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ANEXO I – Modelo

```
set ORIG;                 # origins_i (plants, farms, terminals, CD, exporters)
set PLATFORM;             # logistic platform_j
set DEST;                 # destinations_k (ports, countries, costumers)
set PRODUCT;              # product_p

param price {DEST,PRODUCT}  >= 0;                  # price of product p
param supply {ORIG,PRODUCT} >= 0;          # amounts available at origins of product p
param demand {DEST,PRODUCT} >= 0;                  # amounts required at destinations of product p
param beta {PLATFORM,PRODUCT}>=0 ,<=1;             # % change of volume of product p
param capac_prod {PLATFORM,PRODUCT}>= 0;           # capacity of each product p
param totalcapacity {PLATFORM}>=0;                 # total capacity of logistic platform
param costin {ORIG,PLATFORM,PRODUCT}>=0;           # transport cost from plant to logistic platform
param costout{PLATFORM,DEST,PRODUCT}>=0;           # transport cost from logistic platform to destinations
param fcost {PLATFORM}>= 0;                        # fixed cost to instal a logistic platform
param vcost {PLATFORM,PRODUCT}>= 0;                # variable costs per unit
#param Z:=6;                                       # Number maximum of logistics platforms

var Xin {ORIG,PLATFORM,PRODUCT}>= 0;               # units to be shipped inbound from origin to logistic platform
var Xout {PLATFORM,DEST,PRODUCT}>= 0;              # units to be shipped outbound from logistic platform to destinations
var Y {PLATFORM} >=0 binary;                       # 1 If Logistic platform is open and 0, otherwise

maximize total_profit:
sum {j in PLATFORM, k in DEST,p in PRODUCT} price[k,p]* Xout[j,k,p] –
sum {i in ORIG,j in PLATFORM,p in PRODUCT} costin[i,j,p]* Xin[i,j,p] -
sum {j in PLATFORM} fcost[j]* Y[j] -
sum {i in ORIG,j in PLATFORM, p in PRODUCT} vcost[j,p] * Xin[i,j,p] -
sum {j in PLATFORM, k in DEST, p in PRODUCT} costout[j,k,p]* Xout[j,k,p];

subject to Supply {i in ORIG, p in PRODUCT}:
  sum {j in PLATFORM} Xin[i,j,p] <= supply[i,p];

subject to Demand {k in DEST, p in PRODUCT}:
  sum {j in PLATFORM} Xout[j,k,p] = demand[k,p];


subject to Limit_1 {j in PLATFORM, p in PRODUCT}:
  sum {i in ORIG} Xin[i,j,p] <= capac_prod[j,p]* Y[j];
```

```
subject to Limit_2 {j in PLATFORM}:
   sum {p in PRODUCT, i in ORIG} Xin[i,j,p] <= totalcapacity[j]*Y[j];

subject to equilibrium {j in PLATFORM, p in PRODUCT}:
   sum {i in ORIG} beta[j,p]* Xin[i,j,p] - sum{k in DEST} Xout[j,k,p]= 0;

subject to number:
  sum {j in PLATFORM} Y[j]<=6;
```

