CHOICE OF GEOGRAPHIC LOCATION

AGENDA

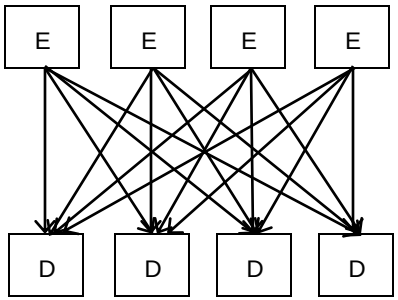
- FEDERAL EXPRESS
- UPS
- IMPORTANCE OF A LOCATION DECISION
- LEVELS OF A LOCATION DECISION
- DETERMINANTS OF A LOCATION DECISION
- THE BMW CASE
- LOCATION CHOICE TECHNIQUES

FEDERAL EXPRESS

Description: For nearly 60 years, Federal Express has consistently relied on the concept of central location. The first FedEx center[1] was built in Memphis, Tennessee, and hosts 100 FedEx planes carrying 700,000 parcels each night. Subsequently, a center was built in Paris and Subic Bay (Philippines). In 1998, to prevent a possible closure of the latter due to potential political unrest, a second Asian center was established in Taipei (Taiwan). Today, FedEx has a fleet of 600 aircraft through 325 airports worldwide, and a fleet of 38,000 delivery vans.

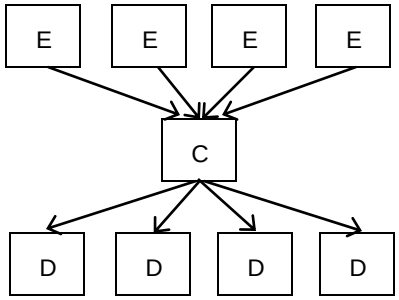
Benefits of central location:

* Expansion of the number of services with fewer planes,
* Matching flights and transported loads,
* Controlling the trajectory of parcels (reduction of destination errors)



N = 4 × 4 = 16 planes

E = Expedition
C = Hub
D = Destination



N = 4 + 4 = 8 planes

Reasons for choosing central location in Memphis:

- Memphis is in the center of the United States,
- The climate is favorable.

[1] The size of the center of Memphis equals 33 football fields.

IMPORTANCE OF LOCATION DECISION

The choice of location has a lasting impact on:

- Fixed costs (costs of construction, equipment…),
- Variables costs (energy cost, labor cost…),
- Overall profit.
- Location = cost driver[2] (or income[3])
  + cost rigidity factor.

➔ *Rule = be at the right place at the right moment.*

A location strategy is contingent upon the nature activity:

- Location of a factory = cost minimization,
- Location of a warehouse = cost and delivery time minimization,
- Location of a sales point = revenue maximization.

➔ In general, the objective is to maximize the benefit drawn from a location.

Location options include:

- On-site expansion of the production capacity of an existing plant,
- Off-site expansion of the production capacity of an existing plant,
- The relocation of an existing factory.

Location decisions are rare and are due to:

- Excess demand compared to local production,
- A change in the labor productivity,
- Long-lasting change in exchange rates and/or costs, etc.

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[2] Manufacturing activities.
[3] Service activities.

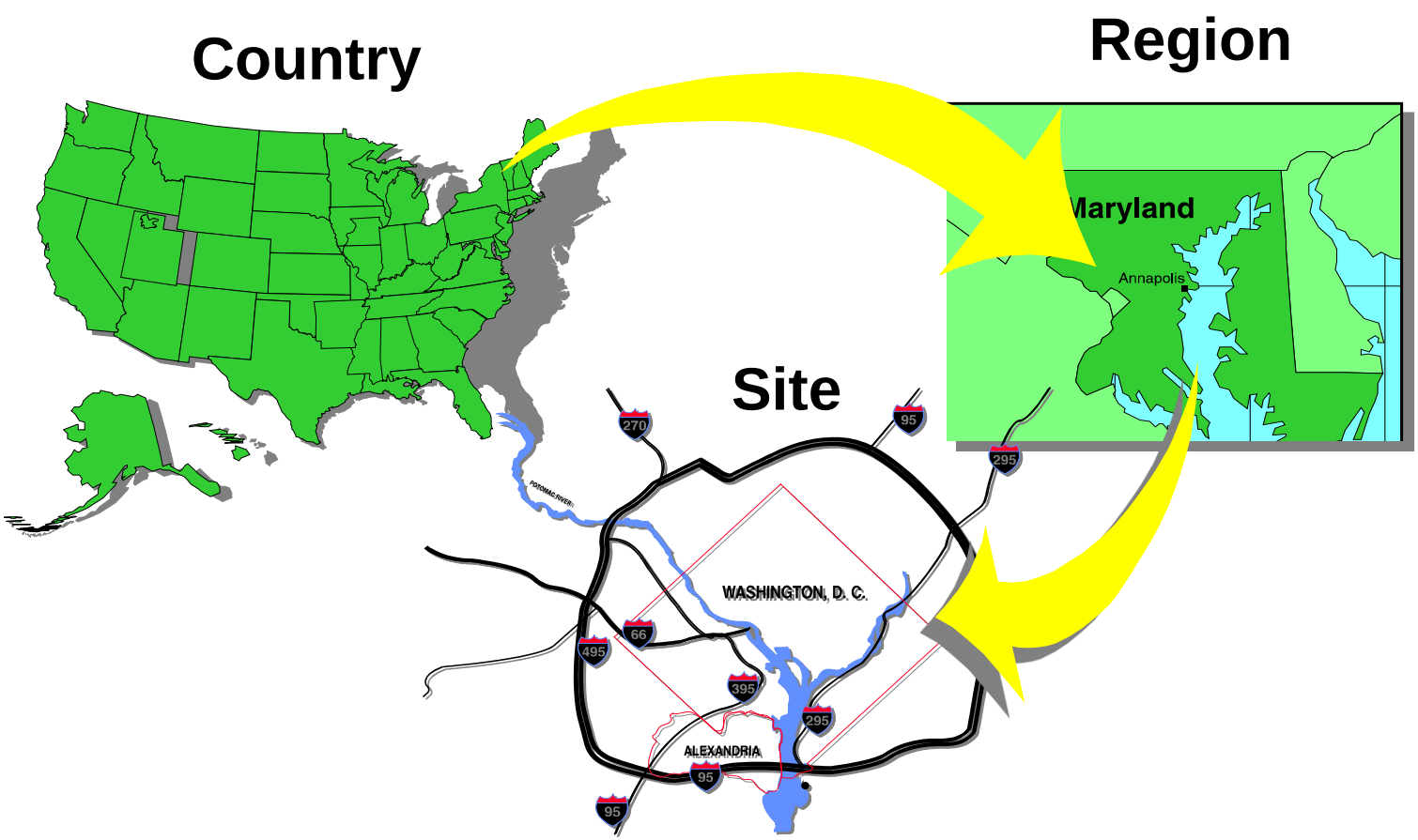
LOCATION DECISION LEVELS

Note: The choice of location transcends national borders

➔ Three levels of decision:

- the country,
- the region,
- the site.

DECISION SEQUENCE



FACTORS AFFECTING THE LOCATION DECISION

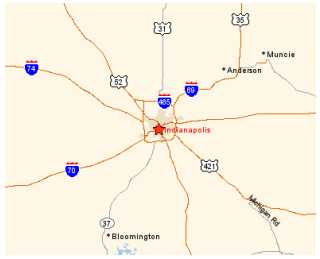
Country

1. National regulations, attitudes, stability, incentives
2. Economic and cultural issues
3. Market location
4. Availability of manpower, attitudes, productivity, costs
5. Availability of services, communications, energy
6. Exchange rate

Region

1. Expectations of the company
2. Attractiveness of the region (culture, taxes, climate, etc.)
3. Availability of manpower, costs, attitude of the unions
4. Cost and availability of services
5. Environmental regulations
6. Government incentives
7. Proximity to raw materials and consumers
8. Field / Construction Costs

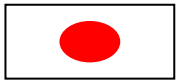
Site



1. Size and cost of the site
2. Air, rail, road, navigation network
3. Zone restrictions
4. Proximity of services / suppliers
5. Environmental issues

DETERMINANTS DU CHOIX DE LOCALISATION (1)

Labor productivity[4]

Hourly Salary Rate ($) in Industry (2016)		
GERMANY		43.18
JAPON		26.46
UNITED STATES		39.03
TAIWAN		9.82
MEXICO		3.91

!! The tradeoff must be based on the unit salary rate and not that of the hourly salary rate !!

