2561595

MICHIGAN STATE UNIVERSITY LIBRARIES

3 1293 00594 5658

LIBRARY
Michigan State
University

This is to certify that the

dissertation entitled

A United States-Canada-Mexico Free Trade Area:
The Location Implications of an Integrated
North American Market

presented by

John Cameron Taylor

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Marketing

Donald J. Bowersox
Major professor

Date 1/30/91

MSU is an Affirmative Action/Equal Opportunity Institution

0-12771

PLACE IN RETURN BOX to remove this checkout from your record.
TO AVOID FINES return on or before date due.

DATE DUE	DATE DUE	DATE DUE
JUL 05 1995		
DEC 04 1995		
0 9 1995		
APR 1 6 1996		
NOV 05 1995		
FEB 2 8 1995		

MSU Is An Affirmative Action/Equal Opportunity Institution

A UNITED STATES-CANADA-MEXICO FREE TRADE AREA: THE LOCATION IMPLICATIONS OF AN INTEGRATED NORTH AMERICAN MARKET

Volume I

By

John Cameron Taylor

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Department of Marketing and Transportation Administration
Graduate School of Business Administration

1991

ABSTRACT

A UNITED STATES-CANADA-MEXICO FREE TRADE AREA: THE LOCATION IMPLICATIONS OF AN INTEGRATED NORTH AMERICAN MARKET

By

John Cameron Taylor

A North American integrated market may become a reality in the not too distant future. This research examines the logistics implications of integration from a firm's perspective. The research questions focus on how changes in the geopolitical and geoeconomic environments can be expected to effect distribution system configuration, total system cost, and logistics cost.

The potential impact of integration is examined using an established simulation model. The model allows the effects of several research variables on distribution system configuration and costs to be studied in an experimental setting. The research variables are the level of integration, tariffs, cross-border transportation rates and consumer demand. While the research is primarily conducted in a food industry setting, the consumer appliances and women's clothing industries are also studied.

Although conclusions are difficult to generalize beyond the data tested, indications are that integration could have a major impact on manufacturing and logistics operations. United States-Canada integration leads to shifts in manufacturing location, the assignment of Northeastern and Mideastern United States markets to new distribution centers sourced from Canadian manufacturing plants, and the utilization of West Coast distribution centers to serve cross-border markets.

Full integration of Mexico into the North American economy leads to exclusive Mexican manufacturing because of dramatically lower production costs. While this results in much lower total system cost, logistics cost increases substantially in order to secure the benefits of lower production costs at distant sources. Integration also establishes the need for a number of additional distribution centers to reduce transportation costs to Northern markets as much as possible.

There are several implications of the research. For theorists, the research illustrates the important relationship between production and transportation cost, and leads to generalizations concerning key location variables. For practitioners, the research underlines the importance of reevaluating distribution locations and operations on a

North American-wide basis in order to achieve lowest total cost trade-offs. For policy makers, the research provides insight into the likely impact of tariff elimination. The research also points out the importance of reducing barriers to cross-border trade so that consumers may benefit from North American-wide manufacturing rationalization.

Copyright By
JOHN CAMERON TAYLOR
1991

To Nancy, Lisa and Anne

In Memory of

JOHN LEWIS HAZARD

Teacher, Friend and Inspiration

ACKNOWLEDGEMENTS

This research would not have been possible without the assistance of many individuals who contributed their expertise and time.

I am especially indebted to the members of my dissertation committee. The committee was composed of Dr. Donald J. Bowersox, Dr. David J. Closs, and Dr. S. Tamer Cavusgil. Dr. Donald J. Bowersox, Chairman of the Committee, has been responsible for much of my professional development, and contributed long hours to the dissertation concept development, research implementation and dissertation writing effort. For this I am forever grateful and thankful.

Dr. David J. Closs devoted many hours to the simulation research. His knowledge of simulation modeling, and his patient assistance, were invaluable to the completion of this research. Dr. S. Tamer Cavusgil possesses a wealth of knowledge on international trade issues, and provided

helpful insights throughout the dissertation process. I wish to thank both Dr. Closs and Dr. Cavusgil for their many hours of assistance.

Dr. Robert W. Nason, Chairman of the Department of Marketing and Transportation Administration, provided much appreciated assistance and support throughout my Ph.D. program. I also wish to acknowledge the role of Dr. John L. Hazard in my professional development, and in this dissertation. He was a source of inspiration and knowledge, and will be missed.

Ms. Diane M. Smith and Ms. Jacklyn M. Tissot typed, word processed, and proofed countless drafts of the text, tables, and figures. Their professionalism is greatly appreciated.

I would also like to acknowledge the support of the Dialog Systems Division of A.T. Kearney, Inc., management consultants, for making available their simulation model, professional expertise, computer hardware and facilities. Several current and former A.T. Kearney employees offered much help. Ms. Laurie A. Taylor provided invaluable technical assistance on use of the model, as did Ms. Susan L. Oaks and Mr. Kerry J. Frey. A.T. Kearney is also

providing a post-doctoral research fellowship to pursue research directions discovered during the dissertation work, and I wish to thank them for all of their support.

I also wish to acknowledge and thank my mother and father for all of their support. My mother, Shirley M. Taylor, provided many hours of library and research assistance throughout the Ph.D. program. My father, Dr. Donald A. Taylor, has been a constant source of inspiration, and guided much of my early thinking on marketing, markets and trade.

Finally, I wish to thank my family - Nancy, Lisa, and Anne, for their patient understanding and countless hours of support. To my wife Nancy, I am most grateful. Her love and friendship made this research possible.

TABLE OF CONTENTS

Page

List Of Tables.....xv

List Of Figures.....xix

Chapter 1 - Introduction.....1
The Business Setting.....4
North American Economies and Their Economic Relationships.....4
Tariff Barriers.....8
United States-Canada Tariffs.....9
United States-Canada and Mexican Tariffs....11
Non-Tariff Barriers.....14
Current and Potential Trade Agreements.....15
United States-Canada Free Trade Agreement.....17
United States-Mexico Trade Agreements.....21
United States-Canada-Mexico Free Trade Agreement.....23
Corporate Reactions To North American Economic Integration.....25
Research Approach and Questions.....28
Methodology Overview.....32
Experimental Methodology and Simulation.....
Analysis Approach.....32
Model Data Development.....33

Chapter 2 - Literature Review.....37
Location Theory Related Literature.....37
Strategic Location Theory.....41
Classical Location Theorists.....41
Conceptual Theory - Cost Based Location Theory.....42
Conceptual Theory - Profit and Geography Based Location Theory.....44
Applicational Theory - Classical Location Theorists.....46
Logistics Oriented "Total Cost" Theorists.....47
Conceptual Theory - Total Cost.....49
Applicational Theory - Total Cost.....53
Applicational Theory - Variables.....55
Applicational Theory - Modeling.....55

"Total Profits" Location Theorists.....60
Conceptual Theory - Total Profits.....60
Applicational Theory - Total Profits.....62
Site Selection Theory.....63
Conceptual Theory - Site Selection.....64
Applicational Theory - Site Selection.....65
International Theory.....66
Conceptual Theory - International.....67
Conceptual Theory - Foreign Direct Investment.....67
Conceptual Theory - International Logistics.....72
Applicational Theory-International.....74
Research Variable Literature.....76
Extent of Country Market Integration.....77
Size of Country Market Demand.....78
Tariff Levels.....79
Cross-Border Transportation Rates.....80
Literature Synthesis and Application.....83

Chapter 3 - Methodology.....89
General Approach and Model Selection.....89
Model Selection and Operating Processes.....90
Modeling Approach.....94
Variable Definition.....95
Research Variables.....98
Industry Set Variables.....101
Dependent Variables.....109
Research Questions.....109
Model Data Development.....113
Market Areas.....113
Product Demand.....115
Facility Locations and Network Linkages.....121
Manufacturing Plants.....121
Distribution Centers and Transfer Points.....123
Network Linkages.....126
Facility Costs.....127
Production and Variable Handling Costs.....128
Variable Production Costs.....132
Variable Handling Costs.....133
Distribution Center Fixed Costs.....135
Inventory Carrying Costs.....136
Tariff Costs.....137
Transportation Rates.....139
Experimental Design.....146

Chapter 4 - Simulation Results and Discussion.....159
Validation.....159
Simulation Findings.....167
Research Question 1A - United States-Canada Basic Integration.....170
United States Results.....171
Canada Results.....177
Basic Integration Results.....178

Research Question 1B - United States-Canada Tariff Variation.....180
50 Percent Tariff Reduction Results.....180
100 Percent Tariff Reduction Results.....183
Research Question 1B - United States-Canada Freight Rate Variation.....185
10 Percent Freight Rate Reduction Results.....185
20 Percent Freight Rate Reduction Results.....187
Research Question 1B - United States-Canada Canadian Demand Variation.....188
Research Question 1C - United States-Canada "Most Likely" Environment.....189
"Most Likely" Results.....192
Research Question 1D - United States-Canada Cross Industry Comparison.....195
Consumer Appliances Industry Results.....197
Women's Clothing Industry Results.....200
Research Question 2A - United States-Canada-Mexico Basic Integration.....203
Mexico Only Results.....204
Integrated United States-Canada-Mexico Market.....206
Research Question 2B - United States-Canada-Mexico Tariff Variation.....209
50 Percent Tariff Reduction Results.....211
100 Percent Tariff Reduction Results.....213
Research Question 2B - United States-Canada-Mexico Freight Rate Variation.....216
10 Percent Freight Rate Reduction Results.....218
20 Percent Freight Rate Reduction Results.....219
Research Question 2B - United States-Canada-Mexico Mexican Demand Variation.....220
Research Question 2C - United States-Canada-Mexico "Most Likely" Environment.....221
"Most Likely" Results.....223
Research Question 2D - United States-Canada-Mexico Cross Industry Comparison.....226
Consumer Appliances Industry Results.....227
Women's Clothing Industry Results.....229

Chapter 5 - Conclusions.....233
Conclusions and Generalizations.....233
Summary of Conclusions By Research Question.....234
United States-Canada Integration Research Questions.....234
United States-Canada Basic Integration.....234
United States-Canada Variable Combinations.....235
United States-Canada "Most Likely" Environment.....237
United States-Canada Cross Industry Comparisons.....239

United States-Canada-Mexico Integration Research Questions.....242
United States-Canada-Mexico Basic Integration.....242
United States-Canada-Mexico Variable Combinations.....244
United States-Canada-Mexico "Most Likely" Environment.....247
United States-Canada-Mexico Cross Industry Comparisons.....247
Overall Generalizations.....250
United States-Canada Production Shifts.....250
United States-Canada Distribution Center Location Shift.....251
United States-Canada-Mexico Production Shift.....252
United States-Canada-Mexico Distribution Center Numbers and Location Shift.....253
United States-Canada-Mexico Total System Cost Changes.....253
Research Variable Impact on Location.....254
Implications.....255
Theory Relevancy.....255
Practitioners Relevancy.....262
System Evaluation and Logistics Cost Management Implications.....262
Organizational and Institutional Management Implications.....263
Specific Location Implications.....264
United States-Canada Integration.....265
United States-Canada-Mexico Integration....267
Policy Relevancy.....268
Future Research.....271
Simulation Modeling Research.....272
General Research.....274
Research Limitations.....276

Appendices

Appendix A Market Areas Definition and Percent of Country Demand by Market Area.....278

Appendix B Sales By Industry By Country.....296

Appendix C Production and Handling Cost by Industry by City.....303

Appendix D Food Industry Tariff Calculations.....320

Appendix E Mexican Freight Rate Calculations.....325

Appendix F Simulation Results.....327

List of References.....359

LIST OF TABLES

Page

Table 1 - North American Population, Gross Domestic Product and Trade 1989 5

Table 2 - Average United States and Canadian Tariffs By Country As Percent of Sale Price 1988 10

Table 3 - United States and Mexican Tariffs on Imports from Each Other As a Percent of Product Sale Price 12

Table 4 - United States-Canada Tariff Elimination Categories 19

Table 5 - Research Variables and Intensities Foods Industry 102

Table 6 - Industry Set Variables by Industry 105

Table 7 - United States-Canada Research Questions 111

Table 8 - United States-Canada-Mexico Research Questions 112

Table 9 - Simulation Schedule 147

Table 10 - Published Industry and Model Logistics Cost To Revenue Ratio 164

Table 11 - Findings - United States-Canada Basic Integration - Question 1A 172

Table 12 - Findings - United States-Canada Tariff Variation - Question 1B 181

Table 13 - Findings - United States-Canada Freight Rate Variation - Question 1B 186

Table 14 - Findings - United States-Canada Canadian Demand Variation - Question 1B 190

Table 15 - Findings - United States-Canada.....191
"Most Likely" Environment - Question 1C

Table 16 - Findings - United States-Canada.....196
Cross Industry Comparisons - Question 1D

Table 17 - Findings - United States-Canada-Mexico.....205
Basic Integration - Question 2A

Table 18 - Findings - United States-Canada-Mexico.....211
Tariff Variation - Question 2B

Table 19 - Findings - United States-Canada-Mexico.....217
Freight Rate Variation - Question 2B

Table 20 - Findings - United States-Canada-Mexico.....222
Mexican Demand Variation - Question 2B

Table 21 - Findings - United States-Canada-Mexico.....224
"Most Likely" Environment - Question 2C

Table 22 - Findings - United States-Canada-Mexico.....228
Cross Industry Comparison

Appendix A Tables

A1 - United States Market Area and Percent.....278
of Country Demand by Market Area

A2 - Canadian Market Areas and Percent of.....286
Demand by Market Areas

A3-1 - Mexican Market Areas and Percent of.....290
Demand by Market Areas

A3-2 - Mexican Urban Population by State.....292

A3-3 - Mexican Urban Population by Major City.....293

Appendix C Tables

C1-1 - Food Industry Variable Production Costs....303

C1-2 - Women's Clothing Industry Variable.....305
Production Costs

C1-3 - Consumer Appliances Industry Variable.....307
Production Costs

C2-1 - Food Industry Variable Handling Costs.....309

C2-2 - Women's Clothing Industry Variable.....312
Handling Costs

C2-3 - Consumer Appliances Industry Variable.....315
Handling Costs

C3 - Distribution Center Fixed Costs by City....318

Appendix E Tables

E1 - Mexican Freight Rates Over 20,000 Pounds...325

E2 - Mexican Freight Rates Under 20,000 Pounds..326

Appendix F Tables

F1 - United States Separate Market.....327

F2 - Canadian Separate Market.....328

F3 - Integrated United States-Canada Markets....329

F4 - United States-Canada 50 Percent Tariff.....330
Reduction

F5 - United States-Canada 100 Percent Tariff....331
Reduction

F6 - United States-Canada 10 Percent Freight....332
Rate Reduction

F7 - United States-Canada 20 Percent Freight....333
Rate Reduction

F8 - United States-Canada 15 Percent Canadian...334
Demand Increase

F9 - United States-Canada 30 Percent Canadian...335
Demand Increase

F10 - United States-Canada "Most Likely".....336
Research Environment

F11 - United States-Canada Cross Industry.....337
Comparisons Consumer Appliances

F12 - United States-Canada Cross Industry.....338
Comparisons Women's Clothing Three
Manufacturing Plants

F13 - United States-Canada Cross Industry.....340
Comparisons Women's Clothing Atlanta
Manufacturing Plant

F14 - Mexican Separate Market.....342

F15 - Integrated United States-Canada-Mexico.....343
Markets

F16 - United States-Canada-Mexico 50 Percent.....344
Tariff Reduction

F17 - United States-Canada-Mexico 100 Percent....345
Tariff Reduction

F18 - United States-Canada-Mexico 10 Percent.....346
Freight Rate Reduction

F19 - United States-Canada-Mexico 20 Percent.....347
Freight Rate Reduction

F20 - United States-Canada-Mexico 25 Percent.....349
Mexican Demand Increase

F21 - United States-Canada-Mexico 50 Percent.....351
Mexican Demand Increase

F22 - United States-Canada-Mexico "Most.....352
Likely" Research Environment

F23 - United States-Canada-Mexico Cross.....353
Industry Comparisons Consumer
Appliances

F24 - United States-Canada-Mexico Cross.....355
Industry Comparisons Women's Clothing
Four Manufacturing Plants

F25 - United States-Canada-Mexico Cross.....357
Industry Comparisons Women's Clothing
Atlanta Manufacturing Plant

LIST OF FIGURES

Page

Figure 1 - North American Continent Map.....7

Figure 2 - Total Cost Logistical Network.....54

Figure 3 - Location Strategy Factors.....96

Figure 4 - Facility Locations.....125

Appendix A Figures

A1 - United States Market Areas Map.....285

A2 - Canadian Market Areas Map.....289

A3 - Mexican Market Areas Map.....295

CHAPTER 1 - INTRODUCTION

As the last decade of the 20th century begins, the world geopolitical and geoeconomic order is in the midst of substantial change. In Eastern Europe and the Soviet Union market based economies that promise to unleash new competitive forces are emerging after decades of economic stagnation. In the Triad (Ohmae 1987) countries of Western Europe, Japan and the United States a new competitive parity has developed following years of American dominance. This new world order is also marked by increasing globalization of cultures, desires and earning power (Levitt 1983).

The globalization trend, while not strong enough to eliminate natural and artificial barriers across all countries, has been sufficiently strong to encourage regional economic integration between neighboring countries. These regional alliances permit greater country specialization to achieve comparative advantage and typically improve the standard of living for member countries (Garland, Farmer and Taylor 1990).

As a result of the above factors, and in order to obtain the scale economies present in the other Triad countries, the European Community (EC) has moved aggressively towards full regional integration through the process which has come to be known as "EC 92.". In response, the United States and Canada have moved to integrate their economies, and the three North American countries have announced negotiations which are expected to lead to a continentwide regional market which would include Mexico. United States companies have expressed a great deal of interest in the "EC 92" process but have paid less attention to the changes taking place on the North American continent.

The regional economic integration described above does in fact have a number of implications for North American firms. Garland, Farmer and Taylor (1990) describe the individual firm implications of regional integration as follows:

> "As countries integrate economically to increase efficiency and to improve economic performance, so to do enterprises integrate their international activities in order to improve profitability and long term competitive positions. The two developments are inseparable, and reinforce each other. Successful macrolevel integration is based on the behavior of firms, and successful firm-level integration derives from strategic responses to changes in the macroeconomic environment. When developments ensue such as that of the United States-Canadian Free Trade Agreement or "EC 92", it is essential that firms respond proactively to ensure viable economic positions."

But respond how? One major area of response must be in the manufacturing and logistics sphere, for the barriers being removed by economic integration could have a pronounced effect on the firm's overall distribution system. In fact, many of the efficiencies being sought at both a macro and micro level will come from realignments of corporate manufacturing and logistics systems which have been distorted to accommodate artificial barriers (Cecchini 1988). Those artificial barriers, in many cases, have been established by nation states in order to protect domestic industry.

The objective of this research is to examine the manufacturing and logistics implications of North American economic integration from the perspective of the firm. More specifically, the question is one of how changes in the basic geopolitical and geoeconomic environment can be expected to affect the distribution system configuration and cost of operations. The distribution system configuration is defined to include the number and location of both manufacturing and distribution center facilities. Cost of operations includes total system cost and separate logistics cost, excluding manufacturing and tariff costs.

In addressing the above question it is important to consider the impact of several variables including those of tariffs and cross-border transportation rates. Transportation rates

are important because, in many cases, failure to efficiently integrate results from a variety of transportation barriers and costs that impose penalties on cross-border moves. Answers to distribution system configuration questions are sought for both a United States-Canadian integrated market and for a potential United States-Canada-Mexico free trade area.

THE BUSINESS SETTING

Before analyzing the impact of economic integration on distribution system configuration, it is important to understand (1) the three North American economies and their economic relationships, (2) the nature of current and potential trade agreements on the North American continent, (3) and corporate reactions to North American economic integration. The following sections provide this background.

NORTH AMERICAN ECONOMIES AND THEIR ECONOMIC RELATIONSHIPS

As shown in Table 1, the North American countries of the United States, Canada and Mexico had a combined population of 360.1 million and a combined Gross National Product (GNP) of $5.9 trillion (all dollar figures in this document reflect United States dollars) in 1989 (Bank of Montreal

Table 1

North American Population,
Gross Domestic Product and Trade
1989

	United States	Canada	Mexico	Total North America	Total European Community
Population (Millions)	248.8	26.3	85.0	360.1	324.0
Gross Domestic Product ($ Billions)	5200.8	531.6	201.4	5933.8	4800.0
Exports ($ Billions)	370.0	121.0	22.8	513.8	NA
Imports ($ Billions)	480.1	115.9	23.4	619.4	NA

United States-Canada Trade	$167.0 Billion
United States-Mexico Trade	$ 52.0 Billion
Canada-Mexico Trade	$ 2.3 Billion

Source: Royal Bank of Canada (1990), "Mexico - U.S. Free Trade Talks: Why Canada Should Get Involved," Econoscope, Special Edition (September), Montreal, Canada, 1-12.

1990). In comparison, the 12 European Community countries have a combined population of 324 million and produce $4.8 trillion annually. Within the North American market, the United States population includes 248.8 million people (69.1 percent of the North American total), while Canada's population is 26.3 million (7.3 percent of the total) and Mexico's population is 85 million (23.6 percent of the total). In terms of Gross Domestic Product, the United States economy produces $5.2 trillion (87.6 percent) of the total GNP, Canada accounts for $531.6 billion (9 percent of the total), and Mexico accounts for $201.4 billion (3.4 percent) of the total. Figure 1 provides an overview map of the North American continent for reference purposes.

While the size of the Canadian and Mexican economies relative to the United States is small, there is considerable business interaction because of different areas of comparative advantage. The United States economy is generally regarded to have a comparative advantage in capital and technology, while the Canadian advantage is natural resources, and the Mexican advantage is in low cost direct labor. As indicated in Table 1, these variations in comparative advantage have led to total United States-Canada trade of $167.0 billion in 1989 and two-way trade between the United States and Mexico of $52.0 billion (Holstein and Borrus 1990). The United States-Canada trade ranks as the largest bilateral relationship in the world. For Canada,

Figure 1

North American Continent Map



sales to the United States represent 70 percent of its total exports. For the United States, exports to Canada account for 22 percent of the total (Tausz 1990). For regions of the United States bordering on Canada and Mexico the current trade also represents a significant share of total regional economic activity. For instance, Michigan, in 1989, exported $13.9 billion to Canada and imported $21.0 billion from Canada (Statistics Canada 1990).

The flow of trade is restricted by a number of tariff and non-tariff barriers between the three countries. The latter barriers consist of a number of governmental rules and practices that limit cross-border trade, or that make such trade more inefficient than would otherwise be the case. The non-tariff barriers also include the organizational and managerial practices of firms, many of which result in each country being viewed as separate and distinct markets, rather than as part of an overall integrated market.

Tariff Barriers

Tariff barriers to trade have been established by each of the three countries for imports from the others. The following section presents the United States-Canada tariffs. The second section contains information on tariffs between the United States and Canada and Mexico.

United States-Canada Tariffs

At passage of the United States-Canada Free Trade Agreement in 1988, Canadian tariffs averaged 9 percent of product value and United States tariffs averaged 4 percent of product value, although, some 70 percent of 1989 trade was already tariff-free under the provisions of the United States-Canada Auto Pact of 1965. The 1988 tariff levels have since been reduced approximately 20 percent by each country to comply with the Agreement. Table 2 provides a summary of 1988 directional tariff levels. The Table indicates Canadian average tariff percentages of 15.5 for prepared food, 16.9 for textiles, 23.7 for clothing, 14.3 for furniture, and 5 to 10 percent for most metal products. The tariffs on specific products can be quite high. For instance, many food preparations have a tariff percentage of 17.5, pasta with meat has a 17.5 tariff, mushrooms have a 20 percent tariff, spades and shovels 9.2, refrigerators 12.6, sailboards 15, men's cotton jackets 30, women's jackets and shirts 25, soap 10, deodorants 12.2, and so on (Canada-U.S. Free Trade Agreement Annex 401.2 1989).

For goods entering the United States from Canada, Table 2 indicates tariff percentages on food of 3.8 percent, on clothing of 18.4, furniture 4.6, glass products 5.7, electric machinery 4.5 percent to name a few. Tariffs percentages on specific products include margarine at 7,

Table 2

Average United States And Canadian Tariffs By Country As Percent Of Sale Price (1988)

	United States Tariffs on Imports from		Canadian Tariffs on Imports from	
	Canada	Other	U.S.	Other
Agriculture	1.6	1.8	2.2	1.8
Food	3.8	4.8	15.5	13.6
Textiles	7.2	9.1	16.9	16.4
Clothing	18.4	21.4	23.7	22.1
Leather Products	2.5	3.8	4.0	8.7
Footwear	9.0	8.9	21.5	21.9
Wood Products	.2	3.8	2.5	4.9
Furniture and Fixtures	4.6	2.9	14.3	14.1
Paper Products	0	1.3	6.6	6.5
Printing and Publishing	.3	.7	1.1	1.0
Chemicals	.6	3.5	7.9	7.0
Petroleum Products	0	.1	.4	.1
Rubber Products	3.2	2.0	7.8	6.5
Nonmetal Mineral Products	.3	7.2	4.4	8.5
Glass Products	5.7	5.8	6.9	7.9
Iron and Steel	2.7	3.9	3.1	4.5
Nonferrous Metals	.5	.8	3.3	2.7
Metal Products	4.0	4.4	8.6	8.9
Nonelectric Machinery	2.2	3.2	4.6	4.8
Electric Machinery	4.5	4.1	7.5	7.1
Transportation Equipment	0	2.5	0	2.5
Misc. Manufactures	.9	2.0	5.0	5.3
Average	.7	4.3	3.8	7.4

Source: Brown, Drusilla K. and Robert M. Stern, 1987, "A Modeling Perspective," in *Perspectives on U.S.-Canadian Free Trade Agreement*, Robert M. Stern, Philip H. Trezise and John Whalley, Eds., Washington, D.C.: The Brookings Institution.

mustard at 2, women's dresses at 25, refrigerators at 2.9, pasta at 10, soups at 10, ketchup at 7.5, hair preparations at 4.9, and soap at 3.1 (Canada-U.S. Free Trade Agreement Annex 401.1, 1989).

United States-Canada and Mexican Tariffs

Mexican tariffs were relatively high until the early 1980s. However, in recent years Mexico has undergone substantial liberalization. The maximum tariff on Mexican imports from the United States is now 20 percent with an average of approximately 10 percent. As indicated in Table 3, the Mexican tariff percentage for general food preparations is 20, for finished metal products 20, for most appliances 20, for lab instruments generally 10, and for clothing generally 20 (United States Department of Commerce 1990).

For imports to the United States from Mexico, one of two levels of tariff apply. For products originating in the special border zones, or "maquiladora" factories which perform in-bound assembly operations, imports to the United States fall under Sections 806 and 807 of the United States Customs Code. These Sections provide that goods will be subject to an ad valorem tariff only (a tariff applied to the value added in the manufacturing process). These ad valorem tariffs range from 2 to 12.5 percent of the Mexican value added. Because most of the componentry for such

Table 3

United States and Mexican Tariffs on Imports From Each Other As Percent of Product Sale Price

Description	Mexican Tariff On Imports From U.S. (Percent)	U.S. Tariff On Imports From Mexico[1] (Percent)
Food Preparations	20.0	10.0
Soaps without Meat	NA	7.0
Toothpaste	NA	4.9
Women's Blouses	20.0	16.4
Women's Dresses	20.0	17.7
Finished Metal Products	20.0	NA
Appliances - Refrigerators	20.0	10.0
Automotive Components	20.0	2.2
Floor Polishers	20.0	NA
Lab Instruments	10.0	NA

[1] May be tariff-free if general system of preferences eligible

Source: United States Customs Service, Telephone Interview with Import Specialist, October, 1990; and United States Department of Commerce, Mexican Tariff Schedules, 1990.

products originated in the United States, the tariff is primarily applied to labor costs incurred in the assembly process (McCray and Gonzalez 1989).

Goods imported to the United States from non-maquiladora operations are subject to the United States tariffs for "Beneficiary Developing Countries for Purposes of the Generalized System of Preferences" (GSP) for qualifying products. Tariffs range from 5 to 20 percent for many products, and are reduced to zero on a wide variety of products if the percent of Mexican local content is sufficient. For instance, as shown in Table 3, the tariffs on most prepared foods average 20 percent but are zero if the product qualifies for GSP treatment (United States Customs Service, 1990). The tariffs for non-food consumables and consumer appliances range from 2 to 10 percent and again can be reduced to zero for GSP eligible products. Textile imports are subject to a separate United States-Mexico Agreement that includes both quotas and tariffs. The tariff levels range from 15 to 20 percent.

Imports to Canada from Mexico vary substantially by product and generally range from 5 to 20 percent (Revenue Canada 1990). Most food preparations would be subject to a 5 to 15 percent tariff. For instance, Revenue Canada indicates that the tariff on mushrooms is 12.5 percent, and that the tariff

on mustard is 15 percent. Tariffs on clothing are generally the highest, while tariffs on metal products and electrical machinery fall into a middle range.

Non-Tariff Barriers

As indicated earlier, there are a number of non-tariff barriers to trade that are imposed by governments, along with several managerial practices that have the same effect. The governmental non-tariff barriers include quotas, taxation rules, customs rules, differing technical standards, discriminatory government procurement policies, travel restrictions, immigration work rules, investment restrictions, and exchange restrictions. Perhaps the most important of these barriers are the number of regulations, bureaucratic rules and other complexities that increase the cost or difficulty of physically moving product within a country or across borders. Foremost among these are the costs of cabotage rules which limit the operating rights of carriers to nationals of each country, the costs of immigration rules for transportation workers, and the costs of customs inspection and paperwork (Tausz 1989, 1990). These factors can make both intracountry and cross-border transportation more costly than would be the case in a free environment and can lead to a reduction in trade levels in favor of parallel manufacturing and distribution systems within each country.

Another non-tariff barrier to the free flow of goods, managerial practices, is also very important. For years, corporations have treated each country in North America as a separate market with unique manufacturing and logistics systems (Litvak 1988). This myopic view of individual countries, along with government barriers, has prevented firms from systematically evaluating the potential for cross-border manufacturing and logistics systems. The parallel systems approach, particularly with regard to United States-Canada operations, has been incorporated into a number of institutional practices which inhibit innovative thinking about free trade across the two countries. These institutional practices include separate legal entities, transfer pricing and profit splitting arrangements between legal entities, and organizational practices that isolate the operations in each country.

CURRENT AND POTENTIAL TRADE AGREEMENTS

The potential for economic integration between two countries or within a region, and the extent of efficiency gains that might be possible are determined by the underlying comparative advantage relationships between the countries. Whether or not such opportunities are taken advantage of depends in part on the extent and nature of artificial barriers between the respective countries. Regional trade

agreements, whether they be bilateral or multinational in scope, are designed to remove some of the barriers to the free flow of trade along lines of natural comparative advantage.

There are several levels of economic integration which can be addressed by trade agreements. One common classification system includes free trade areas, customs unions, common markets, economic unions, monetary unions, and finally, total economic integration (Garland, Farmer and Taylor 1990). The "free trade area" features an elimination of tariffs on trade between the countries, while allowing each country to establish its own tariff level on trade with external countries. The "customs union" goes one step further by mandating that member countries adopt uniform tariff levels with external countries. In the "common market" the free movement of all factors of production is added to the duty free goods provisions. The "economic union" features the addition of a common monetary unit and harmonization of member countries fiscal policies. In a "monetary union" there is further harmonization of monetary policy, and finally, with "total economic integration" there is complete unification of economic policy.

While the European Community has achieved the status of a common market, current and envisioned North American integration has been limited to the scope of a free trade

area with the exception of some features of the common market arrangement. These later features include provisions for some relaxation of restrictions on capital, labor and technology movements. The nature of the United States-Canada Free Trade Agreement, Mexico-United States Agreements, and a potential United States-Canada-Mexico trade area is covered in the following subsections.

United States-Canada Free Trade Agreement

The United States-Canada Free Trade Agreement was negotiated over several years and took effect on January 2, 1989. The Free Trade Agreement was subject to considerable debate in Canada and was, in effect, put to a national referendum in parliamentary elections called by Canadian Prime Minister Brian Mulroney in the fall of 1988.

The Free Trade Agreement will liberalize many aspects of trade between the United States and Canada over a ten year implementation period. The Free Trade Agreement includes several key components, one of which involves tariffs (Litvak 1988). The tariffs to be eliminated have been divided into three categories. Tariffs in the first group of products (Category A) were eliminated on January 1, 1989. Tariffs on the second category (B) of products are to be phased out over five years at the rate of a 20 percent reduction per year. Tariffs in a third category (C) of

products, considered to be most sensitive to competition, are being eliminated over ten years in equal installments. The Agreement also includes a provision which allows companies in an industry to petition for the early removal of tariffs subject to both government's consent. Over 400 products have already been made tariff-free under this provision. Some examples of the products in each category and the tariff elimination schedule are shown in Table 4.

In addition to reducing tariffs, the Free Trade Agreement will eventually eliminate Canadian duty remission programs which provide incentives for the use of Canadian auto suppliers in Canada, will liberalize trade in used cars, will liberalize temporary entry standards for professionals and salespersons, will partially end some agricultural quotas, prohibits discriminatory application of technical standards, and provides for a bilateral dispute resolution mechanism (Taylor 1990).

The Agreement does not result in as large an impact on technical standards, entry provisions, or services trade as some would have preferred. Nor does it deal with a number of transportation issues, especially cabotage laws, that inhibit the free and efficient flow of goods across the border (Tausz 1989). This latter omission results in continued immigration restrictions on the use of non-national drivers in point-to-point moves within a country.

Table 4

United States-Canada Tariff Elimination Categories

		TARIFF PERCENTAGES	
Item Tariff	Category	U.S.	Canada
Computers	A	3.0	9.2
Motorcycles	A	2.5	8.0
Calculators	A	2.0	3.9
Skis	A	1.0	11.4
Circular Saws	B	4.5	9.2
Refrigerators	B	4.5	12.6
Floor Polishers	B	4.5	12.5
Waste Disposers	B	4.0	12.5
Furniture	B	4.6	14.3
Prepared Food	C	3.8	15.5
Shovels	C	4.0	9.2
Freezers	C	4.5	12.5
Electric Tools	C	4.5	9.2
Men's Jackets	C	18.4	30.0

Source: Canada-U.S. Free Trade Agreement Annex 401.2, 1989.

The restrictions make it more costly to obtain backhaul loads and also require the payment of tariffs on non-national trucks used in domestic commerce. Most importantly, the Agreement does not deal with the maze of regulations, rules, and procedures that must be followed in order to conduct trade across the border. In fact, in many instances the Agreement has introduced new levels of complexity, such as in the case of "rule of origin" regulations (Hirsch 1990). These regulations require importers seeking treatment under the provisions of the Free Trade Agreement to prove that the product in question consists of at least 50 percent North American content. Such proof requires detailed and costly record keeping by the manufacturer.

Perhaps the most important feature of the Free Trade Agreement has been the psychological impact it has had on executives and consumers (United States International Trade Commission 1990). The Agreement has begun to focus executive attention on the continental nature of North American markets and on the potential efficiencies possible from an integrated manufacturing and logistics system. In select cases, barrier levels were sufficiently low to justify cross-national integrated distribution, however, a lack of awareness or focus on the potential resulted in the continuation of inefficient operations and systems. In other cases institutional practices such as legal entity

transfer pricing and exclusivity agreements have prevented management from acting on opportunities. Because of the potential for these types of suboptimizing factors, it is important to investigate how distribution system configurations might change in response to analyzing a total North American demand market, rather than examining each country separately as has been the traditional approach.