ANEXO II – Dados do Modelo

```
set ORIG        := ACAI,ARAG,DOUR,CUI,LOND,CG;
set PLATFORM:= ITQ,TUB,SAT,PAR,SFS,RG;
set DEST        := HAM,ROT,SHG;
set INSUM       := Soy;
set PRODUCT  := Soy,Bran,Oil;
set SERVICE    := ARM,ESM,PROD;

param: supply:=
        ACAI            Soy             70000
        ARAG            Soy             80000
        DOUR            Soy            200000
        CUI             Soy            250000
        LOND            Soy            300000
        CG              Soy            300000;

param: demand_max:=
        HAM             Soy         1200000
        HAM             Bran         960000
        HAM             Oil          240000
        ROT             Soy         1200000
        ROT             Bran         960000
        ROT             Oil          240000
        SHG             Soy         1200000
        SHG             Bran         960000
        SHG             Oil          240000;

param: beta:=
        ITQ     ARM     Soy     Soy     1
        ITQ     ARM     Soy     Bran    0
        ITQ     ARM     Soy     Oil     0
        ITQ     ESM     Soy     Soy     0
        ITQ     ESM     Soy     Bran    0.8
        ITQ     ESM     Soy     Oil     0
        ITQ     PROD    Soy     Soy     0
        ITQ     PROD    Soy     Bran    0
        ITQ     PROD    Soy     Oil     0.2
        TUB     ARM     Soy     Soy     1
        TUB     ARM     Soy     Bran    0
        TUB     ARM     Soy     Oil     0
        TUB     ESM     Soy     Soy     0
        TUB     ESM     Soy     Bran    0.8
        TUB     ESM     Soy     Oil     0
        TUB     PROD    Soy     Soy     0
        TUB     PROD    Soy     Bran    0
        TUB     PROD    Soy     Oil     0.2
        SAT     ARM     Soy     Soy     1
        SAT     ARM     Soy     Bran    0
        SAT     ARM     Soy     Oil     0
        SAT     ESM     Soy     Soy     0
        SAT     ESM     Soy     Bran    0.8
        SAT     ESM     Soy     Oil     0
        SAT     PROD    Soy     Soy     0
        SAT     PROD    Soy     Bran    0
```

```
        SAT     PROD    Soy     Oil     0.2
        PAR     ARM     Soy     Soy     1
        PAR     ARM     Soy     Bran    0
        PAR     ARM     Soy     Oil     0
        PAR     ESM     Soy     Soy     0
        PAR     ESM     Soy     Bran    0.8
        PAR     ESM     Soy     Oil     0
        PAR     PROD    Soy     Soy     0
        PAR     PROD    Soy     Bran    0
        PAR     PROD    Soy     Oil     0.2
        SFS     ARM     Soy     Soy     1
        SFS     ARM     Soy     Bran    0
        SFS     ARM     Soy     Oil     0
        SFS     ESM     Soy     Soy     0
        SFS     ESM     Soy     Bran    0.8
        SFS     ESM     Soy     Oil     0
        SFS     PROD    Soy     Soy     0
        SFS     PROD    Soy     Bran    0
        SFS     PROD    Soy     Oil     0.2
        RG      ARM     Soy     Soy     1
        RG      ARM     Soy     Bran    0
        RG      ARM     Soy     Oil     0
        RG      ESM     Soy     Soy     0
        RG      ESM     Soy     Bran    0.8
        RG      ESM     Soy     Oil     0
        RG      PROD    Soy     Soy     0
        RG      PROD    Soy     Bran    0
        RG      PROD    Soy     Oil     0.2;

param: capac_prod :=
        ITQ             ARM             100000
        ITQ             ESM             100000
        ITQ             PROD            50000
        TUB             ARM             300000
        TUB             ESM             100000
        TUB             PROD            00000
        SAT             ARM             200000
        SAT             ESM             100000
        SAT             PROD             60000
        PAR             ARM             400000
        PAR             ESM             280000
        PAR             PROD            100000
        SFS             ARM             100000
        SFS             ESM              60000
        SFS             PROD            50000
        RG              ARM             100000
        RG              ESM              90000
        RG              PROD            50000;

param: totalcapacity:=
        ITQ             250000
        TUB             500000
        SAT             360000
        PAR             780000
        SFS             210000
        RG              240000;
```

```
param: costin:=
        ACAI    ITQ     Soy     32
        ACAI    TUB     Soy     99
        ACAI    SAT     Soy     99
        ACAI    PAR     Soy     99
        ACAI    SFS     Soy     99
        ACAI    RG      Soy     99
        ARAG    ITQ     Soy     99
        ARAG    TUB     Soy     50
        ARAG    SAT     Soy     50
        ARAG    PAR     Soy     40
        ARAG    SFS     Soy     41
        ARAG    RG      Soy     43
        DOUR    ITQ     Soy     99
        DOUR    TUB     Soy     26
        DOUR    SAT     Soy     48
        DOUR    PAR     Soy     46
        DOUR    SFS     Soy     40
        DOUR    RG      Soy     41
        CUI     ITQ     Soy     99
        CUI     TUB     Soy     62
        CUI     SAT     Soy     42
        CUI     PAR     Soy     25
        CUI     SFS     Soy     27
        CUI     RG      Soy     28
        LOND    ITQ     Soy     99
        LOND    TUB     Soy     28
        LOND    SAT     Soy     20
        LOND    PAR     Soy     25
        LOND    SFS     Soy     25
        LOND    RG      Soy     27
        CG      ITQ     Soy     99
        CG      TUB     Soy     99
        CG      SAT     Soy     20
        CG      PAR     Soy     22
        CG      SFS     Soy     23
        CG      RG      Soy     25;

param: costout:=
        ITQ     HAM     Soy     35
        ITQ     HAM     Bran    35
        ITQ     HAM     Oil     35
        ITQ     ROT     Soy     35
        ITQ     ROT     Bran    35
        ITQ     ROT     Oil     35
        ITQ     SHG     Soy     40
        ITQ     SHG     Bran    40
        ITQ     SHG     Oil     40
        TUB     HAM     Soy     35
        TUB     HAM     Bran    35
        TUB     HAM     Oil     35
        TUB     ROT     Soy     35
        TUB     ROT     Bran    35
        TUB     ROT     Oil     35
        TUB     SHG     Soy     40
```

```
        TUB             SHG             Bran            40
        TUB             SHG             Oil             40
        SAT             HAM             Soy             40
        SAT             HAM             Bran            40
        SAT             HAM             Oil             40
        SAT             ROT             Soy             40
        SAT             ROT             Bran            40
        SAT             ROT             Oil             40
        SAT             SHG             Soy             45
        SAT             SHG             Bran            45
        SAT             SHG             Oil             45
        PAR             HAM             Soy             49
        PAR             HAM             Bran            49
        PAR             HAM             Oil             49
        PAR             ROT             Soy             49
        PAR             ROT             Bran            49
        PAR             ROT             Oil             49
        PAR             SHG             Soy             57
        PAR             SHG             Bran            57
        PAR             SHG             Oil             57
        SFS             HAM             Soy             49
        SFS             HAM             Bran            49
        SFS             HAM             Oil             49
        SFS             ROT             Soy             49
        SFS             ROT             Bran            49
        SFS             ROT             Oil             49
        SFS             SHG             Soy             57
        SFS             SHG             Bran            57
        SFS             SHG             Oil             57
        RG              HAM             Soy             49
        RG              HAM             Bran            49
        RG              HAM             Oil             49
        RG              ROT             Soy             49
        RG              ROT             Bran            49
        RG              ROT             Oil             49
        RG              SHG             Soy             57
        RG              SHG             Bran            57
        RG              SHG             Oil             57;

param: fcost:=
        ITQ             500000
        TUB             500000
        SAT             500000
        PAR             500000
        SFS             500000
        RG              500000;

param: gserv:=
        ITQ             ARM             50000
        ITQ             ESM             40000
        ITQ             PROD            80000
        TUB             ARM             50000
        TUB             ESM             60000
        TUB             PROD            80000
        SAT             ARM             60000
        SAT             ESM             70000
```

```
        SAT             PROD            80000
        PAR             ARM             50000
        PAR             ESM             60000
        PAR             PROD            80000
        SFS             ARM             60000
        SFS             ESM             70000
        SFS             PROD            80000
        RG              ARM             60000
        RG              ESM             70000
        RG              PROD            80000;

param: alfa:=
        ITQ     ARM     Soy     18
        ITQ     ESM     Soy     20
        ITQ     PROD    Soy     22
        TUB     ARM     Soy     15
        TUB     ESM     Soy     20
        TUB     PROD    Soy     21
        SAT     ARM     Soy     16
        SAT     ESM     Soy     22
        SAT     PROD    Soy     23
        PAR     ARM     Soy     15
        PAR     ESM     Soy     18
        PAR     PROD    Soy     19
        SFS     ARM     Soy     17
        SFS     ESM     Soy     20
        SFS     PROD    Soy     21
        RG      ARM     Soy     17
        RG      ESM     Soy     21
        RG      PROD    Soy     22;

param: price:=
        HAM             Soy             290
        HAM             Bran            250
        HAM             Oil             350
        ROT             Soy             290
        ROT             Bran            250
        ROT             Oil             350
        SHG             Soy             290
        SHG             Bran            250
        SHG             Oil             350;
```