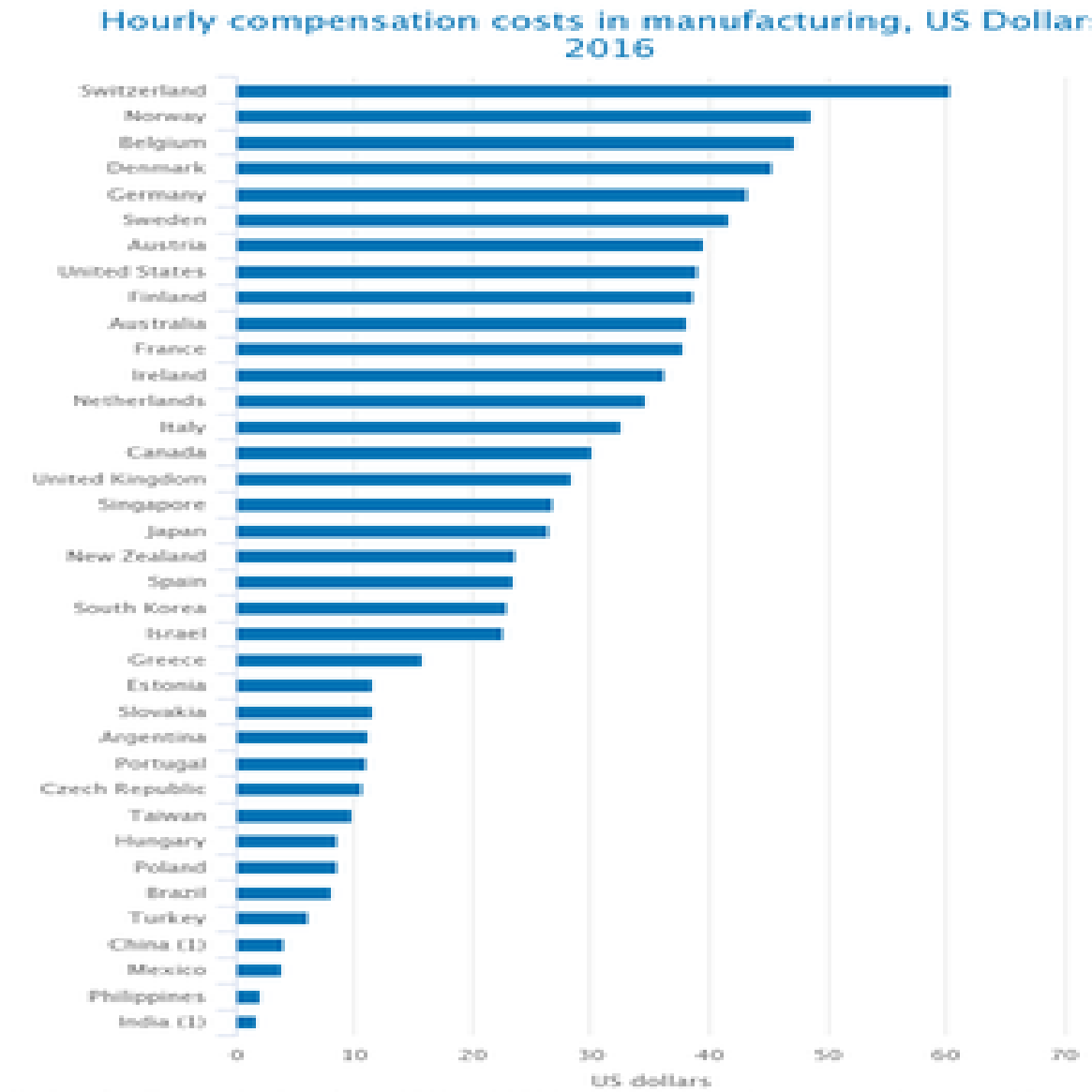
Unit salary rate[5] = salary rate per day/production per day

Case 1 : Connecticut plant $70 per day/60 units per day = $1.17/unit
Case 2 : Juarez plant $25 per day/20 units per day = $1.25/unit

4 By relocating its Connecticut plant to Juarez, Mexico, Quality Coils Inc has reduced its salary costs by two-thirds. Nevertheless, low productivity, linked to high absenteeism, led the company to return to Connecticut and rehire some of its former employees. In this sense, low salary costs are not a substitute for worker skills, quality of transportation and access to technology.

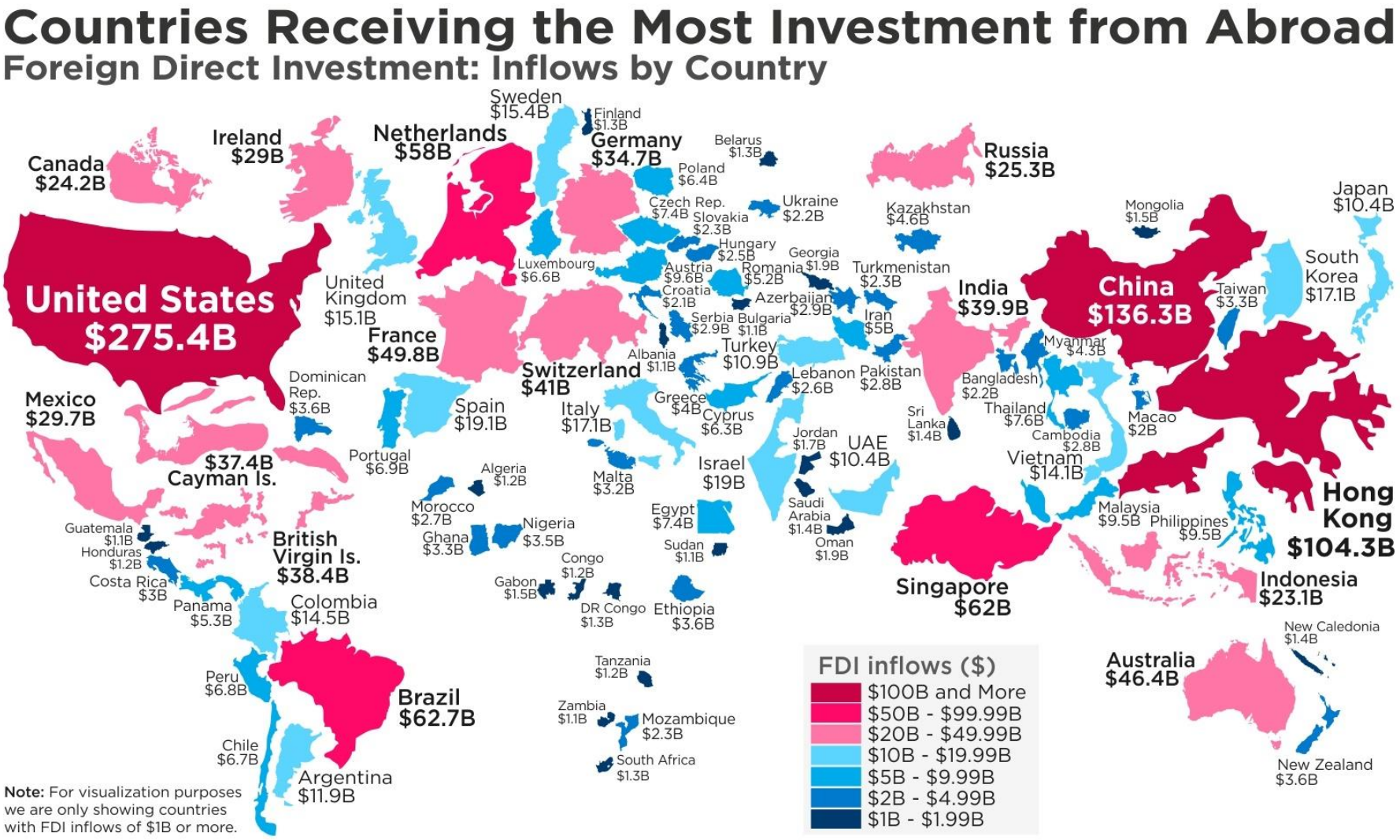
5 [5] The arbitration criterion must be that of the wage cost per unit produced and not that of the hourly wage.