United States-Mexico Trade Agreements

Current United States-Mexican trade is either of a general nature or specifically related to the Mexican "maquiladora" program. General trade was highly restricted by the Mexican government until 1982 when the dissolution of the previous protectionist philosophy began. Since that time there has been increasing liberalization of Mexican trade tariffs and rules. In 1987, the United States and Mexico signed the United States-Mexico Framework Agreement, the most comprehensive trade agreement ever signed by the two countries (Smith 1989). The Agreement provides a framework for consultative mechanisms designed to liberalize trade. Consultative mechanisms of this type are extremely important because they have the potential to address a number of the regulatory and procedural issues that complicate United States-Mexico trade. The Framework is also a potential vehicle for future trade negotiations concerning a Free Trade Agreement.

The other dimension of United States-Mexico trade is the Maquiladora, or "Border Industrialization" program as it is officially known in Mexico. This program was designed to encourage investment in Mexico and was initially restricted to border communities. However, during the 1980s the program was expanded to allow investment in most areas of Mexico. Despite these changes, over 90 percent of the investments remain in the border area. During the 1980s the Mexican law changed to permit products produced in the zone to be sold within the country. Currently, some 67 percent of the investments in manufacturing plants is by United States owned firms. Japan, Korea, and other countries; however; have a growing presence in the Maquiladora program.

While there is not a specific United States-Mexico Agreement governing the Maquiladora zones, the exclusion from general tariff requirements serves the same purpose. Those exceptions allow machinery and components to be imported into Mexico on a tariff-free basis, and allow for foreign majority control of the investments (Greene 1989). However, the most important feature of the zones is the supply of inexpensive labor. Hourly compensation costs in Mexico are approximately 10 percent of United States levels. These labor costs, coupled with inexpensive transportation to relatively proximate United States markets, make the Maquiladora area an attractive manufacturing plant location.

The prospects for a future United States-Mexico Free Trade Agreement similar to the United States-Canada Free Trade Agreement are more likely now that the United States and Mexico have agreed to begin negotiations for such an agreement. The two countries agreed to negotiate an agreement the week of June 13, 1990 and the Bush Administration requested that Congress authorize "fast-track" approval procedures for such an agreement on September 26, 1990 (Maggs 1990). Negotiations are expected to take approximately two years. Such an agreement is projected to phase out all tariffs over a ten year period, eliminate many passenger and commercial transportation barriers, provide for intellectual property protection, and allow for freer movement of capital between the two countries (Koble 1988). The end result could be improved access to the relatively large Mexican market. Such areas could have a substantial impact on distribution system configurations designed to serve both countries. However, any such agreement is likely to retain many troublesome rules, regulations and procedural complexities that are major cost factors in cross-border business.

United States-Canada-Mexico Free Trade Agreement

Now that the United States and Mexico have agreed to negotiate an agreement there is speculation about a

potential North American-wide agreement (Wickens 1990, Lary 1989, Holstein and Borrus 1990). In fact, the Royal Bank of Canada (1990) released a report in September of 1990 advocating Canadian involvement in United States-Mexico free trade negotiations. Such an agreement would pool low cost labor, resources, capital, and technology into the largest trading block in the world. It is presumed that an agreement would be similar to the United States-Canada Free Trade Agreement but would be more likely to include additional agricultural and transportation related provisions (Green 1990).

The likelihood of an agreement increased substantially on September 24, 1990 when Canada announced that it would seek to join the imminent United States-Mexico negotiations (Journal of Commerce 1990). Since that time the United States and Mexico have agreed to Canadian participation. Canada will join the talks as a full partner as a result of this agreement. However, recent information indicates that the pace of the negotiations will not be held up in order to secure Canadian approval. Recent information also indicates that the United States and Mexico plan on completing an agreement in 12 to 15 months. Such a timetable is necessary in order to complete politically sensitive negotiations before the upcoming Mexican election.

CORPORATE REACTIONS TO NORTH AMERICAN ECONOMIC INTEGRATION

There are two general reactions to potential North American economic integration. Many United States multinationals respond to questions about the opportunity to rationalize their North American distribution system configuration with the statement that "they don't get involved in those kinds of issues because they have a separate Canadian subsidiary" (Taylor 1990)! Such responses emphasize the point that many managers do not fully understand or have not as yet focused on the opportunity. At the opposite end of the spectrum are firms that have moved aggressively to rationalize operations despite the continued existence of tariffs and other barriers. General Electric's consumer appliances division is a case in point. A recent article indicates that:

> "General Electric was one of the first to restructure its United States, Canadian and Mexican industrial strategy to take advantage of impending free trade. In June, General Electric is opening a gas-range plant in San Luis Potosi in central Mexico with an eye to supplying not only the United States but also Mexico and Canada. In General Electric's unfolding North American strategy, the largest mass-production facilities will be built in the United States, more specialized and flexible lines will be in Canada, and certain less sophisticated products such as gas ranges will be made in Mexico" (Holstein and Borrus 1990).

The General Electric strategy clearly summarizes the potential of a North American free trade area. The strategy

also raises the question of where specific manufacturing plants and distribution centers should be located to minimize total system cost.

Firms that are reacting to the United States-Canada Free Trade Agreement opportunities have generally made one of three types of accommodations. The first accommodation involves the specialization of United States and Canadian manufacturing plants along lines of comparative advantage in an effort to obtain increased economies of scale. The General Electric example typifies this response. Whirlpool provides a second example. The company is shutting down its 108 year old washing machine manufacturing plant in Toronto and shifting a portion of its dryer production to a new specialized manufacturing plant in Ontario. Avon, foreseeing a somewhat different opportunity, is specializing along geographic lines so that each facility can serve markets in its area on both sides of the border (Hawkins and Holstein 1989). Du Pont is dedicating one of its Canadian manufacturing plants to production of a fluorocarbon substitute and will serve all North American markets from the manufacturing plant (Journal of Commerce 1989). A final example of the dedication of manufacturing plants to North American-wide production can be found in the case of Campbell Soup. They have closed several manufacturing plants in the Eastern United States and focused production of low volume items in a Toronto manufacturing plant,

thereby doubling the size of the plant. The company says the new manufacturing plant will be serving a "North American common market" and that the United States-Canada Free Trade Agreement was a catalyst for the change in strategy (Wickens 1990).

The second kind of accommodation involves closing manufacturing plants that are not economically justified, rather than keeping facilities open and specializing production. A 1986 article in the Economic Development Review predicted that branch manufacturing plants, or manufacturing plants which were initially established in order to avoid tariffs, would close following elimination of those tariffs (Peters 1986). The same fate could be predicted for manufacturing plants that were established primarily because of the subsidiary's autonomous operations. In fact, there has been a rash of Canadian plant closings (Hawkins and Holstein 1989). For instance, Bilt-Rite Upholstery Co. Ltd. closed its Toronto manufacturing plant and moved production to Tupelo, Mississippi. Florsheim Shoes and Gillette both closed Canadian manufacturing plants recently and transferred production to United States manufacturing plants (Schulz and Rosenfeld 1990).

The third accommodation to the United States-Canada Free Trade Agreement has been the establishment of new manufacturing plants and/or distribution centers near the

border. As multinational companies specialize production in manufacturing plants to service North America-wide markets there is an increasing need for distribution centers where products can be mixed into assortments and consolidated for customer shipment. Several such distribution center facilities have been established in the Buffalo, New York area (McConnell and MacPherson 1990).

These accommodations raise a number of questions as to why companies chose the distribution system configuration described. The accommodations also lead to questions about what the optimum distribution system configuration sites and service areas might be in various situations. These motivations form the basis for the formal research approach and questions described in the next section.

RESEARCH APPROACH AND QUESTIONS

Discussions with a number of executives verify that, for those who have focused on the issue, there is considerable interest in the impact of economic integration on distribution system configuration. These discussions substantiate that several North American firms are evaluating distribution system configuration redesign and rationalization to exploit new opportunities. Discussions with executives also indicate that various newcomers to the

North American market, such as Japanese firms, and Canadian or United States firms that currently serve only their home country market, are considering the impact of integrated markets. Firms are attempting to determine what their specific distribution system configuration designs should be in an integrated environment.

The research objective, therefore, is to help gain an understanding of the impact of integrated markets on distribution system configuration design. There are two elements to this objective. First, the research is designed to help firms answer basic questions about the way in which distribution system configurations should change as a result of free trade. Secondly, the research is designed to provide location theoreticians with an understanding of the impact of individual variables on location decision making. In order to fully address both elements of the objective the research is conducted for both United States-Canada and United States-Canada-Mexico integration environments.

The research objective is investigated by modeling a typical manufacturing and distribution system for the food industry, assuming parallel facilities in each country, and then evaluating the changes in distribution system configuration that results from integrating country markets. The impact of changes in individual variable intensity, and the impact of the "most likely" combination of research variable

intensity levels is then tested. Finally, the effect of a change in industry characteristics under the "most likely" integration environment is investigated to determine the consistency and generalizability of findings. Two additional industries are considered in this latter step -- consumer appliances and women's clothing.

The above industries were selected for several reasons. First, they represent a cross-section of industrial activity. Both durable and packaged goods are represented, as are a wide range of price levels. Secondly, the industries were selected because they offer a range of unit volumes, weights, and product values. This range of characteristics, and the resulting differences in total transportation costs, production costs, and inventory carrying costs are important for testing the consistency and generalizability of results. Finally, these industries were selected because each has expressed interest in the potential for North American integration.

From an experimental standpoint it is necessary to identify the appropriate research and dependent variables. The research variables, which emerge from the literature review in chapter two, are 1) the extent of country market integration, 2) the size of country market demands, 3) tariff levels, and 4) cross-border transportation rates. These variables are modified on an individual basis, and in

combination so as to represent several economic integration environments. An additional range of model "set" variables, such as potential manufacturing locations, market locations, handling costs, product weight and production costs are necessary to operationalize the model but are not treated as research variables which would change as a result of economic integration. Some of these "set" variables are representative of specific industries and are modified in the model to replicate each industry being studied. An example of such a variable is product weight, which changes depending on the industry. The dependent variables are 1) distribution system configuration, 2) total system cost, and 3) logistics cost.

The specific research questions are detailed in chapter three. They are summarized below to provide a general idea of the research scope. The research questions first examine the potential impact of serving a combined United States-Canada market under several research variable environments. the questions are then repeated with the Mexican market also integrated. The general questions are:

1. What is the appropriate distribution system configuration, and what are the cost implications of serving integrated markets, assuming the initial research variable environment?

2. How do changes in specific research variables such as tariff levels, cross-border freight rates and demand size affect the distribution

systems configuration, and how does the "most likely" combination of these future variables affect configuration and costs?

3. How do changes in industry effect the distribution system configuration and cost?

METHODOLOGY OVERVIEW

The experimental methodology and simulation analysis approach are considered in the next section. An overview of the model data requirements is provided in the following section.

EXPERIMENTAL METHODOLOGY AND SIMULATION ANALYSIS APPROACH

The research questions are addressed using an experimental methodology that incorporates a simulation model to test controlled combinations and levels of the four research variables. The approach permits various situational environments to be tested in a controlled manner thereby allowing the resulting impact on distribution system configuration and system cost to be isolated. The experimental methodology also permits the impact of individual variables to be tested on a controlled cause and effect basis.

For a given set of research variables and facility location options the simulation model will identify the low cost

distribution system configuration from among the set of optional sites, assign market areas to the selected facilities, and quantify costs for the system. The simulation model accomplishes this by projecting total cost required to serve market demand from each potential manufacturing plant and distribution center combination and selecting the low cost option for each market.

For each research question a research design incorporating a series of simulations has been identified to address the relevant issues. Each simulation represents a unique situational environment of research and industry variables. The specific simulation runs and the treatment of research variables is presented in chapter three.

MODEL DATA DEVELOPMENT

The simulation model data has been collected for the food industry first. Data is factored up or down to reflect different industry environments to accommodate test conditions. Several categories of information are required by the simulation model.

The first category of information includes the location of potential manufacturing plants, potential distribution center sites, the definition of market areas within each country, and the definition of product characteristics.

While not research variables for the purpose of this investigation, the manufacturing plant location and product characteristics data are modified in the model to reflect the industry being studied in any given simulation run.

The second category of information is the demand data for each country, and for each market area within the country. The countries included in a given simulation (the first research variable) vary depending on the extent of economic integration being studied. The size of the demand in a country (the second research variable) also is varied depending on the environment being modeled. Demand levels are based on an estimate of typical company sales in each country for the industry, and are spread by market area based on the population ratio of each area to the country total. The company sales figure for each country is estimated in one of several ways, primarily by obtaining an industry size relative to the United States and assuming a market share to arrive at company sales. Demand is further segmented based on an assumed mix of customer order sizes.

The third category of data required by the simulation model is information on production costs, fixed and variable handling costs at facilities, and inventory carrying costs. Information on production costs and variable handling costs is based on typical United States cost levels for the industry in question. Ratios based on total hourly

compensation levels and direct labor as a percent of cost of goods sold are used to determine average variable production costs in Canada and Mexico overall. Production and handling costs at locations around the United States and Canada are varied based on an index of wage costs by region of the country. Mexican costs are assumed to be the same in each city.

Flow costs make up the fourth category of simulation model information requirements and include the transportation rates from facility to facility and from facility to market area, along with the relevant tariff. While the simulation model requires information for all possible facility/market links which can be used, the research variable being subjected to experimentation is the cross-border transportation rate linkages (the third research variable). This is because economic integration will primarily affect the level of cross-border transportation rates. The transportation rates are based on actual or estimated data for the individual countries and for cross-border linkages. Mexican transportation rates are based on selected data for key links. Cross-border Mexican transportation rates consist of the United States portion of the link and the Mexican portion of the link in combination. Typical industry tariff levels are tested based on average rates and experimentally varied to reflect other rate levels on a "what-if" basis (the fourth research variable). The

underlying freight rate and tariff is included in the model transportation freight rate link from a technical standpoint so as to reflect variations in tariff levels by source country.

CHAPTER 2 - LITERATURE REVIEW

The literature review addresses location theory and material on the initial level of key research variables. The first section focuses on several dimensions of location theory. The second section discusses the key research variables.

LOCATION THEORY RELATED LITERATURE

The principal objective of this research is to determine the impact of North American economic integration on distribution system configuration and cost. Fortunately, there are three bodies of location theory literature which are directly applicable to the topic. That literature begins with the work on strategic location theory and includes contributions from the classical location economists, logistics based total cost theorists, and more recent work which focuses on a "total profits" orientation. Secondly, there are several contributions from the site selection literature. Finally, there are a number of

relevant contributions from the international foreign direct investment literature. The international logistics literature is also reviewed in this latter section.

The literature review considers the contributions of each literature discipline in the order described above. Each literature discipline is assessed to determine the key contributors, and then analyzed to determine the relevant theoretical contributions. Following the literature review a synthesis of the material is offered and the appropriate theoretical perspective and research variables for this investigation are selected. The determination of the appropriate theoretical perspective is based in part on the approach which is best applied to the location questions which have been raised and in part on the approach which best reflects the environment of economic integration across countries.

There are two important dimensions to applied location theory. The first is the conceptual theory which underlies the overall theory. The second is the applicational theory which allows the location theory to be applied to real problems. A useful location theory must contain both of the above elements (Bowersox 1958). Each literature base is first reviewed to determine the underlying conceptual theory. Secondly, the literature is reviewed to gain an understanding of how the conceptual theory is applied to

location problems. The applicational theory generally deals with the types of analysis tools which can be used to apply the concepts, and with the variables that are incorporated in the theory. The review of each literature includes an assessment of the critical variables to be considered. Given the above approach, the review of each literature base includes two dimensions: conceptual theory and applicational theory.

Strategic location theory has evolved over the years from an orientation that was primarily conceptual and macro-economic (i.e. Von Thunen 1826, Weber 1929, Palander 1935, Hoover 1937, Losch 1954, Hotelling 1929, Greenhut 1952) to one that has increasingly focused on applicational or micro-economic dimensions (Lewis, Culliton and Steele 1956; Forester 1958; Magee 1960; Parker 1962). At the same time, the factors that location theory has emphasized have changed several times during the last century. The work of the classical economists tended to be cost oriented initially (Von Thunen 1826, Weber 1929, Palander 1935, Hoover 1937) but then evolved into a consideration of geographic and profit oriented factors (Losch 1954, Greenhut 1956, Yaseen 1956). As location theory became more applicational however, the focus returned to measurement of total system costs (Holmes 1930; Keefer 1934; Atkins 1952; Yaseen 1956; Brink 1957; Lewis, Culliton and Steele 1956; Shycon and Maffei 1960; Smykay 1959; Bowersox 1960; Magee 1960; Smykay, Bowersox and

Mossman 1961; Gordon 1969; Bowersox, Helferich and Marien 1971; Geoffrion 1976; Mossman, Bankit and Helferich 1977; Helferich and Closs 1979; Bender 1985; Bowersox, Closs and Helferich 1986). The focus on cost did, however, take into account both geographic dimensions of demand and plant location, and the economic costs considered by the early classical economists. More recently, in both the micro-economic and logistics literatures, there has been an increasing focus on the "total profit" aspects of location theory (Greenhut and Ohta 1975; Greenhut, Norman and Hung 1987; Ingram, Bayne and Gassaway 1986; Hodder and Jucker 1985; Burbridge 1986; Hanjoul and Peeters 1987; Logendran and Terrell 1988; Bowersox and Closs 1989; Hanjoul, Hansen, Peeters and Thisse 1990).

The site selection literature has focused on applicational theory, and specifically on the variables which should be taken into account in examining location alternatives (Gabe 1984; Shackleford 1984; Thompson and Harding 1985; Epping 1986; Gage 1987; Darragh 1989; Lopez and Henderson 1989; Whitney 1989; Artman and Clancy 1990). International location theory, however, has tended to focus much more on conceptual theory, although there are several contributions of a more applicational nature that involve practical location decisions. (Calvet 1981; Buckley and Casson 1985; Dunning 1988; Dunning 1989; Hodder and Jucker 1985; Hodder

and Dincer 1986; Arcelus 1989). Several international logistics contributions are oriented towards both conceptual theory and applicational theory.

The following sections examine the contributions of each literature base.

STRATEGIC LOCATION THEORY

Strategic location theory includes the work of the classical location economists, the work of the spatial/temporal integration or "total cost" theorists, and more recent work by economists and logisticians on the need for location theory to be based on profit maximization. Each of the works is reviewed in the following sections.

Classical Location Theorists

Early location theory emerged from the German classical school of economics. The German school received only minimal recognition through the mid 1900s because of the prevailing acceptance of Ricardo's differential rent theory (Bowersox 1960). That theory assumed all firms were located in the same space and hence there was no need to consider the differential impact of location. However, as the concepts of spatial monopoly and monopolistic competition were introduced by Chamberlin (1956), concepts that had

their roots in the German school, increasing attention was focused on location theory (Bowersox 1960). This focus was due to the recognition that location could play an important role in securing a differential advantage for the firm.

The classical location economist's work evolved from a cost focus to a consideration of cost and geographic factors. The latter focus eventually led to a profit maximization approach. However, the classical economist's work dealt with manufacturing plant locations, and did not specifically address distribution center location decisions.

Conceptual Theory - Cost Based Location Theory

The earliest location work is generally acknowledged to be that of Von Thunen (1826). Von Thunen's theory of location was oriented towards an investigation of the types of farm commodities that would be produced in various locations relative to a central city. He assumed a single city, identical cost suppliers, and transport cost as a function of weight and distance. His theory stated that price would equal the origin price plus transportation cost and implied that farm location was dependent on weight relative to value. He went on to suggest that heavier products relative to value would be produced nearer to markets than those of a lighter weight relative to value. Von Thunen's principal

contribution was in stimulating thought about the importance of transportation cost in location decisions (Richards 1972).

Alfred Weber (1929), however, was interested in determining the manufacturing location of a particular type of product. Weber assumed multiple consumption points and the potential for differential production costs. According to Richards (1972), Weber argued that if all other costs were equal, manufacturing would gravitate to areas where transportation costs for inbound raw materials and outbound finished products were minimized. This led Weber to hypothesize that products which gained weight in manufacturing would be produced near markets, while products that lost weight in manufacturing would be located near raw material sources. He went on to suggest that if production costs varied, manufacturing would shift to sites where labor savings exceeded transportation cost penalties. Finally, Weber discussed what he termed "agglomerating forces." These forces related to the presence of auxiliary industries, retail outlets, or location economies of scale that could determine a location when transportation costs and production costs were equal at all sites. According to Greenhut (1956), Weber purposefully excluded variables such as taxes, insurance and interest on the grounds that these were temporary phenomena that could change at any time. Instead, Weber believed it appropriate to focus on natural

factors. Weber's contribution was to extend the analysis beyond transportation costs and to raise cautions about the inclusion of non-natural variables. However, he did not explicate a means for analyzing transportation and production costs jointly.

Hoover (1937) describes specific factors which influence the location of a given industry according to Richards (1972). His work studies forces leading to the concentration of industries, but still relies primarily on differences in transportation costs. According to Bowersox (1960), Hoover's task was to:

> "formulate principles governing the interrelation of plant locations, the significance of location change, and the legitimate scope of public planning and control."

However, Bowersox (1960) goes on to suggest that Hoover's primary contribution was to modernize the works of Weber.

Conceptual Theory - Profit and Geography Based Location Theory

Losch (1954) was one of the first spatial economists to reject the concept of cost based location decisions. His primary contribution was to suggest that location should be based on the concept of profit maximization. Losch assumes a plane with an even distribution of raw materials, uniform

transport rates, and a homogeneous population evenly distributed. Losch then assumes that sales intensity will be higher for market areas closer to a manufacturing point, and lower as the product is sold further into the hinterlands. Based on these assumptions Losch's generalized theory states that each firm will service circular market areas around the highest demand potential locations. Between these circular areas are islands that no firm can serve at a profit. Eventually Losch hypothesizes that small-scale firms will emerge to serve each of the spatial islands. The weakness of Losch's theory is that it focuses too much on demand and assumes away cost differences.

Greenhut's 1956 work also took explicit account of demand influence, and hence profitability, in explaining manufacturing plant location. His theory also considered the impact of differential costs by location. Greenhut postulated that infinitely inelastic demand leads to centralized manufacturing, and that infinitely elastic demand leads to manufacturing in market areas because price increases due to freight costs eliminate demand. Greenhut succeeded in integrating least cost analysis with the geographic dimensions of locational interdependence in a way which allowed for location decisions to be conceptualized in terms of total profits.

Applicational Theory - Classical Location Theorists

The primary contribution of the classical location theorists was conceptual, however they did help to identify key variables of interest, and there was some contribution to procedural approaches. The key variables that emerged were those of transportation costs, both inbound and outbound, and production costs. Losch and Greenhut also addressed the demand variable.

Three separate authors played a major role in shaping early applicational theory according to Bowersox (1958). Holmes, in 1930, presented one of the first attempts to describe a location procedure. He described a three stage process in which the general territory is selected first, a community is selected next, and an actual site is selected as a third step. Holmes summarized his approach as one of selecting the location with the "least delivered-to-customer cost." Atkins (1952) developed a brief outline of the procedure which should be followed in solving an actual location problem. He suggested a two-step process in which the general area is selected, and then a second step in which the specific community is studied. Yaseen described a third approach in 1956. His recommended approach involved self-evaluation of requirements first, an analysis of alternative communities secondly, and actual site selection third.

Several rudimentary modeling approaches were inspired by the conceptual theories developed by the classical location economists (Bowersox 1960). Among these were conceptualizations based on the ton-center, mile-center, ton-mile center, and time-ton-mile center. Each conceptualization makes different assumptions about what the least cost transportation system is based on (i.e. distance in miles, weight, time, or some combination). One application of the ton-center concept was known as the "BB method" and involved the use of a cardboard plane and BB's placed to represent the tons of demand in various market areas shown on the cardboard. The fulcrum point of the cardboard was then selected as the center of gravity, or least cost manufacturing point (Keefer 1934). More advanced applications involved the adoption of Cartesian coordinate systems and analog computers (Brink 1957, Smykay 1959). Generally, with each of these approaches the emphasis was primarily on transportation costs, however, the beginnings of a more advanced "total cost" approach to analysis were apparent.

Logistics Oriented "Total Cost" Theorists

The logistics oriented "total cost" theorists represent the next step in the evolution of location theory. Their work is an extension of the total cost concepts that were developed by classical location economists such as Weber

(1929) and Holmes (1930). The new theorists built on the older classical work with solid conceptual contributions of their own. However, unlike the classical location economists, the new theorists were much more interested in applicational theory. This interest in procedure, or in problem-solving, was in part due to the contributors increasingly being aligned with the field of business administration - either as academics in college's of business or as business practitioners and consultants (Lewis, Culliton and Steele 1956; Forrester 1958; Magee 1960; Smykay, Bowersox and Mossman 1961; Flaks 1963; Bucklin 1965; Heskett 1966; Bowersox, Smykay and LaLonde 1968; etc.).

The other important distinction between the classical economists work and that of the total cost theoreticians is the latter's focus on distribution center or warehouse location decisions. While both groups of work are applicable to the location of manufacturing plants, the classical economists did not discuss distribution center location in any significant way. The focus on distribution center location displayed by the total cost school makes it an especially important body of work for the problem being addressed in this research.

Conceptual Theory - Total Cost

As the "total cost" approach evolved from the classical work an increasing number of cost variables were identified as being relevant to the location decision. Among the cost categories that were detailed as being relevant were the classical transportation cost categories, production costs, communication costs, order entry costs, etc. (Wassmansdorf 1960). However, the new theorists also began focusing on a number of costs related to inventory. An important contribution was the concept of inventory carrying costs. The concept of inventory carrying costs allowed the analyst to begin with balance sheet inventory and convert the inventory to a number which could be added to other P and L costs. The transportation costs were classified as spatially oriented, while the inventory costs provided a temporal dimension (Forrester 1958). This focus on temporal costs was important because previous least cost location decisions had been made on the basis of reducing spatial costs alone.

Work by Lewis, Culliton and Steele (1956) and Forrester (1958) combined the spatial and temporal dimensions and permitted an integrated least cost solution which included both factors. An article by Heskett in 1966 entitled "A Missing Link in Physical Distribution System Design" focused on the need to integrate the spatial and temporal dimensions

of location planning. Spatial/temporal integration proved to be a major theoretical development because it allowed for an analysis of both cost to cost and cost to service tradeoffs in planning distribution center locations. By integrating all relevant costs into one solution, the analyst was able to develop a least cost solution for the entire system, rather than simply reducing the costs of one particular distribution function at the expense of another. For instance Lewis, Culliton and Steele (1956) demonstrated that air freight could reduce total system cost by reducing inventory costs, even though transportation costs would be dramatically higher than in a traditional transportation system.

A key to understanding the appropriate number and location of distribution centers is to understand the theoretical rationale for the inventory they might hold, and the theoretical rationale for the warehouses themselves. In 1957 Alderson wrote on the rationale for inventory and warehouses. Bucklin (1965) provided additional insights on when inventory would appear in the system. In their analysis, inventory or the lack of inventory, is based on the competing forces of postponement and speculation. The firm postpones a commitment to inventory because inventory represents a differentiated position in the marketplace which leads to risk and uncertainty. The firm speculates on inventory in order to achieve economies of scale in

manufacturing, and because customers are unwilling to accept the risk entailed by a lack of producer inventory. In the Alderson (1957) and Bucklin (1965) analyses an inventory will occur whenever the carrying costs of inventory are less than the savings which can be obtained from postponement.

Warehouses, however, come about because of the transportation economics of consolidated shipping. When goods must be shipped in small quantities to distant customers a substantial penalty in less-than-truckload (LTL) transportation costs is incurred. If the same volume of goods can be shipped to a distant warehouse in a consolidated truckload quantity substantial cost reductions are available from the carrier due to the economies of truckload shipping. Warehousing will occur whenever the cost of manufacturing plant to warehouse transportation, warehousing, inventory carrying cost, and local delivery charges are less than the cost of direct delivery to customers from the manufacturing plant.

There are several types of warehouses which may be used in order to minimize system costs. Bowersox, Closs and Helferich (1986) discuss market oriented, production oriented and intermediate oriented facilities. Market oriented warehouses are located near markets and allow for maximum freight consolidation savings. Production oriented facilities are located to provide grouping of products

produced in several specialized manufacturing plants. The grouping allows the manufacturer to ship complete orders of diverse products to customers in one shipment. Intermediate positioned facilities are designed to serve both functions and are especially common when production of specialized product is spread across a wide geographic area. Warehouses are located at points that will produce the maximum savings in distribution costs while still providing necessary service levels.

The number of warehouses which will be present in a system is dependent on the way transportation costs and inventory carrying costs behave as warehouses are added. Transportation costs are initially reduced as warehouses are added to the system because of the savings brought about by consolidated shipments (Bowersox, Closs and Helferich 1986). However, as additional warehouses are added the ability to obtain consolidated full truckload (TL) shipments to each facility is reduced. Eventually, total transportation costs begin to go up as facilities are added because of the lack of consolidation opportunities. Inventory carrying costs, however, increase steadily as the number of warehouses is increased (Bowersox, Closs and Helferich 1986). This is because the safety stocks which are needed to cover demand uncertainty and warehouse resupply lead time uncertainty are greater when inventories are committed to multiple facilities than they are when inventories are centralized.

When the two curves for transportation cost and inventory carrying cost as a function of the number of warehouses are added together an integrated total cost curve is obtained. Figure 2 represents a typical total cost curve. High inventory carrying costs and low transportation costs for premium transportation services shift the curve to the left, thereby reducing the optimum number of facilities in a system.

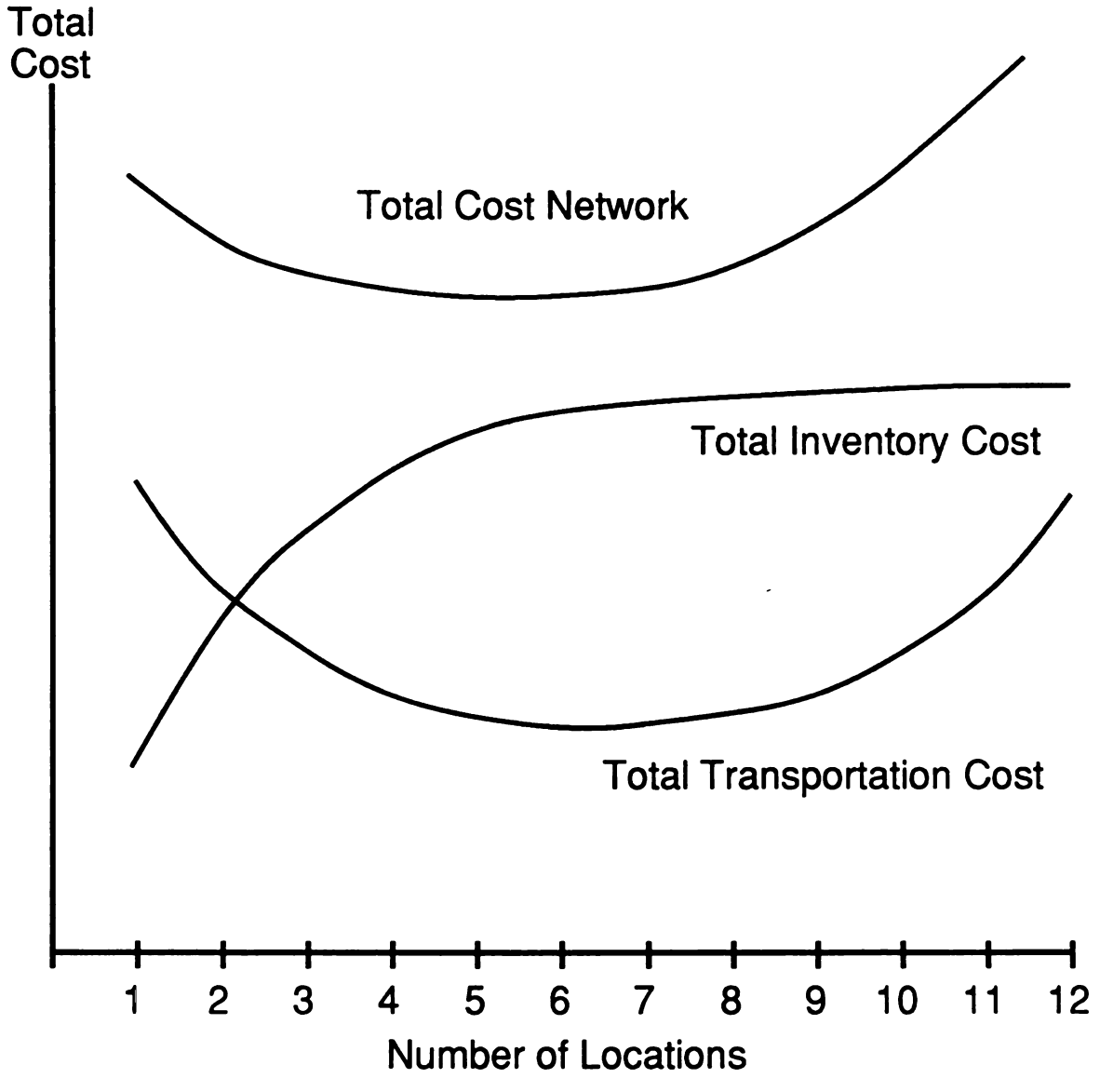
The total cost curves in Figure 2 represent the heart of spatial/temporal logistics cost integration and were first explicated by Smykay, Bowersox and Mossman (1961). The concepts presented above allow for total cost analysis which also takes into account the level of customer service being provided (as represented by inventory levels). Applicational theory in the form of total cost modeling approaches makes assumptions about the shape of the inventory curve, and relies on detailed information on transportation costs to develop the transportation cost curve.

Applicational Theory - Total Cost

Because the total cost theories are oriented towards location problem solving there is a large volume of work on the variables that should be considered, and on the tools which can be used to implement the concepts.

Figure 2

Total Cost Logistical Network



Source: Bowersox, Donald J. (1974), Logistical Management, New York: Macmillan Publishing Co., Inc.

Applicational Theory - Variables

The variables which have been identified include fixed and variable production costs, fixed and variable warehouse costs, inbound and outbound transportation costs by freight class and by shipment size, inventory carrying costs, and many other incidental costs (Flaks 1963; LeKashman and Stolle 1965; Wassmansdorf 1960; Smith 1966). Because the output of the various models that can be used is only as good as the cost data which is entered, great care must be used in developing costs for an actual corporate location decision. Several authors have contributed to the literature on how to develop appropriate distribution costs. These include Miller (1961), Rayburn (1967), and Lewis (1968). These authors wrote on the problems encountered in tracking functional physical distribution costs in corporate accounting systems that are dominated by natural accounts. More recently, Ballou (1987) has written on the information considerations in logistics network planning. He discusses the tradeoffs between information accuracy and detail, and the need for practicality in data gathering.

Applicational Theory - Modeling

The conceptual developments in "total cost" logistics have been linked with sophisticated distribution system modeling

almost from the beginning. Several early models were developed by Baumol and Wolfe (1958). Bowersox (1960) analyzed alternative approaches to solving food supermarket distribution system location problems in his 1960 dissertation. A 1960 article by Shycon and Maffei focused on simulation based approaches to solving warehouse location problems. Kuehn and Hamburger (1963) discussed a heuristic program for solving warehouse location problems. Bowersox discussed the planning of physical distribution systems using dynamic simulation in a 1972 article. Geoffrion (1975) offered one of many guides to computer-assisted methods for distribution system planning in a 1975 article.