ANEXO III

1) Resultados do modelo para Z ≤ 6 terminais especializados

```
sw: ampl
ampl: model MOD4_V17_multicommodity.mod;
ampl: data MOD4_V17_multicommodity.dat;
ampl: solve;
MINOS 5.5: ignoring integrality of 24 variables
MINOS 5.5: optimal solution found.
76 iterations, objective 241910000
ampl: option solver cplex;
ampl: solve;
CPLEX 8.0.0: optimal integer solution; objective 241910000
82 MIP simplex iterations
0 branch-and-bound nodes
ampl: option display_round 0;
ampl: display Y;
Y [*] :=
ITQ   1
PAR   1
RG    1
SAT   1
SFS   1
TUB   1;

ampl: display Yserv;
Yserv :=
ITQ   ARM   1
ITQ   ESM   0
ITQ   PRO   0
PAR   ARM   1
PAR   ESM   0
PAR   PROD  0
RG    ARM   1
RG    ESM   0
RG    PROD  0
SAT   ARM   1
SAT   ESM   0
SAT   PROD  0
SFS   ARM   1
SFS   ESM   0
SFS   PROD  0
TUB   ARM   1
TUB   ESM   0
TUB   PROD  0;

ampl: display Xin;
Xin [*,*,ARM,Soy]
          :     ITQ      PAR      RG    SAT   SFS     TUB     :=
ACAI     70000        0       0       0       0       0
ARAG     30000    50000       0       0       0       0
CG           0   200000       0       0  100000       0
CUI          0   150000  100000       0       0       0
DOUR         0        0       0       0       0  200000
LOND         0        0       0  200000       0  100000
```

```
[*,*,ESM,Soy]
:           ITQ PAR  RG SAT SFS TUB    :=
ACAI          0   0   0   0   0   0
ARAG          0   0   0   0   0   0
CG            0   0   0   0   0   0
CUI           0   0   0   0   0   0
DOUR          0   0   0   0   0   0
LOND          0   0   0   0   0   0

 [*,*,PROD,Soy]
:           ITQ PAR  RG SAT SFS TUB    :=
ACAI          0   0   0   0   0   0
ARAG          0   0   0   0   0   0
CG            0   0   0   0   0   0
CUI           0   0   0   0   0   0
DOUR          0   0   0   0   0   0
LOND          0   0   0   0   0   0;

ampl: display Xout;
Xout [*,HAM,ARM,*]
      :   Bran     Oil       Soy      :=
ITQ         0        0     100000
PAR         0        0          0
RG          0        0     100000
SAT         0        0          0
SFS         0        0     100000
TUB         0        0          0

 [*,HAM,ESM,*]
      :   Bran     Oil       Soy    :=
ITQ         0        0          0
PAR         0        0          0
RG          0        0          0
SAT         0        0          0
SFS         0        0          0
TUB         0        0          0

 [*,HAM,PROD,*]
      :   Bran     Oil       Soy    :=
ITQ         0        0          0
PAR         0        0          0
RG          0        0          0
SAT         0        0          0
SFS         0        0          0
TUB         0        0          0

 [*,ROT,ARM,*]
      :   Bran     Oil         Soy   :=
ITQ         0        0           0
PAR         0        0      400000
RG          0        0           0
SAT         0        0      200000
SFS         0        0           0
TUB         0        0      300000
```

