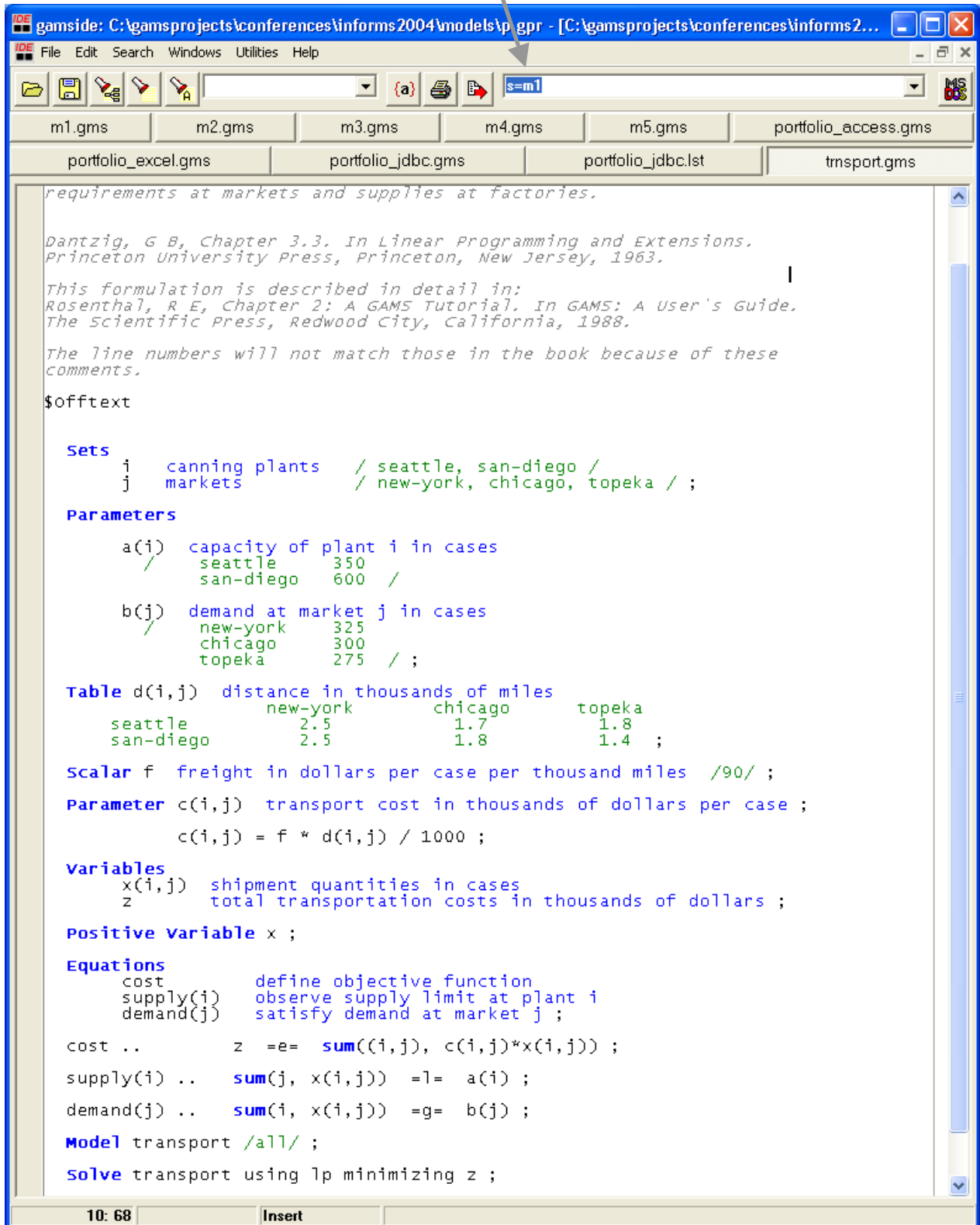


Transport.gms (LP case): solve with s=m1 (save model to file m1)



```
requirements at markets and supplies at factories.

Dantzig, G B, Chapter 3.3. In Linear Programming and Extensions.
Princeton University Press, Princeton, New Jersey, 1963.

This formulation is described in detail in:
Rosenthal, R E, Chapter 2: A GAMS Tutorial. In GAMS: A User's Guide.
The Scientific Press, Redwood City, California, 1988.

The line numbers will not match those in the book because of these
comments.
$offtext

Sets
  i  canning plants  / seattle, san-diego /
  j  markets         / new-york, chicago, topeka / ;

Parameters
  a(i)  capacity of plant i in cases
        / seattle  350
          san-diego 600 /
  b(j)  demand at market j in cases
        / new-york  325
          chicago   300
          topeka   275 / ;

Table d(i,j)  distance in thousands of miles
  new-york  chicago  topeka
seattle    2.5      1.7      1.8
san-diego  2.5      1.8      1.4 ;

Scalar f  freight in dollars per case per thousand miles /90/ ;

Parameter c(i,j)  transport cost in thousands of dollars per case ;
              c(i,j) = f * d(i,j) / 1000 ;

Variables
  x(i,j)  shipment quantities in cases
  z       total transportation costs in thousands of dollars ;

Positive Variable x ;

Equations
  cost      define objective function
  supply(i) observe supply limit at plant i
  demand(j) satisfy demand at market j ;

cost ..      z =e= sum((i,j), c(i,j)*x(i,j)) ;
supply(i) .. sum(j, x(i,j)) =l= a(i) ;
demand(j) .. sum(i, x(i,j)) =g= b(j) ;

Model transport /all/ ;

Solve transport using lp minimizing z ;
```

10: 68 Insert

transport.gms: debugging – clicking on error takes you automatically to code where error occurred.

gamside: C:\gamsprojects\conferences\informs2004\models\p.gpr

File Edit Search Windows Utilities Help

C:\gamsprojects\conferences\informs2004\models\transport.gms

m1.gms m2.gms m2.lst m3.gms m3.lst m4.gms m4.lst

m5.gms m5.lst