While pre-1980 location models required the use of mainframe computers, the 1980s brought development of many personal computer based models (Steltzer 1990). These sophisticated analytical and simulation based tools have been incorporated into "decision support systems" that allow the researcher to analyze a number of options on a "what-if" basis (Helferich 1983, LeMay and Wood 1989). Such models are being used both by consultants and individual firms to analyze a wide range of location issues. The new models are similar to the 1960s versions in that they use a multi-echelon network of facilities to replicate the firm's existing and potential facilities. However, the new models allow for more detail in product types, facility costs, and transportation rates. In addition, the more recent models allow the user to easily

modify demand levels, costs, and other information on a flexible, user friendly basis (Steltzer 1990). While a number of single country models have been reported on, there is no known logistics literature on international oriented models.

There are three basic approaches to modeling physical distribution systems for location planning purposes. These three approaches involve analytical techniques, heuristic techniques, or simulation techniques. Each of the approaches requires the analyst to construct a model of the existing and/or potential distribution system. Each approach has advantages and disadvantages and a following of individuals that advocate one system over another for most applications. The following paragraphs provide an overview of the different approaches and the advantages and disadvantages of each.

Analytical techniques are those that seek an optimum solution through mathematical logic. The earliest types of analytical techniques were the various forms of gravity models based on ton centers, ton-mile centers, and other relevant factors. More advanced models solve for the optimum location based on the nodal points allowed, and based on cost functions or point to point cost data. The problems are solved using one of several variations of linear programming, network optimization, integer

programming, mixed integer linear programing, or non linear programming (Powers 1989). Globally optimal techniques find truly optimum solutions but often require more computing power and time than is practical in complicated systems. As such, heuristics, or rules of thumb are often used in analytical techniques to simplify the problem. Heuristics offer partially global solutions, and because optimization is used for only part of the problem, the results are not completely optimum. The advantages of optimization are in the identification of the best location, in the ability to solve problems given capacity constraints, in the ability to deal with nonlinear scale economies, and in the ability to evaluate a number of options quickly. The disadvantage of optimization is that real world problems must be simplified to use optimization (Ballou 1989).

Heuristic models, as indicated above, are ones that use rules of thumb to determine a satisfactory rather than optimal solution. The heuristic is in effect a short-cut which reduces the number of options that are to be tested. Heuristics represent a connecting point between simulation techniques and optimization techniques because both approaches tend to make use of some heuristics in order to simplify the problem (Ballou 1989).

Simulation is a detailed mathematical description of a decision problem and it is the level of detail that

distinguishes simulation from other techniques (Ballou 1989). While the level of detail is a significant advantage, the disadvantage of the technique is that the analyst must determine all potential solutions that are to be tested. The technique involves costing out the implications of each network option that is presented (Bowersox and Closs 1989). Often, simulation modeling is coupled with heuristics that the model uses, for instance, to make decisions about what facilities to eliminate from a solution. Simulation approaches can be classified into the two sub categories of static and dynamic simulation. Static simulation makes no provisions for multiple time periods, while in dynamic simulation the events which occur in one time period may influence future time periods. This is an important characteristic in inventory related operational problems but is not generally of as great a concern in location problems. A distinguishing feature of both sub categories of simulation is the ability to introduce stochastics, or probability distributions, into the modeling problem (Bowersox and Closs 1989). Again, this is not an important feature in most location problems.

Simulation modeling becomes more important as the complexity of problems increases. While early simulation models were used to evaluate simple least cost problems, today's total cost problems have been complicated with international variables, multiple production processes, and other

variables. These additional cost variables make simulation modeling the tool of choice in many cases. An increased emphasis on modeling cost-to-service tradeoffs also favors the use of dynamic simulation modeling because of the ability to model the time dimension and uncertainty effectively.

"Total Profits" Location Theorists

The strategic location theory literature has begun to re-emphasize the importance of "total profit" solutions that take into account the impact of various variables on revenue and profits. This focus on maximum profit solutions had been emphasized by location economists such as Losch and Greenhut in the 1950s. However, during the 1950s to late 1980s the emphasis of the logistics profession was on developing models capable of at least minimizing cost effectively. It has only been recently that the logistics profession's attention has been turned to profit measurement.

Conceptual Theory - Total Profits

Conceptual contributions to profit based location theory again seem to be coming from the location economists. A recent work by Greenhut, Norman and Hung (1987) takes fresh interest in a spatial approach to the economics of imperfect

competition. While their book primarily relies on Greenhut's original 1956 work to derive a maximum profit plant location theory, they do update the concept and explain it further for several conditions of competition. They go on to explain the relationship of pricing and demand distribution to location choice in considerable detail and state that the firm's optimal location, while influenced by cost considerations, is also affected by pricing policy. Their theory emphasizes the effect of the demand function, the form of the delivery cost function, the perceptions of management, the distribution of customers, and the degree of competition as variables which effect pricing policy and location decisions.

The logistics literature is also beginning to reflect more of an emphasis on profit maximization location decisions. For instance, Burbridge (1986) discusses the need to go beyond the total cost approach in modeling location decisions. He indicates that pricing policies of the firm have a significant impact on distribution performance. Powers and Closs (1987) discuss the role of trade incentives on system performance, although not in the context of location decisions. Bowersox and Closs (1989) suggest the increasing importance of profit considerations in their discussion of the role of simulation in location modeling.

Applicational Theory - Total Profits

There are a number of profit based applicational models discussed in the economic development and operations research literature. For instance, in the Economic Development Review Ingram, Bayne and Gassaway (1986) discuss their M.A.P.S. model which is designed to help in the location of branch manufacturing plants to serve undersupplied markets. The goal of M.A.P.S. is "to maximize client manufacturers' profits by reducing transportation and production costs and maximizing market share for a service area." The model requires an identification of geographic areas where consumption exceeds production, and an analysis of local production cost penalties and transportation cost savings for serving the spatial monopoly from a local branch manufacturing plant. An article in Regional Science and Urban Economics by Hanjoul and Peeters (1987) discusses the modification of the simple manufacturing plant location model to reflect the preference ordering of customers for particular sites. These preference orderings are converted into a set of constraints to be applied to the basic model.

The operations research literature describes two models that take into account profit maximization. One model (Logendran and Terrell 1988) addresses a profit-maximizing uncapacitated transportation plant location-allocation problem. The model uses a two step heuristic in which the

markets with the greatest profit contribution are rank ordered and given the highest allocation priority, and plant fixed costs are ranked in descending order of fixed costs with the high cost plant given the highest priority to be dropped. A second model (Hanjoul, Hansen, Peeters and Thisse 1990) is designed to determine the prices, number, locations, sizes, and market area of manufacturing plants given a system of client demand functions. Three alternative pricing scenarios are tested to determine the impact on location. The three scenarios are uniform mill pricing, uniform delivered pricing, and spatial discriminatory pricing. As predicted by Greenhut, Hansen and Hung (1987), the optimization model results in widely differing manufacturing plant locations for each pricing scenario.

SITE SELECTION THEORY

The site selection literature is focused primarily on manufacturing plant location decisions although they also address distribution location decisions in some cases. While the writings in this discipline do not meet the formal definitions of theory, there is a clearly distinguished set of practitioners in the field with their own trade journals.

Site selection theory is generally considered to be relevant only at the secondary stage of location studies. The

prevailing view is that total cost theory should be used to analyze the fundamental geographic and economic costs in order to select a general area for a facility. Only after that strategic decision has been made should the detailed site selection criteria be applied.

Site selection theory focuses on a detailed analysis of the specific factors that comprise total production costs, transportation costs, and other costs considered by the broader total cost theory. While total cost theory implicitly takes into account most if not all of the site selection costs, it often does so in a very generic way. In fact, in many location studies that the author is familiar with, costs such as taxes, utility costs, waste discharge costs, and labor costs are assumed to be equal from location to location. In fact Weber (1929) advocated holding these costs constant because of their mercurial nature.

Conceptual Theory - Site Selection

The conceptual contribution of site selection theory is that it calls attention to costs, and profit impacting factors, that while often artificial, may in fact be just as important as the natural cost differentials that arise from geography and traditional economic factors. (Fulton 1972). The site selection literature also suggests detailed methods of collecting, analyzing and measuring individual cost

categories. To the extent that cost categories such as taxes, insurance, and pollution discharge costs are likely to remain higher or lower in one strategic location or another they should be taken into account in the strategic analysis. For instance, if water treatment costs in the Northeast will remain 15 to 20 times higher than in the Midwest for the medium term future, than those costs should be taken into account in assigning production costs to potential locations.

In addition, many of the cost factors that the modern multinational must take into account in determining manufacturing or distribution locations do not have anything to do with production or distribution. For instance, while distribution center costs might be equal across sites in several regions, location at one site might expose the corporation to taxation of its worldwide profits. Such possibilities must be taken into account at the strategic level unless they can be avoided by moving the site a short distance within a region.

Applicational Theory - Site Selection

The main contribution of site selection theory has been to identify specific variables that need to be taken into account in location decisions. It is therefore applicational in terms of helping to determine the costs

that should be considered in either a strategic or site-specific location problem. Fulton (1972) discusses some of the new cost factors that were emerging at the time of his writing. In the area of labor costs, he identifies the emerging difficulty in securing educated labor forces in Southern United States sites. He goes on to point out the need to assess productivity rates as well as hourly wage costs in determining a cost factor for a potential site. While one can rely on current unit costs for existing manufacturing or distribution sites, this is not possible for potential sites. Fulton also conducts a detailed analysis of several other cost categories including pollution costs, energy costs, and taxes. More recent articles (Whitney 1990) discuss the need for uncongested international airports to be in close proximity to facilities in some industries, such as mail order clothing. For such companies, the Memphis Federal Express facility might draw a company's distribution center to Memphis as opposed to another low cost site.

INTERNATIONAL THEORY

Two streams of international literature are reviewed in this section- the foreign direct investment literature and the international logistics literature. The foreign direct investment literature has tended to be highly conceptual with limited applicational theory emerging from the

discipline. However the literature does identify several important factors that need to be considered in analyzing the impact of economic integration on distribution center location. The literature is also almost exclusively manufacturing oriented and does not address distribution center locations.

The second literature stream, international logistics, has received very little attention despite several articles that state the important role it will play in the future.

Conceptual Theory - International

The foreign direct investment literature will be reviewed first in this section followed by a review of international logistics conceptual contributions.

Conceptual Theory - Foreign Direct Investment

The foreign direct investment literature attempts to predict how companies make investment decisions from among the many choices of potential markets available. The literature also attempts to predict what country variables are important in attracting corporate investment.

One of the principal theories of foreign direct investment is known as the market imperfections theorem (Calvet 1981). The theory suggests that several forms of market imperfections are responsible for investment outside of the home market and is quite consistent with the work of spatial economists such as Greenhut (1987). The four forms of imperfections discussed in the literature are: imperfections in goods markets, imperfections in factor markets, scale economies, and government disruptions. Imperfections in factor markets include differentials in wage rates and provide an excellent explanation for investment in high productivity (output per dollar of wage) locations such as Northern Mexico. Government disruptions of the market are the other principal cause of imperfections that cause foreign direct investment. These disruptions refer to tariffs, quotas or other artificial barriers to trade that can force a producer to locate locally in order to compete. The theory concludes that in a state of pure competition the need for foreign direct investment is eliminated and that trade will occur along lines of comparative advantage.

The imperfections that are addressed are artificial or quasi-artificial imperfections in terms of their causes. Interestingly, the theory seems to ignore, or place less emphasis on naturally occurring imperfections such as those caused by geography and spatial monopoly. These naturally occurring imperfections are caused by the costs of

transportation required to overcome them, and are made worse by artificial barriers that increase the costs of cross-border transportation.

An alternative view is that the theory of foreign direct investment is comprised of three sub-theories (Buckley and Casson 1985). The three sub-theories are: the theory of international capital markets, the theory of the international firm, and the theory of international trade. This conceptualization essentially argues that the theory of international trade, which determines location, is modified by the impact of the theories of capital markets and of the international firm. The theory of capital markets focuses on the international allocation of "waiting" and "risk bearing" between individuals. Theory of the firm is concerned with the optimum size and structure of the firm. The later theory suggests that the firm size and structure is dependent on the types of economies that prevail. There are four types of economies -- manufacturing plant economies, multiplant economies, marketing economies and transfer pricing economies. These economies explain the rationale behind common ownership of multiple facilities in terms of reduction of external transaction costs. According to Buckley and Casson (1985), the integration of trade and firm theory suggests that:

> "the growth of firms by the internationalization of markets proceeds only so long as internationalization increases efficiency, and that the allocation of resources affected by the firm is always efficient."

In effect, the theory suggests that in the face of trade barriers firms will internationalize markets through foreign direct investment that is designed to circumvent barriers. However, the investment will occur only so long as the multi-facility operations remain sufficiently efficient to continue allowing a return to stockholders.

The eclectic paradigm of international production (Dunning 1988) is one which assumes market failure in international trade, and one which would not be needed if international markets were barrier free. The eclectic paradigm states that the pattern of international manufacturing is based on the configuration of three sets of conditions that the multinational may have relative to local producers. The first condition relates to the extent to which competitive advantage offsets the costs of establishing and operating local manufacturing. The second condition is based on the extent to which it is advantageous for firms with ownership advantages to transfer across international boundaries within the firm as opposed to via external sales. The third condition depends on the degree to which there is a benefit

from merging intermediate transferable products with local country factor endowments that are immobile. The later will determine the "where" of international manufacturing.

Dunning goes on to state that the form of the third condition, and therefore the choice of location, may be affected by spatial market failures. He states that:

> "Historically the imposition of trade barriers has led to a lot of foreign manufacturing investment by firms. At the same time a reduction in transport costs and the formation of customs unions or regional trading blocks have prompted greater regional specialization of production by firms."

Dunning also states that even without natural spatial monopolies or artificially induced ones, firms may still establish local foreign manufacturing. This is because of the transaction gains that may be possible from the common governance of activities in different locations.

Dunning also calls for more explicit modeling of the eclectic paradigm in order to determine its power for explaining specific international manufacturing location decisions. This statement appears to be a call for applicational theory.

Dunning, in a 1989 article makes one additional important point about the critical success variables for multinationals in the future. He states that:

> "multinational success is usually due to the way complimentary assets of various kinds are combined by the MNC" and that "the ability to manage transaction related activities of organization and strategy are key."

This is an interesting statement because it relates closely to the comments of Rockart and Short (1989) about the critical role of managing organizational interdependence in the 1990s. This critical function has also been identified by Bowersox, et. al. (1989) as an important factor of logistics success. The management of an integrated North American distribution network will test the ability of firms to implement the concepts and methods of organizational interdependence discussed by Rockart and Short (1989) and Bowersox, et. al. (1989).

Conceptual Theory - International Logistics

The international logistics literature has at times focused on the differences (tariffs, customs, transportation modes, documentation) inherent in international operations (Davies 1987, Anderson 1988), and at times on the opportunities for integration being brought about by globalization of markets (Bowersox and Sterling 1982, Kallock 1988).

At a conceptual level a paper by Bowersox and Sterling in 1982 underscored the opportunities presented by globalization. They state that:

> "Development of a coordinated international logistics logic is timely for two reasons. First, the potential of a global movement/storage system presents an opportunity for a higher order of trade-off and synergistic benefits than is attainable from logistical planning on a nation-by-nation basis. Second, the limited concepts of physical distribution and materials management create the danger of a dysfunctional interface when applied individually to multinational situations."

They go on to state that firms must take the current individual distribution systems in each country and integrate them into a coordinated logistical activity.

Kallock (1988) discusses the rapid growth of globalization and specifically talks about the recent trade agreements between the United States and Canada, and about "EC 92." He also stresses the benefits which can be gained by globally integrated distribution systems and suggests the opportunity for analysis of transnational strategies. This analysis should include an examination of the number and location of distribution centers and manufacturing plants according to the author. Kallock also discusses the fact that:

> "The establishment of international distribution centers has particular potential in light of "EC 1992" developments."

However the author does not extend this call for investigation of international distribution centers to the United States-Canada environment.

Applicational Theory - International

The foreign direct investment literature has not yet evolved an applicational theory capable of being used in corporate decision making. Although, as noted above, there have been some calls for the development of applicational models (Dunning 1988). However, the foreign direct investment theory does make an important applicational contribution in helping to define several questions about the impact of economic integration on manufacturing plant location, and on the impact of integration on production approaches. The conceptual theory also clarifies the role of several important variables in terms of the way they contribute to spatial monopoly. These variables include tariffs, cross-border transportation rates, and labor costs.

The international logistics literature provides several insights into the types of analysis companies should be performing given potential integration. The literature also clarifies the potential for "international distribution centers." A 1989 paper (Van der Hoop 1989) discusses the specific opportunities for rationalization of distribution

center operations in the context of European economic integration. The paper suggests that following economic integration, firms need to ask questions about the centralization of distribution center inventory, and about the location and numbers of facilities. The literature on "EC92" also discusses the impact that changes in border procedures and economic regulation of trucking can have on cross-border transportation rates (Bowman 1990).

The logistics and operations research literature also reveals three international manufacturing plant location models that have been developed in recent years. Hodder and Jucker (1985) discuss a proposed model to deal with international manufacturing plant location decisions under conditions of price and exchange rate uncertainty. The model uses mixed integer quadratic programming with branch and bound methods to allow reasonably large problems to be solved with conditions of price and exchange rate uncertainty.

Hodder and Dincer (1986) discuss a model for analyzing international manufacturing plant location and financing decisions under conditions of uncertainty . The model considers location and financing simultaneously because subsidized financing and preferential tax treatment are important factors in international location decisions. The model is computationally feasible for medium problems while

still including the effects of uncertainty, financial subsidies, and hedging strategies. The model is in some ways an application of site selection constructs to the international strategic location setting.

A final model by Arcelus (1989) considers the problem of locating a manufacturing plant in a developing country where production costs are lower but risks are higher, in comparison to operating from the home country. The traditional profit maximization framework is extended to include a linkage between investment and profits. Sensitivity analysis is used to measure the impact of different wage, productivity, and taxation levels on location.

RESEARCH VARIABLE LITERATURE

The research approach discussed in chapter one requires that several intensities of each research variable be experimentally tested in order to determine the impact of changes in the variable on manufacturing plant and distribution center location. In addition, the research approach requires that an initial variable intensity be determined, and that the "most likely" intensity for each

variable under an economic integration environment be determined. The following sections discuss the literature foundation for the research variable intensity settings.

EXTENT OF COUNTRY MARKET INTEGRATION

The literature clearly indicates that companies have until the recent past, to a large degree, considered each of the three countries as separate markets for logistics planning purposes (Holstein and Borrus 1990, Peters 1986, Litvak 1988, Kallock 1988). The same sources indicate that a number of companies are beginning to consider the potential for distribution system configuration planning on an integrated country basis. Most companies discussed in the literature are considering a United States-Canada integrated market at this time, however some are also discussing a North America-wide market (Holstein and Borrus 1990, Wickens 1990). Given the various integration possibilities, the integration variable will be tested at intensities representing separate country operations, at a basic integrated United States-Canada level and at a basic integrated United States-Canada-Mexico level. The "most likely" environment will assume two country as well as three country integration.

SIZE OF COUNTRY MARKET DEMAND

The location theory literature indicates that the location and size of demand is a critical factor in the location of both manufacturing plants and distribution centers. The level of initial demand for each of the three industries considered in this research has been established based on industry statistics. However, the range of potential demand changes for each country is more difficult to predict. Literature on economic integration does indicate that personal income and spending will increase in low income countries following integration into a regional trading block (Cecchini 1988; Garland, Farmer and Taylor 1990). In addition to general industry size increasing, economic integration will make it easier for multinationals to serve markets across countries. The ease of entry into markets will make it possible for multinationals to increase market share substantially (Calvet 1981, Cecchini 1988, Langer and Hitzig 1990, Wickens 1990, Payne et. al. 1990). While it is impossible to predict the size of typical future company sales, it is apparent that United States multinationals could gain extremely large sales increases in Mexico because of the previous lack of focus on this market, and as a result of income growth. For experimental purposes growth of between 25 and 50 percent should be evaluated from a "what-if" standpoint. As such, the Canada demand variable

will be tested at a 25 percent and 50 percent increase. For the "most likely" environment, a Mexican market size increase of 25 percent will be assumed.

In the Canadian market, where United States firms already have a substantial presence, the market size for an individual company is not likely to grow at anywhere near the same level as Mexico. However, a range of growth of between 15 to 30 percent seems possible from a "what-if" investigation standpoint. As such, the Canadian demand variable will be tested at a 15 percent increase and 30 percent increase. A conservative "most likely" environment would assume no growth in Canadian sales levels for the typical company.

TARIFF LEVELS

For the United States and Canada the Free Trade Agreement defines the level of tariff reductions over the next ten years. The Agreement indicates that for the industries reviewed in this research, tariffs will be halved within four years and that those tariffs will be eliminated completely within eight years (Canada-United States Free Trade Agreement Annex 401.2 1989). As such, the tariff variable will be studied at pre-agreement levels, at half initial levels and at zero.

For the United States and Mexico, the level of future tariffs is more difficult to determine. However, the literature indicates that tariffs could be reduced by 50 to 100 percent within ten years (Kolbe 1988, Payne et. al. 1990, Green 1990). The "most likely" level of tariffs is zero for the industries in question given initial tariff levels and a ten year planning horizon. As in the case of the United States-Canada, tariffs will be examined at levels ranging from the initial one to zero.

For Mexico and Canada, it is unlikely that food products being modeled under tariff conditions would move from Canada to Mexico, however, it is possible that product would move from Mexico to Canada. In either case, the tariff level should be evaluated at initial levels, at half levels, and at the zero level. While it is difficult to predict the likely outcome of North American trade negotiations involving Mexico, for purposes of this research it is assumed that the "most likely" future environment will involve zero tariffs. As such, the Mexican-Canadian tariff level in the "most likely" environment will be set at zero.

CROSS-BORDER TRANSPORTATION RATES

Current United States-Canada cross-border transportation rates are based on freight rate data made available by carriers. This data indicates that cross-border freight

rates between the United States and Canada are higher than equidistant internal United States rates. The freight rates are higher due to congestion, border inspections and procedures, cabotage and immigration rules, and, until recently, a lack of cross-border operating authority for United States carriers (Tausz 1989, Tausz 1990, Taylor 1988). In fact, during 1989, the Niagara cross-border rate bureau filed for rate increases because of border congestion (Transport Topics 1989). The potential reductions in cross-border transportation rates range from 10 to 20 percent and would be due primarily to increased competition from United States carriers. Possible future reductions in border controls could also contribute to a reduction in transportation rates. The "most likely" reduction in rates is approximately 10 percent according to executives interviewed by the author (Chrysler, Yellow Freight, Consolidated Freightways 1990). As such, the cross-border freight variable will be studied at initial levels, at levels reflecting a 10 percent reduction, and a 20 percent reduction.

Mexican internal freight rates are considerably higher than internal United States rates. One source indicates that "while freight in California moves at about $1.10 per mile, it runs about $1.50 a mile in Mexico" (Horowitz 1990). United States-Mexico cross-border transportation rates are based on internal Mexican freight rates and the United

States portion of the link. Cross-border rates are believed to be 20 to 25 percent higher than comparable distance United States rates due to the higher Mexican internal rates. These higher Mexican rates are due to poor infrastructure, border controls, cabotage, and an overall lack of competition (Global Trade 1988, C. H. Robinson 1990, Lawrence 1989, McRae 1990, Consolidated Freightways 1990). In fact, Mexican businessman are reported to believe cross-border freight rates through Laredo are 20 percent higher than they should be (Barrett 1990). The same sources indicate that cross-border rates could be reduced by up to 20 percent as a result of increased competition and reduced border controls. The primary reduction would come about as a result of increased competition and by allowing through transportation of loads on one vehicle. Current practice requires that trailers be decoupled from power units at the border and recoupled to the power units of national carriers for transit within the destination country. The "most likely" level of cross-border transportation rates reduction is in the 20 percent range, assuming progress on United States-Mexico transportation negotiations. For purposes of this research, the cross-border transportation rate variable will be set at levels reflecting initial rates, and at a level reflecting reductions of 10 percent and 20 percent on the Mexican portion of cross-border freight rates. The "most likely" environment will assume a 20 percent reduction on the Mexican portion of the cross-border freight rates.

LITERATURE SYNTHESIS AND APPLICATION

The literature review provides interesting insights and guidance concerning the research question at hand. From a conceptual standpoint, the foreign direct investment literature provides a framework concerning the manufacturing location impact that should be expected from economic integration. Dunning (1988) specifically addresses the impact that can be expected from the formation of customs unions or free trade areas. He hypothesizes increased centralization and specialization of manufacturing, as does Calvet (1981), when the degree of market imperfection is reduced. Additional insights into the location of manufacturing are provided by Weber's (1929) concepts on the role played by the relationship between production and transportation costs. Dunning (1989) also calls attention to the critical role that managing organizational interdependence will play in determining the success of multinationals. Bowersox and Sterling (1982) and Kallock (1988) provide conceptual guidance on the impact of globalization on international distribution center location and practices.

The classical location economists and the "total cost" theorists also provide the conceptual support for an approach to evaluating alternative distribution center

locations under various conditions of economic integration. The "total cost" approach appears to be the most relevant because it specifically addresses distribution center location and not just manufacturing plant location as is the case with several of the other schools of thought. The total cost theory suggests that the number and location of distribution centers is dependent on the interrelationship of transportation costs, warehousing costs, and inventory carrying costs. The theory further states that depending on the form of these curves, a low cost network of facilities can be determined. The total cost theory forms the basis for the simulation modeling approach used in the research.

A total cost approach that focuses on logistics variables which are geographically influenced, or which relate to underlying economic cost differences, is also justified by the fact that economic integration eliminates many of the artificial factors that must be taken into account in unintegrated markets. By examining the location issues in their simplest geographic and economic terms a better understanding of the underlying market dynamics can be obtained. The total cost approach, as opposed to the site selection or total profit approach, is also justified by Weber's belief that only permanent, naturally occurring cost factors should be included in the analysis.

The literature review also provides insight into the type of procedure which should be used to analyze location impact. The research objectives relate to determining manufacturing plant and distribution center configurations and costs under various research variable and industry environments, and to gaining an understanding of the impact of individual variables on location and cost. Because a level of control necessary for experimentation is desired, and because various "what-if" capabilities are desired, a personal computer based model was sought. The literature review suggested that both simulation and optimization models would be appropriate. However, given the research situation, the literature does not indicate any substantial advantages for optimization. As such, the research methodology utilizes a simulation model.

From an applicational theory standpoint the literature provides a number of insights into the variables which should be used to determine location impact. While there are many factors that could be considered in a study of manufacturing plant and distribution center location, the literature review suggests that key variables should include location and amount of demand, production location and costs, logistics costs of various types, and the level of tariffs. Given this literature, the research variables selected for study include the 1) extent of country market integration, 2) the size of country market demand, 3) the

level of tariffs, and 4) the level of cross-border transportation rates. The above variables are those that relate to underlying geographic and economic factors and the foreign direct investment literature indicates that such factors will become more important as economic integration eliminates or reduces artificial barriers. These variables have also been singled out for experimentation because they are the factors that are likely to change as a result of economic integration of the three countries.

The literature on the above research variables indicates that several levels of operationalization are feasible for each. The research design calls for each variable to be tested at initial or current intensities or settings, and at intensity levels that are likely during and after economic integration occurs. As such, the literature was reviewed to determine the likely intensity ranges for each variable.

For the country market integration variable it is apparent that the research should be conducted assuming separate country operations first, and then at several levels of basic integration. The literature on current and potential trade agreements indicates that the United States and Canadian economies will be integrated over the next ten years. As such, this variable is also tested at a basic integration intensity with the United States and Canadian markets brought together for distribution system design

purposes. The literature on the potential for a trilateral free trade area including Mexico also dictates that the country integration variable should be studied at a three country integration level.

The literature on the size of country market demand indicates that there is a potential for increased Canadian and Mexican demand following integration. Such changes in demand would be due to increased disposable income and/or increased market share for United States firms. The literature suggests that demand increases in Canada and Mexico could range from 15 to 50 percent.

The literature on tariffs indicates that the current levels will drop to zero if existing and anticipated agreements are implemented. As such, the literature suggest that tariffs should be tested at initial levels and then at zero levels. Because of the possibility that tariffs might not be fully eliminated, this variable should also be tested at a 50 percent reduction level.

Finally, the literature on cross-border transportation rates indicates that current rates are higher than they might be with full economic integration. Specific information on Canada indicates that rates could be reduced from 10 to 20 percent, while information on Mexican rates indicates that they could be reduced by a similar amount. The "most

likely" future environment is that Canadian border rates and Mexican internal rates could be reduced by 10 percent and 20 percent respectively.

CHAPTER 3 - METHODOLOGY

The methodology section will discuss the general approach and model selection, variable definitions, research questions, model data development, simulation research design, and analysis approach.

GENERAL APPROACH AND MODEL SELECTION

The research objectives are to identify the likely distribution system configuration and cost levels under various research variable and industrial environments, and to determine the impact of selected research variables on location patterns. The distribution system configuration refers to the number and location of both manufacturing plants and distribution centers.

The research methodology is to use a simulation model to test the impact of the research variables and industrial environments on the dependent variables. The research variables are 1) the extent of country market integration,

2) size of country market demand, 3) tariff levels, and 4) cross-border transportation rates. The dependent variables are 1) distribution system configuration, 2) total system cost, and 3) logistics cost. The research methodology allows selected variables to be tested, under differing economic integration assumptions, with the resulting impact on distribution system configuration and costs determined.

MODEL SELECTION AND MODEL OPERATING PROCESSES

In deciding how to test the research variable impact, both simulation models and analytical tools were considered. While an analytical tool can develop "optimum" locations, and a simulation model can only develop "partial optimum" solutions, the data approximations necessitated by the generic industry approach tend to render the analytical tool's extra precision meaningless. This fact, and time and budget constraints on the number of freight links that can be entered into a model, substantially restrict the number of network options a model will be asked to evaluate and results in further suboptimization of the analytical tool's results. Finally, the research questions do not require the consideration of capacity constraints on facilities, a particular strength of analytical tools. Because of the above factors, a simulation model will provide comparable

results to an analytical tool. As such, and because a simulation model was available to the author, such a model was selected for the research.

The concept of experimental simulation has previously been used a number of times in logistics research (Powers 1985, Cook 1980, Closs 1978, Sims 1974, Speh 1974). Experimental simulation involves use of an experimental methodology to test the impact of selected research variables on the dependent variables being studied. The design provides control of variables not being tested thereby isolating the impact of research variables on the dependent variables.

The experimental approach is implemented using a well tested static simulation model known as NETSIM II (Traffic Management 1985). The model permits a North American manufacturing and distribution system to be represented in terms of demand areas, manufacturing plant locations, logistics cost, government barriers, and optional distribution center locations. For a given set of research variables and industrial environment, and an array of manufacturing plant and distribution center locations, the simulation procedure will isolate the recommended distribution system configuration, assign market areas to each facility, and report total system cost and logistics cost.

The model determines the low cost distribution system configuration by using a sort-down algorithm to determine the low cost network of distribution centers. The sort-down process starts with all eligible distribution centers available to be assigned demand, and proceeds with the deletion of one facility at a time until the low cost network of facilities is obtained. This algorithm finds the distribution center that either reduces the total system cost the most, or, if savings are not possible, increases the total system cost the least. The simulator then eliminates that distribution center and completes the next iteration until the number of facilities specified for removal have been deleted. In making this determination, the model considers all fixed and variable costs except for inventory carrying cost. Once the iterations are completed, the researcher reviews the results and selects the point at which the number of distribution centers reduces total system cost, including inventory carrying cost, to the lowest point.

The distribution centers that remain in the system are those that result in the lowest total system cost utilizing the sort-down algorithm. It should be noted that this cost level and distribution center configuration is not necessarily the lowest cost system or the optimal location pattern. This is because the sort-down algorithm is not an optimization technique, but is instead a heuristic which

approximates the best solution. The potential for non-optimum results is greatest when sorting down to a small number of distribution centers because once a facility is eliminated it is not reconsidered in any further facility combinations which might have resulted in a lower cost. The advantage of using the sort-down algorithm to determine distribution system configuration and cost is that it provides an unbiased approach in each simulation. The alternative approach would be for the researcher to select various facility combination options to test in each simulation. However, this approach would reduce consistency across runs and increase the potential for variance associated with researcher judgement.

The static simulation model selected possesses excellent data modification and "what-if" analysis characteristics. The model also allows user-friendly downloading of data from data management programs. These features are important in that they allow a number of alternative distribution systems to be tested with minimum effort.

This model was also chosen because of its proven track record in numerous industry applications. The extensive cross-industry use has proven the model's internal reliability and has also proven the model's external validity. Given the generic industry nature of the data in this research it is difficult to validate the initial

simulation model output. However, the initial model output has been reviewed to verify that total output costs are in line with per unit cost data entered into the model. In addition, the output costs from the model are compared to norms for the industry being evaluated in order to assure that the simulation model cost relationships and data are reasonable.

MODELING APPROACH

In order to obtain realistic information on the size of markets in each country, the costs of transportation and production, and other variables, an initial industry is assumed. The basic industry structure is then systematically modified by changing several industry "set" variables including those for manufacturing plant location, production cost, product weight and total country demand. In this way various industries can be created on a "what-if" basis. The different industry environments allow for the potential to generalize results, and also allows the researcher to evaluate the impact of various industry characteristics on the dependent variables.

The research will first be conducted with data that is representative of a food industry product. The impact of a full range of research variable options on the dependent variables will be tested for this industry. This will

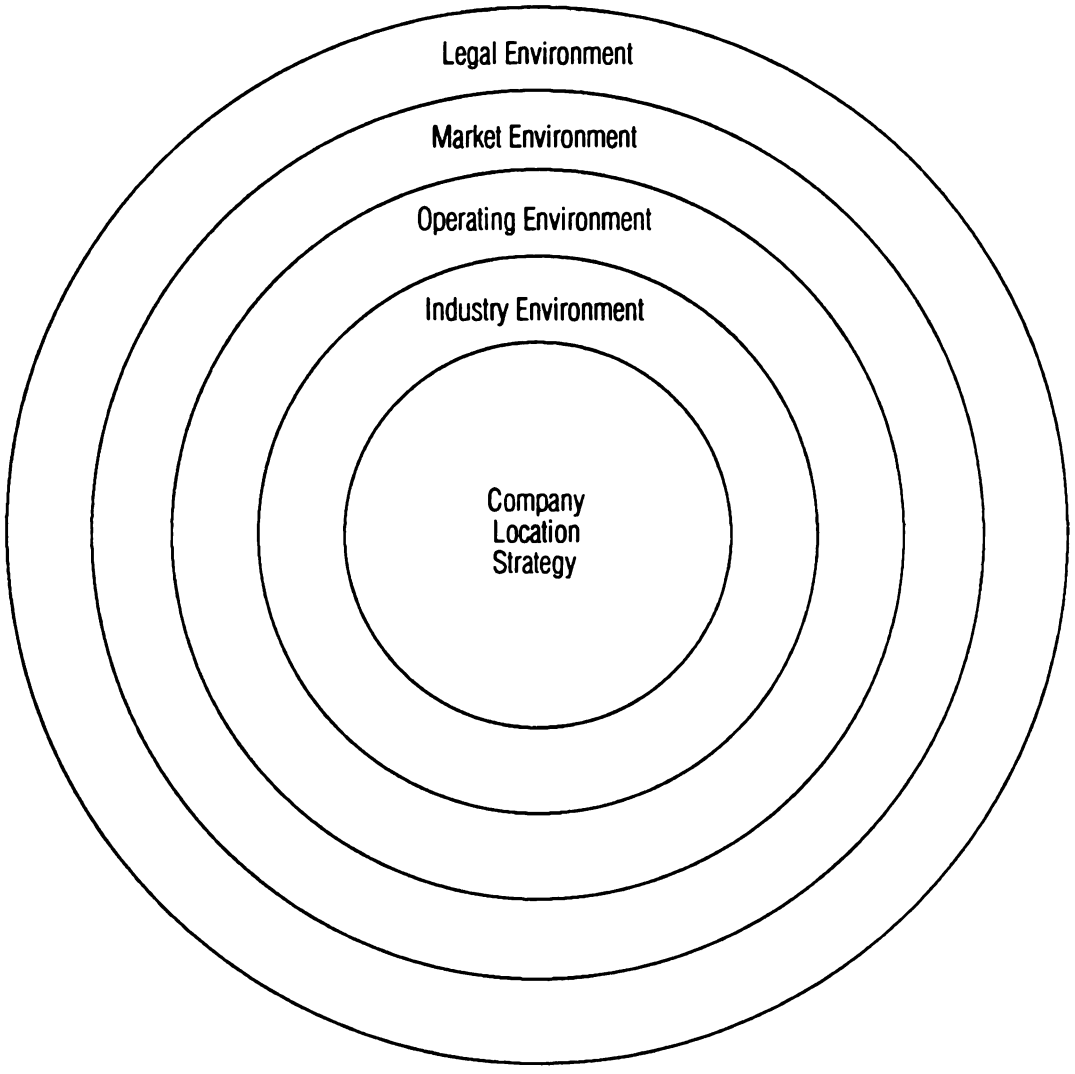
result in each research question being addressed for the food industry. A second set of data have been created to reflect the women's clothing industry. The consumer appliances industry, specifically a refrigerator product, will also be replicated. For the latter two industries, the impact of just the "most likely" research variable environment will be tested. The food, women's clothing, and consumer appliances industries were selected because of the interest that industry firms have shown in a North American market, and because of the contrasts in the production to transportation cost ratios across the industries.