[*,ROT,ESM,*]

	Bran	Oil	Soy	:=
ITQ	0	0	0	
PAR	0	0	0	
RG	0	0	0	
SAT	0	0	0	
SFS	0	0	0	
TUB	0	0	0	

[*,ROT,PROD,*]

	Bran	Oil	Soy	:=
ITQ	0	0	0	
PAR	0	0	0	
RG	0	0	0	
SAT	0	0	0	
SFS	0	0	0	
TUB	0	0	0	

[*,SHG,ARM,*]

	Bran	Oil	Soy	:=
ITQ	0	0	0	
PAR	0	0	0	
RG	0	0	0	
SAT	0	0	0	
SFS	0	0	0	
TUB	0	0	0	

[*,SHG,ESM,*]

	Bran	Oil	Soy	:=
ITQ	0	0	0	
PAR	0	0	0	
RG	0	0	0	
SAT	0	0	0	
SFS	0	0	0	
TUB	0	0	0	

[*,SHG,PROD,*]

	Bran	Oil	Soy	:=
ITQ	0	0	0	
PAR	0	0	0	
RG	0	0	0	
SAT	0	0	0	
SFS	0	0	0	
TUB	0	0	0;	

2) Resultados do modelo para Z ≤ 5 terminais especializados

```
sw: ampl
ampl: model MOD4_V17_multicommodity.mod;
ampl: data MOD4_V17_multicommodity.dat;
ampl: solve;
MINOS 5.5: ignoring integrality of 24 variables
MINOS 5.5: optimal solution found.
70 iterations, objective 236387000
ampl: option solver cplex;
ampl: solve;
CPLEX 8.0.0: optimal integer solution; objective 235100000
89 MIP simplex iterations
0 branch-and-bound nodes
ampl: option display_round 0;
ampl: display Y;
Y [*] :=
ITQ   1
PAR   1
RG    0
SAT   1
SFS   1
TUB   1;

ampl: display Yserv;
Yserv :=
ITQ   ARM   1
ITQ   ESM   0
ITQ   PROA  0
PAR   ARM   1
PAR   ESM   0
PAR   PROD  0
RG    ARM   0
RG    ESM   0
RG    PROD  0
SAT   ARM   1
SAT   ESM   1
SAT   PROD  0
SFS   ARM   1
SFS   ESM   0
SFS   PROD  0
TUB   ARM   1
TUB   ESM   0
TUB   PROD  0;

ampl: display Xin;
Xin [*,*,ARM,Soy]
      :    ITQ    PAR      RG     SAT     SFS     TUB    :=
ACAI    70000      0       0       0       0       0
ARAG    30000  50000       0       0       0       0
CG          0 100000       0  100000  100000       0
CUI         0 250000       0       0       0       0
DOUR        0      0       0       0       0  200000
LOND        0      0       0  100000       0  100000

 [*,*,ESM,Soy]
      :  ITQ   PAR     RG      SAT     SFS     TUB   :=
ACAI     0     0      0        0       0       0
ARAG     0     0      0        0       0       0
CG       0     0      0        0       0       0
```

```
CUI          0          0         0          0         0          0
DOUR         0          0         0          0         0          0
LOND         0          0         0     100000         0          0

 [*,*,PROD,Soy]
          :   ITQ       PAR       RG       SAT       SFS       TUB   :=
ACAI          0            0        0         0         0         0
ARAG          0            0        0         0         0         0
CG            0            0        0         0         0         0
CUI           0            0        0         0         0         0
DOUR          0            0        0         0         0         0
LOND          0            0        0         0         0         0;

ampl: display Xout;
Xout [*,HAM,ARM,*]
          :   Bran   Oil    Soy     :=
ITQ            0     0       0
PAR            0     0  400000
RG             0     0       0
SAT            0     0       0
SFS            0     0  100000
TUB            0     0       0

 [*,HAM,ESM,*]
          :    Bran  Oil      Soy    :=
ITQ            0       0        0
PAR            0       0        0
RG             0       0        0
SAT        80000       0        0
SFS            0       0        0
TUB            0       0        0

 [*,HAM,PROD,*]
          :   Bran   Oil        Soy    :=
ITQ            0      0         0
PAR            0      0         0
RG             0      0         0
SAT            0      0         0
SFS            0      0         0
TUB            0      0         0

 [*,ROT,ARM,*]
:             Bran    Oil          Soy      :=
ITQ           0          0         100000
PAR           0          0              0
RG            0          0              0
SAT           0          0         200000
SFS           0          0              0
TUB           0          0         300000

 [*,ROT,ESM,*]
:             Bran      Oil     Soy    :=
ITQ              0        0       0
PAR              0        0       0
RG               0        0       0
SAT              0        0       0
SFS              0        0       0
TUB              0        0       0
```

```
 [*,ROT,PROD,*]
:          Bran      Oil      Soy    :=
ITQ           0        0        0
PAR           0        0        0
RG            0        0        0
SAT           0        0        0
SFS           0        0        0
TUB           0        0        0

 [*,SHG,ARM,*]
:          Bran     Oil      Soy    :=
ITQ           0        0        0
PAR           0        0        0
RG            0        0        0
SAT           0        0        0
SFS           0        0        0
TUB           0        0        0

 [*,SHG,ESM,*]
:          Bran Oil Soy    :=
ITQ           0   0   0
PAR           0   0   0
RG            0   0   0
SAT           0   0   0
SFS           0   0   0
TUB           0   0   0

 [*,SHG,PROD,*]
:          Bran Oil Soy    :=
ITQ           0   0   0
PAR           0   0   0
RG            0   0   0
SAT           0   0   0
SFS           0   0   0
TUB           0   0   0;
```