HOURLY COMPENSATION COSTS IN MANUFACTURING IN 2016 (US $)



(1) Data for China and India refer to 2013 and 2014, respectively, and are not strictly comparable with each other or with data for other countries. For definitions and country information, see www.conference-board.org/ilcprogram/compensation.
Source: The Conference Board, International Labor Comparisons program, Feb. 2018

FOREIGN DIRECT INVESTMENTS INFLOWS (2017)



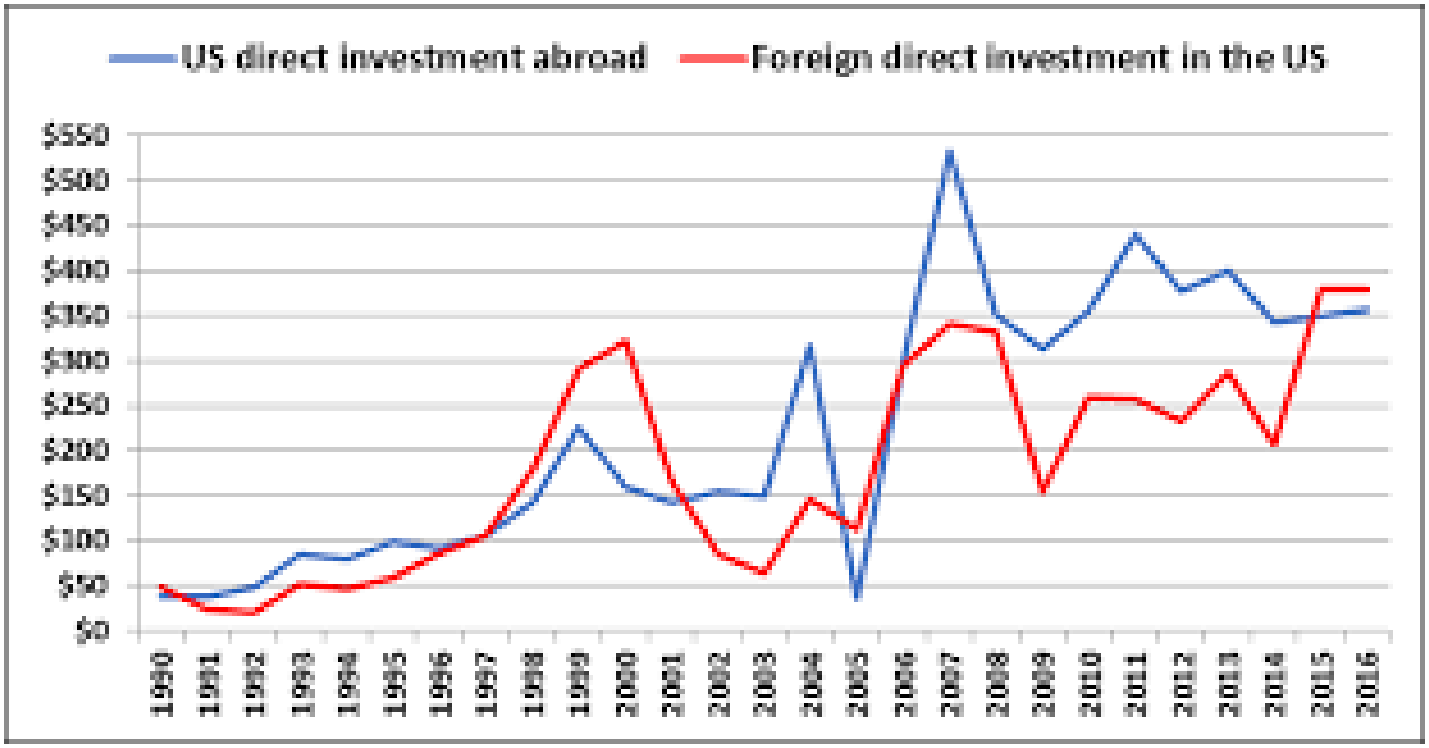
Note: For visualization purposes we are only showing countries with FDI inflows of $1B or more.

How to read this map: Countries appear bigger as their FDI inflow is higher. e.g. United States. Conversely, countries that have a lower FDI inflows appear smaller e.g. Sudan.

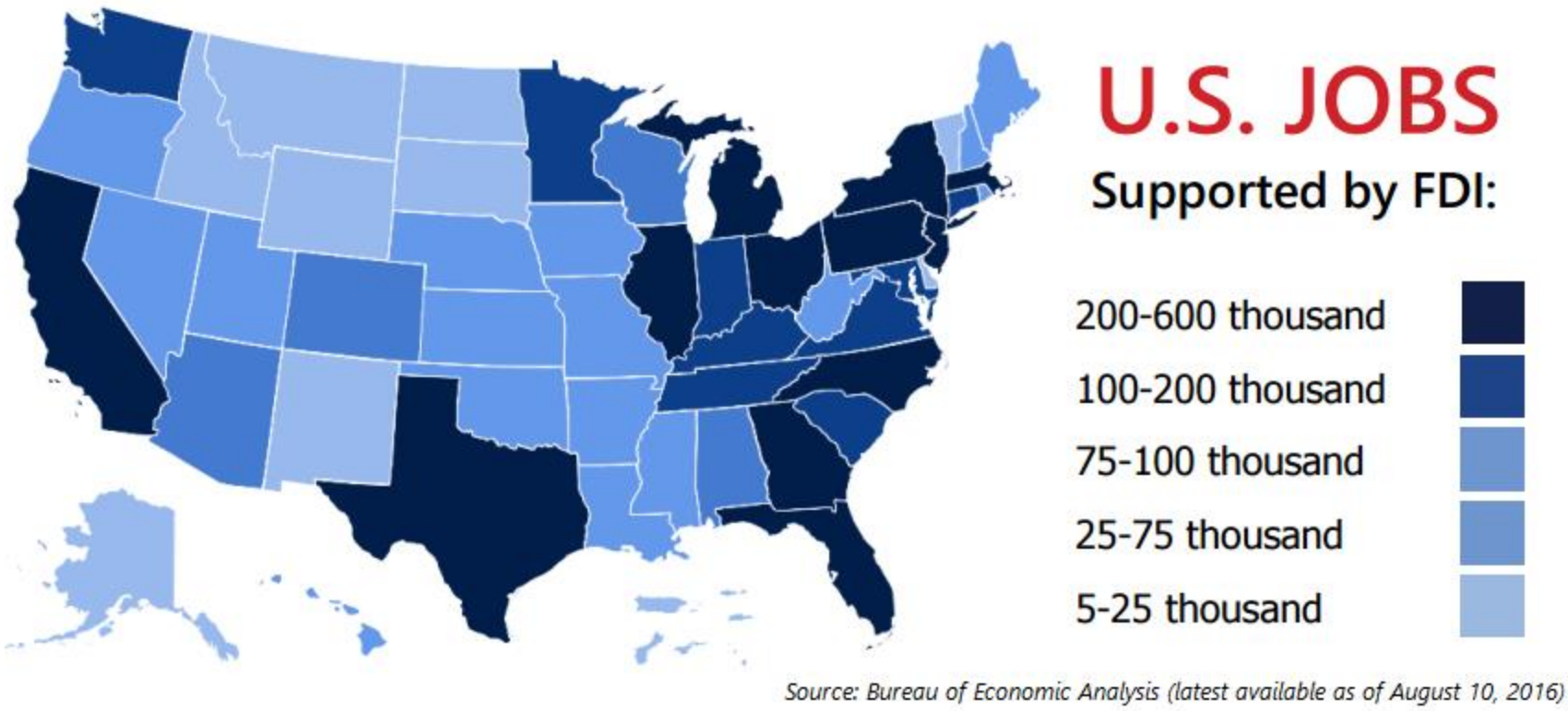
Article & Sources:
https://howmuch.net/articles/countries-receiving-most-investment-from-abroad
United Nations, World Investment Report 2018 - https://unctad.org