VARIABLE DEFINITION

Location strategy is effected by a number of factors, some of which are subject to change as a result of potential economic integration, some of which are industry specific, and some of which are constants for the situation under study. Figure 3 positions the various factors in terms of four environments. The industry environment is closest to the individual firm and has a significant impact on location strategy. Characteristics of the industry environment include the 1) manufacturing plant location, 2) product characteristics, 3) variable production and handling costs, 4) company demand level by country, and 5) freight class and transportation rates. For purposes of this research the

Figure 3

Location Strategy Factors



LEGAL ENVIRONMENT
Research Variables
  Tariffs

MARKET ENVIRONMENT
Research Variables
  Country Market Integration
  Country Demand Size

OPERATING ENVIRONMENT
Research Variables
  Cross-Border Transportation Rates
Industry Set Variables
  Manufacturing Plant Location
  Production Costs

INDUSTRY ENVIRONMENT
Industry Set Variables
  Production Cost Per Unit
  Product Weight
  Demand Level

industry environment is assumed to be a constant not effected by economic integration. However, the three industry environments noted earlier are studied under the "most likely" variable environment in order to determine the impact of industry characteristics on location, and in order to increase the potential generalizability of the results.

The operating environment first includes the various manufacturing plant locations, distribution center site options, and transit point nodes that are representative of current and/or potential operating environments. These locations are a given for the research with the exception of changes which are required to replicate a particular industry. The second dimension of the operating environment is the cost of facilities. While these costs vary by city and country based on wage levels, the appropriate costs by city are a constant in terms of this research. The third dimension of the operating environment is transportation cost. Cross-border transportation rates are likely to change as a result of economic integration and are treated as a research variable.

The market integration environment impacts location strategy in two ways. First, the country markets which are included in the location analysis has a major impact on the choice of location. Secondly, the size of demand by country may

influence the location decision. Both of these aspects of the marketing environment are effected by economic integration and are treated as research variables.

The legal environment has a major impact on international location decisions. For purposes of this research the primary legal environment variable is the level of tariffs. As such, the tariff level is treated as a research variable in this inquiry.

In order to implement the research methodology and build the simulation model data, it is important to define the specific nature and intensity of the variables being examined. The following sections define the research variables, the industry "set" variables which are modified to change industry environments, and the dependent variables. Details concerning data collection for all model structure variables, including the research and industry "set" variables, are discussed in the model data development section later in this chapter.

RESEARCH VARIABLES

The research variables being studied in this inquiry are those factors that have a potentially significant impact on distribution system configuration, and which are subject to change as a result of economic integration. The four

research variables are 1) the extent of country market integration, 2) the size of country market demand, 3) tariff levels, and 4) cross-border transportation rates. Each variable is discussed below and the variable intensities which are to be tested for the food industry are summarized.

1. Extent of country market integration - This variable represents the degree to which companies view the three countries as an integrated market for logistics system design purposes. The literature indicates that many companies have viewed each country separately for logistics planning purposes in the past but are now beginning to consider the integrated market as a whole (Peters 1986, Litvak 1988, Journal of Commerce 1990). The three intensities for the variable are 1) separate United States, Canadian, and Mexican markets, 2) a combined United States and Canadian market, and 3) a combined United States-Canada-Mexico market.

2. Size of country market demand - The amount of demand in a geographic area is a key determinant of both manufacturing plant and distribution center location according to both classical and more recent location theorists (Losch 1954, Greenhut 1956, Shycon and Maffei 1960, Bowersox 1972). Economic integration is also likely to effect both the overall size of the market and the share of market that a multinational would be likely to capture. While it is impossible to predict the actual extent of changes in demand size by country, it is possible to consider the options on a "what-if" basis. The variable intensities are designed to allow for such "what-if" analysis and are set as a combination of the following depending on the research question under review: 1) United States-Initial demand levels, Canada-Initial demand levels; 2) United States-Initial demand levels, Canada-15 percent increase; 3) United States-Initial demand levels, Canada-30 percent increase; 4) United States-Initial demand levels, Canada-Initial demand levels, Mexico-Initial demand levels; 5) United States-Initial

demand levels, Canada-Initial demand levels, Mexico-25 percent increase; and 6) United States-Initial demand levels, Canada-Initial demand levels, Mexico-50 percent increase.

3. Tariff levels - Tariffs represent government induced imperfections which can significantly alter distribution patterns (Calvet 1981). As one of the principal goals of a Free Trade Agreement is to eliminate or reduce tariffs, this variable is tested at several intensities. The model initially is developed using average initial tariff levels for the food industry. These tariff levels are then reduced to determine the impact of tariff rates on location. Subsequent analyses of other industries assumes the "most likely" future tariff level for the industry, or for this research, a zero level. The possible variable intensities for the food industry are 1) United States-Canada: Initial tariff, 2) United States-Canada: 50 percent reduction, 3) United States-Canada: Zero, 4) United States-Canada: Zero, United States-Mexico: Initial, 5) United States-Canada: Zero, United States-Mexico: 50 percent reduction, and 6) United States-Canada: Zero, United States-Mexico: Zero.

4. Cross-border transportation rates - Transportation rates are a major factor in determining location of any facility (Weber 1929, Bowersox 1972). Economic integration is likely to result in reduced cross-border transportation rates (Tausz 1989, Global Trade 1989, Van der Hoop 1989). As such, cross-border rates are treated as a research variable. The variable is initially operationalized by using existing cross-border transportation rates for each linkage between potential manufacturing and distribution center cities and market areas. The cross-border transportation rates are then lowered to examine several levels of increased efficiency reflective of economic integration. The variable intensities are 1) United States-Canada: Initial levels; 2) United States-Canada: 10 percent reduction; 3) United States-Canada 20 percent reduction; 4) United States-Canada: 10 percent reduction, United States-Mexico: Initial levels; 5) United States-Canada: 10 percent reduction, United States-Mexico: 10

percent reduction; and 6) United States-Canada: 10 percent reduction, United States-Mexico: 20 percent reduction.

The research variables and their alternative intensities are summarized in Table 5. The research questions defined in the following section call for the intensities of research variables 2, 3 and 4 to be set in one of three ways. First, the variables are set at "initial" intensities to reflect an environment in which markets are analyzed on a joint basis, but with no changes in other variables. Secondly, the intensities of either research variable 2, 3, or 4 are changed one at a time, while the other two variables are held constant. Third, the research variables are set at the "most likely" environment intensity which will prevail following economic integration. The "most likely" environment is based on the literature review discussed in the previous chapter.

INDUSTRY SET VARIABLES

The industry set variables allow the researcher to modify various model set and research variables so as to replicate additional industries. The study of several industries allows the researcher to check for consistency in the findings and potentially provides for more generalizable results.

Table 5

Research Variables and Variable Intensities Food Industry

1. Extent Of Country Market Integration
   - a. Separate United States and Canadian markets
   - b. Combined United States and Canadian markets
     Most likely United States-Canada
   - c. Combined United States, Canadian and Mexican markets
     Most likely United States-Canada-Mexico

2. Size Of Country Market Demand
   - a. United States - initial demand intensities
     Canada - initial demand intensities
     Most likely United States-Canada
   - b. United States - initial demand intensities
     Canada - 15 percent increase
   - c. United States - initial demand intensities
     Canada - 30 percent increase
   - d. United States - initial demand intensities
     Canada - initial demand intensities
     Mexico - initial demand intensities
   - e. United States - initial demand intensities
     Most likely United States-Canada-Mexico
     Canada - initial demand intensities
     Mexico - 25 percent increase
   - f. United States - initial demand intensities
     Canada - initial demand intensities
     Mexico - 50 percent increase

Table 5 (Cont'd.)

3. Tariff Intensities

   a. United States-Canada: initial tariff

   b. United States-Canada: 50 percent reduction

   c. United States-Canada: zero
      Most likely United States-Canada

   d. United States-Canada: zero
      United States-Mexico: initial tariff
      Canada-Mexico: initial tariff

   e. United States-Canada: zero
      United States-Mexico: 50 percent reduction
      Canada-Mexico: 50 percent reduction

   f. United States-Canada: zero
      Most likely United States-Canada-Mexico
      United States-Mexico: zero
      Canada-Mexico: zero

4. Cross-Border Transportation Rates

   a. United States-Canada: initial intensities

   b. United States-Canada: 10 percent reduction
      Most likely United States-Canada

   c. United States-Canada: 20 percent reduction

   d. United States-Canada: 10 percent reduction
      United States-Mexico: initial intensities

   e. United States-Canada: 10 percent reduction
      United States-Mexico: 10 percent reduction

   f. United States-Canada: 10 percent reduction
      Most likely United States-Canada-Mexico
      United States-Mexico: 20 percent reduction

The three industries being studied are foods, women's clothing, and consumer appliances. More specifically, the food industry is assumed to represent a combination of several processed foods that are bottled or packaged. The four specific products are margarine sticks in cardboard packs, mayonnaise in jars, olives in jars, and mustard in jars. Each product is assumed to represent one quarter of the "product" being represented in the model. The selection of specific products is necessary for calculation of tariff levels and in order to estimate product demand at the national level. The women's clothing model product is assumed to consist of a combination of women's skirts, dresses, and blouses. The consumer appliances product is assumed to be a medium sized and priced refrigerator.

The model set variables which are used to create the three industries studied in this research are 1) manufacturing plant location, 2) product characteristics, 3) variable production and handling costs, 4) company demand level by country, and 5) freight class and transportation rates. Each variable is discussed below and the data by industry is highlighted in Table 6. Details on calculation or estimation of the industry set data is presented in the data development sections.

Table 6

Industry Set Variables by Industry

	Food Industry	Women's Clothing Industry	Consumer Appliances Industry
1. Manufacturing Plant Location[1]	Chicago Kansas City Toronto Monterrey	Chicago Kansas City Toronto Monterrey Atlanta	Chicago Kansas City Toronto Monterrey
2. Product Characteristics (US$ per unit)			
a. Product description	24 pack case	12 garments	1 refrigerator
b. Product price[2]	20.00	456.00	400.00
c. Product cost[3]			
1. Percent direct labor	20.00%	35.00%	20.00%
2. Direct labor	2.80	111.00	40.00
3. Materials	4.20	112.00	160.00
4. Variable production cost[2]	7.00	223.00	200.00
5. Overhead	7.00	96.00	80.00
6. Total COGS[2]	14.00	319.00	280.00
d. Inventory characteristics			
1. Distribution center inventory turns[2]	16	16	16
2. Distribution center resupply lead time[2]	30 days	30 days	30 days
3. Inventory carrying cost percent[2]	14.00%	14.00%	14.00%
e. Product weight[2] (pounds per unit)	20.00	24.00	230.00

Table 6 (Cont'd.)

3. Variable Production and Handling Costs[3] (US$ per unit)			
a. Production cost[2]	7.00	223.00	200.00
b. Handling cost[2]	.20	.24	5.48
4. Company Demand Level (Millions of US$)			
United States	500.0	300.0	420.00
Canada	63.9	39.0	58.7
Mexico	40.9	32.0	24.2
Total	603.9	371.0	502.9
5. Freight Class[2]	70	70	92.5

[1] Specific simulation runs use various combinations of plant locations depending on the research question being addressed.

[2] Model data input variable.

[3] Costs are for a Chicago base case city. Costs for other cities are indexed against the direct labor portion of total cost. Details by city are shown in the data development section.

1. Manufacturing plant location - For the food industry the basic configuration includes facilities in Chicago and Kansas City for the United States, a Toronto facility for Canada, and a Monterrey facility for Mexico. Facilities are available or not available depending on the level of economic integration being studied. In the three country integrated environment, all four facilities are used in one simulation. The same locations are used for the consumer appliances industry depending on the level of country integration being studied. For the women's clothing industry, the above facilities are used in one simulation, and a separate simulation is conducted with just one manufacturing plant, located in Atlanta.

2. Product characteristics - The product characteristics data vary considerably by industry and includes product price, cost of goods sold (COGS), inventory characteristics, and product weight. The product price reflects a manufacturer's net sale price to a third party and is used as the basis for application of any tariffs. The cost of goods sold is a constant 70 percent of unit price across industries but varies with the unit price as a result. The inventory characteristics assume 16 turns per year for each industry, a 30 day resupply lead time at distribution centers, and a 14 percent inventory carrying cost percentage. The same policy is assumed across all three industries, however, the amount of system inventory which results varies dramatically because of the different cost of goods sold levels. The system inventory levels vary with the number of distribution centers being used based on application of a standard square root of n inventory formula. Product weight is based on the typical weight for each industry's products and ranges from 20 pounds per case demand unit in the food industry to 230 pounds per unit for refrigerators in the appliances industry. The product weight variations result in a range of production cost to transportation cost ratios, and transportation cost to inventory carrying cost ratios. These varying ratios are important for testing the generalizability of results under the "most likely" environment.

3. Variable production and handling cost - The production and handling costs for each industry are based on typical cost levels for each industry assuming a Chicago facility. An assumed direct labor cost portion of those cost levels are then indexed by city based on wage levels. The portion of COGS assumed for direct labor is 20 percent in the food industry, 35 percent in the women's clothing industry, and 20 percent in the consumer appliances industry. The same wage index is used across industries. The actual production and handling costs used for the base city of Chicago are shown in Table 6. The values by city and the development of the production and handling costs are shown in the data development section. The absolute level of production cost by industry, and the absolute production cost differentials by city result in substantial differences by industry. These differences will be important for testing the generalizability of findings across industries.

4. Company demand level by country - The demand level by country also varies by industry. A company demand level was calculated for the United States and varied by country in each industry based on available data on relative industry size by country and an assumed market share in each country. The company demand level for each country is shown in Table 6. Details on development of the demand data by country are discussed in the data development section.

5. Freight class and transportation rates - The food and women's clothing industries assume a Class 70 freight classification based on input from representatives of each industry. The consumer appliances industry assumes a 92.5 class for refrigerators based on input from industry representatives. This results in a higher level of per hundredweight transportation rates for the consumer appliances industry compared to the other two industries. Development of actual transportation rates does not vary by industry except with respect to the freight class.

DEPENDENT VARIABLES

The dependent variables are 1) distribution system configuration, 2) total system cost, and 3) logistics cost in a sort-down least cost simulation run. The sort-down least cost simulation is one in which the model determines the low cost number of distribution centers and assigns markets to facilities on the lowest cost basis possible given the potential distribution center locations and given model set variables. The dependent variables are:

1. Distribution system configuration - This variable is an endogenous model variable, in that the model output consists of reports which list the manufacturing plant and distribution center locations for a given simulation.

2. Total system cost - This is also an endogenous model variable and represents total system cost including production costs.

3. Logistics cost - This too is an endogenous model variable and represents separate logistics costs. Logistics cost is also measured as a percent of revenue.

RESEARCH QUESTIONS

The research questions are based both on the literature review and on the interests of executives. The principal concern of executives is one of how their firms should respond to economic integration. The most important questions relate to 1) what the distribution system

configuration should look like in a North America-wide market, 2) where facilities should be located, 3) what region's facilities should serve, 4) how much cost can be reduced by rationalizing distribution configurations, and 5) how changes in research variables and industry environment effect the answers to the previous questions.

The first category of research questions concern the impact of serving a combined United States-Canada market under various research variable and industry environments. These questions first address the fundamental impact of market integration in terms of combining two country market areas and designing a least cost system for the entire geographic area. The research questions go on to explore the impact of individual research variables on the dependent variables, and the impact of the "most likely" economic integration environment on the dependent variables. The above questions are addressed from the vantage point of the food industry first. The location impact of the two alternative industry environments is then evaluated assuming the "most likely" research variable environment. The research questions for the United States-Canada set and for the United States-Canada-Mexico set are quite similar and are shown in Tables 7 and 8.

Table 7

United States-Canada Research Questions

RQ1A:	For the food industry, what is the appropriate distribution system configuration, and how do total system cost and logistics cost change in an integrated United States-Canada distribution system when compared to the traditional separate country design, assuming no changes in the other research variables?
RQ1B:	For the food industry, how do changes in the levels of the tariff, cross-border transportation costs, and demand research variables affect distribution system configuration, total system cost, and logistics cost when compared to the least cost network defined in RQ1A?
RQ1C:	For the food industry, under the "most likely" research variable environment, what impact will there be on distribution system configuration, total system cost, and logistics cost when compared to the least cost integrated system design found in RQ1A?
RQ1D:	For the women's clothing and consumer appliances industries, under the "most likely" research variable environment, what impact will there be on distribution system configuration, total system cost, and logistics cost when compared to the least cost integrated system design found in RQ3C?

Table 8

United States-Canada-Mexico Research Questions

RQ2A:	For the food industry, what is the appropriate distribution system configuration, and how do total system cost and logistics cost change in an integrated United States-Canada-Mexico market compared to a United States-Canada market, assuming initial research variables?
RQ2B:	For the food industry, how do changes in the levels of the tariff, cross-border transportation cost, and demand research variables affect least cost distribution system configuration, system cost, and logistics cost when compared to the least cost network defined in RQ2A?
RQ2C:	For the food industry, under the "most likely" research variable environment, what impact will there be on distribution system configuration, total system cost, and logistics cost when compared to the least cost network defined in RQ2A?
RQ2D:	For the women's clothing and consumer appliances industries, under the "most likely" research variable environment, what impact will there be on distribution system configuration, total system cost, and logistics cost when compared to the least cost integrated system design found in RQ2C?

MODEL DATA DEVELOPMENT

The specific model set variable data required by the simulation model and the method by which the data was gathered for each industry are presented in the following data development sections. The approach to model set variable data for the three countries and the actual data developed is shown under each data development section. It should be noted that all dollar figures represent United States dollars.

MARKET AREAS

The simulation model requires market areas to be established for the demand being modeled. The market area definitions are a constant in the model and are not changed to reflect alternative industries or for any other purpose. For the United States a standard three digit zip code grouping georeference system of 204 market areas is used. The market areas are summarized in Table A1 of Appendix A. Figure A1 of Appendix A offers a map of the market area. This 204 zip code area grouping was prepared by the Dialog Systems Division of A.T. Kearney and is reproduced from the NETSIM II Documentation Manual (A.T. Kearney, Inc. 1990). These market areas have been validated as an accurate representation of United States demand in a number of logistics network design studies across various industries.

The market areas are mutually exclusive, stable, data is available at the market area level represented, it is feasible to determine distance from distribution facilities to the market areas, and demand within each area is relatively homogeneous. Given the above attributes, it appears that the system meets the criteria for a georeference system outlined in Bowersox, Closs, and Helferich (1986).

Canadian market areas were established based on the Census Federal Electoral districts. A total of 45 market areas were established by grouping the electoral districts into what appears to be geographically contiguous trading area regions (Statistics Canada 1988). Table A2 in Appendix A provides a summary of the Canadian market areas, and Figure A2 of Appendix A contains a map of the market area. Market size data based on population was available for these market areas. The 45 areas should provide sufficient detail given that there are double the number of market areas on a per capita basis compared to the United States, and given that the Canadian population is concentrated along the border with the United States. They also meet the criteria for evaluating georeference systems discussed earlier (Bowersox, Closs, and Helferich 1986).

For Mexico, 62 market areas have been defined. The market areas were established by reviewing urban population levels

on a state by state basis. Major cities within a state were established as separate market areas and the remainder of the state was divided into several additional areas depending on the extent of urban population present. Urban population of 44.3 million represents 51.5 percent of Mexico's total population. Urban population is defined as all persons residing in locations of over 2500 population. Appendix A, Table A3 contains a summary of the market areas and a map (Appendix A, Figure A3) outlines the market area borders. Table A3 also includes a listing of the principal city codes shown on the map.

PRODUCT DEMAND

The demand for each industry category was first established for the United States market based on industry size/market share and/or typical companies' sales of the products in question. The actual sales figure used is not particularly important, however, the sales should be within the bounds of what firms experience in the United States. The sales number also should be feasible for a two manufacturing plant operation in the United States. Company sales were then determined for Canada and Mexico for each industry category. The level of this demand relative to United States demand could be quite important in that a substantial under or overstatement might shift manufacturing plant and distribution center locations away from or towards United

States borders. Total dollar sales of demand in each country was then converted to case or unit demand by dividing dollar sales by the price per unit.

Following determination of a company sales level in units in each country, the country demand was apportioned by market area in the country. For the United States and Canada, total population was used to determine the share of population in each market area relative to the country total. The market area population share percentage was then used to assign total country units of demand to the market area. For the United States, population in each market area was determined by obtaining 1980 census population for each three digit zip code comprising a market area and adding them together to obtain the market area's overall population. Population figures were obtained from the Rand McNally Zip Code Atlas (Rand McNally 1983). For Canada, 1986 census population figures for each market area were obtained from the 1986 Census of Canada, as reported in the Census Federal Electoral Districts Report (Statistics Canada 1986). For Mexico, the urban population by market area was used to spread total country demand. The urban population by market area was estimated using data on urban population by state and by principal city (Pick, Butler and Lanzer 1989).

Finally, unit demand in each market area was split into three equal order size categories by weight group. The three weight groups are demand under 10,000 pounds, demand between 10,000 and 20,000 pounds, and demand for truckload orders. The demand in each weight group is transported from source facilities to markets at the freight rate appropriate for that particular demand weight group.

A summary of the company sales calculations by industry for each country is presented in the following paragraphs. Appendix B contains details on the estimates and calculations used to arrive at company sales by industry for each country. The Appendix A tables defining market areas by population also include a column indicating the percent of total country demand assigned to each market area. The Mexican table also includes data on urban population by state and city population. This data on urban population was used to arrive at urban population by market area in Mexico.

For the food industry, United States company sales were estimated $500.0 million. Company sales in Canada were estimated to equal 12.7 percent of United States sales, or $63.9 million. Mexican sales were estimated at $40.9 million, or 8.1 percent of United States company sales. The United States company sales of $500.0 million were based on sales figures reported for major United States processed

food companies (Standard and Poor's Corporation 1988) and confirmed against an estimated U.S. industry size of $5.81 billion for the food products in question. The $500.0 million in sales was also checked with a United States manufacturer and confirmed as reasonable. The United States industry size was arrived at by factoring up detailed Canadian industry size data (Statistics Canada 1986) and by comparing to United States four digit SIC code data reported in the United States Industrial Outlook (U.S. Department of Commerce, Industrial Outlook 1990). For Canada, estimated company sales of $63.9 million were calculated based on detailed data on industry size of each specific food product in question (Statistics Canada 1986), and based on an assumed 11 percent market share. The sales figure seemed reasonable relative to the United States sales figure given the relative population and given higher levels of concentration found in Canadian industry. The number also seemed reasonable when compared to the sales levels reported for major Canadian food processing companies (Predicasts 1989). For Mexico, industry size was estimated as a percentage of the United States industry size using Mexican population over a moderate income level relative to the United States population as a proxy. Mexican population over a moderate income level was 6.9 percent of the United States population and hence Mexican industry size of $400.9 million was obtained. Assuming an 11 percent market share, company sales of $40.9 million were arrived at.

For the women's clothing industry, the United States company sales are set at $300.0 million. Company sales in Canada were estimated to equal $39.0 million, or 12.9 percent of United States sales. Mexican sales were estimated at $32.0 million, or 10.7 percent of United States sales. The United States company sales of $300.0 million are based on typical clothing company sales (Standard and Poor's Corporation 1988) and on an assumption of 2.5 percent market share in an industry with 316 million units of shirts, dresses and blouses demand (Predicasts Forecasts, Inc. 1990). Considerably lower market shares were assumed in women's clothing to reflect the much lower concentration levels in this industry. For Canada, estimated sales of $39.0 million are based on the 11 percent relative population of Canada compared to the United States, and on an assumption of a 3 percent market share. The higher market share in Canada is again designed to reflect higher concentration levels in Canadian markets. For Mexico, the industry size is assumed to be equal to 6.9 percent of the United States industry size. The 6.9 percent figure is based on the same ratio of Mexican population over a moderate income level relative to the total United States population that was used in the food industry. Company sales of $32.0 million are based on a 4 percent share of the Mexican industry.

For the consumer appliances industry, United States company sales were set at $420.0 million, or 1,050,000 units. Company sales in Canada were estimated to equal $58.7 million, or 13.9 percent of United States sales. Mexican sales were estimated at $25.1 million or 6 percent of United States sales. The lower percentage of Mexican demand relative to the United States, compared to food and clothing is due to the reduced ability to purchase a high priced durable goods product. The United States company sales are based on an industry size for refrigerators of 7 million units (Predicasts Forecasts, Inc. 1990) and an assumed 15 percent market share. For Canada, estimated sales of $58.7 billion were based on a Canadian industry size of 669,000 units (Predicasts 1989) and an assumed market share of 22 percent. Again, a higher market share figure was used in Canada relative to the United States to reflect greater concentration ratios in Canadian markets. Mexican demand was again based on an industry size equal to 6.9 percent of the United States level. The 6.9 percent figure reflects the Mexican population relative to United States population that exceeds moderate income standards. Actual company sales of $25.1 million are based on a market share of 13 percent.

FACILITY LOCATIONS AND NETWORK LINKAGES

The facility location points in the model represent cities where potential manufacturing plants, distribution centers, or freight transfer points are located. The latter transfer points are used in modeling freight movements between the United States and Mexico and are necessary because through freight rates are seldom quoted. Instead, rates from one country to the other consist of the rate from the origin to the transfer point, and then a rate from the transfer point to destination. Shipments also are transferred from one carrier to another at the transfer points or at the very least trailers are uncoupled from power units and rehooked to power units approved for operation in the destination country.

Manufacturing Plants

Manufacturing plant locations were selected so as to replicate typical sites for each industry. Sites were also chosen so as to replicate typical manufacturing locations for each country. A partial combination of five cities are used depending on the research question and industry being modeled. The five cities are Chicago, Kansas City, Atlanta, Toronto and Monterrey.

As discussed in the industry set variables section, for the food industry, Chicago and Kansas City are used for the United States, Toronto is the Canadian site, and Monterrey is the Mexican site. Atlanta is not used for the food industry. These locations were selected because they represent historical sites of manufacturing for the food industry. The United States midwestern cities are typical locations for production in the food industry. It should be noted that inclusion of an Eastern United States manufacturing location would alter the results considerably.

For separate country simulations, only those manufacturing plants in the country are used. As two country and three country integrated environments are considered, all available manufacturing plants in the countries being modeled are available. For the three country integrated market and "most likely" variable environment, one simulation is conducted using all four sites.

For the women's clothing industry, the United States-Canada integrated environment first assumes only one manufacturing plant available in Atlanta. Atlanta is used instead of Kansas City, Chicago and Toronto because it is an apparel production center with lower cost labor. A second simulation, however, is conducted assuming production in Kansas City, Chicago and Toronto. This second simulation allows direct comparison with the food industry production

locations under the "most likely" research variable environment. The United States-Canada-Mexico environment also assumes an Atlanta only manufacturing location first. While a Monterrey only manufacturing location would certainly be a logical option, such a simulation was not conducted due to time and expense limitations. A second simulation utilizes facilities in Chicago, Kansas City, Toronto and Monterrey for comparison purposes again.

For the consumer appliances industry the Kansas City, Chicago and Toronto facilities are used for the United States-Canada integrated environment. The Monterrey manufacturing plant is added for the fully integrated three country environment. These cities provide direct comparability with the food industry but were selected because they are cities where appliances manufacturing has occurred over the years. Kansas City may be an exception to this principle but is included for comparison purposes.

Distribution Centers And Transfer Points

Potential distribution center sites were established in a number of traditional United States, Canadian and Mexican cities, as well as in cities which may become more important distribution hubs in an integrated North American market.

Figure 4 depicts the facilities on a map of the North American continent. For the United States distribution center's are located in the following cities:

New York	Kansas City
Syracuse	Dallas
Buffalo	Houston
Pittsburgh	Laredo
Philadelphia	El Paso
Atlanta	Denver
Memphis	Phoenix
Minneapolis	Los Angeles
Detroit	San Francisco
Monroe	Seattle
Chicago	

Canadian distribution center's have been established in:

Montreal	Winnipeg
Ottawa	Calgary
Toronto	Vancouver
Windsor	

For Mexico distribution center sites were established in:

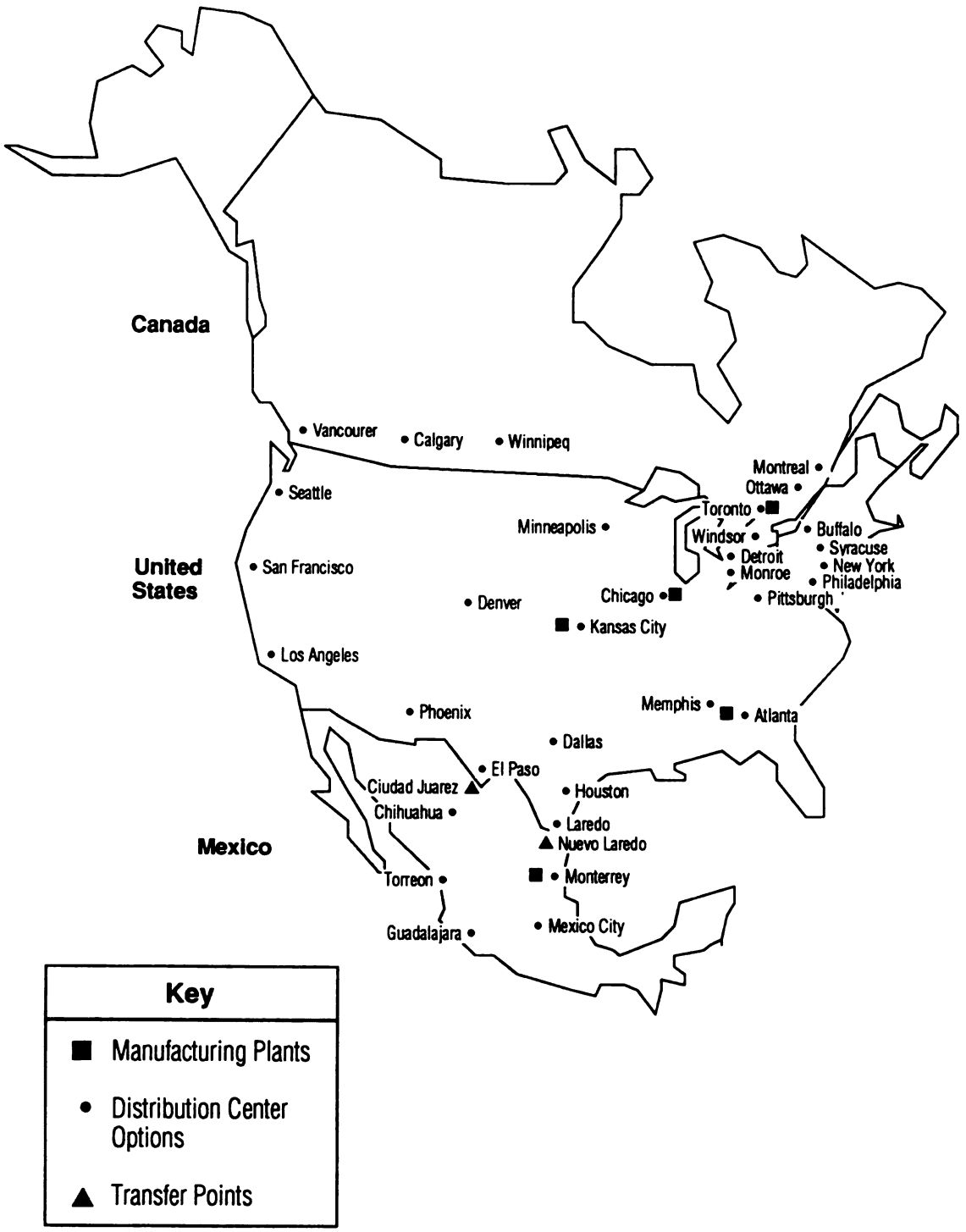
Mexico City	Monterrey
Guadalajara	Torreon
Chihuahua	

Freight transfer points have been established for two of the major border crossing points between the United States and Mexico. These are in:

Ciudad Juarez
Nuevo Laredo

Figure 4

Facility Locations



Network Linkages

The simulation model network of facilities includes the manufacturing plants, distribution centers and Mexico-United States border transfer points discussed above. The network design allows manufacturing plants to ship to distribution centers or transfer points, but does not allow manufacturing plants to ship to customers directly. Each manufacturing plant city is also a distribution center city and the distribution center is assumed to be adjacent to the manufacturing plant. There are no freight costs incurred between the manufacturing plant and adjacent distribution center.

All manufacturing plants are allowed to ship to all distribution centers either directly or through the border transfer points when crossing the United States-Mexico border. Distribution centers in Canada and the United States are allowed to ship to all markets within their own country, and are allowed to ship to markets within approximately 2000 miles of their location on cross-border shipments. Mexican distribution centers located in Mexico City and Monterrey may ship to all Mexican markets while facilities at Guadalajara, Chihuahua and Torreon are linked to Mexican markets within approximately 1000 miles of their location. The Mexican manufacturing plant and distribution

centers in Monterrey and Chihuahua are linked to the border transfer points, and via the transfer points to all United States and Canadian distribution centers.

The border points are not allowed to ship directly to United States or Canadian markets. As such, the Mexican manufactured product must reach United States and Canadian markets through United States and/or Canadian distribution centers. This constraint is due to model technical considerations but is also reasonable given likely current and future needs for inspecting merchandise, integrating items with other materials, customer order communication constraints, and a need to ship to customers on short lead times without the possibility of border delays. United States and Canadian manufactured product is also required to reach Mexican markets through Mexican distribution centers.

FACILITY COSTS

Several categories of cost data are required to operationalize the model. The cost categories include production and variable handling costs, fixed costs, and inventory carrying costs; and are discussed in the following sections.

