



PROCESS ECONOMICS PROGRAM

SRI INTERNATIONAL

Menlo Park, California

94025

Abstract

Process Economics Program Report No. 119

CONSTRUCTION COSTS

This study compares the historical trends in chemical plant construction costs in Europe and Japan relative to the United States. As part of the study we developed plant cost-escalation indices for Japan and W. Germany (analogous to the U.S. PEP Cost Index which we have been publishing since 1975), and also established time-series for relative cost parameters for these locations.

Cost escalation indices for components representative of chemical plant were compiled from regularly published statistical data. The costs of the components for mid-77 were developed in cooperation with plant contractors and equipment vendors in Japan, W. Germany, and the United States. These two independent sets of inputs were then combined with the PEP data base of investment estimates for over 100 different chemical plants to generate the PEP Cost Indices for the three locations, and location factors for Japan and W. Germany relative to the United States.

To enable ready application of the data to generate "customized" indices, the mechanics of index and location factor construction are discussed in some detail. The purchasing-power-parity (parity rate) concept is examined and recommended as a useful tool for transnational comparisons and projections over periods when exchange rates fluctuate severely.

In addition, some tentative projections are made of plant cost escalation to 1981. Means to apply the data and techniques to other locations are discussed, and some suggestions are made on scaling of costs for screening estimates.

The results of the plant cost analysis show that subsequent to the floating of the exchange rates at the turn of the decade, the equivalent U.S. dollar cost (i.e., location factor) for chemical plant construction in both Japan and W. Germany rose steadily from its previously low levels (ca. 0.6-0.7) to almost unity by 1973, in line with the depreciation of the dollar. The complex consequences of the oil embargo have since given rise to changes in the location factor in which no single trend dominates. To the extent that currency exchange rates reflect relative inflation, a location factor oscillating around unity could be expected for both Japan and W. Germany in the medium-term future. However, with the substantial and continuing U.S. trade deficit and its effect on the exchange rates, excursions in these location factors well above unity may be expected at times.

Report No. 119

CONSTRUCTION COSTS
COMPARISON OF TRENDS FOR W. GERMANY,
JAPAN AND THE UNITED STATES

WALTER SCHLEGEL
WALTER SEDRIKS

contributions by

LESLIE A. CARMICHAEL
HIROKO ITOH
MAX SACKS

December 1978

A private report by the
PROCESS ECONOMICS PROGRAM

Menlo Park, California 94025

For detailed marketing data and information, the reader is referred to one of the SRI programs specializing in marketing research. The CHEMICAL ECONOMICS HANDBOOK Program covers most major chemicals and chemical products produced in the United States and the WORLD PETROCHEMICALS Program covers major hydrocarbons and their derivatives on a worldwide basis. In addition, the SRI DIRECTORY OF CHEMICAL PRODUCERS services provide detailed lists of chemical producers by company, product, and plant for the United States and Western Europe.

CONTENTS

1	INTRODUCTION.	1
2	SUMMARY	5
	Definitions	6
	PEP Cost Index.	8
	PEP Cost Index Values	10
	Location Factors and Parity Rates	19
	Chemical Plant Costs in Relation to GDP Expenditures.	28
3	COST INDICES AND RELATIVE COSTS--GENERAL CONSIDERATIONS.	33
	Background.	35
	Cost Indices.	39
	The Need for a New Chemical Plant Construction Index	40
	Features of the PEP Cost Index.	42
	Selection of Components for the PEP Cost Index.	43
	Weighting of the PEP Index.	46
	Individual Plant Indices.	47
	Industry Average Index.	54
	Derived Component Weightings for the PEP Indices for Europe and Japan.	58
	Index Projection.	63
	Location and Parity Factors	63
	Background.	63
	The Market Basket	70
	The Construction Cost Module.	71
	Time Series for Relative Cost Factors	73
	Parity Rates.	74
	Location Factors.	76
	Summary	78
4	UNITED STATES	79
	The Escalation in Plant Construction Costs.	80
	The PEP Cost Index for the United States.	81
	Construction Labor.	93
	Changes in the U.S. PEP Index	97
	Updating Past Estimates	100

CONTENTS

5	WEST GERMANY.	105
	The PEP Cost Index for W. Germany	105
	Index Components.	107
	Construction Labor and Engineering Construction Overhead Components	114
	Comparison of the W. German PEP Cost Index with Other Escalation Indices.	116
	Index Projection.	119
	Parity Rates and Location Factors	119
	Relation of Chemical Plant and GDP Parity Rates	130
6	JAPAN	135
	The PEP Cost Index for Japan.	135
	Index Components.	140
	Construction Labor Component.	143
	Index Comparison.	144
	Index Projection.	144
	Parity Rates and Location Factors	147
	Relation of Chemical Plant and GDP Parity Rates	155
7	OTHER COUNTRIES	157
	Developed Countries	157
	Developing Countries.	165
8	SCALING OF COSTS.	173
	Use of PEP Data	173
	Replication of Material	174
	Approximate Correlation from PEP Estimates.	178
	Example of Application.	180
APPENDIX A	SELECTIONS FROM THE MARKET BASKET	183
APPENDIX B	SUMMARY OF CHAPTER 3 NOMENCLATURE AND EQUATIONS	195
APPENDIX C	SUMMARY OF PROCEDURE FOR ESTABLISHING PEP COST INDEX, PARITY RATE, AND LOCATION FACTOR TIME SERIES.	197
CITED REFERENCES	199