howmuch.net

US DIRECT INVESTMENTS INFLOWS AND OUTFLOWS



FDI CONTRIBUTION TO US JOBS



Source: Bureau of Economic Analysis (latest available as of August 10, 2016)

DETERMINANTS OF LOCATION CHOICE (2)

Exchange rate stability: A viable location in 2005 can be disastrous in 2012[6]

costs:

- tangible: installations, labor, taxes, transport of raw materials and finished products, ...

=> Identifiable and measurable

- intangible: quality of workforce training, level of education, cost of living, transport infrastructure, social protection system, local attitudes, climate, etc.

=> Difficultly quantifiable

Attitudes of local and national authorities[7, 8]: relationship to private property, location, pollution, stability of employment, ... and incentives for public authorities[9]

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[6] For example, a currency devaluation can significantly influence location decisions (the devaluation of the Mexican peso in December 1994 led many US plants in Juarez, Tijuana and Matamoros in Mexico to relocate their activities).

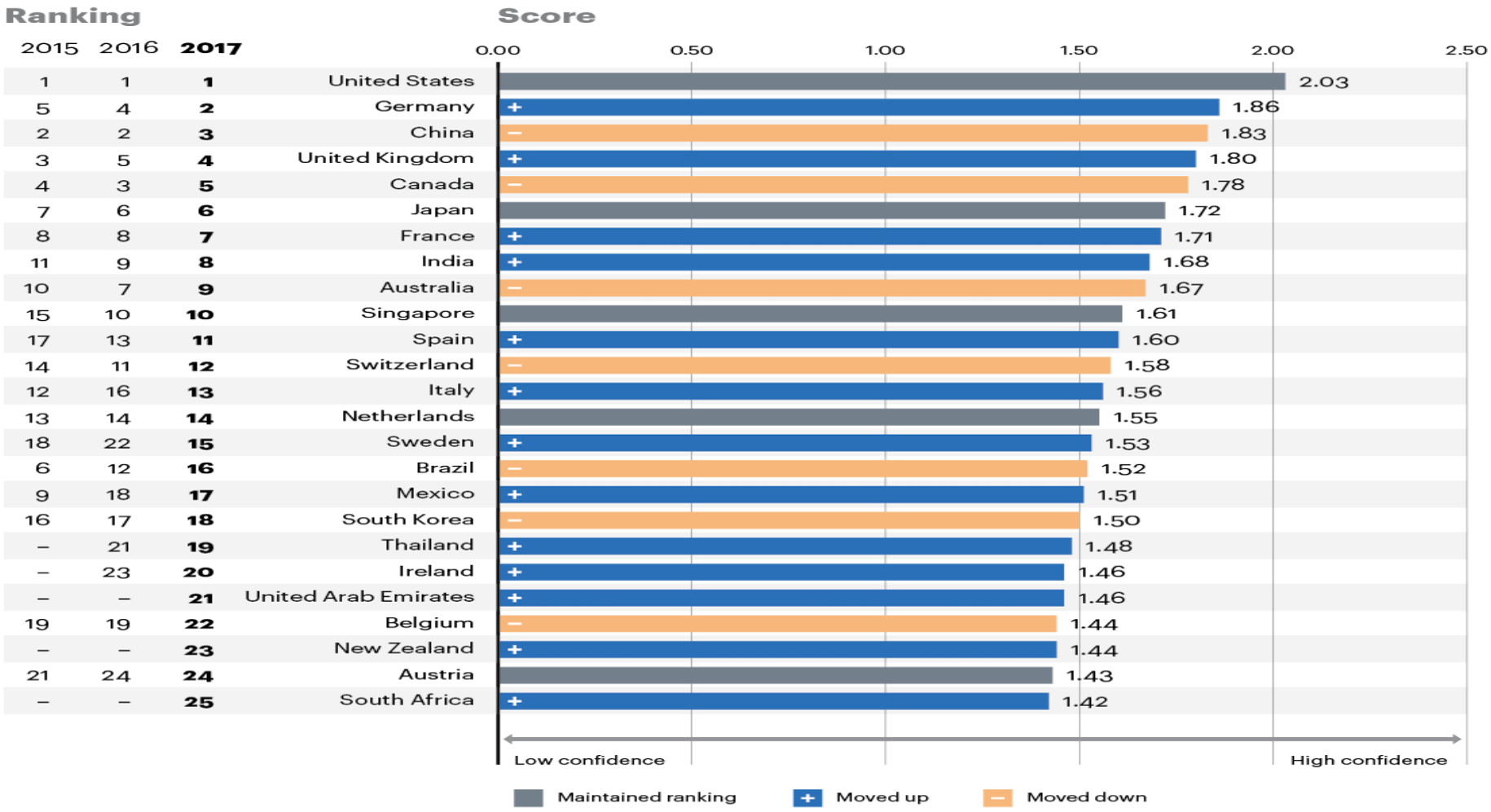
[7] Between 1992 and 1996, Hong Kong held the first place in terms of the attractiveness of foreign companies on its soil. The interest of attracting foreign investment for the nation-states is particularly related to employment: in France, 27,335 jobs were created in 2003 thanks to foreign investment.

[8] With a population of 8.4 million and a GDP of $ 358 billion (2012), Québec is an attractive market for companies in the United States (i.e., the leading foreign investor). For a long time, the influence of the separatist movement in Quebec nevertheless raised doubts with certain US companies, who feared the non-accession of an independent Quebec to free trade agreements with the United States, which made the establishment less viable in the eyes of US companies Despite this, companies such as Bristol-Myers, Squibb, Goodyear, Hyundai, IBM and Kraft Foods have a multi-million dollar development in Quebec in recent years.

[9] For example, the establishment of a Toyota plant in Princeton, Indiana in 1998 allowed the company to benefit from a $ 72 million grant from the State of Indiana in the form of reductions. taxes, incentives for employment, etc.

FDI CONFIDENCE INDEX

2017 A.T. Kearney FDI Confidence Index®



Note: Values are calculated on a 0 to 3 scale, with 3 being the highest level of confidence in a market as a future destination for FDI.
Source: 2017 A.T. Kearney Foreign Direct Investment Confidence Index

DETERMINANTS OF LOCATION CHOICE (3)

Proximity to the markets: it is the essential criterion of location of the service activities (drugstores, restaurants, post offices, hair salons ...), and certain industrial activities including products that are difficult or expensive to transport[10].

Proximity to suppliers: this is an important criterion for industrial activities, particularly because of perishable nature of raw materials (canning factories), transportation costs (metallurgy), or reduction in the volume of raw materials after processing (wood factories).

=> The relative importance of the location criteria varies according to the activity considered.

- For Motorola, for example, a global producer of integrated circuits, the cost of labor has become a marginal consideration, as Motorola's business is highly capital intensive[11]. In these circumstances, other criteria become more critical.
- Before choosing Alabama as a location, Mercedes-Benz first considered Mexico. The firm then changed its mind in order to preserve the coherence of its brand image[12].