3) Resultados do modelo para Z ≤ 4 terminais especializados

```
sw: ampl
ampl: model MOD4_V17_multicommodity.mod;
ampl: data MOD4_V17_multicommodity.dat;
ampl: solve;
MINOS 5.5: ignoring integrality of 24 variables
MINOS 5.5: optimal solution found.
68 iterations, objective 229247000
ampl: option solver cplex;
ampl: solve;
CPLEX 8.0.0: optimal integer solution; objective 227900000
92 MIP simplex iterations
0 branch-and-bound nodes
ampl: display Y;
Y [*] :=
ITQ   1
PAR   1
 RG   0
SAT   1
SFS   0
TUB   1;

ampl: display Yserv;
Yserv :=
ITQ   ARM   1
ITQ   ESM   0
ITQ   PROA  0
PAR   ARM   1
PAR   ESM   0
PAR   PROD  0
RG    ARM   0
RG    ESM   0
RG    PROD  0
SAT   ARM   1
SAT   ESM   1
SAT   PROD  0
SFS   ARM   0
SFS   ESM   0
SFS   PROD  0
TUB   ARM   1
TUB   ESM   1
TUB   PROD  0;

ampl: option display_round 0;
ampl: display Xin;
Xin [*,*,ARM,Soy]
:          ITQ     PAR   RG   SAT   SFS     TUB    :=
ACAI     70000       0    0      0     0       0
ARAG     30000   50000    0      0     0       0
CG           0  100000    0 200000     0       0
CUI          0  250000    0      0     0       0
DOUR         0       0    0      0     0  100000
LOND         0       0    0      0     0  200000

 [*,*,ESM,Soy]
:          ITQ  PAR   RG   SAT   SFS     TUB    :=
ACAI       0      0     0      0     0       0
ARAG       0      0     0      0     0       0
```

```
CG          0       0       0       0       0       0
CUI         0       0       0       0       0       0
DOUR        0       0       0       0       0  100000
LOND        0       0       0  100000       0       0

 [*,*,PROD,Soy]
:           ITQ  PAR  RG SAT SFS TUB    :=
ACAI          0    0    0   0    0   0
ARAG          0    0    0   0    0   0
CG            0    0    0   0    0   0
CUI           0    0    0   0    0   0
DOUR          0    0    0   0    0   0
LOND          0    0    0   0    0   0;

ampl: display Xout;
Xout [*,HAM,ARM,*]
:          Bran Oil    Soy      :=
ITQ           0   0   100000
PAR           0   0   400000
RG            0   0        0
SAT           0   0        0
SFS           0   0        0
TUB           0   0        0

 [*,HAM,ESM,*]
:          Bran     Oil    Soy    :=
ITQ           0       0        0
PAR           0       0        0
RG            0       0        0
SAT       80000       0        0
SFS           0       0        0
TUB       80000       0        0

 [*,HAM,PROD,*]
:          Bran    Oil        Soy    :=
ITQ           0       0         0
PAR           0       0         0
RG            0       0         0
SAT           0       0         0
SFS           0       0         0
TUB           0       0         0

 [*,ROT,ARM,*]
:            Bran    Oil    Soy      :=
ITQ             0     0       0
PAR             0     0       0
RG              0     0       0
SAT             0     0  200000
SFS             0     0       0
TUB             0     0  300000

 [*,ROT,ESM,*]
          :  Bran    Oil       Soy    :=
ITQ             0     0         0
PAR             0     0         0
RG              0     0         0
SAT             0     0         0
SFS             0     0         0
TUB             0     0         0
```

```
 [*,ROT,PROD,*]
:             Bran Oil Soy   :=
ITQ            0   0    0
PAR            0   0    0
RG             0   0    0
SAT            0   0    0
SFS            0   0    0
TUB            0   0    0

 [*,SHG,ARM,*]
:             Bran   Oil    Soy   :=
ITQ             0     0      0
PAR             0     0      0
RG              0     0      0
SAT             0     0      0
SFS             0     0      0
TUB             0     0      0

 [*,SHG,ESM,*]
          :  Bran    Oil     Soy   :=
ITQ             0     0      0
PAR             0     0      0
RG              0     0      0
SAT             0     0      0
SFS             0     0      0
TUB             0     0      0

 [*,SHG,PROD,*]
          :  Bran    Oil     Soy   :=
ITQ             0     0      0
PAR             0     0      0
RG              0     0      0
SAT             0     0      0
SFS             0     0      0
TUB             0     0      0;
```