ILLUSTRATIONS

2.1	United States--Comparison of Component Indices with PEP and CE Plant Cost Indices	13
2.2	PEP Plant Cost Indices.	15
2.3	Comparison of Plant Cost Escalation Rates as Measured by PEP Cost Indices	16
2.4	GDP Deflators	18
2.5	Plant Parity Rates, Exchange Rates, and Plant Location Factors for Japan and W. Germany Relative to the United States	22
2.6	Comparison of the U.S. PEP Cost Index with the Dollar Equivalent of the PEP Cost Index for Japan and W. Germany.	24
2.7	Comparison of the U.S. PEP Cost Index with the Parameter $I(\$) \cdot L_0$ for W. Germany and Japan.	25
2.8	W. Germany/United States--GDP Parity Rates and Location Factors	29
2.9	Comparison of Chemical Plant and GDP Parity Rates	31
3.1	International Comparisons of Economic Output per Employee.	44
3.2	Frequency Distributions of Individual Plant Indices (I_{mi}) for the United States	52
3.3	Variation of the Individual Plant Index Distributions	53
3.4	Expenditure Pattern for the Construction of a Typical Chemical Plant.	64
3.5	Exchange Rate Variation	66
4.1	United States--Comparison of Equipment Cost Indices with the CE Index	86
4.2	United States--Comparison of PEP and CE Plant Cost Indices	88
4.3	United States--Comparison of PEP Cost Index with the GDP Deflator and the ENR Building Index	90
4.4	United States--Comparison of PEP Index Trends with the Trend of the HPI Activities Count	92
4.5	Comparisons of Productivity Changes for Labor in Nonresidential Building	95

ILLUSTRATIONS

4.6	Comparison of Old and New PEP Cost Indices for the United States	99
4.7	Deviations Between the Old PEP Cost Index and the New PEP Cost Index for the United States.	101
4.8	Projections of U.S. PEP Cost Index to Mid-1981.	103
5.1	W. Germany--Comparison of PEP Cost and Other Related Indices	108
5.2	W. Germany--Comparison of Component Cost Indices with the Schulze Index (Net of Tax).	117
5.3	W. Germany--Projection of PEP Cost Index to 1981.	120
5.4	W. Germany--Comparison of PEP Cost Index Trends with Exchange Rate Movements	121
5.5	W. Germany/United States--Chemical Plant Parity Rates and Location Factors.	129
5.6	W. Germany/United States--GDP Parity Rates and Location Factors	131
5.7	Comparison of Chemical Plant and GDP Parity Rates	133
6.1	Japan--Comparison of PEP Cost Index with the GDP Deflator.	137
6.2	Japan--Variation of the Individual Plant Index Distributions	138
6.3	Japan--Comparison of Component Index Trends	145
6.4	Japan--Projections of PEP Cost Index to Mid-1981.	146
6.5	Japan/U.S.--Chemical Plant Parity Rates and Location Factors	151
6.6	Japan/W. Germany--Chemical Plant Parity Rates and Location Factors.	154
6.7	Japan/U.S.--GDP Parity Rates and Location Factors	156
7.1	Illustrative Example of Location Factor Projection.	159
7.2	Exchange Rate Index (ERI)	170
8.1	Plant Capacity in the United States, Eight Major Chemicals	175
8.2	Approximate Correlation of Scaling Exponents with Relative Plant Size	179

TABLES

2.1	Principal Components of the PEP Cost Indices.	11
2.2	PEP Cost Index Values	12
2.3	Plant Parity Rates, Exchange Rates, and Plant Location Factors for W. Germany and Japan Relative to the United States	21
2.4	U.S. Dollar Equivalent Indices, $I(\$)$, and Values of Parameter $I(\$) \cdot L_o$ for Japan and W. Germany.	26
3.1	Component Weights in the PEP Cost Indices	61
3.2	Comparative Shell Thicknesses for a Cylindrical Pressure Vessel	68
3.3	Comparative Construction Labor Costs.	73
4.1	U.S. PEP Cost Index Sources of Component Index Base Data.	83
4.2	U.S. Construction Cost Indices.	84
5.1	W. German PEP Cost Index Sources of Component Index Base Data.	109
5.2	W. German Construction Cost Indices	110
5.3	W. German Construction Cost Indices: Installation Subcontracted	112
5.4	W. German Construction Cost Parity Rates.	124
5.5	W. German Construction Cost Location Factors.	126
6.1	Japanese PEP Cost Index Sources of Component Index Base Data.	141
6.2	Japanese Construction Cost Indices.	142
6.3	Japanese Construction Cost Parity Rates	149
6.4	Japanese Construction Cost Location Factors	150
7.1	Plant Cost Escalation for the United States and the United Kingdom.	160
7.2	Relative Cost Parameters United Kingdom Versus the United States	161
7.3	Exchange Rates per U.S. Dollar.	168
7.4	Exchange Rate Index (ERI)	169

TABLES

7.5 Comparative Costs: Saudi Arabia Versus the United States	171
8.1 Component Scaling Exponents (No Replication).	178
8.2 Scaling Exponents Versus Relative Capacity.	180