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[10] For example, Coca-Cola, which uses water as its main ingredient, prefers to locate factories in cities rather than having to transport heavy and fragile containers (glass) across entire regions.

[11] When a worker in Southeast Asia manufactures 120 integrated circuits each hour, a machine produces 640. In addition, a worker can simultaneously control 8 machines for a total production of 5,210 units.

[12] i.e., selling "Made in Mexico" automobiles at $ 50 000 seemed difficult to justify from a marketing point of view.

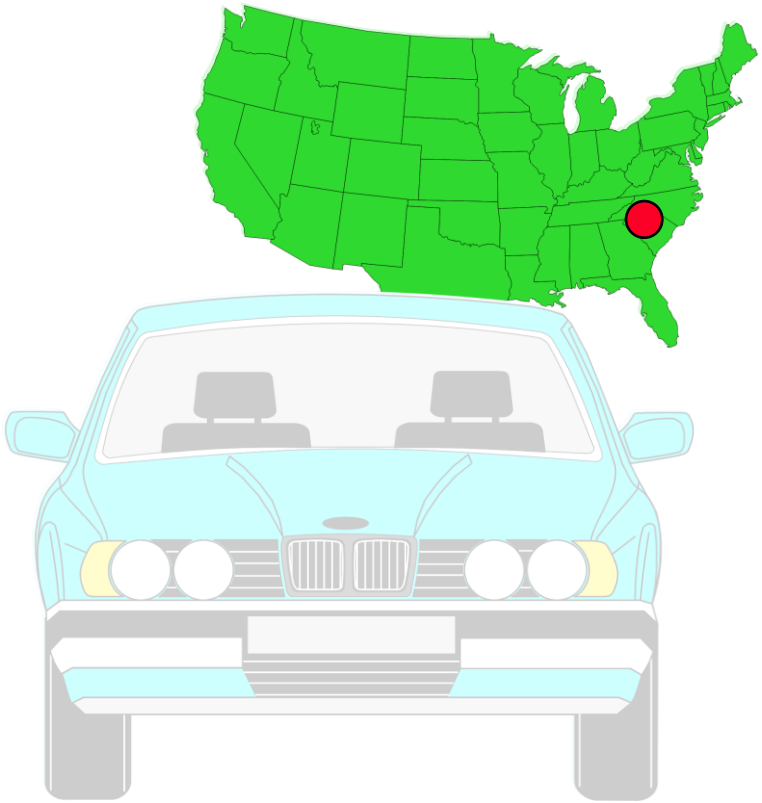
DISTANCE JAPANESE AUTOMOTIVE MANUFACTURERS/SUPPLIERS IN THE USA

Suppliers	Mean	Median	Standard deviation	Minimum	Maximum	n
Autoalliance	366.47	245.00	453.83	5.00	2013.00	59.00
Diamond-Star	316.78	264.77	312.61	0.00	1726.29	50.00
Honda	262.47	152.00	379.63	0.00	2022.00	117.00
Nissan	343.21	251.20	347.35	6.96	1801.80	64.00
NUMMI	1749.85	1959.24	651.28	33.05	2191.87	25.00
Saturn	310.68	294.34	243.14	27.28	922.54	17.00
Subaru-Isuzu	309.94	193.37	411.14	19.60	1837.73	53.00
Toyota	335.30	174.19	481.32	0.00	1897.00	67.00
	(in Miles)					

BMW CASE

In 1995, BMW set up its first factory in production abroad, in Spartanburg (South Carolina).

Launching	March 1995
Area	130 000 m²
Investment	$ 800 Millions
Production (2008)	200 000 units
Employees (2000)	≈ 3 400
Car models	1.Z3 2.Z3 Coupé 3.M Coupé 4.X4 5.X5



BMW CASE: CRITERIA FOR DECISION

At country level

Market:

- the United States was the largest luxury car market (and remains yet),
- the market was growing;

Job:

- the hourly wage rate is lower than in Germany ($ 17 an hour against $ 27),
- labor productivity is higher than in Germany (11 days of annual leave against 31);

Other:

- a reduction in the cost of transportation was expected ($ 2,500 less),
- an increase in productivity due to the new plant and equipment was anticipated (lower unit cost of production from $ 2,000 to $ 3,000).

At the level of the region

Job:

- the average annual salary is among the lowest in the United States ($ 17,000 versus a national average of $ 27,05,1[13])

Government incentives:

- $ 135 million in local and state subsidies in the form of tax cuts,
- Total deductible on raw material imports and auto exports.

[13] According to a survey conducted on 1993 metropolitan averages, all activities combined.

BMW CASE: REVIEW

Centralization of global production of Z3, Z3 Coupé, M Coupé, X5 roadster models

Extension of production capacity in 2007

- Additional investment of $ 300 million
- Creation of 500 new highly skilled jobs

Partnership network of 36 suppliers

- Choice of localization
- Global operating investment of $ 1 billion

LOCATION CHOICE TECHNIQUES

Weighted Scores Method:

- commonly used
- industrial and service locations
- taking into account qualitative and quantitative factors
- subjective treatment mode

Break even point Analysis:

- analysis of the minimum cost/volume ratio for each location
- industrial locations

Gravitational methods:

- determining a distribution center connected to multiple existing destinations
- production and service locations

WEIGHTING SCORES METHOD

Steps:

1. Determination of relevant choice factors
2. Assignment of a weighting index to each factor
3. Construction of an evaluation scale for each factor (disjunctive scale, Likert scale ...)
4. Determination of a score for each location
5. Calculation of the sum of the weighted scores for each location
6. Selecting the location obtaining a maximum weighted score.

RELEVANT CHOICE FACTORS

- Labor cost
- Availability of the workforce
- Proximity to suppliers
- Proximity to the markets
- Local tax policy
- Local environmental policy
- infrastructures
- Cost of the site
- Availability of modes of transport
- Quality of life
- Exchange rate
- "Quality" of the government

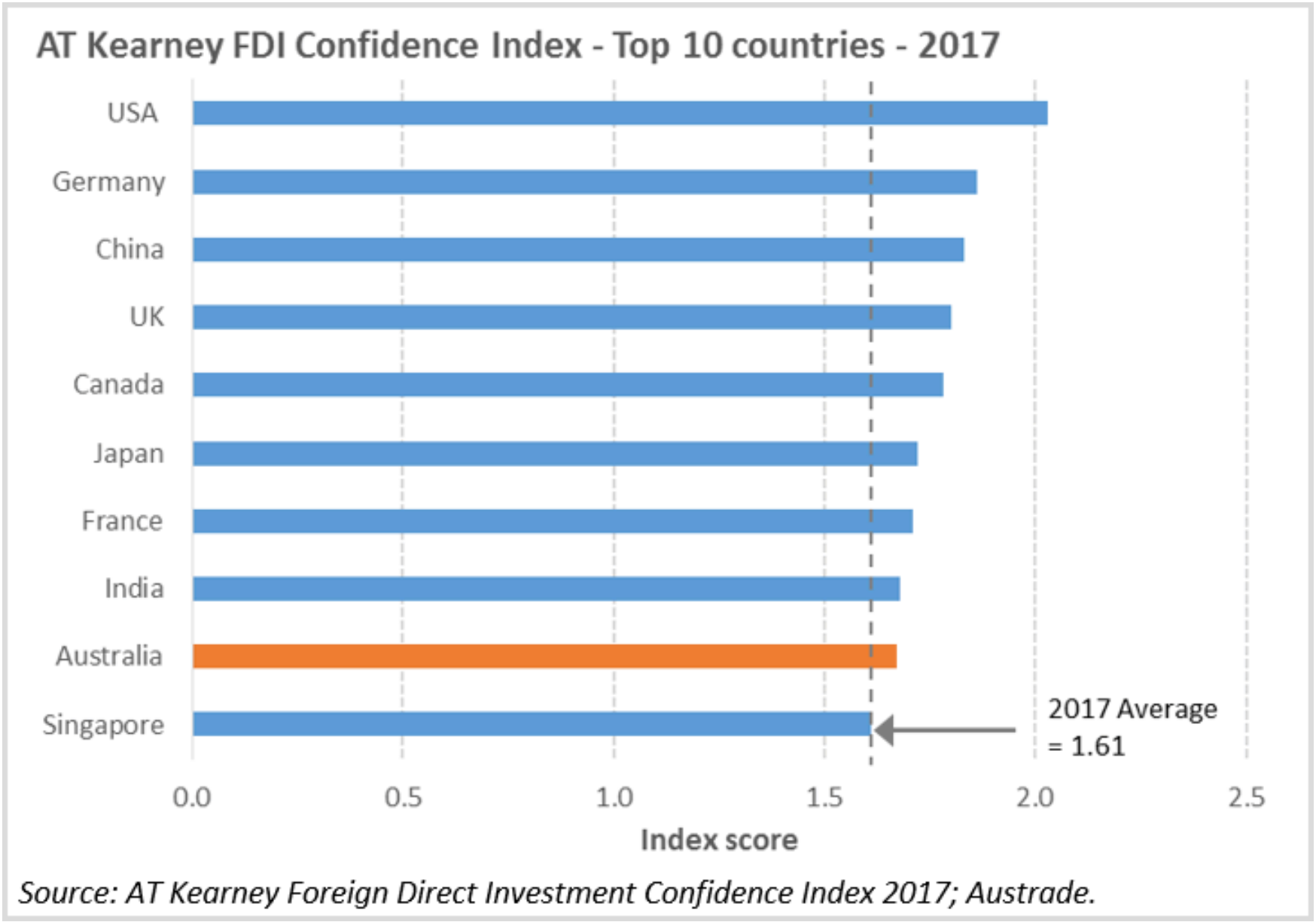
Scores awarded by automotive industry suppliers located in Tennessee, USA