4) Resultados do modelo para Z ≤ 3 terminais especializados

```
sw: ampl
ampl: model MOD4_V17_multicommodity.mod;
ampl: data MOD4_V17_multicommodity.dat;
ampl: solve;
MINOS 5.5: ignoring integrality of 24 variables
MINOS 5.5: optimal solution found.
55 iterations, objective 217698071.4
ampl: option solver cplex;
ampl: solve;
CPLEX 8.0.0: optimal integer solution; objective 216470000
100 MIP simplex iterations
0 branch-and-bound nodes
ampl: display Y;
Y [*] :=
ITQ   0
PAR   1
RG    0
SAT   1
SFS   0
TUB   1;

ampl: display Yserv;
Yserv :=
ITQ   ARM   0
ITQ   ESM   0
ITQ   PROA  0
PAR   ARM   1
PAR   ESM   1
PAR   PROD  0
RG    ARM   0
RG    ESM   0
RG    PROD  0
SAT   ARM   1
SAT   ESM   1
SAT   PROD  0
SFS   ARM   0
SFS   ESM   0
SFS   PROD  0
TUB   ARM   1
TUB   ESM   1
TUB   PROD  0;

ampl: option display_round 0;
ampl: display Xin;
Xin [*,*,ARM,Soy]
      :   ITQ   PAR   RG   SAT   SFS   TUB    :=
ACAI      0     0     0     0     0   70000
ARAG      0     0     0     0     0       0
CG        0  170000   0  130000   0       0
CUI       0  230000   0     0     0       0
DOUR      0     0     0     0     0  100000
LOND      0     0     0  70000    0  130000

 [*,*,ESM,Soy]
      :   ITQ   PAR   RG   SAT   SFS   TUB    :=
ACAI      0     0     0     0     0       0
```

```
ARAG          0   80000      0        0          0        0
CG            0         0      0        0          0        0
CUI         0     20000       0        0         0        0
DOUR      0           0       0        0         0   100000
LOND      0           0        0   100000      0         0

 [*,*,PROD,Soy]
:           ITQ PAR  RG SAT SFS TUB    :=
ACAI         0     0    0    0     0      0
ARAG         0     0    0    0     0      0
CG           0     0    0    0     0      0
CUI          0     0    0    0     0      0
DOUR       0     0    0    0     0      0
LOND        0    0     0    0     0      0;

ampl: display Xout;
Xout [*,HAM,ARM,*]
:           Bran Oil    Soy      :=
ITQ         0       0        0
PAR         0       0   400000
RG          0       0        0
SAT         0       0        0
SFS         0       0        0
TUB         0       0        0

 [*,HAM,ESM,*]
:            Bran  Oil    Soy    :=
ITQ            0       0       0
PAR        80000   0       0
RG             0       0       0
SAT        80000   0       0
SFS            0       0       0
TUB        80000   0       0

 [*,HAM,PROD,*]
:            Bran Oil           Soy    :=
ITQ         0       0            0
PAR         0       0            0
RG          0       0            0
SAT         0       0            0
SFS         0       0            0
TUB         0       0            0

 [*,ROT,ARM,*]
:            Bran Oil       Soy      :=
ITQ         0        0         0
PAR         0        0         0
RG          0        0         0
SAT         0        0    200000
SFS         0        0         0
TUB         0        0    300000

 [*,ROT,ESM,*]
:            Bran   Oil      Soy    :=
ITQ         0         0          0
PAR         0         0          0
RG          0         0          0
SAT         0         0          0
SFS         0         0          0
TUB         0         0          0
```

```
 [*,ROT,PROD,*]
:          Bran Oil Soy    :=
ITQ          0   0   0
PAR          0   0   0
RG           0   0   0
SAT          0   0   0
SFS          0   0   0
TUB          0   0   0

 [*,SHG,ARM,*]
:          Bran Oil Soy    :=
ITQ          0   0   0
PAR          0   0   0
RG           0   0   0
SAT          0   0   0
SFS          0   0   0
TUB          0   0   0

 [*,SHG,ESM,*]
:          Bran Oil Soy    :=
ITQ       0   0   0
PAR       0   0   0
RG        0   0   0
SAT       0   0   0
SFS       0   0   0
TUB       0   0   0

 [*,SHG,PROD,*]
:          Bran Oil Soy    :=
ITQ       0   0   0
PAR       0   0   0
RG        0   0   0
SAT       0   0   0
SFS       0   0   0
TUB       0   0   0;
```