Production and Variable Handling Costs

The production and variable handling costs category includes cost data for manufacturing plant variable production cost per unit, manufacturing plant variable handling costs, and distribution center variable handling costs. The common feature of these cost items is the degree to which they may differ from country to country and from city to city as a result of variations in hourly labor compensation rates. While a number of factors may affect variable production and handling costs by city, for purposes of this research, hourly labor compensation rates are the sole factor used to calculate differences by city. This factor was used because it is believed to be the major item responsible for differences by city, and because data on differences by country and/or city were generally available for all facility locations. A limitation of the research is that it does not consider other factors that might increase or decrease costs by city.

In determining the impact of differential labor compensation rates, there are two key factors. The first is the percent of direct labor content in the variable production or handling cost. The second is the actual hourly compensation rate. The percent of direct labor content is critical because the hourly compensation differentials apply only to that portion of production or handling total cost per unit.

A lower direct labor percentage minimizes the impact of lower hourly compensation costs, a higher one increases the impact.

The percent of direct labor content varies by industry, and by cost category (i.e., production versus handling). For this research, variable production costs were assumed to include direct labor equal to 20 percent of cost of goods sold in the food and consumer appliances industries, and 35 percent of direct labor in the women's clothing industry. The higher labor content in clothing is reflective of the labor intensive nature of clothing manufacturing. The figures used are based on industry experience and were confirmed as reasonable estimates in interviews with representatives of the three industries (Whirlpool 1990, Nabisco Foods 1990, Adidas 1990). For the distribution center variable handling costs it was assumed that direct labor represents 60 percent of total system cost. This figure was also confirmed as reasonable with industry representatives.

The second key factor is the hourly compensation costs by country and city. For purposes of this research, total compensation levels including benefits have been used, rather than simple base wage levels by hour. In order to obtain a final production or handling variable cost by city, an index of hourly benefit loaded compensation costs was

constructed for each city. This index was then applied to the direct labor portion of production or handling costs to obtain the final unit costs by city. In order to create the index, hourly compensation costs by country were first obtained for Canada and the United States. These costs were then indexed within each country using data on wage differentials by city for each country. Mexican costs were assumed to be the same in each city due to the lack of an index. Finally, an all-cities combined index was created.

The hourly compensation costs for each country were obtained from two sources. For the United States and Canada, an academic paper comparing total hourly compensation costs in the two countries was used (Roberts and Smith 1989). The paper concludes that despite a common perception that labor costs are higher in Canada, the actual benefit loaded costs are far lower than in the United States. This is primarily due to lower company benefit costs in Canada as a result of governmental benefit programs. The compensation costs that result from their study are $15.45 per hour in the United States for manufacturing, compared to $13.81 in Canada. For wholesale trade, the category used for distribution center variable handling costs in this research, the costs are $15.14 per hour in the United States, and $11.13 per hour in Canada. The Canadian hourly rates were converted into United States dollars at an exchange rate of 1.15. For Mexico, the total compensation costs, including all

benefits, amount to $1.57 per hour (United Nations 1987). This rate was used for both manufacturing and handling cost categories. While the Mexican data is for 1986, it is not believed that the combined effect of inflation and exchange rates since 1987 would have substantially changed the number. More recent data including benefit cost was not available, however, data on basic wages for 1988 indicates Mexican wages were about 10 percent of the United States level (Gruben 1990). It is unlikely that any possible increase would be significant enough to effect the final outcome.

The average compensation level in the United States and Canada was then indexed by city using a wage index for each country. The Mexican compensation levels were assumed to be the same for each city because no index was available by city. In the United States, an index of wage levels by city maintained by Distribution Centers, Inc. was used to adjust hourly compensation levels by city (Distribution Centers, Inc. 1989). For cities not covered in the index, an estimate of the likely costs relative to other cities was made. For Canada, a report on employment, earnings and hours by city was used (Statistics Canada 1985). This report, the only Statistics Canada report of wages by city, was discontinued in 1985 so that was the most recent year

for which data was available. While a limitation of this research, it is assumed that relative wage levels by city would not have changed significantly since 1985.

The result of these calculations was a city index of labor costs for production costs, and for variable handling costs, by industry. The index was then applied to the base unit costs for each cost category and industry. The base costs were determined for a Chicago manufacturing plant and distribution center for each industry. The production and handling costs for each industry are summarized in the following sections. Appendix C includes tables with the index and cost calculations and resulting costs by city.

Variable Production Costs

Calculation of the variable production costs for each industry is shown in Appendices C1-1 through C1-3. For the food industry, the base variable production cost per unit was assumed to equal $7.00. This figure assumes a Chicago base and was judged reasonable by industry representatives (Nabisco Foods 1990). The unit cost in Kansas City equals $6.94. In Toronto, the cost is $6.64 per unit, and in Monterrey, the cost is $4.45 per unit.

For the women's clothing industry, the base cost in Chicago equaled $223.00 per unit of 12 garments. This base cost was

also verified as reasonable with sources (Adidas 1990). The unit production variable costs in Kansas City were $221.00 per unit, $200.00 in Atlanta, $208.00 in Toronto, and $122.00 in Monterrey.

For the consumer appliances industry, the base variable production cost in Chicago was assumed to be $200.00 per unit. This base cost was also deemed reasonable by industry representatives (Whirlpool 1990). The unit variable production costs in Kansas City were $199.00, $193.00 in Toronto, and $149.00 in Monterrey.

Variable Handling Costs

The cost of handling and storing product in manufacturing plants and at distribution centers is reflected in variable handling costs per unit. For purposes of this research, manufacturing plant transfer handling costs and distribution center handling costs are assumed to be at the same level. Costs do, however, vary by city and by industry. Appendices C2-1 through C2-3 contain the handling cost calculations and final unit cost detail by city.

For the food industry, the base variable handling cost in Chicago was set at $.20 per unit. This base case was deemed reasonable by industry representatives (Nabisco Foods 1990). Following adjustment for compensation costs in each city,

the variable handling costs in the United States ranged from a high of $.224 per unit in Detroit to a low of $.172 in Memphis. In Canada, costs ranged from $.153 in Ottawa to $.186 in Windsor. Mexican handling costs were $.092 per unit.

For the women's clothing industry, the base variable handling cost in Chicago was set at $.24 per unit. This base case was also deemed reasonable by industry representatives. Following adjustment for compensation costs in each city, the variable handling costs in the United States ranged from a high of $.269 per unit in Detroit to a low of $.207 in Memphis. Canadian costs ranged from $.184 in Ottawa to $.223 in Windsor. Mexican handling costs were $.110 per unit.

For the consumer appliances industry, the base variable handling cost in Chicago was set at $5.48 per unit. This figure was confirmed as reasonable by industry representatives (Whirlpool 1990). After adjusting for compensation costs in each city the variable handling costs in the United States ranged from a high of $6.13 per unit in Detroit to a low of $4.72 in Memphis. In Canada, costs ranged from $4.20 in Ottawa to $5.09 in Windsor. Mexican handling costs were $2.52 per unit.

Distribution Center Fixed Costs

The distribution center facilities in the model are assumed to reflect a public warehouse operation. However, because some fixed costs will be present in any distribution center operation, and because a public warehouse's charges will in part reflect their own fixed cost levels, a small fixed cost component is included in the model. These fixed costs vary from city to city based on warehouse space costs and as such, the model fixed costs by city vary based on an index of space costs by city. Within the United States, the space costs index maintained by Distribution Centers, Inc. is used (Distribution Center, Inc. 1989). For cities not covered in the index, an estimate of the likely costs relative to other cities was made. For Canadian cities, an index of space costs relative to United States cities was used (Canada Facts 1990). Mexican space costs were assumed to equal 65 percent of Dallas costs.

A base fixed cost of $100,000 was assumed for Chicago. The same fixed cost is assumed for all three industries. The space cost index is assumed to apply to 60 percent of the base cost, while 40 percent of the base cost is not subject to variation. As such, the space cost index is applied only to 60 percent of the cost. The calculation of fixed costs by city and a summary of these costs is shown in Appendix C3.

Following adjustment for the cost of space in varying cities, fixed costs at United States distribution centers vary from $100,000 in Chicago to a high of $115,000 in New York, to a low of $70,000 in El Paso and Laredo. Canadian fixed costs vary from a low of $72,000 in Winnipeg and Calgary, to a high of $101,000 in Toronto. Mexican costs are set at $65,000.

Inventory Carrying Costs

An inventory carrying cost of 14 percent was assumed for inventories located in all countries on the assumption that a North America-wide competitor would finance inventories on a continentwide basis. The 14 percent cost is designed to cover an average cost of funds of approximately 9 percent, and the remaining 5 percent is designed to cover costs for taxes, insurance and obsolescence. Storage costs, which in some methodologies are included in inventory carrying costs, are not included because they are included in the fixed costs and handling costs. The capital costs reflect a cost of funds approach, as opposed to an opportunity cost of capital approach, because a number of firms take this approach, and because it would be difficult to set an opportunity cost. Either approach is acceptable (Bowersox, Closs and Helferich 1986), however, it should be noted that

the cost of funds approach used biases the model in favor of additional distribution centers because the cost penalty of safety stock in multiple facilities is minimized.

TARIFF COSTS

Tariffs were entered into the model for the food industry only because that is the industry that is tested at full and partial variable intensities. The women's clothing and consumer appliances industries are only tested at "most likely" zero tariff levels and as a result it was not necessary to develop tariff information for those products.

Tariffs for the food industry were obtained for movements from the United States to Canada, from Canada to the United States, from the United States to Mexico, from Mexico to the United States, and from Mexico to Canada. The actual tariffs for each product comprising the representative model food product, and the calculations of tariff cost per hundredweight, are shown in Appendix D. The tariff data was obtained from United States Customs and Revenue Canada, and for Mexican tariffs on United States imports, from the United States Department of Commerce (United States Customs 1990, United States Department of Commerce 1990, Revenue Canada 1990). Rates were obtained as a percentage of dollar value or in cents per kilo and converted to a rate per demand unit and then to a rate per hundredweight. The

tariff cost per hundredweight was also calculated at half tariff levels. The tariff for a given origin-destination direction was then added to the freight rate in the appropriate freight rate file on all possible links in that direction.

The actual full tariffs ranged from 3.8 to 18.75 percent. The tariff for food products entering Canada from the United States equaled 17.5 percent. This tariff amounts to $3.50 per case or $17.50 per hundredweight. For movements from Canada to the United States, the tariff equals 3.8 percent, or $.76 per case, and $3.80 per hundredweight.

For Mexican imports from the United States, the food products tariff is 18.75 percent, or $3.75 per case and $18.75 per hundredweight. For imports to the United States from Mexico, a 10 percent average overall tariff was used for the food product. This tariff level resulted in a charge per case of $2.00, or $10.00 per hundredweight at full levels. Finally, for imports to Canada from Mexico, the food product tariff is 9.75 percent, or $1.95 per case. The charge per hundredweight is $9.75.

The tariffs per hundredweight described in this section are added to freight rates on all transportation links between the appropriate origin and destination. The resulting freight rate in the model is a combination of transportation

charges and tariff costs. The process by which tariffs were added to freight rates is more fully described at the end of the following section on transportation rates.

TRANSPORTATION RATES

The NETSIM II model requires transportation links and freight rates between markets and their potential source facilities, and between facilities that are eligible to ship to one another. Two types of freight rates are entered, transfer rates between facilities, and customer rates from source facilities directly to markets. For transfer rates, it is assumed that truckload shipments are made between facilities, and hence full truckload freight rates for a given facility to facility link are entered. For customer rates, freight rate data on a link is entered for each weight group of demand defined in the demand file. Market demand is broken into three equal weight groups in this research -- under 10,000 pounds, between 10,000 and 20,000 pounds, and full truckload.

As a result, freight rates for each weight group have been entered for each customer freight rate link. Separate sets of freight rates are entered on each link/weight group for each industry, based on the appropriate freight class. For the food and women's clothing industries, a similar 20 to 24 pound box is the shipping unit and a class 70 rate is used

for both. For the consumer appliances refrigerator product, a 92.5 rate is used based on advice from industry representatives (Whirlpool 1990).

Freight rates for the United States are based on the Yellow Freight System, Inc. Zip Disk freight rates (Yellow Freight System, Inc. 1990). This data and look up diskette provides freight rates for each three digit zip code combination within the United States by freight class and by weight group. The rates are based on ICC tariff YF54 500-G. The look up program also allows the user to specify a discount rate to be applied to the list price rates. Because firms in the United States typically receive a discount of from 30 to 45 percent off list prices in interstate commerce, it was necessary to determine the discount to be used (Michigan Intra-State Motor Tariff Bureau, Inc. 1988). Based on the general level of discounts, and based on interviews with industry representatives and consultants, it was decided that a 40 percent discount level should be applied (Nabisco Foods 1990, Whirlpool 1990, Adidas 1990, A.T. Kearney 1990).

For major cities, the Yellow data includes rates from high cost five digit origin zones, and for lower cost suburban origin zones. A data download program was used to secure the appropriate rates data and to format the data for direct loading into the NETSIM II model. It should be noted that the program is designed to select the data for the first

three digit zip encountered with the correct numbers, and as such the high cost origins in major cities were selected. Because of the fact that major city origin freight rates reflect the high cost area five digit origins. These high cost origin freight rates can be as much as $2.50 per hundredweight higher than the suburban lower cost rates in the same city. However, since the same approach was used for all cities in the United States, and since the results indicated only one location that may have been effected by this bias, it is believed that the data is acceptable with the understanding that caution should be used in drawing conclusions about specific cities.

For shipments from Canadian origins to destinations, freight rates were obtained from the Canada rate diskette published by CP Freight and Express, Ltd. (1990). Again, the applicable discount had to be determined. Based on an interview with CP Freight and Express rate personnel, it was decided that a 25 percent discount should be applied (CP Freight and Express Interview 1990). The 25 percent discount represents somewhat more than half of the United States discount level, however, CP personnel indicated that 1) the published CP rates are more in line with actual charges than is the case in the United States, and that 2) discount levels in Canada are not as great as in the United States because freight rates are in fact higher in Canada.

Because all goods meeting a minimum weight/cube criterion are rated at one common rate class, rating classification options do not exist. Instead, products outside the criteria are charged rates which have been factored up. Thus it was necessary to determine how to apply the Canadian rates to the freight class structure used for United States internal linkages. It was determined that the standard CP rates should be applied to the food and women's clothing product classes established in the model. However, given that the United States rates for the refrigerator product reflected higher class 92.5 rates, and given that CP rate personnel indicated this product might draw somewhat higher rates, it was decided that the CP rates should be factored up for the refrigerator product. As such, the consumer appliances refrigerator product rates reflect the standard CP rates factored up by 20 percent. The 20 percent factor is an estimate of the difference between United States class 70 and 92.5 rates used in the model. While the 20 percent factor is a rough approximation, no other viable approach was available. In addition, since the consumer appliances industry is only compared to the other two industries in one research question, it was possible to review the results and determine if the 20 percent freight rate factor had any significant impact in changing results from what would otherwise have occurred. That review did not indicate any such impact.

United States-Canada cross-border freight rates are based on the rate diskette published by Consolidated Freightways, Inc. (1990). The diskette contains rates for most origin-destination links across the border for United States freight classification codes, by weight group. For those links not provided on the diskette, an estimated rate was determined by examining comparable distance rates on other cross-border links. The rates are based on Rocky Mountain Tariff Bureau, Inc. tariffs CFWY 555, 755, 783, and 785. A 30 percent discount was applied to these rates based on input from Consolidated Freightways (1990) rate personnel. The rate personnel were informed of the discounts being applied to internal United States and Canadian rates so as to obtain the correct relative discount levels.

Mexican internal freight rates were not available on diskette. Nor are Mexican rates stated in terms of the United States classification system. Several attempts were made to obtain point-to-point rates for the full range of freight links from Mexican plants and distribution centers to markets and border points, and from border points to Mexican facilities and markets. However, only a sample of freight rates could be obtained and these were provided by Yellow Freight's Laredo office (Yellow Freight Systems, Inc. 1990). The freight rates provided by Yellow are actual charges and are not discounted further as a result. The

freight rates which were obtained were for truckload and for less-than-truckload categories. As such, the Mexican rates for the under 10,000 pound and 10,000 to 20,000 pound weight groups are identical.

The Mexican rates sample was used to construct a distance based regression of freight rates for Mexico. Two regressions were created, one for truckload rates and one for less-than-truckload rates. The regression results are shown in Appendix E.

In order to maintain compatibility with the United States and Canadian internal freight rates for refrigerators, the Mexican freight rates were also factored up 20 percent for the refrigerator freight class.

Cross-border United States-Mexico freight rates are a combination of the Mexican portion of a shipment and the United States portion. All cross-border shipments are moved through one of two transfer points established in the model. Interviews with carrier executives indicate that while some through rates are quoted, most freight across the border moves under the combined rate approach (Consolidated Freightways 1990, Yellow Freight Systems, Inc. 1990). Movements from the Mexican manufacturing plant to Canadian distribution centers are routed through the United States-Mexico border point and on to the Canadian distribution

center. These Mexico to Canada freight rates are a combination of the Monterrey to border point rate and the border point to Canadian distribution center rate. The border point to Canadian distribution center rate is a United States-Canada cross-border rate generated from the Consolidated Freightways cross-border diskette.

In order to test the various cross-border freight rate and tariffs levels called for in the experimental design, a total of 12 freight rate/tariff files were created. The first six files included United States-Canada freight rates and tariffs only. The six freight rate/tariff files are as follows:

File A	Freight Rates Initial/Tariffs Initial
File B	Freight Rates Initial/Tariffs Half
File C	Freight Rates Initial/Tariffs Zero
File D	Freight Rates Off 10 Percent/Tariffs Initial
File E	Freight Rates Off 20 Percent/Tariffs Initial
File F	Freight Rates Off 10 Percent/Tariffs Zero

The second set of six freight rate tariff files consists of the File F United States-Canada data representing the "most likely" future environment with the following six sets of Mexico-United States-Canada freight rate and tariff data added on:

File FA	Freight Rates Initial/Tariffs Initial
File FB	Freight Rates Initial/Tariffs Initial
File FC	Freight Rates Initial/Tariffs Zero
File FD	Freight Rates Off 10 Percent/Tariffs Initial
File FE	Freight Rates Off 20 Percent/Tariffs Initial
File FF	Freight Rates Off 20 Percent/Tariffs Zero

The experimental design calls for the cross-border freight rate variable to be tested at intensities representing 10 and 20 percent reductions from initial rates. For United States-Canada cross-border movements, the through cross-border freight rate is reduced. For the United States-Mexico cross-border rates, the Mexican portion of the combined cross-border rate is reduced since there is not a through rate.

EXPERIMENTAL DESIGN

The experimental design involves a series of simulation runs that were conducted for each research question defined earlier in this chapter. The specific simulation runs are outlined in Table 9. The Table lists the simulation runs by research question in the rows. The research variables that are experimentally modified to conduct each simulation run are labeled in the columns. The cells indicate the intensities of each research variable for a given simulation.

A full set of simulations are first conducted for the United States-Canada. Following those simulations, the research questions are repeated for a United States-Canada-Mexico environment. In each of the two sets, the food industry is

Table 9

Simulation Schedule
Table Part A1

Research Question	Simulation Run	Solution Type	Industry Application	Markets Included	Markets Size	Production Facilities
Validation	Variety	Sort-down Least Cost	Three Industries	All	Current	All
RQ1A1, RQ1A2 Separate Countries	Base Case Two Separate Countries	Sort-down Least Cost	Food	a: Separate US b: Separate Canada	Current Typical	Canada: Toronto U.S.: K.C., Chicago
RQ1A3 Integrated System	Integrated System	"	"	Integrated U.S. and Canada	"	"
RQ1B1 RQ1B2	Tariff Variation	"	"	"	"	"
RQ1B3 RQ1B4	Cross-Border Transportation Cost Variation	"	"	"	"	"
RQ1B5 RQ1B6	Market Size Variation	"	"	"	Canada 15% ↑ Canada 30% ↑	"
RQ1C1	Most Likely Integration Environment	"	"	"	Current Typical	"

Table 9 (Cont'd.)

Table Part A2

Research Question	Schedule Potential DC Sites	Tariffs	Rate Class	Product Weight	Cross-Border Transporation Costs	Variable Production Costs
Validation	All	Current	All	Current	Current	Current
RQ1A1, RQ1A2 Two Country vs. Integrated	All Available Canada: All U.S.: All	Current	Consumer Packaged Foods Class 70	20 lbs./case	Current	Typical for Each Country for Consumer Packaged Foods
RQ1A3 Integrated System	"	"	"	"	"	"
RQ1B1 RQ1B2	"	a: 50% ↓ b: 100% ↓	"	"	"	"
RQ1B3 RQ1B4	"	Current	"	"	a: 10 % ↓ to current b: 20 % ↓ to current	"
RQ1B5 RQ1B6	"	"	"	"	Current	"
RQ1C1	"	Zero	"	"	10 % ↓ to current	"

Table 9 (Cont'd.)

Table Part B1

Research Question	Simulation Run	Solution Type	Industry Application	Markets Included	Markets Size	Production Facilities
RQ1D1	U.S./Canada Most Likely Consumer Appliances Refrigerators	"	Consumer Appliances Refrigerators	"	"	"
RQ1D2a	U.S./Canada: Most Likely Women's Clothing	"	Women's Clothing	"	"	U.S.: Chicago, Kansas City; Canada: Toronto
RQ1D2b	U.S./Canada: Most Likely Women's Clothing	"	Women's Clothing	"	"	U.S.: Atlanta

Table 9 (Cont'd.)

Table Part B2

Research Question	Schedule Potential DC Sites	Tariffs	Rate Class	Product Weight	Cross-Border Transporation Costs	Variable Production Costs
RQ1D1	All	Zero	Consumer Appliance Typical Class 92.5	230 lbs./unit	10% ↓	Typical for Each Consumer Appliance
RQ1D2a	"	"	Women's Clothing Class 70	24 lbs./case	"	Typical for Each Country For Women's Clothing
RQ1D2b	"	"	"	"	"	"

Table 9 (Cont'd.)

Table Part C1

Research Question	Simulation Run	Solution Type	Industry Application	Markets Included	Markets Size	Production Facilities
RQ2A1	Seperate Mexico	Sort-down Least Cost	Consumer Packaged Foods	Mexico Only	Current Typical	Monterrey Only
RQ2A2 US-Can-Mexico Integrated Sys.	Integrated Sys. Current Variables	"	"	Integrated U.S., Canada, and Mexico	"	Canada: Toronto; U.S.: K.C.,Chicago; Mexico: Monterey
RQ2B1 RQ2B2	Tariff Variation	"	"	"	"	"
RQ2B3 RQ2B4	Cross-Border Transportation Cost Variation	"	"	"	"	"
RQ2B5 RQ2B6	Market Size Variation	"	"	"	Can: Most Likely Mexico: 25% ↑ Mexico: 50% ↑	"
RQ2C1	U.S./Canada: Most Likely US/Can/Mexico: Most Likely	"	"	"	Canada: Current Mexico: 25% ↑	Canada: Toronto; U.S.: K.C.,Chicago; Mexico: Monterey

Table 9 (Cont'd.)

Table Part C2

Research Question	Schedule Potential DC Sites	Tariffs	Rate Class	Product Weight	Cross-Border Transportation Costs	Variable Production Costs
RQ2A1	All Available	Not Applicable	Class 70	20 lbs./case	Not Applicable	Typical for Each Country
RQ2A2	"	"	"	"	US/Can:Most Likely US/Can/Mexico: Current	"
RQ2B1 RQ2B2	"	U.S./Canada: Most Likely US/Can/Mexico: a: 50% ↓ b: Zero	"	"	"	"
RQ2B3 RQ2B4	"	U.S./Canada: Most Likely US/Can/Mexico: Current	"	"	US/Can:Most Likely US/Can/Mexico: a: 10% ↓ b: 20% ↓	"
RQ2B5 RQ2B6	"	U.S./Canada: Most Likely US/Mexico: Current	"	"	U.S./Canada: Most Likely US/Can/Mexico: Current	"
RQ2C1	"	U.S./Canada: Zero U.S./Canada/ Mexico: Zero	"	"	U.S./Canada: % ↓ US/Can/ Mexico: % ↓	"

Table 9 (Cont'd.)

Table Part D1

Research Question	Simulation Run	Solution Type	Industry Application	Markets Included	Markets Size	Production Facilities
RQ2D1	Most Likely Consumer Appliances Refrigerators	"	Consumer Appliances Refrigerators	"	Can: Current Typ. Mex: Current Typ.	"
RQ2D2a	US/Can/Mexico: Most Likely Women's Clothing	"	Women's Clothing	"	"	Canada: Toronto; U.S.: K.C., Chicago; Mexico: Monterrey
RQ2D2b	"	"	"	"	"	U.S.: Atlanta

Table 9 (Cont'd.)

Table Part D2

Research Question	Schedule Potential DC Sites	Tariffs	Rate Class	Product Weight	Cross-Border Transportation Costs	Variable Production Costs
RQ2D1	"	"	Consumer Appliances Typical Class 92.5	230 lbs./unit	"	Typical For Each Country for Appliances
RQ2D2a	"	"	Typical Women's Clothing Class 70	24 lbs./unit	"	Typical For Each Country for Women's Clothing
RQ2D2b	"	"	"	"	"	"

the principal one studied. The women's clothing and consumer appliances industries are only studied under the "most likely" variable environments. The three industries can then be compared under the "most likely" variable environment.

The first simulations are conducted to validate the model data and output. These simulations do not relate to any specific research questions but are conducted across a range of variable intensities to assure validity. The first simulations shown in Table 9 relate to validation.

In the case of the United States-Canada analyses, the first simulation set relates to research question RQ1A. This question investigates the impact of market integration. The first simulation runs in this set represent a base case of separate United States and Canadian systems (RQ1A1-2). The base case least cost sort-down solutions of each country serve as a comparison point for a single simulation which assumes basic integration of the two country markets (RQ1A3). The integration solution then serves as a comparison point for additional simulations in which individual research variables are experimentally varied. In this second set of simulations (RQ1B1-6), the impact of individual research variables is investigated. Specific runs are conducted to investigate the impact of varying tariff levels, cross-border transportation rates, and market

sizes. Tariff levels are reduced by 50 percent and 100 percent for the tariff level investigation. During the cross-border transportation rates study, costs are reduced 10 percent, and then by 20 percent. Finally, in studying demand levels, Canadian demand is increased 15 percent, and then by 30 percent. Initial intensities are assumed for all variables not being experimentally varied in each of these simulations.

A third set of simulations relates to research question RQ1C1. For this research question a simulation run for the "most likely" future environment of the research variables is conducted (RQ1C1). The above simulations assume a food industry. The fourth set of simulation runs relate to research question RQ1D and involve simulations of the women's clothing and consumer appliances industries (RQ1D1-2). Simulations of the women's clothing and consumer appliances industries were conducted following changes in the industry set variables. The simulations assume the "most likely" research variable environment. For the women's clothing industry, two sets of manufacturing locations were studied. In the first simulation, Kansas City, Chicago and Toronto manufacturing points are assumed thereby allowing direct comparison to the other two industries in terms of manufacturing plant locations

(RQ1Da). A separate simulation is conducted with manufacturing in Atlanta only to reflect a more realistic manufacturing plant setting for this industry (RQ1D2b).

A similar set of simulation runs was conducted for a United States-Canada-Mexico environment. First, a separate simulation of Mexico was conducted to allow comparison of separate and combined systems (RQ2A2). The second simulation (RQ2A2) relates to research question RQ2A and examines the implications of an integrated United States-Canada-Mexico market. The second set of simulations (RQ2B1-6) involves examination of the individual variable impacts. The simulations assume United States-Canada variable intensities are set at the "most likely" level. Variables impacting Mexican interrelationships with the United States and Canada are then changed one at a time as was the case in the United States-Canada situation. Results are compared to RQ2A2 to determine the impact of variable intensity changes.

The third simulation set (RQ2C1-3) consists of simulations which examine the location impact of a "most likely" research environment. In this set, the "most likely" environment for the research variables in both Canada and Mexico is used. Finally, in the last simulation set, (RQ2D1-2) the industry variables are changed to reflect the consumer appliances and women's clothing industries under

the "most likely" environment. Again, for the women's clothing industry, one simulation is conducted assuming the same manufacturing plant locations as in the other industries (RQ2Da), and a second simulation is conducted assuming just an Atlanta facility (RQ2Db).

CHAPTER 4 - SIMULATION RESULTS AND DISCUSSION

Chapter four summarizes the simulation findings by research question and provides analysis of the results. Conclusions concerning the results, and the implications of the results are discussed in chapter five. Before reviewing the findings, the validation of the simulation data and output is discussed.

VALIDATION

Modeling tools should be validated at two levels before the output is relied upon (Closs 1978). The first level relates to technical validation of the developmental effort. The second level relates to managerial validation. As discussed in the methodology chapter, the NETSIM II model has undergone extensive internal developmental validation from a technical standpoint. In addition, the model has been further validated through several Beta applications and a number of full scale industry applications.

The second level of validation, managerial validation, must be completed on a case by case basis for each application. For purposes of this research, four types of managerial validation were completed. The four approaches included error detection validation, input-output validation, general reasonableness validation, and industry reasonableness validation. Each is discussed next.

The validation process resulted in over 20 simulation runs being conducted so that the model data could be tested across a range of variable environments. The large number of validation simulations was also necessary in order to correct several data problems involving missing data. The data problems were primarily discovered using the model's error detection procedures. These built-in validation and diagnostic aids were used to conduct the first of the validation steps - error detection validation. Problems that were discovered included missing transportation links from several facilities, facilities that were not "turned on" in the model for a given industry, erroneous product demand unit to freight rate unit ratios, and markets that were not properly turned on or off for a given simulation. Another problem that was discovered using the error detection process was the presence of markets with demand that was not linked to potential sources. These markets were for military zip codes, Hawaii, and Puerto Rico. The markets were eliminated from the model since they could not

be reached by truck. Demand which had been allocated to these markets was also eliminated resulting in an approximate one percent reduction in model demand compared to the totals which were initially calculated for each industry. This error detection analysis is perhaps the most important of the four validation steps because plausible but erroneous results can be obtained if problems are not discovered and corrected.

The second type of validation, input-output validation, is conducted to assure that the per unit data which has been entered into the model is accurately reflected in output aggregate results. For instance, if a facility handling cost of $.20 per demand unit has been entered into the model, does the output total handling cost for the facility accurately reflect that unit handling cost? This type of validation was conducted for various unit data/aggregate output elements including unit price/total revenue output, unit handling and transportation cost/total cost elements, unit weight/total weight elements, and others. No problems other than initially incorrect unit costs were discovered during this validation.

The general reasonableness validation involved an examination of the facilities utilized in various research environments, the overall system costs, the relative freight costs, and other general reviews of the model output.

Several errors were discovered during these "face validity" checks of the model output. The most common problem discovered involved a failure to use the proper version of a data file for a given research environment. For instance, in modeling a research question calling for Mexican demand to be factored up 50 percent, the base demand level file was inadvertently used. This overall face validity review resulted in the conclusion that the model output for each simulation environment was reasonable. That is, costs were in line with expected levels and the distribution center configurations selected were sensible.

The fourth validity check involving industry reasonableness validation was accomplished at two levels. The first check was a comparison of industry logistics cost ratios to the model logistics cost output ratios. The second check involved a review of the model costs with industry representatives. While the model output generally conformed with industry ratios, the problem with this form of validity check is that the very general industry data may be more dated and inaccurate than the model output. The industry ratio data that was used dates to 1983 and represents averages for very broad industries such as "appliances," and "textiles." None-the-less, this information does provide some basis for benchmarking results.

Table 10 contains a summary of the published industry ratios and the model ratios for United States-Canada and United States-Canada-Mexico environments. For food manufacturing, the published 1983 data for the United States indicates a cost equal to 10.6 percent of revenue, while the model output for United States-Canada suggests logistics cost of 9.5 percent of revenue. For the United States-Canada-Mexico environment the model logistics cost represents 12.1 percent of revenue. The model costs are on the one hand likely to be lower as a result of reductions in logistics cost since 1983, and on the other hand, higher because of greater distances covered in serving the wider market area from more distant low cost sources. In general, the food industry ratios appear reasonable.

For the appliances industry, the 1983 data indicates logistics cost equaled 8.3 percent of revenue, while the model output costs equal 8.5 percent of revenue for the United States and Canada, and 10.1 percent of revenue when Mexico is integrated. As with the food industry, the United States-Canada data appears very much in line with the published data. The higher costs as a percent of revenue when Mexico is included are explainable for the same reasons indicated in the food industry.

The published and model costs for the women's clothing industry are significantly different, however, it should be

Table 10

Published Industry and Model Logistics Cost To Revenue Ratio

Industry	Published Estimate For U.S. In 1983	Model Output U.S.-Canada	Model Output U.S.-Canada-Mexico
Food Manufacturing	10.6%	9.5%	12.1%
General Appliances	8.3%	8.5%	10.1%
General Textiles	4.0%	1.4%	1.5%

Source: National Council of Physical Distribution Management, Measuring and Improving Productivity in Physical Distribution 1984, Prepared by A.T. Kearney, Inc., Chicago, IL, 1984.

noted that the industry data is for the overall textile industry, and not specifically women's clothing. The published data indicates logistics cost as a percent of revenue is equal to 4 percent, while the model output for the two and three country environments indicates logistics cost as a percent of revenue is equal to 1.4 and 1.5 percent respectively. The difference is believed to be due to the generic textiles industry data including lower sales value product, and hence a higher cost to sales ratio, than is the case for the women's clothing industry modeled. The women's clothing industry has a very high sales level relative to weight and this drives down logistics cost as a percentage of revenue. A review of the data in the model for this industry does not indicate any problems that could account for the differences, other than potentially low fixed costs, so the sales value appears to be the factor accounting for the variance. This situation is discussed further in the following paragraph on industry comments.

The review of model logistics cost with industry representatives is also an important validity check. For the food product, the model costs were reviewed with a representative of the industry to determine their reasonableness (Nabisco Foods 1990). The representative believed industry logistics cost was 15 to 25 percent lower than the model total costs as a percent of revenue. However, the industry figures the representative was

referencing did not include inventory carrying cost. As such, it would appear that the model costs of 9.5 percent for the United States-Canada market, including inventory carrying costs, are appropriate.

The costs for the women's clothing and consumer appliances industries were also reviewed with industry representatives (Adidas 1990, Whirlpool 1990). The costs for the consumer appliances industry appeared very comparable to industry experience according to the representative. For the women's clothing business, a direct representative was not available, however, a company with lower cost clothing sales was consulted. Again, costs seemed low as a percent of revenue but this seemed to be a function of the high sales value for the products represented in the model. Another potential reason for the low costs as a percent of revenue in the women's clothing field is the model assumption of very low fixed costs that would be representative of a public warehouse operating environment. This assumption is less realistic in the clothing industry where company's are more likely to own high fixed cost distribution centers.

The above industry comments, coupled with the published textile industry ratios, indicate that the model costs for women's clothing as a percent of revenue may be on the low side. As such, the relatively low logistics cost as a percent of revenue for women's clothing is a limitation of

the research. However, the bulk of this difference is still thought to be due to the high sales value for the modeled product. In addition, an increase in the fixed costs or variable handling costs for this industry would not change the basic distribution center configuration which the model results suggests. That configuration is one which utilizes only two or three distribution centers because of the low transportation costs relative to high inventory carrying costs that occur as a result of low total weight relative to value. The potentially low costs as a percent of revenue for this industry does mandate caution in drawing any conclusions regarding the overall logistics cost of this industry relative to the others.