Factors	Excellent	Adequate	Inadequate
Market access for your production	44.9%	54.4%	0.7%
Proximity to the market for the final product	29.7%	68.8%	1.4%
Access to marketing and advertising services	14.7%	79.1%	6.2%
Access to financial, accounting and legal services	26.7%	67.2%	6.1%
Access to engineering and R & D services	12.7%	70.6%	16.7%
Access to raw materials	15.7%	78.4%	6.0%
Availability of the workforce	13.4%	30.6%	56.0%
Skill level of manpower	8.2%	37.3%	54.5%
Labor productivity	15.4%	66.9%	17.6%
Quality of training and workforce development	9.7%	58.2%	32.1%
Wage rates relative to other potential sites	16.5%	78.9%	4.5%
Other labor costs relative to other potential sites	10.8%	82.3%	6.9%
Labor relations / management	39.4%	59.1%	1.5%
Cost of the land	24.2%	69.5%	6.3%
Land Availability	24.3%	67.1%	8.6%
Availability of capital in Tennessee	19.8%	66.1%	14.0%
State taxes	8.5%	65.4%	26.2%
Local taxes	9.9%	71.0%	19.1%
Environmental regulations and constraints	8.8%	83.8%	7.4%
Quality of the motorway network	43.4%	52.9%	3.7%
Quality of the road network	32.3%	59.4%	8.3%

Scores awarded by automotive industry suppliers located in Tennessee, USA (Cont.)

Factors	Excellent	Adequate	Inadequate
Availability of rail transport	9.8%	67.9%	22.3%
Availability of air transport	19.8%	58.8%	21.4%
Quality of electrical installations	2.1%	60.6%	7.3%
Access to natural gas	27.8%	66.9%	5.3%
Price of natural gas	10.6%	82.6%	6.8%
General business climate in Tennessee	33.8%	63.9%	2.3%
Quality of life	65.7%	32.8%	1.5%
Availability of affordable housing	36.0%	55.1%	8.8%
Low crime rate	19.3%	67.4%	13.3%
Quality of public schools	12.5%	55.9%	31.6%
Quality of private schools	44.2%	45.3%	10.5%

FDI CONFIDENCE INDEX: TOP 10 COUNTRIES



Source: AT Kearney Foreign Direct Investment Confidence Index 2017; Austrade.

APPLICATION

The Dynaco Manufacturing Company must build a tire production plant on one of the three sites selected by the general management.

The site evaluation team provided the following information.

		Scores (0 to 100)		
Factors	**Weight**	**Site 1**	**Site 2**	**Site 3**
Availability of manpower	0.30	80	65	90
Proximity to suppliers	0.20	100	91	75
Wage rate	0.15	60	95	72
Social environment	0.15	75	80	80
Proximity to customers	0.10	65	90	95
Modes of transport	0.05	85	92	65
Ecological constraints	0.05	50	65	90

The weighted scores for each site are calculated and reported below.

APPLICATION (Cont.)

	Weighted scores		
Factors	**Site 1**	**Site 2**	**Site 3**
Availability of manpower	24.00	19.50	27.00
Proximity to suppliers	20.00	18.20	15.00
Wage rate	9.00	14.25	10.80
Social environment	11.25	12.00	12.00
Proximity to customers	6.50	9.00	9.50
Modes of transport	4.25	4.60	3.25
Ecological constraints	2.50	3.25	4.50
Total score	**77.50**	**80.80**	**82.05**

Site 3 gets the best weighted score. Nevertheless, a breakeven analysis is a useful complement for assessing the choice of location.

BREAK EVEN POINT ANALYSIS

Steps :

1. Determination of fixed costs and variable costs for each location
2. Graphical representation of the cost function associated with each location
3. Construction of the minimum cost envelope
4. Selecting the location associating a minimum cost with the anticipated production volume

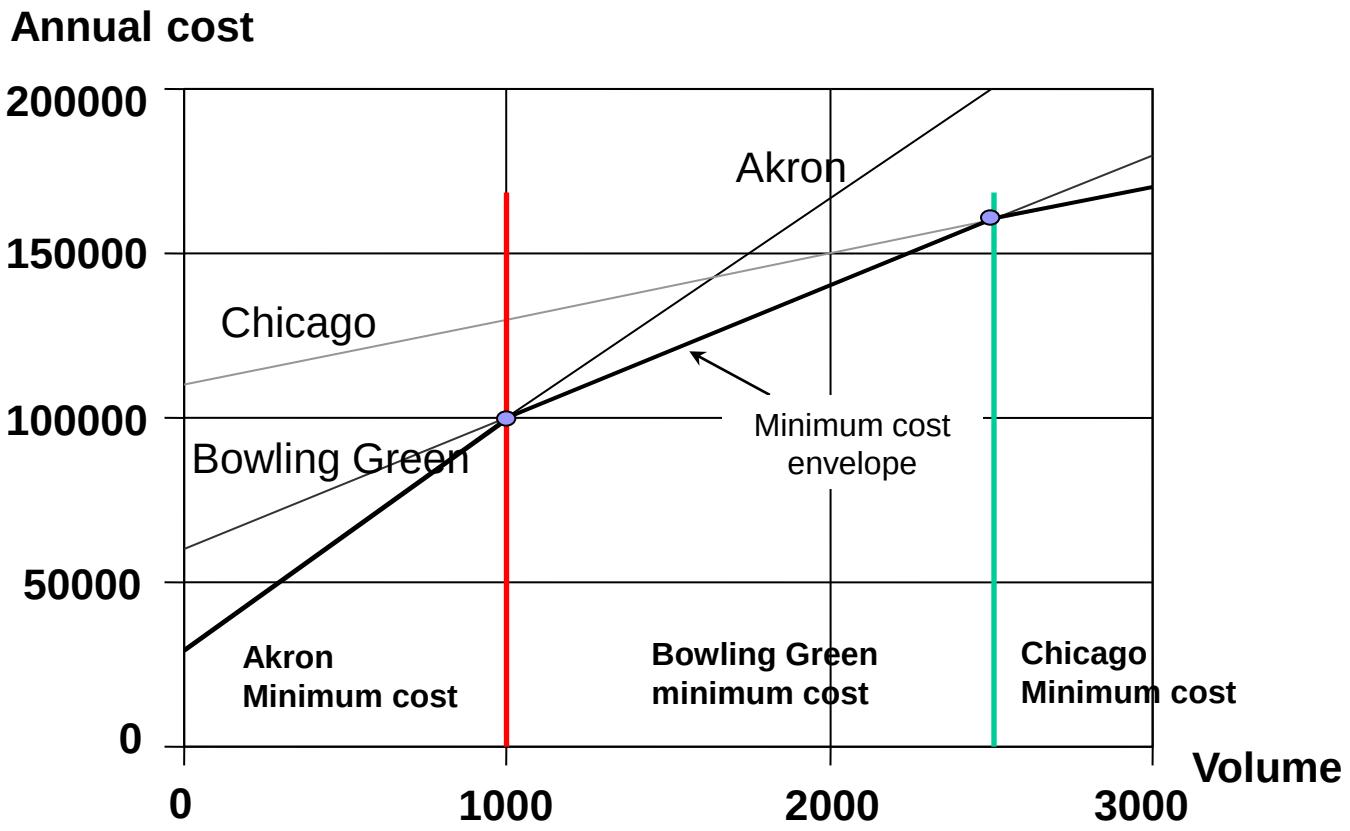
Example: AC Delco is considering the possibility of setting up a new plant at Akron, Bowling Green or Chicago. Fixed costs are estimated at $ 30,000, $ 60,000 and $ 110,000, respectively. Variable unit costs are estimated at $ 75, $ 45 and $ 25, respectively. What is the optimal location for a projected production volume of 2,000 units per year?

