



The (GAMS) Transport Problem




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Outline

- Introduction
- Basic LP programmes
 - The diet problem
 - Comparative advantage
- The GAMS Transport Problem
 - Standard algebraic presentation
- Structure of a GAMS Programme
- The Transport Problem in GAMS Code
- Next



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Introduction

- A classic linear programming (LP) problem
 - LP and CGE problems are optimisation problems
 - LP problems are a slightly simpler starting point
 - AN LP problem can demonstrate all the key elements in a GAMS programme
- The GAMS tutorial uses this LP programme
 - A printed copy of the GAMS tutorial may prove helpful.


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Basic LP Programmes: Diet

- The diet problem
 - OBJ: minimise the cost (C) of achieving a minimum consumption of three nutrients (Z_1, Z_2, Z_3)
 - STO: the two available food commodities (X_1, X_2) supplying the nutrients in different ratio (a_{ij})

$$\begin{aligned} \text{Min } C &= p_1 \cdot X_1 + p_2 \cdot X_2 \\ \text{sto} \\ a_{11} \cdot X_1 + a_{12} \cdot X_2 &\geq Z_1 \\ a_{21} \cdot X_1 + a_{22} \cdot X_2 &\geq Z_2 \\ a_{31} \cdot X_1 + a_{32} \cdot X_2 &\geq Z_3 \end{aligned}$$

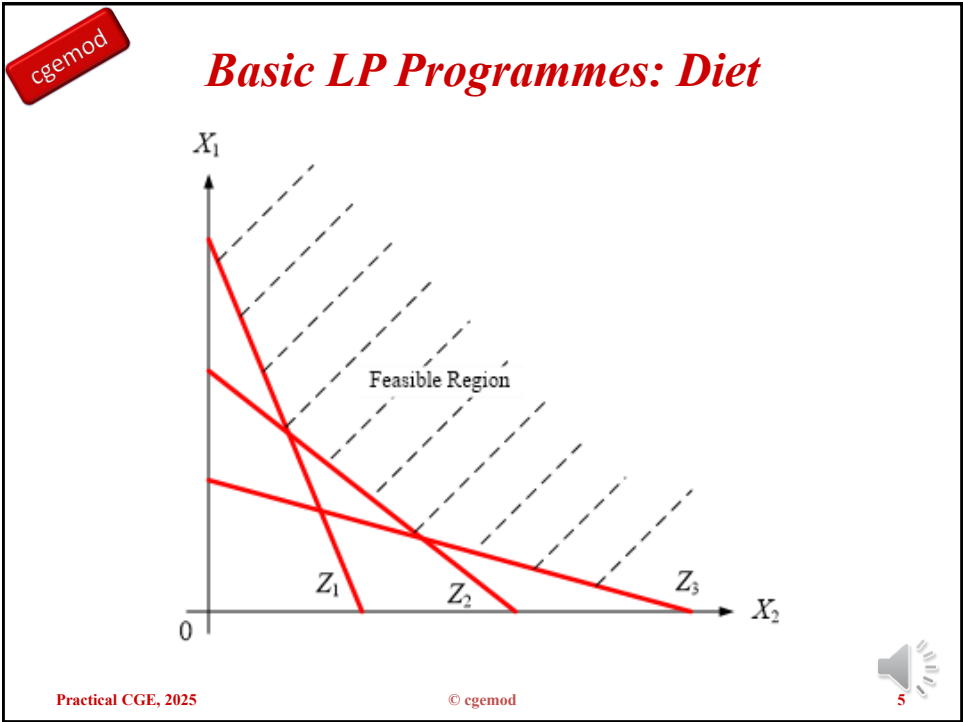
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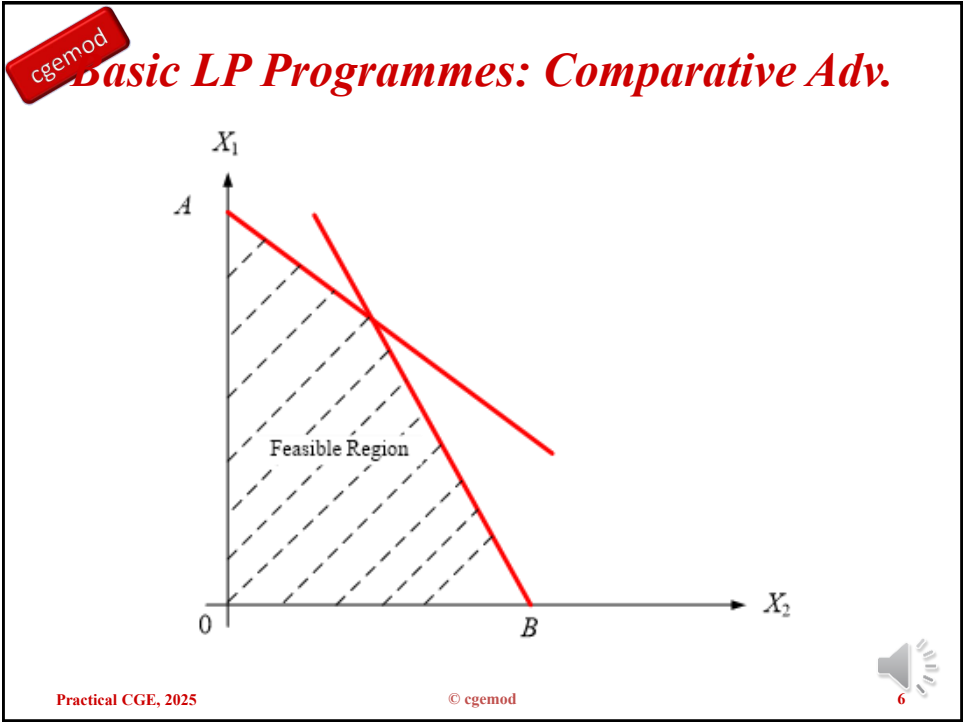