SIMULATION FINDINGS

Before discussing the findings, it is important to reiterate several key points. First, it should be remembered that the findings are based on the facility location and data assumptions specified in the data development section. One of the most important of these assumptions relates to the manufacturing locations in Chicago, Kansas City, Toronto and Monterrey, depending on the integration environment being studied.

It is also important to remember the research variable intensity assumptions for each research question and related simulation run. These are detailed in Table 9. In general, the "basic integration" simulations assume combination of the two countries while maintaining all other research variables at the initial intensities. The basic integration simulations are used as "base cases" for comparison to simulations in which individual research variable intensities or combinations of research variable intensities, are changed to determine the impact on dependent variables. Base case A assumes combination of the United States and Canadian markets. Base case B assumes combination of all three countries, and assumes United States-Canada interactions are at the "most likely" level while interactions between Mexico and the United States-Canada are set at initial intensities.

Both the two country and three country integration simulation sets include a simulation of the "most likely" research variable environment. This environment represents the most likely future intensities for each of the research variables. For the United States and Canada "most likely" integration question, the assumption is that tariffs are reduced to zero, and that cross-border freight rates are reduced 10 percent. The "most likely" United States-Canada interaction assumptions are maintained for all simulations in the United States-Canada-Mexico integration environment.

The United States-Canada-Mexico "most likely" simulation also assumes Mexican demand is increased 25 percent, that tariffs between Mexico and the United States-Canada are reduced to zero, and that Mexican freight rates are reduced 20 percent.

The reader should also be aware that four research variables are considered and they are 1) the extent of country market integration, 2) size of country market demand, 3) tariff levels, and 4) cross-border transportation rates. The dependent variables include 1) distribution system configuration, 2) total system cost, and 3) logistics cost. The distribution system configuration refers to the number and location of manufacturing plants and distribution centers in the low system cost network of facilities. All monetary values are stated in United States dollars.

Finally, a number of simulations display a rather flat total cost relationship as distribution centers are deleted. The flat relationship means that costs do not vary significantly as facilities are deleted, and as such, a system with two or three more or less facilities than the actual low cost system does not vary significantly in logistics cost. The total cost relationship which results as facilities are deleted is quite flat because of 1) the very low level of fixed costs in the system; 2) the relatively low level of safety stock in total inventory and the relatively low

inventory carrying cost percentage; 3) the absence of very small order size demand which becomes more expensive to deliver as facilities are deleted, and because of the relatively large percentage of truckload demand; and 4) the fact that as many facilities are deleted, alternative facilities in the same general area are available to supply a market. The flat total cost curve suggests that the results should be interpreted in general trends in the number of distribution centers and in terms of the general geographical direction; not in terms of specific locations or numbers.

The simulation findings which follow are organized by research question. For each research question, the general issues are discussed and the relevant simulations summarized. The results for each simulation are then presented along with a comparison to the other simulations in the set. Reasons for differences between simulations are presented with each new simulation being discussed.

RESEARCH QUESTION 1A - UNITED STATES-CANADA BASIC INTEGRATION

Research question 1A asks how distribution system configuration, total system cost, and logistics cost changes in an integrated United States-Canada market (base case A) environment compared to separate country operations. This

question applies to the food industry environment and assumes all research variable intensities other than the integration variable remain at initial levels. This means that tariff costs, cross-border transportation rates, and demand remain at initial levels in the integrated environment.

Three simulations (RQ1A1-3) were conducted to address this question and the data assumptions for each is summarized in Table 9. The first simulation models a separate United States market and assumes the option of utilizing the Chicago and Kansas City manufacturing plants along with the 21 United States distribution centers. The second simulation models a separate Canadian market and the simulator has the option of utilizing the Toronto manufacturing plant and seven distribution centers in Canada. The third simulation models demand from both countries simultaneously in a basic integration environment and the model has the option of utilizing any of the United States-Canada facilities. Table 11 summarizes the results for each simulation. Appendix F, Tables 1-3 contains the sort-down detail.

United States Results

For the United States market simulation, both the Kansas City and Chicago manufacturing plants are utilized with 64.4

Table 11

Findings – United States/Canada Basic Integration – Question 1A
Food Industry
(Millions of United States Dollars)

Variable Environment	Separate United States	Separate Canada	United States/ Canada Separate Cases Summed	Base Case A Basic Integration
Revenue	492.2	63.2	555.4	555.4
Cost				
Manufacturing	171.7	21.0	192.7	192.7
Warehousing	10.4	1.3	11.7	11.7
Tariff	--	--	--	--
Freight	31.3	5.9	37.2	37.2
Inventory	4.1	.6	4.7	4.7
Total Cost	217.6	28.7	246.3	246.3
Logistics Cost	45.8	7.8	53.6	53.6
Logistics Cost as a Percent of Revenue	9.3%	12.3%	9.7%	9.7%
Distribution Center Number and Location	7 New York Pittsburgh Atlanta Chicago Kansas City Dallas Los Angeles	3 Montreal Toronto Winnipeg	10 New York Pittsburgh Atlanta Chicago Kansas City Dallas Los Angeles Montreal Toronto Winnipeg	10 New York Pittsburgh Atlanta Chicago Kansas City Dallas Los Angeles Montreal Toronto Winnipeg
Plant Locations Utilized	Chicago Kansas City	Toronto	Chicago Kansas City Toronto	Chicago Kansas City Toronto

percent of the production assigned to the Chicago manufacturing plant. Seven distribution centers are utilized to supply markets. In addition to distribution centers at the manufacturing plants, facilities in Atlanta, Pittsburgh, New York, Dallas and Los Angeles are utilized. The total system cost including production equals $217.6 million and logistics cost equals $45.8 million, or 9.3 percent of revenue.

The seven facility network which represents the low cost point utilizes local distribution centers for several different reasons. The New York facility is utilized to service upper New England and the New York metro area primarily because of the lack of a manufacturing plant east of Chicago. Pittsburgh is also utilized in part because of the lack of an eastern manufacturing plant. The Pittsburgh facility, which is somewhat unusual in actual corporate systems, also results in part because of the use of population as a proxy for demand. While Pittsburgh is fairly well situated to serve demand based on population, it is not as well suited to serve retail chain distribution centers that are the dominant demand points in most corporate food industry studies. A third factor responsible for use of this facility is the relatively low transportation rates inbound and outbound from Pittsburgh.

Atlanta is a typical industry location and is utilized to serve southern markets in the model. Use of the Dallas facility, which would have been the next facility eliminated, is also somewhat unusual. However, in actual corporate location studies, it is also often one of the borderline facilities. Dallas falls within the system with this data set for two reasons. First, the population basis of demand again overstates the market in the area compared to actual industry demand points as represented by chain retail distribution center demand points. Secondly, while intrastate Texas freight rates are in fact very high, the freight rate data provided by Yellow Freight does not account for this fact and therefore understates the costs of serving intra-Texas markets from Dallas. The Los Angeles facility is a common one in industry studies and is utilized to serve the large California demand given the distance to the nearest manufacturing plant.

It is also important to be aware of the last few facilities removed from the network during the sort-down. In this case, the Seattle facility was the last distribution center removed, and Denver was the second to last facility removed. The next facility which would have been removed was the Dallas distribution center. As such, a network with Seattle and Denver included, and Dallas excluded would not have

resulted in a substantially different cost. In such a system, Seattle would serve a portion of the Northwestern United States markets.

Based on the sort-down algorithm results, which are presented for each simulation in Appendix F, the total system cost was minimized with the seven facilities noted. However, the total system cost does not vary substantially around the seven facility number. For instance, while the cost for seven facilities is $217.624 million, the cost for eight facilities is just $217.640 million, and the cost for ten facilities is $217.707 million. Removing an additional facility also does not substantially change costs. However, with just five facilities, costs would be expected to rise substantially and delivery times would begin to fall substantially. Earlier in the sort-down process, as the first few facilities are removed, costs do drop at a more pronounced rate. For instance, elimination of the first and second facilities (Phoenix and San Francisco) reduces costs from $218.558 million to $218.332 million.

Total system cost varies from $218.558 million with all 21 distribution centers in the system, to $217.646 million with six facilities remaining. This relatively small cost reduction as facilities are removed is due to several reasons that hold true across many of the United States-Canada simulations. First, a number of the facilities being

removed are in the same geographic area in the Northcentral United States and alternative facilities are available within similar distance ranges. As such, transportation costs do not increase dramatically as many of the facilities are removed. Secondly, the model has a fairly low quantity of small shipment demand, and a fairly large amount of large shipment demand. There is no demand in very small shipment sizes below 2,000 pounds, for instance, and two thirds of the demand is in above 10,000 pound orders. This fact tends to flatten the transportation costs as facilities are deleted because there is not a major savings from shipping truckloads to a distribution center for shorter distance less than truckload local delivery. This factor drives the model towards use of fewer facilities.

On the other hand, inventory carrying costs do not decrease at a substantial rate as facilities are deleted. Nor do fixed costs go down dramatically. This is because the inventory policy is set in the model at a fairly high level of turns (16), with a minimum amount of safety stock in the total inventory (34 percent of total inventory). The policy also assumes a relatively low inventory carrying cost at 14 percent, and as such, eliminating facilities only reduces total inventory by a modest amount and that inventory reduction is expensed at a low 14 percent rate. Coupled with an assumption of low facility fixed costs ($70-100,000), the result is that there is not a large decrease

in costs as facilities are removed. Both the inventory carrying cost and fixed cost factors drive the model towards utilizing a greater number of facilities. Together, the transportation and inventory factors are such that costs do not change dramatically as facilities are eliminated.

Canada Results

The simulation results for Canada, shown in the second column of Table 11, indicate a three distribution center configuration. The total system cost for the network is $28.7 million, and the logistics cost is $7.8 million, or 12.3 percent of revenue. The Toronto distribution center serves a wide area for all three weight groups and is the primary source for truckload demand in most markets. The Toronto distribution center is adjacent to the Toronto manufacturing plant. The Montreal facility serves the Montreal metro area for all weight groups and for all of Eastern Canada. The Winnipeg facility serves all of Western Canada as one would expect.

The sort-down results again do not demonstrate major absolute cost differences by number of facilities. The seven facility network has a total system cost of $28.774 million while the one facility network has a total system cost of $28.904 million. The high logistics cost as a percent of revenue, 12.3 percent compared to 9.3 percent in

the United States, is due to the more geographically dispersed demand pattern. However, the higher costs of transportation per mile in Canada relative to the United States is also an important factor.

While the low cost point occurred with the elimination of the Vancouver facility, it was the last distribution center removed. Costs with the facility included were just $8,000 higher. As a result, as in the United States case, a low cost network could just as easily include a west coast facility. This point will be important to keep in mind in considering comparisons to distribution center configurations that result under other research variable environments. Elimination of additional facilities after the Vancouver one does result in substantial cost increases. However, a greater share of small less-than-truckload shipments would have resulted in even greater cost penalties for elimination of distribution centers from the system.

Basic Integration Results

The integrated market simulation (base case A) combines the two markets but assumes initial levels for the other three research variables. The integrated distribution system configuration is identical to the combined separate systems. As can be seen in Table 11, a simple summation of the separate systems results in ten facilities, total system

cost of $246.3 million, and logistics cost of $53.6 million, or 9.7 percent of revenue. The basic integrated system, in which the model had the option of sourcing distribution centers and/or markets from cross-border sources, consists of the same ten facilities and has identical costs to the sum of the separate systems at the rounding level used for the costs. The one difference in the two systems is the sourcing of the Buffalo area market from the Toronto manufacturing plant and distribution center instead of the Chicago manufacturing plant and distribution center. This exception resulted in $44.5 thousand in tariff being applied, and a savings in transportation costs that just overcame the tariff costs. As such, the basic integration result has slightly lower logistics cost (excluding tariffs) than the separate systems summed. Additional transborder activity did not occur because of the tariff levels, and because of the level of cross-border transportation rates.

The sort-down summary shown in Table 3 of Appendix F is similar to the two separate system sort-downs. Costs vary from $247.357 with no deletions to $246.332 with a ten facility network. The Seattle and Vancouver facilities are the last and third from last facilities to be removed. Again, there is very little cost difference between a network with 9 to 13 facilities.

In conclusion, the basic integration system is virtually identical to the sum of the two separate systems. This is because the cross-border tariff and transportation rates are too high to allow sourcing across borders.

RESEARCH QUESTION 1B - UNITED STATES-CANADA TARIFF VARIATION

Research question 1B studies the impact of tariff level reductions on distribution system configuration and costs. Simulations with two levels of tariffs, at a 50 percent reduction and at a 100 percent reduction, are studied and compared to the results found at full tariff levels. All other research variable intensities are held constant at initial levels. Table 12 summarizes the results for each of the simulations (RQ1B1-23). Appendix F, Tables 4-5 contain the sort-down detail.

50 Percent Tariff Reduction Results

With tariffs cut in half, the distribution system configuration remains identical to the system in place under full tariffs (base case A). The same three manufacturing plants are utilized and the same ten distribution centers are also utilized. However, the share of production supplied by the Chicago manufacturing plant decreases from 56.8 percent to 52.2 percent. The total system cost at half tariffs decreases to $246.1 million, while logistics cost is

Table 12

Findings – United States/Canada Tariff Variation – Question 1B
Food Industry
(Millions of United States Dollars)

Variable Environment	Basic Case A Basic Integration	Half Tariffs	Zero Tariffs
Revenue	555.4	555.4	555.4
Cost			
Manufacturing	192.7	192.3	191.5
Warehousing	11.7	11.6	11.4
Tariff	--	.6	--
Freight	37.2	36.9	36.4
Inventory	4.7	4.7	4.8
Total Cost	246.3	246.1	244.1
Logistics Cost	53.6	53.2	52.6
Logistics Cost as a Percent of Revenue	9.7%	9.6%	9.5%
Distribution Center Number and Location	10 New York Pittsburgh Atlanta Chicago Kansas City Dallas Los Angeles Montreal Toronto Winnipeg	10 New York Pittsburgh Atlanta Chicago Kansas City Dallas Los Angeles Montreal Toronto Winnipeg	11 New York Pittsburgh Atlanta Chicago Kansas City Dallas Los Angeles Seattle Montreal Toronto Winnipeg
Plant Locations Utilized	Chicago Kansas City Toronto	Chicago Kansas City Toronto	Chicago Kansas City Toronto

reduced to $53.2 million, a $.4 million reduction. Logistics cost as a percent of revenue declines from 9.7 percent to 9.6 percent.

The reduction in costs is due to production shifting to the lower cost Toronto manufacturing plant, and the Toronto and Montreal distribution centers supplied by the manufacturing plant providing product to markets in the Northeastern United States. This shift is made possible by the reduction in United States tariffs from $3.80 a hundredweight to $1.90 a hundredweight. The result is that tariff costs go from a negligible level in the full tariff system to $.6 million in the half tariff environment. Product does not move from the United States to Canada because of the high tariff level, even following a 50 percent reduction, and because of high production costs. Transportation costs on the other hand, are reduced by $.3 million because the Toronto and Montreal facilities are geographically closer to a number of the markets in the Northeastern United States. The lower production cost in the Toronto manufacturing plant, by $.36 per case, also is instrumental in causing Northeastern United States markets to be sourced from Toronto.

The sort-down results for this research environment are similar to previous ones in terms of the range of cost

levels and in terms of the order in which facilities are removed. A network including both Vancouver and Seattle would not cost significantly more.

100 Percent Tariff Reduction Results

Elimination of tariffs results in some change in the distribution system configuration and additional changes in sourcing patterns for existing facilities and markets. Under this environment, the Chicago manufacturing plant loses additional volume to the Toronto manufacturing plant, and an eleventh distribution center is added in Seattle. The Chicago manufacturing plant's volume drops to 42.9 percent of the total compared to 56.8 percent in the full tariffs environment. This occurs despite the fact that the Winnipeg distribution center is sourced out of the Chicago manufacturing plant in the zero tariff environment. The Toronto manufacturing plant volume is more than doubled in order to supply additional United States markets that are geographically closer to Toronto. Shifts in market sourcing that occur under this environment include the sourcing of the northeast and northern mid-Atlantic states from the Toronto and Montreal distribution centers, the sourcing of some mid-Canadian markets from the Chicago and Kansas City distribution centers, and the sourcing of Western Canada from the new Seattle distribution center.

The 11 distribution center configuration results in a total system cost of $244.1 million, a $2.2 million reduction from the base case A costs. Production costs drop $1.2 million compared to base case A, and tariff costs are eliminated. Total logistics cost is reduced by $1.0 million compared to the base case, and decline to 9.5 percent of revenue compared to 9.7 percent of revenue. This drop in logistics cost results from a $.8 million savings in transportation costs in the zero tariff system compared to base case A, and a $.2 million reduction in handling costs.

The sort-down results again show the same pattern as was seen in the base case. However, the New York facility would be the next facility dropped. The Vancouver facility was the first eliminated because of the availability of a viable Seattle distribution center in close proximity with lower delivered costs to market.

In conclusion, as tariffs are reduced to zero the distribution system is reconfigured to take advantage of lower cost production in Toronto, and to allow geographically closer source distribution centers to serve markets on both sides of the border. These changes result in both lower total system cost and lower logistics cost, primarily as a result of lower production costs and lower transportation costs.

RESEARCH QUESTION 1B - UNITED STATES-CANADA FREIGHT RATE VARIATION

The freight rate variation research question addresses the impact that a reduction in cross-border freight rates might have on distribution system configuration and costs. The question is tested in simulations with a 10 percent reduction and with a 20 percent reduction in the cross-border freight rates (RQ1B3-4). The other variable intensities are held constant under an integrated United States-Canada market environment. Results are compared to the base case A simulation and are displayed in Table 13. Appendix F, Tables 6 and 7 contain sort-down details.

10 Percent Freight Rate Reduction Results

There is no change in the distribution system configuration with a 10 percent reduction in cross-border freight rates. Nor do distribution sourcing patterns change any. However, the freight rate reduction is sufficient to cause some sourcing of Northeastern United States markets from the Toronto manufacturing plant and its adjacent distribution center. Volume in the Chicago manufacturing plant drops from 56.8 percent to 55.1 percent as a result of these changes.

The ten facility network has a total system cost which is identical to the base case A costs. The $246.3 million

Table 13

Findings – United States/Canada Freight Rate Variation – Question 1B
Food Industry
(Millions of United States Dollars)

Variable Environment	Base Case A Basic Integration	10% Off Cross-Border Freight Rate	20% Off Cross-Border Freight Rate
Revenue	555.4	555.4	555.4
Cost			
Manufacturing	192.7	192.6	192.4
Warehousing	11.7	11.6	11.6
Tariff	--	.4	.6
Freight	37.2	37.0	36.8
Inventory	4.7	4.7	4.7
Total Cost	246.3	246.3	246.2
Logistics Cost	53.6	53.3	53.1
Logistics Cost as a Percent of Revenue	9.7%	9.6%	9.6%
Distribution Center Number and Location	10 New York Pittsburgh Atlanta Chicago Kansas City Dallas Los Angeles Montreal Toronto Winnipeg	10 New York Pittsburgh Atlanta Chicago Kansas City Dallas Los Angeles Montreal Toronto Winnipeg	10 New York Pittsburgh Atlanta Chicago Kansas City Dallas Los Angeles Montreal Toronto Winnipeg
Plant Locations Utilized	Chicago Kansas City Toronto	Chicago Kansas City Toronto	Chicago Kansas City Toronto

total system cost reflects a $.2 million reduction in transportation costs and $.2 million reduction in production and handling costs. However, the cross-border sourcing results in a $.4 million increase for tariff costs. Logistics cost is reduced from $53.6 million to $53.3 million as a result of the lower freight rates, and due to the use of lower cost facilities in Canada to source the Northeast United States.

Again, there is very little change in the sort-down pattern compared to base case A. Table 6 of Appendix F contains the sort-down detail.

20 Percent Freight Rate Reduction Results

A 20 percent reduction in cross-border transportation rates, given the initial full tariffs, is not sufficient to change the distribution system configuration either. At these freight rate levels, some additional northeastern markets are sourced from Toronto. Total system cost drops another $.1 million compared to the 10 percent reduction environment, or $.2 million compared to base case A. The decrease occurs as a result of a $.2 million reduction in production costs, which is mostly offset by a similar increase in tariffs, when compared to the 10 percent reduction level. Logistics cost drops an additional $.2 million compared to the 10 percent reduction level, or $.5

million compared to the base case. The logistics cost reduction is due to a decrease in freight rates, and to a limited extent to sourcing markets from closer cross-border facilities thereby reducing total transportation cost.

In conclusion, reduction of cross-border freight rates by itself is not sufficient to change the distribution system configuration given initial full tariffs. However, some United States markets are sourced from Toronto under a 10 percent reduction in freight rates, and additional markets are sourced from Toronto with a 20 percent reduction. While logistics cost decreases somewhat under these environments, total system cost does not change substantially because of higher tariff costs.

RESEARCH QUESTION 1B - UNITED STATES-CANADA CANADIAN DEMAND VARIATION

The research question on Canadian demand variation is designed to determine whether a substantial increase in initial Canadian demand, in and of itself, can affect the distribution system configuration. In order to address the question, two simulations were conducted (RQ1B5-6). The first simulation assumed a 15 percent increase in Canadian demand. The second simulation assumed a 30 percent increase in Canadian demand. These simulations were conducted while holding other research variables at the initial intensities.

Neither the 15 or 30 percent demand increases had any impact on distribution system configuration or on sourcing patterns for markets or facilities. The only change which resulted was for costs of serving the Canadian demand to go up in proportion to the additional volume. Total system cost increased from $246.3 million to $250.6 million after the 15 percent demand increase, and went up to $254.9 million after demand had been increased 30 percent. These results are displayed in Table 14. The sort-down details are contained in Tables 8 and 9 of Appendix F.

RESEARCH QUESTION 1C - UNITED STATES-CANADA "MOST LIKELY" ENVIRONMENT

Research question 1C focuses on the possible impact of the "most likely" future variable environment. This future environment assumes a zero tariff and 10 percent reduction from initial cross-border transportation rates. Demand in Canada is assumed to remain at initial levels. The basis for these assumptions is discussed in the last section of the literature review. The "most likely" simulation (RQ1C1) is compared to the base case simulation to determine the impact on distribution system configuration and cost. Table 15 summarizes the results of the "most likely" research environment simulation.

Table 14

Findings - United States/Canada Canadian Demand Variation - Question 1B
Food Industry
(Millions of United States Dollars)

Variable Environment	Base Case A Basic Integration	Canada Demand +15%	Canada Demand +30%
Revenue	555.4	564.9	574.4
Cost			
Manufacturing	192.7	195.9	199.0
Warehousing	11.7	11.8	12.0
Tariff	--	--	--
Freight	37.2	38.1	39.0
Inventory	4.7	4.8	4.9
Total Cost	246.3	250.6	254.9
Logistics Cost	53.6	54.7	55.9
Logistics Cost as a Percent of Revenue	9.7%	9.7%	9.7%
Distribution Center Number and Location	10 New York Pittsburgh Atlanta Chicago Kansas City Dallas Los Angeles Montreal Toronto Winnipeg	10 New York Pittsburgh Atlanta Chicago Kansas City Dallas Los Angeles Montreal Toronto Winnipeg	10 New York Pittsburgh Atlanta Chicago Kansas City Dallas Los Angeles Montreal Toronto Winnipeg
Plant Locations Utilized	Chicago Kansas City Toronto	Chicago Kansas City Toronto	Chicago Kansas City Toronto

Table 15

Findings - United States/Canada "Most Likely" Environment - Question 1C
Food Industry
(Millions of United States Dollars)

Variable Environment	Base Case A Basic Integration	Most Likely Environment
Revenue	555.4	555.4
Cost		
Manufacturing	192.7	190.4
Warehousing	11.7	11.2
Tariff	--	--
Freight	37.2	36.8
Inventory	4.7	4.7
Total Cost	246.3	243.1
Logistics Cost	53.6	52.7
Logistics Cost as a Percent of Revenue	9.7%	9.5%
Distribution Center Number and Location	10 New York Pittsburgh Atlanta Chicago Kansas City Dallas Los Angeles Montreal Toronto Winnipeg	10 Buffalo Atlanta Chicago Kansas City Dallas Los Angeles Seattle Montreal Toronto Winnipeg
Plant Locations Utilized	Chicago Kansas City Toronto	Chicago Kansas City Toronto

"MOST LIKELY" RESULTS

The "most likely" research environment results in a distribution system configuration that includes ten distribution centers and three manufacturing plants. However, there are substantial changes in the manufacturing plant volumes, in the distribution center locations, and in the sourcing of facilities and markets. Under this environment each manufacturing plant produces approximately one third of total production. The Chicago manufacturing plant's volume drops from 56.8 percent of the total to 33.3 percent. The Toronto manufacturing plant volume moves from 11.6 percent of total output in the base case to 33.8 percent of the total. Kansas City volume, 31.6 percent in the base case, increases to 32.9 percent under the "most likely" environment.

The distribution system configuration remains at ten facilities but New York and Pittsburgh are deleted and replaced with Buffalo. Seattle is also added to the network. Buffalo is added to the network because it is sourced from the Toronto manufacturing plant in this research environment. The Winnipeg distribution center is sourced from Chicago. The Buffalo change occurs because it is well situated to serve the northeastern, northcentral, and northern mid-Atlantic states with small size shipments originating in the lower cost Toronto manufacturing plant.

The Winnipeg change occurs because the Chicago manufacturing plant is closer to the facility and its production costs are not high enough to preclude its use as a source.

Extensive cross-border sourcing occurs in the "most likely" environment relative to the base case, because of the availability of lower cost transportation and the elimination of tariffs. For instance, the Kansas City distribution center supplies Regina and Saskatoon markets for weight groups one and two, and the Seattle facility serves Western Canadian markets. The Toronto distribution center, adjacent to the manufacturing plant, serves a wide area of the northcentral and northeastern states in this environment because of lower production costs, shorter distances to those markets, and reduced transportation rates to cross-border markets.

Total system cost in the "most likely" system is $243.1 million, compared to $246.3 million in the base case. This reduction is due to a $2.3 million savings in production costs, a $.5 million savings in warehousing costs, and a $.4 million reduction in transportation costs. Total logistics cost dropped from $53.6 million, or 9.7 percent of revenue, to $52.7 million, or 9.5 percent of revenue. The reduction in logistics cost is due to the lower warehousing costs in Canada, and to the reduction in transportation costs.

Freight costs decline because of shorter distances to market and because of the 10 percent reduction in cross-border freight rates.

The sort-down results shown in Table 10 of Appendix F indicate that costs varied from $244.471 million with zero deletions of facilities, to $243.126 at the 18 deletion low cost point. The Vancouver facility was removed first because of the viability of the Seattle distribution center. The deletion order for other facilities is also fairly similar to that seen in the zero tariff level simulation. Dallas and Seattle would have been the next two facilities removed.

In conclusion, the "most likely" variable environment results in elimination of the New York and Pittsburgh distribution centers and inclusion of a Buffalo facility sourced from Toronto. The eliminated facilities had previously been sourced from the Chicago manufacturing plant. Seattle is also added to the network and sources markets on both sides of the border. This environment results in Toronto sourcing a good deal of the Northeastern United States quadrant for at least truckload orders. Both logistics cost and total system cost drop in this environment with the proposed network.

RESEARCH QUESTION 1D - UNITED STATES-CANADA CROSS INDUSTRY COMPARISON

Research question 1D studies the impact of alternative industry settings on distribution system configuration, total system cost and logistics cost. The food industry, which has been the focus of the previous research questions, is compared to the consumer appliances and women's clothing industries in order to test the generalizability of results. These comparisons are made assuming the "most likely" research environment which involves zero tariff levels and a 10 percent reduction in cross-border transportation rates. The food industry provides a high weight to value ratio product, the woman's clothing industry offers a low weight to high value product, and the consumer appliances industry offers a high weight to high value product. All three industries are simulated using the three manufacturing plant locations used previously in the food industry in order to provide for comparison. The women's clothing industry is then simulated using a single manufacturing plant in Atlanta. The Atlanta manufacturing plant is a more likely production location for women's clothing, and allows the research questions to be tested in a somewhat different location pattern. Table 16 summarizes the results for each of the simulations (RQ1D1, 2a, 2b), and for the base food industry comparison point.

Table 16

Findings - United States/Canada Cross Industry Comparison - Question 1D
Three Industries
(Millions of United States Dollars)

Variable Environment	Food Industry Most Likely Environment Chic/KC/ Tor Plants	Consumer Appl. Most Likely Environment Chic/KC/ Tor Plants	Women's Clothing Ind. Most Likely Environment Chic/KC/ Tor Plants	Women's Clothing Ind. Most Likely Environment Atl Plant
Revenue	555.4	471.5	333.9	333.9
Cost				
Manufacturing	190.4	232.3	152.3	146.5
Warehousing	11.2	12.6	.5	.5
Tariff	--	--	--	--
Freight	36.8	23.7	1.9	1.4
Inventory	4.7	3.9	2.4	2.5
Total Cost	243.1	272.4	157.0	150.8
Logistics Cost	52.7	40.2	4.8	4.4
Logistics Cost as a Percent of Revenue	9.5%	8.5%	1.4%	1.3%
Distribution Center Number and Location	10 Buffalo Atlanta Chicago Kansas City Dallas Los Angeles Seattle Montreal Toronto Winnipeg	7 Buffalo Chicago Kansas City Los Angeles Montreal Toronto Winnipeg	2 Buffalo Toronto	3 Syracuse Atlanta Winnipeg
Plant Locations Utilized	Chicago Kansas City Toronto	Chicago Kansas City Toronto	Toronto	Atlanta

Consumer Appliances Industry Results

The actual low cost point consumer appliances industry manufacturing plant system is somewhat different from the food industry configuration. While all three manufacturing plants are utilized, considerably less demand is sourced from Chicago than was the case in the food industry. Chicago sourced 33.3 percent of all demand in the comparable food industry simulation while it supplies just 26 percent of the refrigerator demand represented for this industry. The Kansas City and Toronto manufacturing plants each produce 37 percent of demand in this industry compared to 32.9 and 33.8 respectively in the food industry.

This change in manufacturing volumes is primarily due to production cost differentials between cities. While the relative unit production costs between manufacturing plant cities are identical in the two industries, the absolute cost difference is much greater in the consumer appliances industry where production cost varies from $200.00 in Chicago to $199.00 in Kansas City to $193.00 in Toronto. In the food industry the total variance was equal to just $.36. This absolute production cost difference, especially between Chicago and Toronto, is greater than the penalty freight rates incurred for shipping greater distances to market, and

as a result, source of supply shifts towards low cost points. This is why Kansas City, and especially Toronto, gain manufacturing volume at the expense of Chicago.

The actual low cost distribution system configuration is quite different in this industry compared to the food industry. However, a configuration similar to the food industry one is only slightly more expensive. The low cost point in the sort-down results is seven distribution centers located in the manufacturing plant cities and in Buffalo, Los Angeles, Montreal and Winnipeg. The model sort down low cost point occurs with a smaller number of facilities than was the case in the food industry, where ten distribution centers were utilized (Appendix F, Table 11). The Seattle, Atlanta, and Dallas facilities, utilized in the food industry are not part of the low cost network in the consumer appliances industry.

This smaller number of facilities is due to total transportation costs, and absolute transportation cost differentials, being lower in this industry despite the higher unit weight. These costs are lower because the higher dollar value per unit in the refrigerator product results in far fewer units being shipped than in the food industry, assuming similar total company sales. The result is that in order to ship approximately the same total dollar sales, 540 million pounds of food must be shipped while just

271 million pounds of refrigerators must be shipped. As such, in the consumer appliances industry, transportation costs do not go up fast enough to offset fixed cost and inventory carrying cost reductions as those three facilities are considered for deletion. The net result is that the actual low cost system excludes those three facilities, and has a total of just seven distribution centers.

The Buffalo facility is utilized in this industry, as in the food industry, because the lowest delivered cost can be obtained by sourcing from the Toronto manufacturing plant. The Toronto distribution center does not directly supply United States markets in the lower weight groups because cross-border freight rates are too high. However, at full truckload rates it is feasible to supply the Buffalo distribution center which can in turn supply markets with small size shipments at relatively low small shipment size freight rates.

The total expenses for the low cost system are $272.4 million, including $40.2 million of logistics cost. The logistics cost as a percent of revenue equals 8.5 percent, which compares to 9.5 percent in the food industry. This lower cost is due almost entirely to the lower transportation costs which result from shipping only about half as much weight in order to complete the same level of total company sales as in the food industry.

Women's Clothing Industry Results

The women's clothing industry analysis includes two simulations, one with manufacturing plants in Kansas City, Chicago, and Toronto (RQ1D2a); and one with a manufacturing plant in just Atlanta (RQ1D2b). The former analysis allows for comparison to the other two industries in that the manufacturing plants are in the same cities, while the latter provides a more realistic manufacturing plant location for this industry.

In the first simulation (RQ1D2a), the distribution system configuration which results is substantially different than was the case in either the food industry, or the consumer appliances industry. That configuration for the women's clothing industry relies exclusively on the Toronto manufacturing plant as a production source. This occurs for the same reasons that Toronto production increased in the consumer appliances industry, and that is because the absolute production cost differentials between cities outweigh logistics cost factors. Again, while the hourly compensation costs ratio between cities is the same across industries, the resulting absolute dollar differences that result with high production cost values dominates. For women's clothing the unit production costs in Chicago, Kansas City and Toronto are $223.00, $221.00 and $208.00

respectively. In addition, the women's clothing industry model data assumes a greater percentage of direct labor cost in cost of goods sold, so the hourly compensation cost differentials are further magnified. The $13.00 per unit production cost advantage held by Toronto allows for substantial logistics cost penalties to be incurred in serving distant markets.

The distribution system configuration which results in this industry is dramatically different than either of the other two industries. The configuration includes just two distribution centers, in Toronto at the manufacturing plant, and in Buffalo. The sort-down curve is also much steeper, meaning that costs go down by a substantial amount after each iteration, and then rise substantially in the one deletion possible after the low cost system is reached (Appendix F, Table 12). The total expenses in the low cost network are $157.0 million, while logistics cost totals just $4.8 million, or 1.4 percent of revenue.

The system utilizes a small number of distribution centers because the absolute level of transportation costs are so low relative to inventory carrying costs in this industry compared to the previous two industries. Because of the high unit sales price of $456.00 the total company sales are achieved with shipment of just 732,292 units, compared to over 27 million units in the food industry, and just over

1.1 million units in the appliances industry. Combined with the low weight of 24 pounds per unit, the total weight shipped amounts to just 17.5 million pounds. This compares to the 540 million pounds in the food industry, and 271 million pounds of refrigerators. Because of the low weight, total transportation costs are extremely low and go up from just $1.762 million with no facilities deleted, to $1.873 million in the low cost network. However, inventory carrying costs and fixed costs decrease by approximately $150,000 with each deletion. The result is that the reductions in inventory carrying costs far outweigh the increases in transportation costs as facilities are deleted and this leads to a network with a small number of facilities.

In evaluating the locations utilized, it is important to understand that in sorting down to such a small number of facilities there is considerable risk of not considering other combinations of facilities that may be more cost effective. As such, care must be used in drawing conclusions about the specific locations suggested in the low cost network. Non-the-less, some observations on the reasons certain facilities were selected are possible. It appears the Buffalo distribution center is utilized because cross-border less-than-truckload freight rates to distant United States markets are still too high compared to internal United States freight rates. As such a facility

nearby to the manufacturing plant is used to make relatively low cost truckload shipments across the border to a distribution center. The distribution center can then make less than-truckload and in many cases truckload shipments to distant markets at a lower cost than would be the case from the Toronto distribution center. Additional United States facilities are not used because of the high inventory and fixed cost penalty costs relative to the low transportation cost benefits that those facilities would achieve.