portfolio_jdbc.gms portfolio.lst

No active process

m2 m3 m4 m5 transport

Princeton University Press
This formulation is described in
Rosenthal, R. E., Chapter 10
The Scientific Press, 1990.
The line numbers will match the
comments.

\$\$\$ofttext

Sets
i canning plants
j markets

Parameters
a(i) capacity of plant i
seattle
san-diego
b(j) demand at market j
new-york
chicago
topeka

Table d(i,j) distance between plants and markets
seattle new-york
san-diego topeka

Scalar f freight in thousands of dollars

Parameter c(i,j) transportation cost between plant i and market j
c(i,j) = f * d(i,j)

Variables
x(i,j) shipment quantities in cases
z total transportation costs in thousands of dollars

Positive Variable x ;

Equations
cost define objective function
supply(i) observe supply limit at plant i
demand(j) satisfy demand at market j ;

cost .. z =e= sum((i,j), c(i,j)*x(i,j)) ;
supply(i) .. sum(j, x(j,i)) =l= a(i) ;
demand(j) .. sum(i, x(i,j)) =g= b(j) ;

GAMS Rev 140 Copyright (C) 1987-2004 GAMS Development. All rights reserved
*** ***** BETA release
*** GAMS Rev 140 BETA 22oct04 WIN.00.NA 21.5 140.000.041.VIS P3PC
*** ***** BETA release
Licensee: Armin Pruessner G040913/0001CR-WIN DC3589
--- Starting compilation
--- transport.gms(60) 3 Mb 2 Errors
*** Error 171 in C:\gamsprojects\conferences\informs2004\models\transport.gms
Domain violation for set
*** Error 171 in C:\gamsprojects\conferences\informs2004\models\transport.gms
Domain violation for set
--- transport.gms(66) 3 Mb 3 Errors
*** Error 257 in C:\gamsprojects\conferences\informs2004\models\transport.gms
Solve statement not checked because of previous errors
--- transport.gms(68) 3 Mb 4 Errors
*** Error 141 in C:\gamsprojects\conferences\informs2004\models\transport.gms
Symbol neither initialized nor assigned
A wild shot: You may have spurious commas in the explanatory
text of a declaration. Check symbol reference list.
--- transport.gms(68) 3 Mb 4 Errors
*** Status: Compilation error(s)
Exit code = 2