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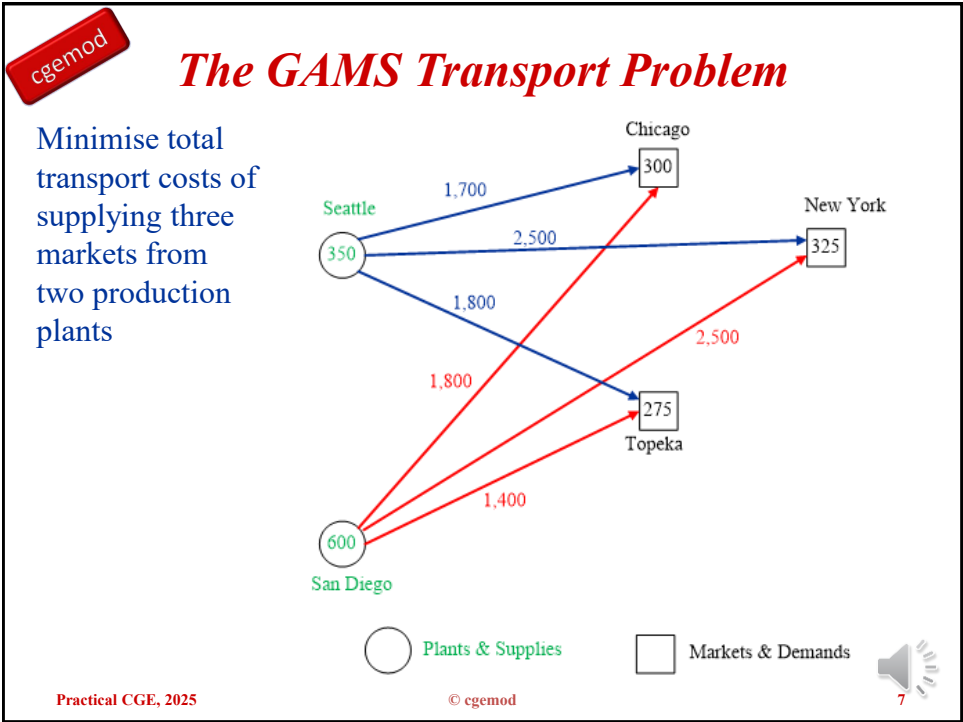
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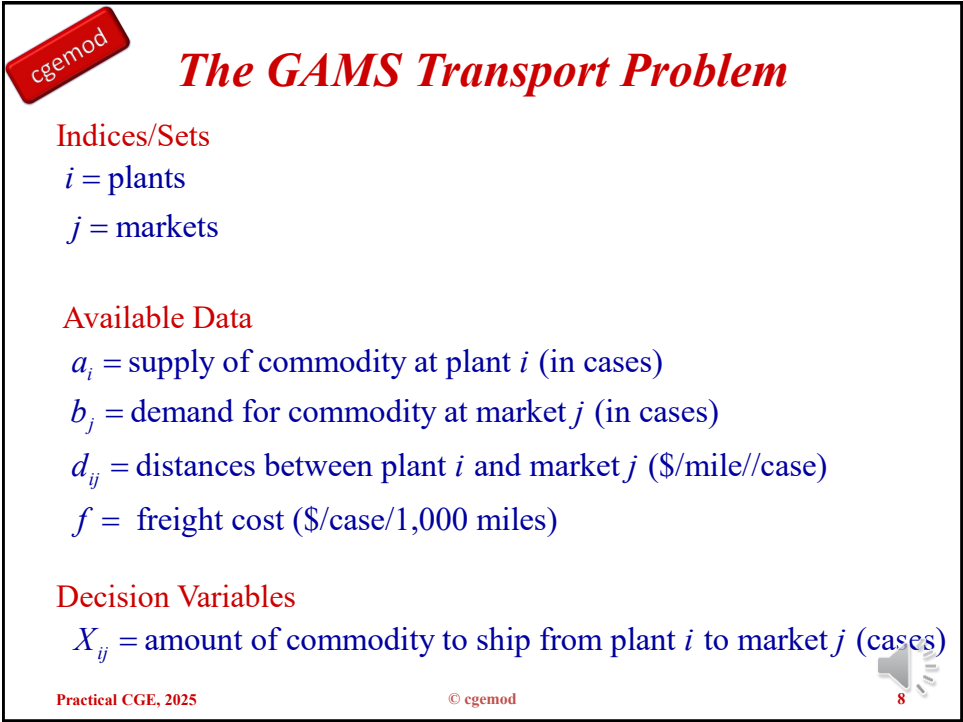
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The GAMS Transport Problem