The simulation utilizing an Atlanta manufacturing plant as the only production point option results in a somewhat similar distribution system configuration (RQ1D2b). The distribution center network includes facilities in Atlanta, Syracuse and Winnipeg. The small number of facilities occurs for the same reasons stated in the previous analysis. The total cost of this system is $150.8 million and logistics cost totals $4.4 million.

RESEARCH QUESTION 2A - UNITED STATES-CANADA-MEXICO BASIC INTEGRATION

Research question 2A investigates distribution system configuration and cost structure in a North America-wide environment and compares the results to Separate United States-Canada and Mexico systems. Research variables relating to the United States-Canada integrated market

assume the "most likely" environment of initial Canadian demand, zero tariffs, and a 10 percent reduction in cross-border freight rates. Research variables relating to interaction between Mexico and the United States or Canada are set at initial levels. This research question and those through research question 1C relate to the food industry.

Two new simulations were conducted to address this research question (RQ2A1 and RQ2A2). RQ2A1 is a simulation of the separate Mexican market. These results are combined with the United States-Canada "most likely" environment results to obtain information on a combined but separate system. The combined system costs are then compared to the basic integration (base case B) simulation results (RQ2A2) to determine the impact of integration at initial Mexico to United States-Canada variable intensities. Table 17 summarizes the results for each simulation. Appendix F, Tables 14 and 15 contain the sort-down results for the Mexican only system and for the basic integration system.

Mexico Only Results

For the Mexico only simulation Monterrey is the sole production point because it is the only available manufacturing location in Mexico. While there are five distribution center sites available for use, all markets are served directly from the Monterrey facility. The total

Table 17

Findings – United States/Canada/Mexico Basic Integration – Question 2A
Food Industry
(Millions United States Dollars)

Variable Environment	United States/Canada Most Likely Environment	Separate Mexico	Separate United States/ Canada Summed With Separate Mexico	Base Case B Basic Integration
Revenue	555.4	40.5	595.9	595.9
Cost				
Manufacturing	190.4	9.0	201.7	181.3
Warehousing	11.2	.4	12.1	11.0
Tariff	--	--	--	14.6
Freight	36.8	3.1	40.3	42.0
Inventory	4.7	.3	5.0	5.1
Total Cost	243.1	12.9	259.2	253.9
Logistics Cost	52.7	3.8	57.4	58.0
Logistics Cost as a Percent of Revenue	9.5%	9.4%	9.6%	9.7%
Distribution Center Number and Location	10 Buffalo Atlanta Chicago Kansas City Dallas Los Angeles Seattle Montreal Toronto Winnipeg	1 Monterrey	11 Monterrey Buffalo Atlanta Chicago Kansas City Dallas Los Angeles Seattle Montreal Toronto Winnipeg	13 Monterrey Buffalo Atlanta Chicago Kansas City Dallas Laredo El Paso Los Angeles Seattle Montreal Toronto Winnipeg
Plant Locations Utilized	Chicago Kansas City Toronto	Monterrey	Monterrey Chicago Kansas City Toronto	Monterrey Chicago Kansas City Toronto

system cost equals $40.5 million while logistics cost totals 3.8 million, or 9.4 percent of revenue. This system cost percentage is similar to the United States level because lower fixed costs and handling costs offset the higher unit transportation costs found in Mexico.

A single distribution center is used because of the Monterrey manufacturing plant and distribution center's relatively central location with respect to demand, and because inventory carrying costs and fixed costs decrease faster than transportation costs increase as facilities are deleted. The relatively low transportation cost increase as facilities are deleted is due to the fact that very little volume was assigned to the non-Monterrey facilities when all five facilities were available. This was due to the location relative to demand, because of the low freight rates from Monterrey, and because less than truckload freight rates for two thirds of the total demand are not substantially enough higher than truckload rates. This latter fact makes it less expensive to ship direct from the manufacturing plant distribution center thereby avoiding transfer freight to alternative local distribution centers.

Integrated United States-Canada-Mexico Market

The integrated market simulation combines the three markets and allows cross-border sourcing. The United States-Canada

variables are set at the "most likely" level, while the variables for interactions between Mexico and the United States-Canada are set at the initial intensities. The basic integration (base case B) environment is compared to the combined separate systems to determine changes that result from integration. As can be seen in Table 17, the combined system utilizes the four manufacturing plants and eleven distribution centers. The cost of the combined system is $259.7 million, while logistics cost totals $57.4 million, or 9.6 percent.

Under basic integration (base case B) all four manufacturing plants are utilized as sources. However, the Monterrey manufacturing plant takes over much of the Kansas City manufacturing plant's volume. Kansas City manufacturing volume accounted for 32.9 percent of the total United States-Canada demand in the separate system, but decreases to just 9.2 percent of the total North American demand in base case B. This production volume is lost to the Monterrey manufacturing plant. The Chicago and Toronto manufacturing plant volumes remain similar to that seen in the separate United States-Canada system.

The integrated system (base case B) utilizes a distribution system configuration consisting of 13 distribution centers, compared to the 11 facilities utilized in the separate system. The additional two facilities are located in Laredo

and El Paso. Because the Mexican manufacturing plant and distribution centers cannot ship directly to the United States or Canadian markets, the nearest United states facility is sought out to make truckload shipments to markets in the United States. Laredo fulfills this requirement, in addition to serving some Texas markets for all three weight groups. The El Paso facility primarily serves Central Southwestern United States markets. While the other separate United States-Canada distribution center locations remain the same in the basic integration system, the sources for some of those facilities changes and the volume assigned also changes significantly. Canadian distribution centers and Buffalo continue to be sourced from the Toronto manufacturing plant. However, Dallas, Los Angeles and Seattle distribution centers are sourced from Monterrey in this environment.

The total system cost for the basic integration environment totals $253.9 million, including $58.0 million in logistics cost. These costs compare to a total of $259.2 million in the separate systems, and a logistics cost of $57.4 million. While production costs drop by $20.4 million in the integrated system as a result of lower Mexican costs, import tariffs amount to $14.6 million. The $.6 million increase in logistics cost is due to $1.7 million in extra transportation costs required to move goods greater

distances, and a $.9 million decrease in warehousing costs. This decrease is due to lower wage levels in the Texas facilities.

The total cost curve is also fairly flat as facilities are deleted in the sort-down process. Total system cost varies from $255.299 and $254.054. Costs do not vary substantially between 10 and 13 facilities. Dallas and El Paso would have been the next two facilities deleted.

In conclusion, the basic integration system (base case B) results in the Monterrey manufacturing plant penetrating southern and western markets. An additional two distribution centers are utilized, in part to serve as a base for truckload shipments to United States markets. Total system cost drops by $5.3 million despite US414.6 million in additional tariff costs.

RESEARCH QUESTION 2B - UNITED STATES-CANADA-MEXICO TARIFF VARIATION

Research question 2B investigates the impact of tariff level reductions on distribution system configuration and costs. Two simulations are conducted and compared to the basic integration system (base case B) with initial variable intensities on Mexican interactions with the United States and Canada. The first simulation (RQ2B1) examines the

impact of a 50 percent reduction in tariff levels. The second simulation examines the impact of a system with zero tariffs. Table 18 summarizes the results for each of the simulations and also presents the results for the comparison simulation. Appendix F, Tables 16 and 17 contain the sort-down results for the two simulations.

50 Percent Tariff Reduction Results

Unlike the United States-Canadian situation, a 50 percent reduction in tariffs between Mexico and the other two countries results in substantial changes in the distribution system configuration. In this environment, the United States manufacturing plants are completely eliminated as sources, with Monterrey and Toronto supplying all production. Monterrey supplies 91.6 percent of all manufacturing volume and Toronto supplies the remaining 8.4 percent. The Monterrey manufacturing increases because tariff levels and logistics cost is not sufficient to offset the production cost differentials. Toronto manufacturing continues because the distance to northern markets results in logistics cost levels from Mexico which exceed the production cost savings. The result is that Monterrey serves all United States distribution centers plus the Winnipeg distribution center. The Toronto manufacturing plant serves just the Toronto distribution center.

Table 18

Findings - United States/Canada/Mexico Tariff Variation - Question 2B
Food Industry
(Millions of United States Dollars)

Variable Environment	Base Case B Basic Integration	Half Tariffs United States/ Canada-Mexico	Zero Tariffs United States/ Canada-Mexico
Revenue	595.9	595.9	595.9
Cost			
Manufacturing	181.3	138.0	132.6
Warehousing	11.0	9.5	9.5
Tariff	14.6	25.2	--
Freight	42.0	58.5	62.5
Inventory	5.1	5.1	5.2
Total Cost	253.9	236.3	209.8
Logistics Cost	58.0	73.1	77.2
Logistics Cost as a Percent of Revenue	9.7%	12.3%	13.0%
Distribution Center Number and Location	13 Monterrey Buffalo Atlanta Chicago Kansas City Dallas Laredo El Paso Los Angeles Seattle Montreal Toronto Winnipeg	15 Monterrey New York Pittsburgh Philadelphia Atlanta Memphis Chicago Kansas City Dallas Laredo El Paso Los Angeles Seattle Toronto Winnipeg	17 Monterrey New York Buffalo Philadelphia Atlanta Memphis Monroe Chicago Kansas City Dallas Laredo El Paso Los Angeles Seattle Montreal Toronto Winnipeg
Plant Locations Utilized	Chicago Kansas City Toronto Monterrey	Toronto Monterrey	Monterrey

The distribution system configuration includes 15 facilities. Compared to the full tariff environment, distribution centers are added in New York, Philadelphia, Pittsburgh and Memphis. Facilities which drop out of the system are located in Buffalo and Montreal. Facilities in New York, Philadelphia and Pittsburgh are added because they can serve local pockets of demand, in the smaller order size categories, at lower cost than is the case from the Mexican border area distribution centers. The Memphis distribution center is also added to supply the first two order sizes of demand but serves a wider range of markets in the southcentral states. The Buffalo distribution center, which previously had been supplied from the Toronto manufacturing plant, is no longer utilized because it is more economical to service the area from Mexican sourced manufacturing volume routed through alternative distribution centers. The Montreal distribution center is eliminated because enough Canadian market areas in Quebec are served cross-border from the United States to preclude the need for this facility. Other Eastern Canada markets are served from the Toronto distribution center.

The total cost of the system is $236.3 million. This compares to a total system cost of $253.9 million under base case B. The cost difference is due to the combination of a $43.3 million decline in production costs, a $16.5 million increase in transportation costs and a $10.6 million

increase in tariffs. The lower tariffs are sufficient to induce the additional Mexican sourcing at low production cost and this in turn results in higher transportation costs to serve the distant markets and higher tariff costs.

Logistics cost equal $73.1 million in the half tariff environment, or 12.3 percent of revenue, compared to $58.0 million, or 9.7 percent of revenue in the full tariff environment. This increase in logistics cost is almost entirely due to the transportation cost increase required to serve distant markets.

The sort-down results indicate that total system cost varies between $237.418 million and $236.532 million across the range of deletions tested. This curve is quite flat for the same reasons discussed in previous analyses. As a result, a range of between 12 and 19 distribution centers has a total system cost of from $236.410 to $236.411 with costs at the low point of the curve totaling $236.329.

100 Percent Tariff Reduction Results

Elimination of tariffs results in all production shifting to the Monterrey manufacturing plant. This again occurs because logistics cost required to serve distant markets

does not exceed the production cost savings, and because there are no tariffs adding to the cost of Mexican sourced goods.

The distribution system configuration increases to 17 facilities in the zero tariff environment. When compared to the 50 percent reduction tariff environment Buffalo and Monroe, Michigan are added to serve local United States markets and a number of Canadian markets. Montreal is also reintroduced to the system to supply a small number of local markets. These facilities supply markets with demand in the first two order size categories. The Pittsburgh distribution center is eliminated because of the addition of the Buffalo and Monroe facilities. When compared to base case B, additional facilities were included in New York, Philadelphia, Memphis, and Monroe.

The zero tariff system results in the Laredo distribution center directly supplying a large number of markets with truckload order demand. The facility also supplies a number of market areas with the mid-range order size demand, and supplies various Texas markets with demand in all three order size categories. In total, the Laredo distribution center supplies 32.7 percent of all United States and Canadian demand, including almost all truckload demand. The Laredo facility is used in lieu of the Monterrey

distribution center because the model network requires United States and Canadian distribution centers to be sourced from a non-Mexican distribution center.

The 17 distribution center configuration results in a total system cost of $209.8 million, a $44.1 million reduction from the base case system at full tariffs. Production costs drop by $48.7 million and the elimination of tariffs results in a $14.6 million reduction in that category. These cost reductions are in part offset by a $20.5 million increase in transportation costs which occurs as a result of greater volumes being moved longer distances. Logistics cost goes up from $58.0 million in the base case system to $77.2 million in the zero tariff system. This increase is almost totally accounted for by the increased transportation costs.

The sort-down results again demonstrate the flat nature of the cost curve for this particular set of model assumptions and data. Total costs range from US211.029 to $209.927 over the range of facility deletions. Between 15 and 21 distribution centers there is very little change in total system cost. Pittsburgh and Minneapolis were the last two facilities removed, while further deletions would have resulted in Montreal, New York and Chicago having been deleted in that order.

In conclusion, elimination of all tariffs results in exclusive utilization of the Monterrey manufacturing plant and the use of additional distribution centers. Logistics cost continues to increase, to 13 percent of revenue, as goods are transported greater distance to market.

RESEARCH QUESTION 2B - UNITED STATES-CANADA-MEXICO FREIGHT RATE VARIATION

The freight rate variation research question addresses the impact that a reduction in cross-border freight rates might have on distribution system configuration and costs. The question is tested by reducing the Mexican portion of cross-border freight rates by 10 and then 20 percent while holding variable intensities on United States-Canada interactions to the "most likely" environment. The "most likely" environment for United States-Canada interactions assumes zero tariffs and a 10 percent freight rate reduction on cross-border movements. All non-freight research variables relating to Mexican interaction with the United States and Canada are held at initial base case levels.

Table 19 contains results for the 10 percent freight rate reduction simulation (RQ2B3) and for the 20 percent freight rate reduction simulation (RQ2B4). Appendix F, tables 18 and 19 contain the sort-down results.

Table 19

Findings - United States/Canada/Mexico Freight Rate Variation - Question 2B
Food Industry
(Millions of United States Dollars)

Variable Environment	Base Case B Basic Integration	10% Off Mexican Freight Rates	20% Off Mexican Freight Rates
Revenue	595.9	595.9	595.9
Cost			
Manufacturing	181.3	179.9	178.7
Warehousing	11.0	10.9	10.8
Tariff	14.6	15.6	16.6
Freight	42.0	41.8	41.4
Inventory	5.1	5.1	5.1
Total Cost	253.9	253.3	252.8
Logistics Cost	58.0	57.8	57.3
Logistics Cost as a Percent of Revenue	9.7%	9.7%	9.6%
Distribution Center Number and Location	13 Monterrey Buffalo Atlanta Chicago Kansas City Dallas Laredo El Paso Los Angeles Seattle Montreal Toronto Winnipeg	13 Monterrey Buffalo Atlanta Chicago Kansas City Dallas Laredo El Paso Los Angeles Seattle Montreal Toronto Winnipeg	13 Monterrey Buffalo Atlanta Chicago Kansas City Dallas Laredo El Paso Los Angeles Seattle Montreal Toronto Winnipeg
Plant Locations Utilized	Monterrey Chicago Kansas City Toronto	Monterrey Chicago Kansas City Toronto	Monterrey Kansas City Chicago Toronto

10 Percent Freight Reduction Results

There is no change in the distribution system configuration when the Mexican portion of cross-border freight rates are reduced by 10 percent. This is in part because the Mexican portion of the rate represents a rather small amount in the total freight rate given the short distances from Monterrey to the border. However, it is that portion of the freight rate which will be most subject to improvements.

The system with a 10 percent reduction in freight rates utilizes all four manufacturing plants, however, 1.3 percent of total demand shifts from a Kansas City production source to the Monterrey manufacturing plant. This change results in some minor changes in volumes by distribution center. However, the same set of 13 distribution centers is utilized in both the full freight rate and reduced rate environments.

The total system cost reflects the lack of change and totals $253.3 million, compared to $253.9 million in the base case. Logistics cost decreases by $.2 million as a result of the freight rate reduction and a small reduction in warehousing costs.

20 Percent Freight Reduction Results

A 20 percent reduction in the Mexican portion of cross-border freight rates is also not sufficient to change the facilities included in the distribution system configuration. However, the Monterrey manufacturing plant increases its share of total production from 31.3 percent to 34.7 percent in the 20 percent reduced freight rate environment. This increase is primarily at the expense of the Kansas City manufacturing plant. Kansas City's share of manufacturing volume decreases from 9.2 percent to 7.1 percent.

The same 13 distribution centers are utilized in this variable environment as well. While volumes at each facility change somewhat the only substantial change occurs at the Kansas City distribution center as a result of the decreased Kansas City manufacturing plant activity. Some markets previously served by this facility are sourced by alternative distribution centers that are in turn sourced from Monterrey.

The Laredo distribution center gains almost all of the volume previously served from Kansas City and as a result its volume increases by 24.1 percent compared to the base case B environment. Most of this increase in volume is in the truckload order size segment.

As a result of the above changes total system cost decreases from $253.9 million in the base case B environment to $252.8 million in the 20 percent freight rate reduction environment. This $1.1 million swing in total system cost is the result of a $2.6 million reduction in production costs, a $.6 million reduction in transportation costs, and a $2.0 million increase in tariffs. Total logistics cost decreases by $.7 million as a result of reductions in the freight and warehousing categories. Logistics cost as a percent of revenue changes from 9.7 percent to 9.6 percent, primarily as a result of the lower freight rates, but also as a result of the decrease in warehousing costs associated with increased Laredo volume.

RESEARCH QUESTION 2B - UNITED STATES-CANADA-MEXICO MEXICAN DEMAND VARIATION

The Mexican demand variation question is designed to determine whether a substantial increase in Mexican demand can alter the distribution system configuration. In order to answer this question one simulation was conducted with a 25 percent increase in Mexican demand (RQ2B5), and one was conducted at a 50 percent increase in demand (RQ2B6). These simulations were conducted while holding other research variables effecting interactions between Mexico and the

United States-Canada at initial intensities, and while holding United States-Canada variable intensities at the "most likely" levels.

Neither the 25 or the 50 percent increase in demand has any impact on distribution system configuration or sourcing of facilities and markets. The results of the two simulations are displayed in Table 20, while the sort-down results appear in Appendix F, Tables 20 and 21.

The only change which occurs in either case is for costs to go up in proportion to the Mexican demand increase. Total system cost increases from $253.9 million in the base case B environment, to $257.1 million in the 25 percent volume increase environment, to $260.3 million in the 50 percent demand increase environment. Logistics cost as a percent of revenue remains constant across all three simulations at 9.7 percent.

RESEARCH QUESTION 2C - UNITED STATES-CANADA-MEXICO "MOST LIKELY" ENVIRONMENT

Research question 2C addresses the impact of the "most likely" future environment on the distribution system. The impact of the "most likely" research variable environment is compared to base case B.

Table 20

Findings - United States/Canada/Mexico Mexican Demand Variation - Question 2B
Food Industry
(Millions of United States Dollars)

Variable Environment	Base Case B Basic Integration	Mexico +25% Demand	Mexico +50% Demand
Revenue	595.9	606.1	616.2
Cost			
Manufacturing	181.3	183.5	185.8
Warehousing	11.0	11.1	11.2
Tariff	14.6	14.6	14.6
Freight	42.0	42.8	43.6
Inventory	5.1	5.2	5.3
Total Cost	253.9	257.1	260.3
Logistics Costs	58.0	59.1	60.1
Logistics Costs as a Percent of Revenue	9.7%	9.7%	9.7%
Distribution Center Number and Location	13 Monterrey Buffalo Atlanta Chicago Kansas City Dallas Laredo El Paso Los Angeles Seattle Montreal Toronto Winnipeg	13 Monterrey Buffalo Atlanta Chicago Kansas City Dallas Laredo El Paso Los Angeles Seattle Montreal Toronto Winnipeg	13 Monterrey Buffalo Atlanta Chicago Kansas City Dallas Laredo El Paso Los Angeles Seattle Montreal Toronto Winnipeg
Plant Locations Utilized	Chicago Kansas City Toronto Monterrey	Monterrey	Monterrey

The first simulation (RQ2C1) in this series assumes the "most likely" future research variable environment. The "most likely" future variable intensities assume an integrated three country system as opposed to separate country systems, zero tariffs, a 10 and 20 percent reduction in freight rates for Canada and Mexico respectively, and a 25 percent increase in Mexican demand. This simulation assumes manufacturing plants are available in the four cities previously used, and that production costs at each facility are the same as previously specified.

Table 21 provides a comparison between the base case B environment and the "most likely" environment. Appendix F, Table 22 contains the sort-down results.

"Most Likely" Results

The "most likely" research variable environment results in a 17 distribution center configuration with all production occurring at the Monterrey manufacturing plant. The dominance of the Mexican manufacturing plant is due to the lower production costs, reduced Mexican portion of cross-border freight rates, and the elimination of all tariff protection.

The distribution center configuration is the same as the system which emerged in the zero tariff environment. As can

Table 21

Findings - United States/Canada/Mexico "Most Likely" Environment - Question 2C
Food Industry
(Millions of United States Dollars)

Variable Environment	Base Case B Basic Integration	Most Likely Environment
Revenue	595.9	606.1
Cost		
Manufacturing	181.3	134.8
Warehousing	11.0	9.6
Tariff	14.6	--
Freight	42.0	58.4
Inventory	5.1	5.3
Total Cost	253.9	208.2
Logistics Cost	58.0	73.3
Logistics Cost as a Percent of Revenue	9.7%	12.1%
Distribution Center Number and Location	13 Monterrey Buffalo Atlanta Chicago Kansas City Dallas Laredo El Paso Los Angeles Seattle Montreal Toronto Winnipeg	17 Monterrey New York Buffalo Philadelphia Atlanta Memphis Monroe Chicago Kansas City Dallas Laredo El Paso Los Angeles Seattle Montreal Toronto Winnipeg
Plant Locations Utilized	Monterrey Chicago Kansas City Toronto	Monterrey

be seen in Table 21, distribution centers in New York, Philadelphia, Memphis and Monroe have been added to the system. These facilities primarily serve local market area needs for smaller order size demand. The Memphis facility serves a somewhat wider regional area than is the case for the facilities in the east. The New York, Buffalo, Monroe, Kansas City and Seattle distribution centers serve Canadian markets in addition to local United States markets. Distribution centers in Montreal, Toronto and Winnipeg also serve Canadian demand. The El Paso facility serves a greater segment of the Rocky Mountain area and southwest than was the case in base case B. The Laredo facility also serves a much wider area, primarily for truckload demand. While in the base case environment Laredo serves 10.8 percent of all demand, in the "most likely" environment it serves 25.5 percent of all demand. However, in addition, the El Paso distribution center serves 19.9 percent of all demand direct. In total, the two distribution centers adjacent to the Mexican border points serve 45.4 percent of all market demand directly, or essentially all truckload demand and a portion of less than full truckload demand.

Total system cost in the "most likely" system is $208.2 million compared to $253.9 million in the base case system. This total system cost represents a reduction of $45.7 million and is due to production costs decreasing by $46.5 million, tariff costs falling by $14.6 million, warehousing

costs decreasing by $1.4 million, and transportation costs increasing by $16.4 million. Inventory carrying costs also increase by $.2 million. Total logistics cost increases from $58.0 million to $73.3 million, or an increase in percent of revenue terms from 9.7 to 12.1. This increased logistics cost is necessary to take advantage of the lower production costs available in Mexico.

RESEARCH QUESTION 2D - UNITED STATES-CANADA-MEXICO CROSS INDUSTRY COMPARISON

Research question 2D investigates the impact of alternative industry environments on distribution system configuration, total system cost and logistics cost. The food industry, which has been the one utilized in previous simulations, is compared to results for the consumer appliances and women's clothing industries. The comparisons are made in the "most likely" research variable environment described in earlier sections. The three industries are simulated using all four manufacturing plant locations in order to allow for comparison without varying the manufacturing plant or distribution center options available in each industry. The women's clothing industry is then simulated assuming Atlanta only production because that is a more realistic manufacturing location for the industry. The food industry provides a high weight to value product, the women's

clothing industry a low weight to very high value product ratio, and the consumer appliances setting offers a high weight to high value product ratio.

Results for the industry comparisons are shown in Table 22. Appendix F, Tables 23-25 contain the sort-down results for the three new simulations.

Consumer Appliances Industry Results

In the consumer appliances industry all production occurs in Monterrey as is the case in the food industry. Monterrey is an even more clear cut choice in this industry because of the large absolute dollar production cost differentials between Monterrey and the other manufacturing plants.

The distribution center configuration consists of 13 facilities compared to 17 in the food industry. The consumer appliances network excludes facilities in New York, Monroe, Dallas, and Montreal that were included in the food industry network. The low cost consumer appliances industry network occurs at a point with fewer facilities than in the food industry because of the difference in absolute transportation costs between the two industries. The food industry has total transportation costs of approximately $58.0 million in the model, while the consumer appliances industry has transportation costs in the $36.0 million

Table 22

Findings - United States/Canada/Mexico Cross Industry Comparison - Question 2D
Three Industries
(Millions of United States Dollars)

Variable / Environment	Food Industry Most Likely Environment Chic/KC/Tor/ Mont Plants	Consumer Appliances Most Likely Environment Chic/KC/Tor/ Mont Plants	Women's Clothing Most Likely Environment Chic/KC/Tor/ Mont Plants	Women's Clothing Most Likely Environment Atl Plant
Revenue	606.1	501.4	366.1	366.1
Cost				
Manufacturing	134.8	186.8	97.9	160.6
Warehousing	9.6	10.4	.6	.6
Tariff	--	--	--	--
Freight	58.4	36.1	2.2	1.6
Inventory	5.3	4.2	2.7	2.7
Total Cost	208.2	237.5	103.3	165.5
Logistics Cost	73.3	50.7	5.5	4.9
Logistics Cost as a Percent of Revenue	12.1%	10.1%	1.5%	1.3%
Distribution Center Number and Location	17 Monterrey New York Buffalo Philadelphia Atlanta Memphis Monroe Chicago Kansas City Dallas Laredo El Paso Los Angeles Seattle Montreal Toronto Winnipeg	13 Monterrey Buffalo Philadelphia Atlanta Memphis Chicago Kansas City Laredo El Paso Los Angeles Seattle Toronto Winnipeg	4 Monterrey Buffalo El Paso Seattle	4 Monterrey Syracuse Atlanta Winnipeg
Plant Locations Utilized	Monterrey	Monterrey	Monterrey	Atlanta

range. This occurs despite the higher refrigerator unit weight because much fewer units are required to reach comparable total company sales levels given the higher refrigerator unit prices. As such, in the consumer appliances industry, transportation costs do not go up fast enough to offset fixed cost and inventory carrying cost reductions as those extra four facilities are considered for deletion. The net result is that the low cost system occurs at a point that excludes the four facilities in question.

Total system cost for the consumer appliances system is $237.5 million, compared to $208.2 million in the food industry. Logistics cost is $50.7 million, or 10.1 percent of revenue compared to $73.3 million, or 12.1 percent of revenue in the food industry. This differential is due to the much smaller level of total weight which must be shipped in the appliances industry to achieve similar company sales levels.

Women's Clothing Industry Results

The women's clothing industry analysis includes two simulations, one with production allowed in all four manufacturing plant cities used to date, and one in which production is only allowed in Atlanta.

In the first simulation, the distribution system configuration which results is markedly different from that seen in the food and consumer appliances industry. That configuration relies exclusively on the Monterrey manufacturing plant as is the case in the other two industries, but utilizes just four distribution centers. The four distribution centers are located in Monterrey, Buffalo, El Paso and Seattle. The four facility configuration compares to the 13 facilities used in the consumer appliances industry and the 17 distribution centers which make up the food industry system.

The total system cost of the network is $103.3 million. Logistics cost is just $5.5 million, or 1.5 percent of revenue, compared to costs of $73.3 million, or 12.1 percent of revenue in the food industry.

The Monterrey manufacturing plant is again utilized because of the extremely large absolute dollar differentials between production costs at the various manufacturing plants. As in the United States-Canada case, where just two distribution centers were utilized, a small number of facilities results because the absolute level of transportation costs is so low compared to inventory carrying costs and fixed costs. Because of the high unit price of $456.00 per unit, just 802,612 units were required to achieve the total corporate sales level being modeled. This compares to over 29 million

units in the food industry. Combined with the low weight per unit of 24 pounds, the total system weight shipped amounts to just 19.3 million pounds. This compares to 540 million pounds in the food industry. Because of the low weight totals, transportation costs are extremely low and go up from just $1.86 million with no facilities deleted to $2.59 million with just one facility in the system. However, inventory carrying costs and fixed costs decline by approximately $150,000 with each deletion. As a result reductions in inventory carrying cost and fixed costs far outweigh increases in transportation costs as facilities are deleted and this leads to a network with a small number of facilities.

The simulation utilizing a single manufacturing plant in Atlanta results in a very similar distribution configuration. That system also utilizes four distribution centers and they are located in Monterrey, Atlanta, Syracuse and Winnipeg. In this system Syracuse and Winnipeg service all of the Canadian market. Syracuse services a good deal of the east coast and all of the northeast. Atlanta serves a broad market area and provides truckload shipments for most market areas.

The above system is almost identical to the configuration selected in the United States-Canada women's clothing simulation involving the Atlanta manufacturing plant. The

only difference is that addition of the Mexican market results in use of the Monterrey distribution center to service Mexico. The small number of facilities occurs for the same reasons stated above in the four plant women's clothing discussion. The location of the facilities varies compared to the previous simulation because Atlanta is much more central to the largest portion of the system demand.

The total cost of the system is $165.5 million. This cost is much higher than in the previous women's clothing simulation because of the higher production costs in Atlanta relative to Monterrey. Logistics cost is just $4.9 million, or 1.3 percent of revenue. These costs are lower than in the previous simulation because of Atlanta's central location.

MICHIGAN STATE UNIV. LIBRARIES
31293005945658

2561 .P95

v.2

MICHIGAN STATE UNIVERSITY LIBRARIES
3 1293 00594 5666

LIBRARY
Michigan State
University

PLACE IN RETURN BOX to remove this checkout from your record.
TO AVOID FINES return on or before date due.

DATE DUE	DATE DUE	DATE DUE
JUL 0 5		
230		
DEC 0		
068		
APR 1 6 1993		
122		
FEB 2 8 1995		

MSU Is An Affirmative Action/Equal Opportunity Institution

A UNITED STATES-CANADA-MEXICO FREE TRADE AREA: THE LOCATION IMPLICATIONS OF AN INTEGRATED NORTH AMERICAN MARKET

Volume II

By

John Cameron Taylor

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Department of Marketing and Transportation Administration
Graduate School of Business Administration

1991

CHAPTER 5 - CONCLUSIONS

Chapter five presents research conclusions, implications, future research topics, and limitations. The first part presents conclusions regarding the research questions posed in chapter three, and presents generalizations based on the research findings. The second part positions the research with respect to the theoretical, business, and governmental policy implications. The third part contains ideas for continued research. The final part summarizes research limitations.

CONCLUSIONS AND GENERALIZATIONS

The first part of this section presents conclusions based on the research findings. The second part presents several generalizations that flow from the research. The conclusions in the first part derive from specific simulation results while the generalizations in the latter part are more generic.

SUMMARY OF CONCLUSIONS BY RESEARCH QUESTION

This part presents findings and conclusions by research question. The first part which follows addresses the United States-Canada integration research questions. The United States-Canada-Mexico integration research questions are presented in the second part.

United States-Canada Integration Research Questions

The conclusions for the four research questions follow.

United States-Canada Basic Integration

The first research question explored basic market integration while maintaining other research variables at initial intensities. Basic market integration had no impact on the food industry distribution system configuration. The impact on total system cost and logistics cost was also negligible.

The integrated system utilized three manufacturing plants and ten distribution centers. The Chicago manufacturing plant accounted for 56.8 percent of production, the Kansas City manufacturing plant, 31.5 percent, and the Toronto manufacturing plant produced 11.6 percent of total volume. Distribution centers were located in New York, Pittsburgh,

Atlanta, Chicago, Kansas City, Dallas, Los Angeles, Montreal, Toronto and Winnipeg. Total system cost was $246.3 million while logistics cost was $53.6 million or 9.7 percent of revenue.

While the base case simulation indicated that a small number of Northeastern United States markets are least cost sourced from Canada, existing tariffs and cross-border transportation rates are too high to have significant reassignment impact. Existing Canadian tariffs are too high to permit sourcing from the United States. The conclusion is that basic integration of markets, without changes in other variables, is insufficient to bring about change in distribution practice.

United States-Canada Variable Combinations

The second research question explored the impact of changes in tariffs, cross-border transportation rates and demand upon distribution system configuration, total system cost, and logistics cost. The conclusion is that only changes in tariff level have a direct impact. Changes in cross-border freight rates, and in the relative size of the Canadian market, while holding tariff levels at initial intensities, had no impact on system configuration or cost.

Variation in tariff level had a direct impact on distribution system configuration, total system cost and logistics cost. As tariff levels are reduced there is a substantial increase in cross-border sourcing. The simulation indicated that given Toronto and Chicago manufacturing plants, production shifts to Toronto as tariffs are reduced. In a zero tariff environment Chicago manufacturing volume drops from 56.8 percent to 43.1 percent while Toronto manufacturing volume increases from 11.6 percent to 23.9 percent. This shift results from lower production costs, and the proximity of Toronto to Eastern United States markets. The number of distribution centers also increases from ten to eleven. Total system cost decreases by $2.2 million to $244.1 million and logistics cost decreases to $52.6 million representing 9.5 percent of revenue.

As tariffs approach zero, the Toronto manufacturing plant's on-site distribution center serves an increasing number of Eastern and East Northcentral United States markets. However, no change occurs in distribution center locations. As tariffs approach zero, several Central and Western Canadian markets are served by United States distribution centers. Distribution centers in Central Canada are sourced from Chicago-based manufacturing.

As tariffs approach zero, a Western United States distribution center is established in Seattle. Integration at zero tariffs results in early elimination of the Vancouver facility because two facilities are not required in the area. The Seattle facility is sourced from the Kansas City manufacturing plant.

The elimination of tariffs resulted in improved efficiency by permitting trade-offs between production and transportation costs. As a result, total system cost was reduced. The elimination of all tariffs resulted in slightly lower logistics cost as markets are served from the lowest cost source irrespective of borders. Thus, it appears that tariff changes may affect the location and utilization of manufacturing plants and distribution centers, and have some impact on both total system cost and logistics cost.

United States-Canada "Most Likely" Environment

The third research question addressed changes under a "most likely" research variable environment. Several additional conclusions about distribution system configuration, sourcing patterns, and costs resulted from simulating that environment. The "most likely" environment assumed zero tariffs and a 10 percent reduction in cross-border transportation rates. The simulation was designed to

estimate the impact of this variable combination on distribution system configuration, total system cost and logistics cost.

The "most likely" environment furthers the expansion of Eastern Canadian manufacturing at the expense of Chicago. In this environment, the Chicago manufacturing plant's production decreases to just 33.3 percent of the total. The Toronto manufacturing plant's volume increases to 33.8 percent from 11.6 percent in the base case simulation. The shift in manufacturing is due to lower production costs and the proximity of Toronto to Eastern United States markets. The number of distribution centers remains at ten, however, several changes occur in the system configuration. Compared to the basic integration environment, total cost is decreased by $3.2 million. Logistics cost fell by $.9 million, or 0.2 percent of revenue.