For each location, the total cost line is given by:

$TC = FC + VC \times Q,$
TC = Total Cost,
FC = Fixed Cost,
VC = Variable Cost,
Q = Production Volume

➔ Akron : $TCA = 30\,000 + 75 \times Q$
➔ Bowling Green : $TCBG = 60\,000 + 45 \times Q$
➔ Chicago : $TCC = 110\,000 + 25 \times Q$

COST FUNCTIONS



CTA = CTBG ➔ A ∩ BG = 1 000
CTBG = CTC ➔ BG ∩ C = 2 500

➔ The optimal location for a projected production volume of 2,000 units per year is Bowling Green.

METHODE DU CENTRE DE GRAVITE

Data:

- Distance between the locations considered (markets, points of sale...)
- Volumes to transport

Steps:

1. Placing existing locations on a two-dimensional space such as:
   - the choice of origin and scale is arbitrary
   - the relative distances are kept
2. Calculate the x and y coordinates of the center of gravity (i.e., location of the distribution center that minimizes the weighted distances)

Formulation:

d_{ix} = X-axis value of location i

- Coordinate x: $C_x = \dfrac{\sum_i d_{ix} W_i}{\sum_i W_i}$

W_i = volume of products transported to or from i

- Coordinate y: $C_y = \dfrac{\sum_i d_{iy} W_i}{\sum_i W_i}$

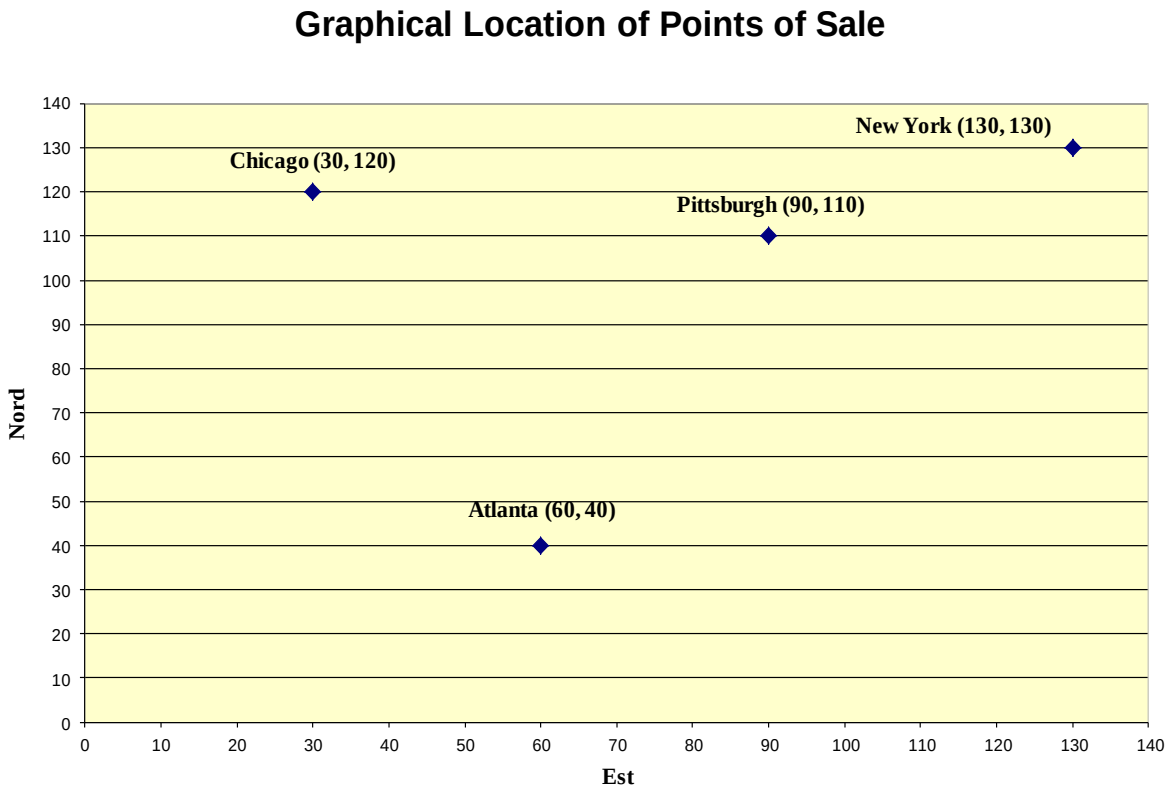
d_{iy} = Y-axis value of location i

APPLICATION

The Kmart distribution chain has four sales outlets respectively located in Chicago, Pittsburgh, New York and Atlanta. Kmart must decide on the location of a new warehouse to supply its points of sale, replacing a former warehouse now unsuitable located in Pittsburgh.

The problem data is provided below.

Points of sale	Monthly number of containers transported
Chicago	2 000
Pittsburgh	1 000
New York	1 000
Atlanta	2 000