Close Open Log Summary only Update

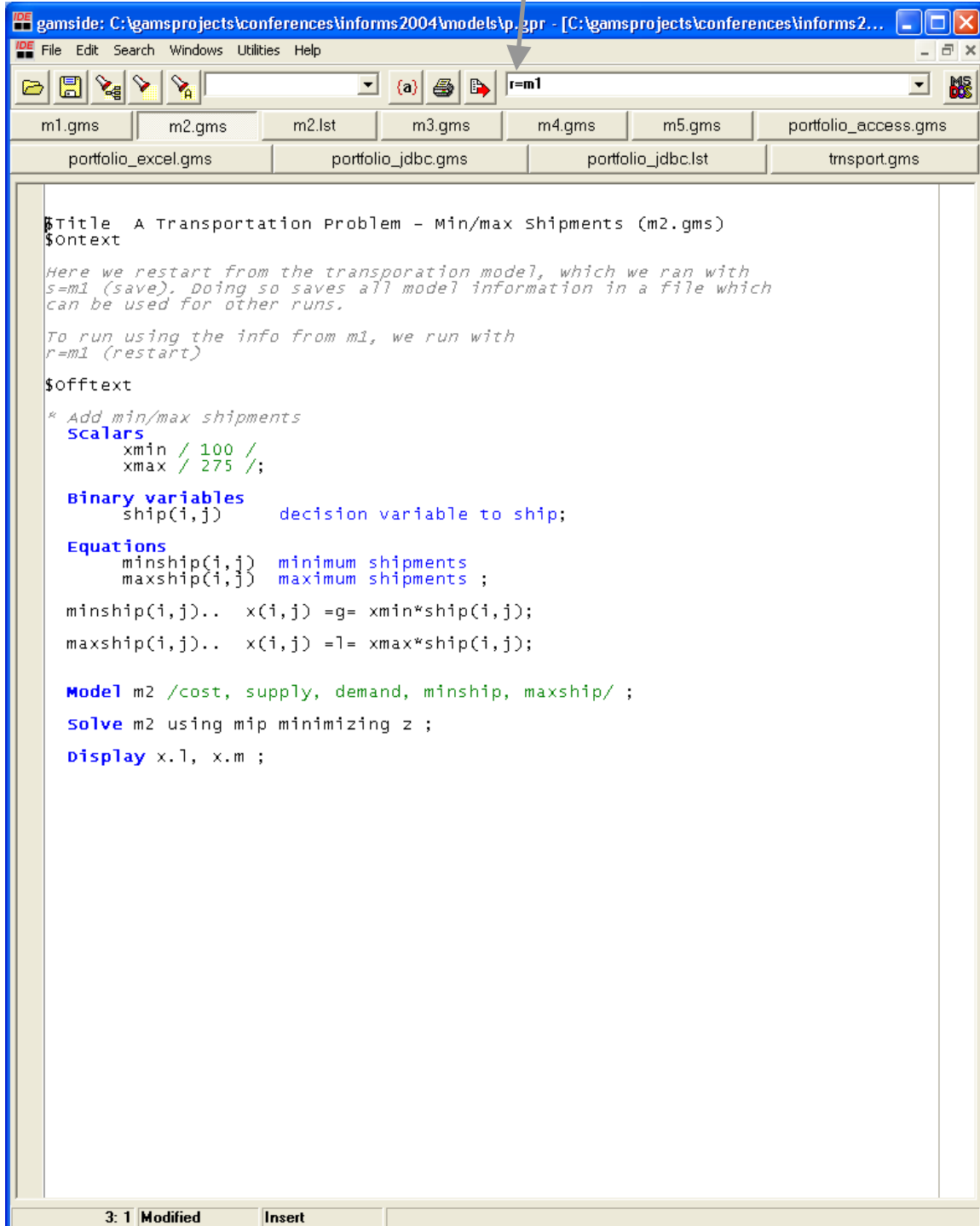
60: 29 Insert

Clicking on error immediately takes you to code that has the error

Incorrect indices x(j,i) instead of x(i,j)

m2.gms: min/max shipments (MIP): solve with r=m1 (restart from file m1)

We use model info from restart file and only need to add changes to previous model.



```
IDE gamside: C:\gamsprojects\conferences\informs2004\models\p.gpr - [C:\gamsprojects\conferences\informs2...
IDE File Edit Search Windows Utilities Help
m1.gms m2.gms m2.lst m3.gms m4.gms m5.gms portfolio_access.gms
portfolio_excel.gms portfolio_jdbc.gms portfolio_jdbc.lst transport.gms

Title A Transportation Problem - Min/max Shipments (m2.gms)