5) Resultados do modelo para Z ≤ 2 terminais especializados

```
sw: ampl
ampl: model MOD4_V17_multicommodity.mod;
ampl: data MOD4_V17_multicommodity.dat;
ampl: solve;
MINOS 5.5: ignoring integrality of 24 variables
MINOS 5.5: optimal solution found.
59 iterations, objective 189034000
ampl: option solver cplex;
ampl: solve;
CPLEX 8.0.0: optimal integer solution; objective 189014000
120 MIP simplex iterations
0 branch-and-bound nodes
ampl: display Y;
Y [*] :=
ITQ   0
PAR   1
RG    0
SAT   0
SFS   0
TUB   1;

ampl: display Yserv;
Yserv :=
ITQ   ARM   0
ITQ   ESM   0
ITQ   PROD  0
PAR   ARM   1
PAR   ESM   1
PAR   PROD  0
RG    ARM   0
RG    ESM   0
RG    PROD  0
SAT   ARM   0
SAT   ESM   0
SAT   PROD  0
SFS   ARM   0
SFS   ESM   0
SFS   PROD  0
TUB   ARM   1
TUB   ESM   1
TUB   PROD  0;

ampl: option display_round 0;
ampl: display Xin;
Xin [*,*,ARM,Soy]
:      ITQ   PAR    RG   SAT   SFS    TUB    :=
ACAI     0     0     0    0     0      0
ARAG     0   30000   0    0     0      0
CG       0  300000  0     0     0      0
CUI      0   70000   0    0     0      0
DOUR     0     0     0    0     0   100000
LOND     0     0     0    0     0   200000
```

```
 [*,*,ESM,Soy]
:          ITQ   PAR    RG   SAT    SFS    TUB     :=
ACAI         0       0      0      0        0       0
ARAG         0       0      0      0        0       0
CG           0       0      0      0        0       0
CUI          0   180000     0      0        0       0
DOUR         0       0      0      0        0  100000
LOND         0   100000     0      0        0       0

 [*,*,PROD,Soy]
:          ITQ PAR  RG SAT SFS TUB   :=
ACAI         0   0   0   0   0   0
ARAG         0   0   0   0   0   0
CG           0   0   0   0   0   0
CUI          0   0   0   0   0   0
DOUR         0   0   0   0   0   0
LOND         0   0   0   0   0   0
;

ampl: display Xout;
Xout [*,HAM,ARM,*]
:            Bran Oil    Soy     :=
ITQ             0   0       0
PAR             0   0   400000
RG              0   0       0
SAT             0   0       0
SFS             0   0       0
TUB             0   0       0

 [*,HAM,ESM,*]
:            Bran  Oil     Soy    :=
ITQ             0     0       0
PAR        224000     0       0
RG              0     0       0
SAT             0     0       0
SFS             0     0       0
TUB         80000     0       0

 [*,HAM,PROD,*]
:          Bran      Oil       Soy    :=
ITQ           0        0         0
PAR           0        0         0
RG            0        0         0
SAT           0        0         0
SFS           0        0         0
TUB           0        0         0

 [*,ROT,ARM,*]
:          Bran      Oil       Soy     :=
ITQ           0        0         0
PAR           0        0         0
RG            0        0         0
SAT           0        0         0
SFS           0        0         0
TUB           0        0    300000

 [*,ROT,ESM,*]
:            Bran   Oil        Soy    :=
ITQ             0      0         0
PAR             0      0         0
```

```
RG          0      0       0
SAT         0      0       0
SFS         0      0       0
TUB         0      0       0

 [*,ROT,PROD,*]
:           Bran Oil Soy    :=
ITQ          0   0   0
PAR          0   0   0
RG           0   0   0
SAT          0   0   0
SFS          0   0   0
TUB          0   0   0

 [*,SHG,ARM,*]
:           Bran Oil Soy    :=
ITQ          0   0   0
PAR          0   0   0
RG           0   0   0
SAT          0   0   0
SFS          0   0   0
TUB          0   0   0

 [*,SHG,ESM,*]
:           Bran Oil Soy    :=
ITQ          0   0   0
PAR          0   0   0
RG           0   0   0
SAT          0   0   0
SFS          0   0   0
TUB          0   0   0

 [*,SHG,PROD,*]
:           Bran Oil Soy    :=
ITQ          0   0   0
PAR          0   0   0
RG           0   0   0
SAT          0   0   0
SFS          0   0   0
TUB          0   0   0;
```