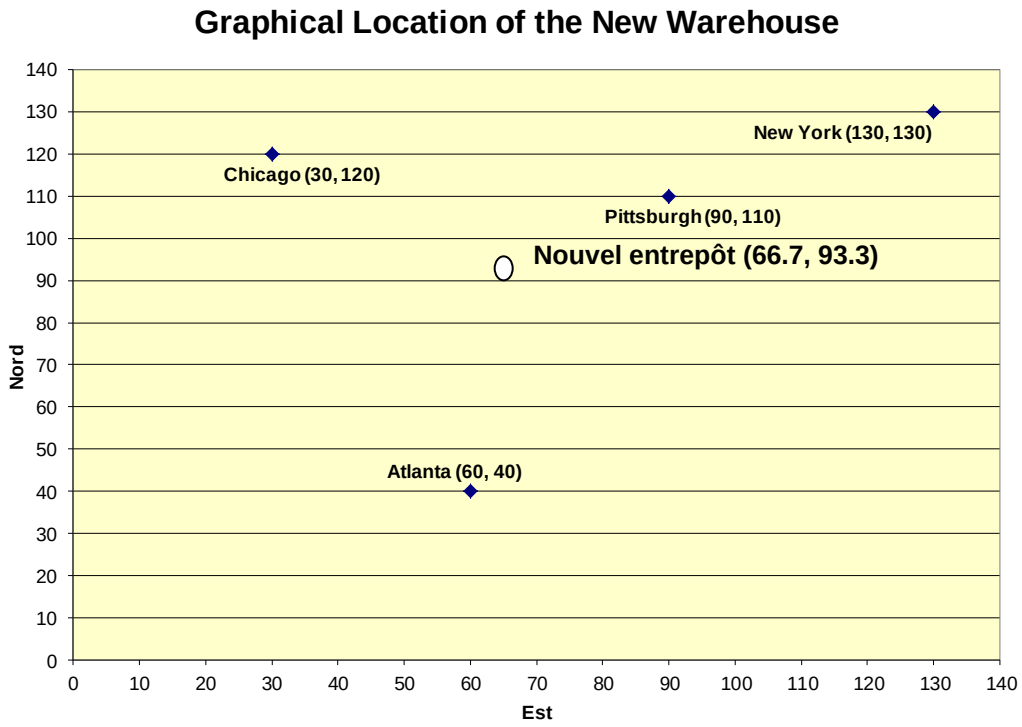


APPLICATION (Cont.)

The calculation of the coordinates of the center of gravity is given below.

$$Cx = \frac{(30)(2000)+(90)(1000)+(130)(1000)+(60)(2000)}{2000+1000+1000+2000} = 400000/6000 = 66.7$$

$$Cy = \frac{(120)(2000)+(110)(1000)+(130)(1000)+(40)(2000)}{2000+1000+1000+2000} = 560000/6000 = 93.3$$



By juxtaposing a map of the United States on the graph above, we see that the new warehouse must be located near Columbus (Ohio).

GRAVITY MODEL

Data:

- Contact information for sources of supply and markets (x_n, y_n),
- Volumes to be transported (D_n),
- Unit transport costs (F_n).

Formulation:

Let (x, y) be the desired location, the distance between this location and the source of supply *n* is:

$$d_n = \sqrt{(x - x_n)^2 + (y - y_n)^2}$$

The total transportation cost is given by:

$$TC = \sum_{n=1}^{k} d_n D_n F_n$$

=> The optimal location is the one that minimizes the total cost of transportation.

APPLICATION

Steel Appliances (SA) produces refrigerators at an assembly plant in Denver supplying the US market. As the demand for SA has increased significantly, the general management has decided to set up a new plant to supply the East Coast of the United States. The supply chain manager must determine an appropriate location for the new plant. Three factories in Buffalo, Memphis and St. Louis will supply components to the new assembly plant, which will serve Atlanta, Boston, Jacksonville, Philadelphia and New York.

The following table shows the coordinates of each source and market, the expected volume of demand in each market, the volume of components required from each component plant, and the cost of transportation for each source or market.

Supply/Markets	**Coordinates (x_n, y_n)**	**Quantities (tons) D_n**	**Cost of Transportation ($/ton/mile) F_n**
Sources of supply			
Buffalo	(700, 1200)	500	0.90
Memphis	(250, 600)	300	0.95
St-Louis	(225, 825)	700	0.85
Markets			
Atlanta	(600, 500)	225	1.50
Boston	(1050, 1200)	150	1.50
Jacksonville	(800, 300)	250	1.50
Philadelphie	(925, 975)	175	1.50
New York	(1000, 1080)	300	1.50

APPLICATION (Cont.)

	A	B	C	D	E	F	G	H
1								
2								
3		**Supply/ Markets**	**$/Ton/Mile F_n**	**Tons D_n**	**Coordinates**			
4					**x_n**	**y_n**	**d_n**	
5	**Supply**	Buffalo	0,9	500	700	1200	1389,244	
6		Memphis	0,95	300	250	600	650	
7		St-Louis	0,85	700	225	825	855,1316	
8	**Markets**	Atlanta	1,5	225	600	500	781,025	
9		Boston	1,5	150	1050	1200	1594,522	
10		Jacksonville	1,5	250	800	300	854,4004	
11		Philadelphia	1,5	175	925	975	1343,968	
12		New York	1,5	300	1000	1080	1471,87	
13								
14								
15	***Facility Location***							
16	**X =**	0						
17	**Y =**	0						
18								
19	**Cost =**	**3277109,65**						

Cell	Cell Formula	Copied to
G5	=SQRT(($B$16-E5)^2+($B$17-F5)^2)	G5 :G12
B19	=SUMPRODUCT(G5:G12;D5:D12;C5:C12)	-

Tools

⇓

Solver

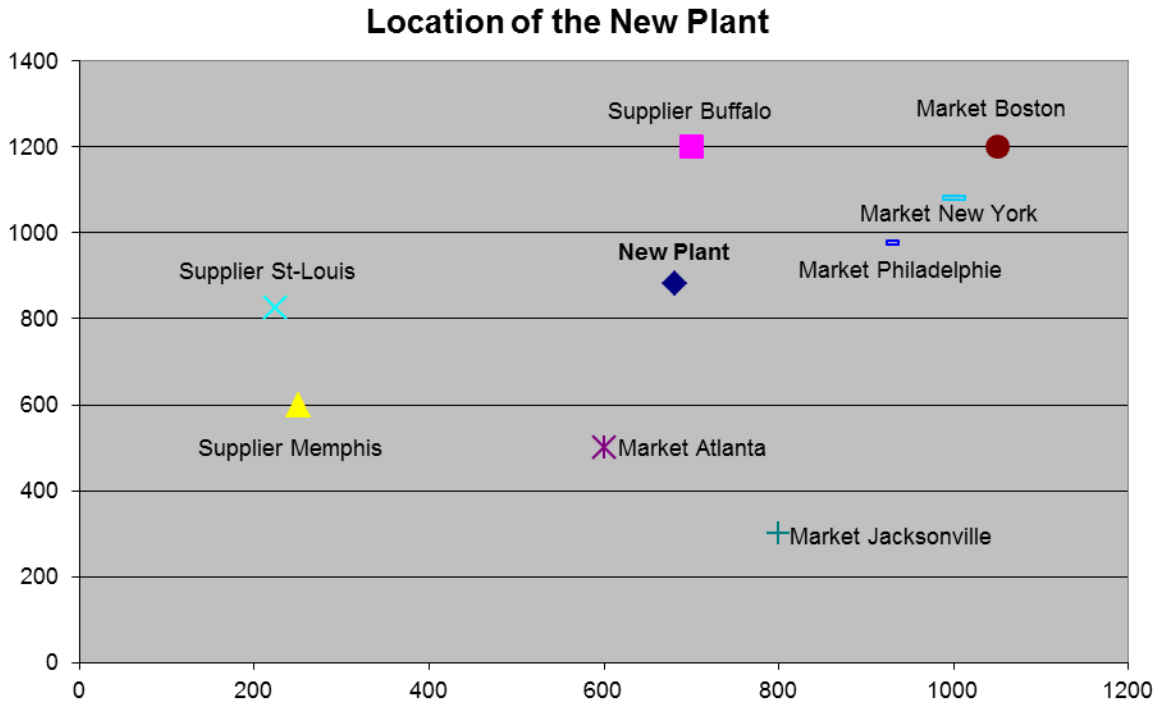
⇓

1. **Target cell : *$B$19***
2. **Equal to : *Min***
3. **By changing : *$B$16:$B$17***
4. **Solve**

APPLICATION (Cont.)

The supply chain manager identifies the coordinate point (x, y) = (681, 881) that minimizes the total cost of transportation, i.e., $ 1,265,235. On a map, these coordinates are close to the North Carolina border and Virginia.

These precise coordinates may not correspond to a feasible location. In this case, the supply chain manager must look for the sites near the optimal coordinates that have the required infrastructure and the appropriate skills.



N.B.: The solution obtained here differs from that obtained by the method of the center of gravity, insofar as the latter is an approximation of the former