$ontext
Here we restart from the transportation model, which we ran with
s=m1 (save). Doing so saves all model information in a file which
can be used for other runs.

To run using the info from m1, we run with
r=m1 (restart)
$offtext
* Add min/max shipments
Scalars
  xmin / 100 /
  xmax / 275 /;

Binary variables
  ship(i,j)  decision variable to ship;

Equations
  minship(i,j)  minimum shipments
  maxship(i,j)  maximum shipments ;

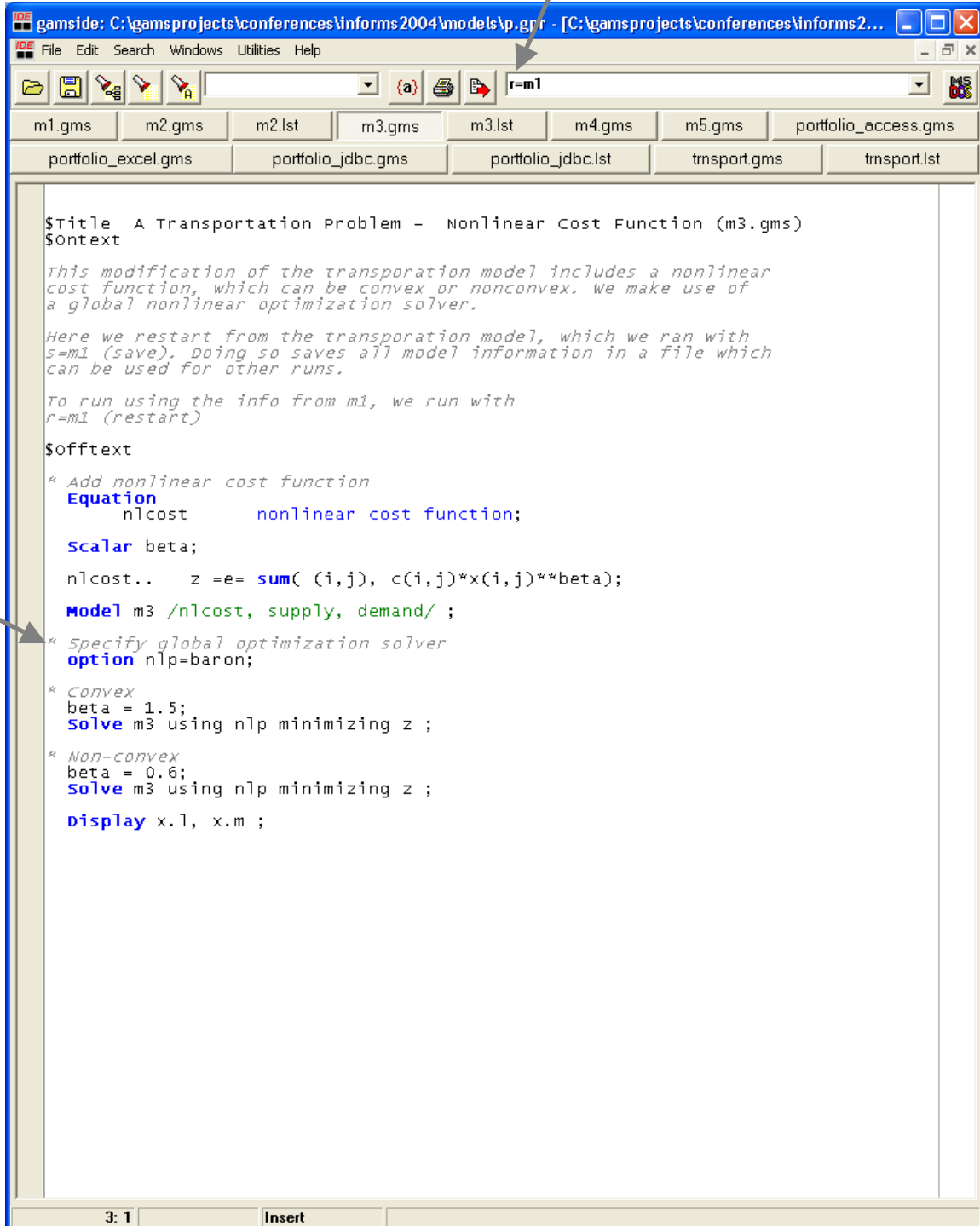
minship(i,j).. x(i,j) =g= xmin*ship(i,j);
maxship(i,j).. x(i,j) =l= xmax*ship(i,j);

Model m2 /cost, supply, demand, minship, maxship/ ;
Solve m2 using mip minimizing z ;
Display x.l, x.m ;

3: 1 Modified Insert
```