6) Resultados do modelo para Z = 1 terminal especializado

```
sw: ampl
ampl: model MOD4_V17_multicommodity.mod;
ampl: data MOD4_V17_multicommodity.dat;
ampl: solve;
MINOS 5.5: ignoring integrality of 24 variables
MINOS 5.5: optimal solution found.
59 iterations, objective 115214000
ampl: option solver cplex;
ampl: solve;
CPLEX 8.0.0: optimal integer solution; objective 115214000
132 MIP simplex iterations
0 branch-and-bound nodes
ampl: option display_round 0;
ampl: display Xin;
Xin [*,*,ARM,Soy]
:          ITQ    PAR   RG SAT SFS TUB    :=
ACAI         0         0     0     0     0        0
ARAG         0         0     0     0     0        0
CG           0     20000     0     0      0        0
CUI          0    150000     0     0      0        0
DOUR         0         0     0     0     0        0
LOND         0    230000     0     0     0        0

 [*,*,ESM,Soy]
:          ITQ    PAR    RG SAT SFS TUB    :=
ACAI         0       0         0     0     0     0
ARAG         0       0         0     0     0     0
CG           0    280000     0     0     0     0
CUI          0       0         0     0     0     0
DOUR         0       0         0     0     0     0
LOND         0       0         0     0     0     0

 [*,*,PROD,Soy]
:          ITQ    PAR    RG SAT SFS TUB    :=
ACAI         0       0       0      0     0      0
ARAG         0       0       0      0     0      0
CG           0       0       0       0     0      0
CUI          0    100000     0      0     0      0
DOUR         0       0       0       0     0      0
LOND         0       0       0       0     0      0;

ampl: display Xout;
Xout [*,HAM,ARM,*]
:          Bran      Oil    Soy      :=
ITQ          0         0       0
PAR          0         0    400000
RG           0         0       0
SAT          0         0       0
SFS          0         0       0
TUB          0         0       0

 [*,HAM,ESM,*]
:          Bran     Oil        Soy    :=
ITQ        0          0         0
PAR    224000     0         0
RG         0          0         0
SAT        0         0        0
SFS        0        0        0
```

```
TUB     0     0     0

 [*,HAM,PROD,*]
:         Bran   Oil       Soy   :=
ITQ       0      0          0
PAR       0    20000        0
RG        0      0          0
SAT       0      0          0
SFS       0      0          0
TUB       0      0          0

 [*,ROT,ARM,*]
:         Bran   Oil       Soy   :=
ITQ       0      0          0
PAR       0      0          0
RG        0      0          0
SAT       0      0          0
SFS       0      0          0
TUB       0      0          0

 [*,ROT,ESM,*]
:         Bran Oil Soy   :=
ITQ       0    0   0
PAR       0    0   0
RG        0    0   0
SAT       0    0   0
SFS       0    0   0
TUB       0    0   0

 [*,ROT,PROD,*]
:         Bran Oil Soy   :=
ITQ       0    0   0
PAR       0    0   0
RG        0    0   0
SAT       0    0   0
SFS       0    0   0
TUB       0    0   0

 [*,SHG,ARM,*]
:         Bran Oil Soy   :=
ITQ       0    0   0
PAR       0    0   0
RG        0    0   0
SAT       0    0   0
SFS       0    0   0
TUB       0    0   0

 [*,SHG,ESM,*]
:         Bran   Oil Soy   :=
ITQ       0       0   0
PAR       0       0   0
RG        0       0   0
SAT       0       0   0
SFS       0       0   0
TUB       0       0   0
```

```
 [*,SHG,PROD,*]
:          Bran Oil Soy    :=
ITQ          0   0   0
PAR          0   0   0
RG           0   0   0
SAT          0   0   0
SFS          0   0   0
TUB          0   0   0 ;
```