j \geq 0, \;\; t_{ij} \geq 0
\end{aligned}$$