m3.gms: nonlinear cost function (NLP): solve with r=m1 (restart from file m1)

We use model info from restart file and only need to add changes to previous model.



```
$Title A Transportation Problem - Nonlinear Cost Function (m3.gms)
$ontext

This modification of the transportation model includes a nonlinear
cost function, which can be convex or nonconvex. We make use of
a global nonlinear optimization solver.

Here we restart from the transportation model, which we ran with
s=m1 (save). Doing so saves all model information in a file which
can be used for other runs.

To run using the info from m1, we run with
r=m1 (restart)

$offtext

* Add nonlinear cost function
Equation
nlcost      nonlinear cost function;

Scalar beta;

nlcost..    z =e= sum( (i,j), c(i,j)*x(i,j)**beta);

Model m3 /nlcost, supply, demand/ ;

* Specify global optimization solver
option nlp=baron;

* Convex
beta = 1.5;
Solve m3 using nlp minimizing z ;

* Non-convex
beta = 0.6;
Solve m3 using nlp minimizing z ;

Display x.l, x.m ;
```

Specify
global
NLP
solver

M4.gms: nonlinear cost function + min/max shipments (MINLP): solve with r=m1 (restart from file m1)

```
$Title A Transportation Problem - Nonlinear Cost Function + Max/Min (m4.gms)
$ontext
Nonlinear cost and min/max shipments.
Here we restart from the transportation model, which we ran with
s=m1 (save). Doing so saves all model information in a file which
can be used for other runs.
To run using the info from m1, we run with
r=m1 (restart)
$offtext
* Add nonlinear cost function and max/min shipments
Scalars
  xmin / 100 /
  xmax / 275 /;
Binary variables
  ship(i,j)    decision variable to ship;
Equation
  minship(i,j) minimum shipments
  maxship(i,j) maximum shipments
  nlcost        nonlinear cost function;
Scalar beta;
minship(i,j).. x(i,j) =g= xmin*ship(i,j);
maxship(i,j).. x(i,j) =l= xmax*ship(i,j);
nlcost..      z =e= sum( (i,j), c(i,j)*x(i,j)**beta);
Model m4 /nlcost, supply, demand, maxship, minship/;
option minlp=baron;
beta = 1.5;
Solve m4 using minlp minimizing z ;
Display x.l, x.m ;
```