Constraints


Supply limit at plant i :
$$\sum_j X_{ij} \leq a_i \quad \forall i$$
Demand at market j :
$$\sum_i X_{ij} \geq b_j \quad \forall j$$
$$X_{ij} \geq 0 \quad \forall i, j$$

Objective Function

Minimise
$$\sum_i \sum_j c_{ij} X_{ij}$$

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The GAMS Transport Problem

Data

		Markets		
Plants	New York	Chicago	Topeka	Supplies
		(Distances '000 m)		
Seattle	2.5	1.7	1.8	350
San Diego	2.5	1.8	1.4	600
Demands	325	300	275	

Freight Cost

\$90 per case per 1,000 miles

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Structure of a GAMS Programme

SETS	Declaration
	Assignment of Members
Data (PARAMETERS, TABLES, SCALARS)	Declaration
	Assignment of Values
VARIABLES	Declaration
	Assignment of Type
	(optional) Assignment of bounds/initial values
EQUATIONS	Declaration
	Definition
MODEL and SOLVE statements	
(optional) DISPLAY statements	

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The Transport Problem in GAMS Code

```
$TITLE  A TRANSPORTATION PROBLEM (TRANSPORT,SEQ=1)
$OFFUPPER
* This problem finds a least cost shipping schedule that meets
* requirements at markets and supplies at factories

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  / ;
```

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The Transport Problem in GAMS Code

```
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 '000 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 ;
```

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The Transport Problem in GAMS Code

```
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 ;

DISPLAY X.L, X.M ;
```


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Next

- Transport Problem Exercises
- Exploring the transport problem model
- Debugging a GAMS model
 - Syntax errors
 - Execution errors
- Changing the model
 - Changing unit transport costs
 - Changing distances
 - Adding a new markets
 - Adding intermediate (wholesale) markets


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The (GAMS) Transport Problem

The End

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