M5.gms: solve all 4 previous models and write solutions to Excel (created intermediate GDX file report.gdx which can be viewed in the IDE)

Note: that we only list part of the model. The initial part is the same as the trnsport.gms model.

```
IDE gamside: C:\gamsprojects\conferences\informs2004\models\p.gpr - [C:\gamsprojects\conferences\informs2...
IDE File Edit Search Windows Utilities Help
m1.gms m2.gms m2.lst m3.gms m3.lst m4.gms m4.lst m5.gms portfolio_access.gms
portfolio_excel.gms portfolio_jdbc.gms portfolio_jdbc.lst trnsport.gms trnsport.lst

Scalar beta;

minship(i,j).. x(i,j) =g= xmin*ship(i,j);
maxship(i,j).. x(i,j) =l= xmax*ship(i,j);

nlpcost.. z =e= sum( (i,j), c(i,j)*x(i,j)**beta);

Model m1 / cost, supply, demand / ;
Model m2 / cost, supply, demand, maxship, minship/ ;
Model m3 /nlpcost, supply, demand / ;
Model m4 /nlpcost, supply, demand, maxship, minship/ ;

Parameter rep(i,j,*) report

Solve m1 using lp minimizing z ;
rep(i,j,'lp') = x.L(i,j);

Solve m2 using mip minimizing z ;
rep(i,j,'mip') = x.L(i,j);

beta = 1.5;
Solve m3 using nlp minimizing z ;
rep(i,j,'nlp-convex') = x.L(i,j);

beta = 0.6;
Solve m3 using nlp minimizing z ;
rep(i,j,'nlp-noncon') = x.L(i,j);

option minlp=baron;
beta = 1.5;
Solve m4 using minlp minimizing z ;
rep(i,j,'minlp') = x.L(i,j);

Display rep;

* Export to Excel (generates intermediate .GDX file)
execute_unload "results.gdx"
execute 'gdxrw.exe results.gdx par=rep'
```

Unload to GDX file which we can view in IDE.

Write GDX file to Excel

1: 1 Insert

M5.gms: GDX view of file results.gdx

The screenshot shows the GAMS IDE interface. The main window displays the GDX view of file results.gdx. The window title is "C:\gamsprojects\conferences\informs2004\models\results.gdx".

The left pane shows a list of model elements:

Entry	Symbol	Type	Dim	Nr Elem
3	a	Par	1	2
4	b	Par	1	3
19	beta	Par	0	1
7	c	Par	2	6
10	cost	Equ	0	1
5	d	Par	2	6
12	demand	Equ	1	3
6	f	Par	0	1
1	i	Set	1	2
2	j	Set	1	3
17	maxship	Equ	2	6
16	minship	Equ	2	6
18	nlcost	Equ	0	1
20	rep	Par	3	24
15	ship	Var	2	6
11	supply	Equ	1	2
8	x	Var	2	6
14	xmax	Par	0	1
13	xmin	Par	0	1
9	z	Var	0	1

The right pane shows the detailed view of the 'rep: report' element. It contains a table of results for various locations and models:

		lp	mip	nlp-convex	nlp-noncon	minlp
new-york	seattle	50	150	142.384077867818		132.557695294
	san-diego	275	175	182.615922132182	325	192.442304706
chicago	seattle	300	200	130.929935459408	300	117.442304706
	san-diego	100	100	169.070064540592		182.557695294
topeka	seattle			76.6859866727733		100
	san-diego	275	275	198.314013327227	275	175

At the bottom of the right pane, there are controls for "Reset", "Decimals", "Max", "Squeeze defaults" (checked), and "Ordering: 213".