The distribution center location configuration was modified in two ways. First, east coast facilities (New York and Pittsburgh) designed to service local markets from Chicago manufacturing were eliminated in favor of a Buffalo distribution center supplied from Canadian manufacturing. Secondly, the use of one western distribution center to serve both the Northwestern United States and Western Canada was firmly established under the "most likely" environment.

The "most likely" environment further contributes to efficiencies and cost reductions by facilitating manufacturing at locations providing the lowest delivered cost irrespective of borders. The environment also results in a realignment of distribution centers to serve customers at the lowest possible total system cost. The conclusion is that reductions in both total system and logistics cost result when tariffs and cross-border transportation cost barriers are eliminated.

United States-Canada Cross Industry Comparisons

A fourth research question explored how distribution system configuration and costs react given modification of the industry simulated under the "most likely" variable environment. The model was structured to replicate consumer appliances and women's clothing industries. These additional simulations clearly illustrate that distribution system configuration and cost changes dramatically given different products. Major changes in product weight, inventory carrying cost, and absolute production cost significantly impact the dependent variables. Therefore, cross-industry generalizations regarding research variables are limited.

Simulating the consumer appliances industry resulted in a substantially different distribution system configuration.

While all three manufacturing plants are utilized, the Chicago manufacturing plant produces just 26 percent of total volume compared to 33.3 percent in the food industry. The Toronto and Kansas City manufacturing plants produce 37 percent of volume in the consumer appliances industry while they produced 33.8 and 32.9 percent respectively in the food industry. In terms of distribution centers, seven facilities are used in the consumer appliances industry compared to ten in the food industry. Logistics cost as a percent of revenue was 8.5 percent in appliances compared to 9.5 percent in the food industry.

The overall system configuration simulated in appliances was different than in the food industry for two reasons. First, manufacturing plant usage differs because the absolute production cost differential is much greater with a high cost consumer durable despite the relative wage differences by city being held constant across industries. This production cost differential is sufficient to offset transportation costs incurred for shipping greater distances. The result is a shift in manufacturing in favor of Toronto. Secondly, a distribution system configuration having fewer facilities emerges as a result of different transportation cost/other logistics cost trade-offs. The appliance total transportation expenditure is lower than simulated for the food industry because fewer units are required to achieve the same sales level as in the food

industry. Fewer units are needed because, given the higher unit price for refrigerators, less units are needed to achieve the same total company dollar sales level as in the food industry. Fewer units are needed because, given the higher unit price for refrigerators, less units are needed to achieve the same total company dollar sales level as in the food industry. As a result, the least total cost appliance distribution system configuration has fewer distribution centers than replicated for the food industry.

The women's clothing industry resulted in a more extreme change in both the production cost differential and the weight/value relationship in comparison to the food industry. The result was a dramatic change in distribution system configuration. The simulation resulted in all manufacturing at Toronto, and the establishment of just two distribution centers. The small number of distribution centers is again a result of the relationship between the transportation cost curve and the cost curve for other logistics costs in a low total weight environment. The logistics cost as a percent of revenue, at 1.4 percent for women's clothing, is lower than in food and appliances because of low total transportation cost. This low total transportation cost results from fewer units and because of the lower weight per unit. The small number of units is due to high unit price and an assumption of similar sales levels across industries.

United States-Canada-Mexico Integration Research Questions

The following parts summarize conclusions for the research questions involving the integration of Mexico. There are four research questions parts.

United States-Canada-Mexico Basic Integration

The first research question in this set focused on integration of the United States, Canada and Mexico markets without changes in other research variable intensities. The simulations resulted in some significant changes in distribution system configuration and associated cost. The system configuration utilized all four manufacturing plants. Kansas City production decreased to 9.2 percent while Monterrey produced 31.3 percent of the total. The Chicago and Toronto manufacturing plants produced 28 percent and 31.5 percent of the total volume respectively. This shift occurred as a result of lower Mexican wage levels. In terms of distribution center configuration, the base case integration resulted in 13 distribution centers. The 13 facilities represent an increase of two locations compared to the separate United States-Canada and Mexican systems. The basic integration environment has a total system cost of $253.9 million and a logistics cost of $58.0 million representing 9.7 percent of revenue.

The most important change is the shift of manufacturing to Mexican locations. With Mexico in the solution, sourcing of distribution centers in the south and west is assigned to Mexican manufacturing. The simulation analysis indicates that even with full tariff levels between the three countries, the Mexican production cost advantage is sufficient to attract manufacturing volume.

Interestingly, the Mexican production cost advantage is not sufficient to displace Canadian manufacturing. Sourcing of Northeastern United States markets from Canada continues because the simulation replicates the "most likely," zero tariff environment between the United States and Canada and because of the high cost of importing goods to Canada in a full tariff environment.

Integration of the three country markets initiates a situation in which total system cost is reduced while logistics cost increases. As will be noted, this trend becomes more significant as variable intensities are changed. The conclusion is that Mexican production costs are sufficiently low to offset higher transportation costs necessary to overcome distant manufacturing. As such, considerable manufacturing shifted to Mexico.

United States-Canada-Mexico Variable Combinations

The second research question in the set addresses changes in individual variable intensities while holding other variables constant. Similar to the United States-Canada, variation of tariff levels in the three country simulation has a major impact on distribution system configuration. In contrast, variation of freight rates and Mexican demand levels had little impact compared to the basic integration environment. An important conclusion is that cross-border freight and demand at the levels tested, do not significantly impact distribution system configuration in a full tariff environment.

Change in the tariff level, however, has a dramatic impact on distribution system configuration. In terms of manufacturing location, a 50 percent tariff reduction results in complete elimination of United States manufacturing plants. In this environment, Monterrey manufactures 91.6 percent of all requirements with Toronto manufacturing the balance. The number of distribution centers increases to 15 in comparison to 13 in the basic integration environment. The total system cost drops from $253.9 million to $236.3 million. This reduction occurs despite logistics cost increases from $58.0 million to $73.1 million. As a percent of revenue, logistics cost increases from 9.7 percent to 12.3 percent.

United States manufacturing is eliminated as a result of major production cost savings in Mexico. These savings are generated by Mexican wage levels which are approximately 10 percent of those in the United States. Canadian manufacturing is continued, however, because of the high transportation costs required to serve Canada and the Northeastern United States from Mexico.

The distribution center configuration increased to 15 facilities because of the need for break-bulk capacity to service less-than-truckload demand. This break-bulk need results in the addition of distribution centers in Memphis and Philadelphia which are sourced from Mexico. Under this environment, the distribution center in Buffalo is eliminated because of reduced sourcing from Canada. New York and Pittsburgh facilities are added as break-bulk points for Mexican manufacturing.

These trends are further intensified when tariffs are eliminated. All manufacturing is located in Mexico when tariffs are eliminated. With no tariffs the number of distribution centers increases from 15 in the 50 percent tariff reduction environment to 17, with facilities being added in Buffalo and Monroe. These facilities are added to serve less than truckload demand and Canadian markets.

The cost implications of tariff elimination reflect fundamental trade-offs. Total system cost drops dramatically. At the same time, logistics cost increases substantially. Total costs are reduced from $253.9 to $209.8 million in the zero tariff environment. Logistics cost increases from $58.0 million, or 9.7 percent of revenue, to $77.2 million, or 13 percent of revenue. Tariff costs move from $14.6 to $25.2 million, to zero as tariffs are eliminated. Tariff cost increases first as more volume flows cross-border as a result of the 50 percent reduction in tariff rates, and then drops to zero when tariffs are eliminated. Transportation cost increases from $42.0, to $58.5, to $62.5 million as tariffs are eliminated and Mexican manufacturing comes on line.

In conclusion, tariff elimination results in exclusive Mexican manufacturing because production cost savings exceed increased logistics cost required to move product to market. This shift in manufacturing creates a need for distribution centers to deliver less-than-truckload demand at the lowest total cost. The result is a system in which logistics cost increases substantially in order to achieve a large reduction in total system cost.

United States-Canada-Mexico "Most Likely" Environment

The third research question evaluated the impact of the "most likely" three country environment upon distribution system configuration. The "most likely" environment is zero tariffs, freight rates between the United States and Canada reduced to 10 percent, the Mexican portion of cross-border rates reduced by 20 percent, and Mexican demand increased by 25 percent.

The result was no change in the distribution system configuration combination isolated in research question three. Except for changes due to increased demand and lower Mexican transportation rates, system costs remain the same. The principal conclusion is that full integration leads to Mexican manufacturing dominance, an increase in the number of distribution centers, and a major reduction in total system cost despite much higher logistics cost.

United States-Canada-Mexico Cross Industry Comparisons

The appliances and women's clothing industries conclusions when Mexico is included display the same trends as were isolated for the United States-Canada environment. While the patterns and trends are similar, the number and location

of manufacturing plants and distribution centers varied considerably. The industry comparisons assumed the "most likely" environment.

For the consumer appliances industry, all manufacturing shifted to Monterrey and a total of 13 distribution centers were utilized. This compares to the food industry setting in which all manufacturing shifted to Monterrey and 17 distribution centers were used. While it is not meaningful to compare absolute cost levels across the industries, the logistics cost as a percent of revenue equals 10.1 percent compared to 12.1 percent in the food industry.

Compared to the food industry, four less distribution centers were required in the consumer appliances industry. The facilities not utilized were located in New York, Monroe, Dallas and Montreal. As in the United States-Canada setting, less distribution centers were utilized than in the food industry because of the considerably lower total weight and transportation cost. While less facilities are used than in the food industry, compared to the United States-Canada consumer appliances industry, six additional distribution centers were utilized. These additional facilities were primarily used to reduce the cost of supplying less-than-truckload demand to distant Northern United States and Canadian markets.

For the women's clothing industry, the distribution system configuration included the Monterrey manufacturing plant and four distribution centers. The logistics cost as a percent of revenue was 1.5 percent. Manufacturing shifts totally to Monterrey because of major production cost savings. These savings are larger for the women's clothing industry because of higher labor content in this industry, and because of the higher absolute production cost dollars that the wage differentials by city are applied to.

As in the United States-Canada women's clothing situation, a small number of distribution centers are utilized because of low total transportation cost. The low total transportation cost is due to the product's high per unit price resulting in low volume to achieve the sales level, and because of the low product unit weight.

The overall conclusion is that manufacturing shifts to Monterrey for all three industries. The greater distances involved in sourcing the United States from Mexico results in the need for additional distribution centers compared to the United States-Canada only environment. Finally, as in the United States-Canada environment, the lower the total transportation cost related to other logistics cost, the fewer the distribution center facilities utilized in the lowest cost system configuration.

OVERALL GENERALIZATIONS

The research findings support several overall generalizations. As noted in the limitations, such generalizations are only relevant within the constraints of the simulated data. Six generalizations, and supporting comments, are reported in the following parts. The first two generalizations relate to United States-Canada integration. The next three relates to United States-Canada-Mexico integration. The last generalization part relates to the role of the research variables.

United States-Canada Production Shifts

Simulation of the United States-Canadian integrated market revealed an increasing shift of manufacturing toward the Toronto plant as barriers were eliminated. The Toronto manufacturing plant served increasing numbers of Eastern United States markets in these simulations. Given these results, it can be stated that:

- Manufacturing will shift toward Eastern Canadian manufacturing plants to serve Eastern United States markets as research variable intensity moves towards the "most likely" environment.

This shift occurs for two reasons. First, because Eastern Canadian manufacturing plants are geographically closer to Eastern United States markets when the United States

manufacturing plant is located at Chicago or in a midwestern location. Secondly, this shift occurs because of the lower costs assumed for Canadian manufacturing plants. The extent of the manufacturing shift depends on the location of the nearest United States manufacturing plant relative to the Eastern United States, and on the extent of absolute production cost differentials between Canadian and United States manufacturing plants.

United States-Canada Distribution Center Location Shift

Simulation of the integrated United States-Canada market results in increasing cross-border market assignments and changes in distribution center locations as trade barriers are reduced. However, complete integration under the "most likely" environment does not lead to a change in the number of distribution centers. For the data set simulated, a single Northwestern United States distribution center emerged to serve markets on both sides of the border, and a Buffalo distribution center emerged to serve the Eastern United States from Toronto sourced product. Interestingly, it does not appear that the Michigan border crossing area is a viable distribution center in the situations tested. Based on these findings, the generalization is:

- The number of distribution centers remains constant but facilities are relocated to the

west coast border area and Northern New York as research variable intensity moves toward the "most likely" environment.

This shift towards border area distribution centers occurs so as to facilitate cross-border sourcing of markets on a least delivered cost basis.

United States-Canada-Mexico Production Shift

The introduction of Mexican manufacturing plants in the simulation analysis led to a major shift in production towards Mexico. This trend was substantial in the basic integration environment, resulted in the elimination of all United States manufacturing at the half tariff level, and resulted in exclusive Mexican manufacturing at the zero tariff level. This shift toward exclusive Mexican manufacturing occurred in all three industries under the "most likely" environment. It can therefore be generalized:

- Manufacturing will shift toward Mexican locations as trade barriers are reduced and will increasingly be exclusively located in Mexico as the size of absolute unit production cost increases and as the level of trade barriers decreases.

This shift occurs because the savings in absolute production cost outweighs the increase in transportation and logistics cost. The larger the size of absolute unit production cost,

the greater the impact of relative hourly compensation cost differentials, and the lower the need for trade barrier reduction in order to affect a production shift.

United States-Canada-Mexico Distribution Center Numbers and Location Shift

Simulation analysis indicated that exclusive manufacturing in Mexico resulted in an increase in the number of distribution centers required. The additional distribution centers were primarily added in distant northern markets. While the extent of the impact on distribution center numbers depends on the product weight, value and volume relationships, it can generally be concluded:

- Exclusive Mexican manufacturing will result in a need for additional distribution centers in distant market areas.

The additional distribution centers are required for break-bulk delivery of smaller shipment size orders at the lowest possible total system cost.

United States-Canada-Mexico Total System Cost Changes

The simulation results indicated that major reductions in total system cost occurred when Mexican manufacturing is utilized. These total system cost reductions result from a trade-off of production cost savings against logistics cost

increases. Total system costs were substantially reduced in each of the three industries when Mexican manufacturing is utilized. As such, it can be generalized:

- Utilization of Mexican manufacturing plants results in reductions in total system cost as a result of lower production cost, however, this reduction is partially offset by significant increases in logistics cost.

The production cost is reduced because of the hourly labor wage differentials between Mexico and the United States.

Research Variable Impact on Location

The simulations indicate that changes in the country integration variable, cross-border freight rates, and country demand size, given initial full tariff levels, are not sufficient to impact distribution system configuration or cost. Only changes in the tariff level, singularly or in combination with changes to other variables, results in major changes in distribution system configuration or cost. Given the results, it can be generalized:

- Only changes in the tariff variable level, and changes in the tariff variable level in combination with changes in intensity for other research variables, will result in a significant change in distribution system configuration and cost.

While changes in intensity were only tested in the food industry, the cross industry simulations that were completed suggest similar results could be expected in other industries. This generalization regarding the lack of impact for non-tariff related variables assumes feasible changes in variable intensity levels.

IMPLICATIONS

This part discusses research implications for theorists, practitioners, and government policy makers. Each part includes several generalizations which should be of interest to the relevant group.

THEORY RELEVANCY

The conclusions and generalizations point out several implications for theory. Theory will become increasingly important as organizations seek guidance concerning manufacturing plant and distribution center facility location in an integrated North American economy.

The research adds additional importance to some fundamental location theory concepts, and the potential to build on those concepts. The concepts relate to factors that

determine manufacturing location and the role that manufacturing and markets play in determining distribution center locations.

Alfred Weber's (1929) research, which is the first such concept, dealt with manufacturing location and focused on the relationship between production and transportation cost. His concepts are highly relevant to any new conceptual theory which focuses on location decisions in a North America-wide market. Weber argued, all other costs being equal, manufacturing would gravitate to areas where transportation cost for inbound raw materials and outbound finished products is minimized. The above hypothesis led to Weber's generalization concerning the manufacturing location of products that gained versus lost weight in production. Weber went on to suggest that if production costs varied, manufacturing would shift to sites where labor savings exceeded transportation cost penalties. These concepts are extremely important in a world market where production costs can vary dramatically by country and city, and where transportation costs can be very high in order to cover world scale distances between low cost manufacturing points and markets.

The extent to which production cost differentials occur in the North American market, and the relatively low cost of overcoming distance from the low cost manufacturing

locations to markets, drives the simulation results reported. In fact, the key conclusion is that even in a North America-wide environment, production cost savings can exceed logistics cost, and thereby shift manufacturing to locations distant from markets.

The resulting manufacturing at distant Mexican locations drives the second key research conclusion, that such distant manufacturing dictates a need for establishing distribution centers to service distant markets at lowest total logistics cost. Existing theory discusses the derived nature of distribution center location (Bowersox 1960), the justification for certain types of distribution centers in terms of consolidation economies (Bucklin 1965), and the number of distribution centers which are ideal under different conditions (Smykay, Bowersox and Mossman 1961). However, theory does not examine how the relationships between several important factors influences location.

The research points out the strong relationship between manufacturing location decisions and distribution center location. It highlights the impact that distant manufacturing location has on distribution center location. While existing concepts on manufacturing location and distribution center location provide separate rationales for each type of location decision, there is little theory which integrates the two separate issues into one conceptual

framework. Nor is there sufficient theory on the international factors that influence the combined manufacturing and distribution center location decision. Finally, existing concepts address the number of distribution centers in terms of the trade-offs between transportation and other costs, but do not discuss the factors which drive differences in these relationships, especially in an international setting. This lack of integrating theory needs to be fully examined in future location theory building.

The research identifies variables and potential interrelationships that should be considered in future conceptual theory. The variables and interrelationships help to identify the way in which different industry groups will be impacted by North American and/or global free trade environments. Based on this research it appears that the key factors for determining combined manufacturing plant and distribution center location include absolute production cost differentials, weight of product, cost of product, unit volume, level of tariffs, and the level of cross-border and general transportation rates. Additional factors which are relevant but which do not emerge in this research include the relative size of country markets, service level requirements, and non-wage production cost factors.

The relationship between absolute production cost differentials, transportation cost, unit cost of goods sold values, and unit volume levels have a critical role in determining the overall location pattern and extent of savings possible from realigning the distribution system configuration. While relative compensation costs by country and city represent the underlying variable that effects production costs, the impact of this variable is mediated by the degree to which direct labor is a factor in total production cost and by the absolute dollar value of production costs. The key point is the absolute production cost differentials between cities, and not relative differentials. This is because the level of absolute unit dollar savings in distant low cost production points must be sufficient to cover the absolute unit dollar costs of transportation to market.

As such, the generalization is:

- The higher the absolute production cost level, and the higher the direct labor content, the greater the influence of low cost wage level availability on absolute unit production cost savings, and the greater the likelihood of manufacturing shifts to low wage areas.

A second key relationship relates to the factors influencing the transportation cost of the product. It can generally be said that:

- The lower the product weight, the lower the order cycle time requirements (and hence pressure for high speed high cost transportation), and the lower the freight rates, the lower the transportation cost per unit.

With regards to transportation cost it can be further stated that:

- The lower cross-border transportation rates are relative to internal freight rates in major markets, the greater the likelihood of cross-border sourcing.

Given the above points it can be stated, based on the simulation model research results conducted here, and on the Weber (1929) theory, that:

- The greater the absolute unit production cost differentials by manufacturing plant city, and the lower the absolute unit transportation costs, the greater the benefits of switching manufacturing to low cost points.

Given distant low cost manufacturing plant locations the need for additional distribution centers in order to achieve low cost delivery is dependent on the relationship between unit volume, unit weight, and unit value as follows:

- High unit volume, medium unit weight, and low unit value resulting in high total transportation cost and relatively low total inventory cost contributes to the low total

cost point including relatively more distribution centers as distance to production source increases.

- Low unit volume, high unit weight, and high unit value resulting in high total transportation cost and relatively higher total inventory cost contributes to the low total cost point including relatively less distribution centers than in the previous case as distance to production source increases.

- Low unit volume, low unit weight, and high unit value resulting in very low total transportation cost and very high total inventory cost contributes to the low total cost point including dramatically less distribution centers than in the previous two cases as distance to production source increases.

In terms of the industries whose distribution system configuration and cost levels are likely to most affected by North American economic integration, the following is proposed:

- Industries with high tariff levels, high absolute production costs, high direct labor content, medium weight, and low inventory value are likely to be most affected as economic integration occurs.

The above industries will be most affected because of the tariff reduction impact, potential savings in absolute production costs, medium cost of transporting goods from distant sources and the need for market area distribution centers to provide delivery economies, and the fact that low inventory value will not preclude opening of additional distribution centers.

PRACTITIONERS RELEVANCY

The research implications for practitioners, and especially for logisticians, are numerous. Some of the implications are general in nature, while others relate to specific trends in the number and location of facilities. The following parts discuss the major implications.

System Evaluation and Logistics Cost Management Implications

The research findings indicate that significant savings can be achieved by integrating United States-Canada operations, and that very large reductions in total system cost can be achieved following Mexican integration at zero tariff levels. However, the savings in total system cost come at the expense of higher logistics cost when Mexican manufacturing is incorporated into the system. Given these findings, the first practitioner implication is:

- The need to evaluate North American distribution system configurations in light of likely changes in both tariff levels and freight costs.

The shift of manufacturing to Mexican sources, and the resulting increases in logistics cost that results, leads to the second practitioner implication which is:

- A need for logistics managers to begin planning ways of minimizing logistics cost related to Mexican manufacturing.

Approaches may include the increased use of rail from Mexican production sources to market area distribution centers. Another approach may involve the use of a greater number of distribution centers to allow for consolidation economies. The extent to which the latter point applies depends on the level of small order size demand, and on the relationship between transportation and inventory carrying cost. Large quantities of small orders, coupled with high transportation cost relative to inventory carrying cost, will lead to the need for additional distribution centers as manufacturing sources become more distant.

The research suggests that strategic realignments of manufacturing plants and distribution centers will be far greater for some industries than others. Practitioners should be aware that:

- Industries with relatively high absolute production costs, high tariffs, high direct labor content, medium unit weight, high unit volume, and low inventory value will confront the greatest opportunity for savings.

Organizational and Institutional Management Implications

In many cases companies currently have zero tariff levels, or close to zero tariff levels, on both United States-

Canada, and United States-Mexico interactions. However, the traditional organization of operations within each individual country into separate legal entities and/or responsibility accounting entities may result in suboptimal sourcing and distribution decisions. Likewise, long standing institutional practices such as transfer pricing relationships designed to shift profits between countries, may result in sourcing practices which do not take full advantage of an integrated market. Given the above situation, another key implication is:

- The need for companies to reassess organizational relationships and institutional practices to take advantage of potential savings as North American barriers are reduced.

Specific Location Implications

In terms of the specific findings of the research, several important trends emerge. However, it must be pointed out that it is difficult to generalize the trends because of the importance of highly situational factors such as the actual location of manufacturing plants. As such, the specific findings are intended to raise questions among executives, and to foster internal corporate research which may lead to the opportunity for individual company improvements.

Specific implications are presented for the United States-Canada environment and then for the United States-Canada-Mexico environment.

United States-Canada Integration

In an integrated United States-Canada environment with no tariffs and somewhat lower cross-border freight rates than is the case today, several findings emerge. First, given a manufacturing plant setting in which production is available in Toronto, but not east of Chicago in the United States:

- A considerable portion of the Northeast United States and northern mid-Atlantic states may be sourced more economically from Toronto.

As such, companies should consider the potential for realignments involving sourcing from Toronto manufacturing. The degree to which Toronto is the preferred source as one moves south from the northeast depends on the exact location of manufacturing plants and on the relative production costs. The research conducted here assumed Toronto unit production costs equaled about 95 percent of United States levels. The lower production costs are based on the theory that fully compensated labor costs, including benefits, are lower in Canada.

Secondly, in a fully integrated United States-Canada environment, the manufacturing shifts to Toronto may be sufficient to eliminate some eastern distribution centers previously sourced from Chicago in favor of distribution centers sourced from Toronto. For instance, given the assumption of manufacturing plant locations in just Kansas City, Chicago and Toronto used in this research, distribution centers in Pittsburgh and New York were eliminated in favor of Buffalo. This may or may not be appropriate depending on the specific company and the location of manufacturing plants. The other trend involving distribution centers is the emergence of a single distribution center in the Northwestern United States or Southwestern Canada. Such a facility serves markets on both sides of the border, and is justified by the two country demand. Given these trends:

- Practitioners should consider the possibility of repositioning distribution centers in the Northcentral United States and in the Northwestern United States or Southwestern Canada.

The third general finding involves the cost savings which can be achieved through cross-border sourcing of markets. Several Canadian and United States border cities are ideally sourced cross-border rather than from in-country distribution centers.

United States-Canada-Mexico Integration

The introduction of Mexican integration results in dramatic savings and shifts in distribution system configuration in the industry situations studied. At half existing tariff levels most United States manufacturing shifts to Mexico assuming a production cost in Mexico equal to 63 percent of the United States level, however, some Canadian manufacturing is maintained. Elimination of tariffs results in all manufacturing shifting to Mexico. This kind of dramatic shift in manufacturing generates large savings in total system cost which are sufficient to more than offset large increases in logistics cost. Given these changes, practitioners should:

- Carefully consider the potential for Mexican manufacturing sources.

The change in manufacturing location generated a need for additional North American distribution centers. In fact, the ideal number of facilities increased from 10 to 17, so as to provide smaller order size consolidation opportunities on the long distance moves from Mexico to Northern United States and Canadian markets. The implication is that:

- Additional distribution centers may be necessary given exclusive Mexican manufacturing.

In general, practitioners may want to consider the potential for changes in manufacturing plant location, as well as the sourcing of markets based on existing manufacturing plant locations. To the extent that manufacturing is available in a location similar to Toronto, and Eastern United States facilities are not available, it may be beneficial to use the Toronto facility to source the Northeastern United States. The opportunities for Mexican production cost savings should also be explored. In terms of distribution centers, the potential for a Northwestern United States, or Southwestern Canadian facility should also be explored. The possibility of reconfiguring Northeastern United States distribution centers should also be reviewed. Finally, assuming Mexican manufacturing, companies should consider the need for additional distribution centers in the Northern United States and Canadian markets.

POLICY RELEVANCY

There are several implications of the research for policy makers. First, the research points out the potential shift of manufacturing to Mexico that could result from full scale integration of the three countries. Such a shift in manufacturing could have a number of adverse effects on the United States and Canadian economies. The research also points out the types of industries most likely to be affected by full-scale integration, and the degree to which

research variables must change to affect major manufacturing shifts. As such, the research methodology offers a way to identify industries which most require continued tariff protection, and the level of tariff protection required to prevent full loss of United States manufacturing. Given this capability:

- Policy makers may want to consider the way in which integration would affect different industries, and examine the levels of tariff required to protect given industries.

Policy makers also may want to investigate some of the socioeconomic implications of major shifts in manufacturing. These implications could relate to job losses, immigration trends, cultural issues, and a number of other topics. Given the potential socioeconomic implications it is suggested that researchers should:

- Consider the socioeconomic implications of potential shifts in manufacturing and begin research on the possible implications.

It should be noted that while the research suggests major shifts of manufacturing to Mexico, there are several factors that could mitigate any such changes. First, the research only examined the impact of direct labor costs on manufacturing locations. Other economic variables such as overhead levels and material costs were not considered. Nor were non-economic factors such as quality levels, language

issues, or technical issues taken into account. To the extent that Mexican production might result in higher costs for these elements, the size of production cost savings may be limited. Policy makers should keep this in mind before making any conclusions about potential loss of jobs as a result of North American integration. Future research should help to address the likely level of production cost savings in Mexico.

At the same time, the research points out the potential savings which could accrue to companies and consumers if the changes were enacted. Several opportunities could be created depending on one's perspective. For specific regions of the country there are opportunities to become major distribution center hubs. This may be true of the upper New York area in the case of United States-Canada integration, and also may be true of the Laredo and El Paso areas as Mexican integration occurs. Interestingly, Southeast Michigan is not likely to gain distribution center facilities in the United States-Canada environment because of high labor costs and outbound freight costs. However, along with a number of other market areas, the potential for Michigan-based distribution centers may increase as manufacturing shifts from other United States cities to Mexico. Given the potential for various regions, economic development officials should:

- Consider the way in which their regions might benefit from location changes which occur as a result of economic integration, and consider how their regions might capitalize on such changes.

For transportation policy makers, the research findings point out the impact of reducing cross-border transportation cost. In the three country integration environment, total cost savings are large, however, transportation costs go up substantially as a result of distant sourcing of markets. Given this fact the goal of policy makers should be to:

- Help reduce the level of cross-border transportation rates, so as to assure the full benefits of production rationalization.

Costs can be minimized by assuring the proper level of competition on cross-border movements, and by assuring the proper border-crossing infrastructure. A prime goal should be to achieve North American operating rights for carriers and drivers throughout all three countries. The European Community, is fast moving to such status and if North America is to improve its competitiveness vis-a-vis the Community, similar liberalization will be necessary.

FUTURE RESEARCH

There are a number of issues which require further investigation. In fact, the research raises many more

questions than it answers. The future research issues relate to similar simulation efforts first, and secondly to a broader agenda which addresses the overall topic of North American economic integration from a materials and logistics management perspective.

SIMULATION MODELING RESEARCH

In terms of simulation modeling of the distribution system impact of North American integration, there are a number of topics which require further research. First, there is the need to simulate a number of alternative industries in order to better understand the generalizability of findings. Secondly, there is a need to model a North American system with explicit consideration of customer service goals and to determine the impact of such goals on distribution system configuration.

Third, and perhaps most important, is the need to further develop the production cost portion of the model. This development should include variation of the other components of production cost, such as materials costs and overhead, by potential manufacturing plant city. This could be accomplished by varying the costs outside of the model and inserting alternative production costs into the model, or by further explicitly modeling the principal product assembly components and the alternative sources of supply and cost

structures for each component. While the current research modeled the manufacturing plant as the first node in the system, an expanded approach should consider the supply sources for each key component being modeled as the initial node. One result might be, that for products assembled in Mexico with United States components, the lower labor costs would be partially offset with higher inbound material costs. Such a result would decrease the savings impact of Mexican manufacturing.

The existing simulation model could also be used to test a number of additional research questions. For instance, in a "most likely" future environment, how much Mexican, and how much Canadian demand is required to impact distribution center location? Along the same lines, how much increase in Mexican wage levels, or in tariffs, is required to offset the advantage of Mexican manufacturing? Also, what effects do changes in transportation rates have in a zero tariff environment?

The simulation research could also be extended by modeling alternative manufacturing strategy approaches and multiple product environments. For instance, what is the impact of switching from a parallel manufacturing strategy, in which three or four products are made in each country, to one in which each country's manufacturing plant specializes in the production of one product for all three country markets? In

such an approach, mixing distribution centers would be required to bring together product assortments and the location of those facilities would be a key dependent variable for consideration.

Finally, the research would have been assisted by the availability of a model specifically designed to address international location decisions. Such a model would allow for consideration of tariff levels, local inflation, exchange rates, and other factors in a detailed manner. As such, future research should focus on developing such a model.

GENERAL RESEARCH

In terms of more general research, a number of opportunities emerge. First is the need for a comprehensive data base of market size, production costs, and freight rate data. There is a special need for research on Mexican freight rates and cross-border United States-Mexico freight rates. Data on such rates is extremely scarce.

Secondly, the cross-border transportation field, in general, offers a number of research opportunities. The basic question is one of isolating ways to reduce transportation

cost and improve service. Research on the degree to which customs and immigration practices affect transportation costs and service levels is also needed.

A third topic for future research is the role that organizational structure and institutional practices play in corporate decision making. To what degree does structure and current practice facilitate or impede implementation of strategies which can reduce costs in a North American integrated environment? Research on this topic should consider the role that legal and responsibility entity structure plays in allowing corporations to take advantage of North American opportunities.

A fourth research stream could address the role that product technical standards, quality issues, manufacturing capacity issues, country risk, and cross-border management issues play in determining the feasibility of non-United States manufacturing and cross-border distribution. Such factors could have a significant role in reducing the attractiveness of Mexican manufacturing. These factors could make United States-Canada, and United States-Canada-Mexico cross-border sourcing from manufacturing plants and distribution centers more difficult to implement.

RESEARCH LIMITATIONS

The research is limited first by its exploratory nature. While a simulation model and experimental design are utilized, the recent development of the actual and proposed integration and the lack of prior research, make this an exploratory effort. The scope of the research is also limited by the small number of industries investigated. While there is some consideration of the consumer appliances and women's clothing industry, the results are most directly applicable to the food industry.

The research is limited by the fact that simulation configurations regarding numbers and locations of facilities do not represent the "optimum" network. There are two factors that limit the generalizability of the findings. First, the simulation sort-down process is not an optimization technique. The simulation approach uses heuristics to develop an approximation of the optimum distribution system. As such, the specific distribution center locations selected are not necessarily the "best" ones. Secondly, because of the data used, the total system cost and logistics cost does not change dramatically as individual distribution centers are eliminated from the system. This means that the number of distribution centers included in the system can vary up or down by two or three without a significant impact on cost. In combination, these

two factors dictate that conclusions should relate to trends and directions in the number and location of distribution centers, and not to specifics.

Finally, the research is limited by lack of precise data and by the assumptions. First, because specific company information was not used; policies, costs, and other data are based on industry averages. The results are limited by the absence of precise cost data. Secondly, because of food industry practice, the manufacturing plant location options did not include an Eastern United States facility. Such a facility would have modified conclusions regarding the Toronto manufacturing plant. This assumption represents a limitation on the generalizability of results. Third, because the data on production costs by country and city focused exclusively on labor cost differentials, the conclusions may overstate the savings inherent in Mexican manufacturing. Consideration of other economic factors such as overhead, material costs, and quasi-economic factors such as quality and technical standards, may in practice mitigate some of the reported Mexican production cost savings. The research conclusions would be altered if these other factors were to substantially offset the assumed Mexican production cost savings. Thus, research conclusions and generalizations are limited by the primary focus on labor cost differential.

APPENDICES

APPENDIX A

MARKET AREAS DEFINITION AND

PERCENT OF COUNTRY DEMAND BY MARKET AREA

Table A1

United States Market Areas And Percent Of Country Demand By Market Area

Market Code	Location	Zip Code	Market Includes Zip Codes ...	Percent*
011	SPRINFLD, MA	01100	011, 010, 012, 013	0.36
016	WORCHES, MA	01601	016, 014, 015	0.27
021	BOSTON, MA	02110	021, 017, 018, 019, 020, 022, 023, 024	1.69
029	PROVIDENC, RI	02901	029, 025, 027, 028, 206	0.66
031	MANCHESTE, NH	03105	031, 030, 032, 033, 034, 038, 039	0.37
041	PORTLAND, ME	04101	041, 040, 042, 043, 045	0.28
047	CARIBOU, ME	04736	047, 044, 046, 049, 048	0.20
054	BURLINGTN, VT	05401	054, 035, 036, 037, 050, 051, 053, 055, 056, 057, 058, 059	0.27
061	HARTFORD, CT	06101	061, 060, 062, 067	0.58
065	NEW HAVEN, CT	06501	065, 063, 064, 066	0.61
069	STAMFORD, CT	06905	069, 068	0.20
071	NEWARK, NJ	07103	071, 070, 072, 073, 074, 075, 076, 078, 079	0.27
081	CAMDEN, NJ	08100	081, 080, 082, 083, 084	0.85
089	NEW BNSWK, NJ	08902	089, 077, 087, 088, 085, 086	0.68
106	WH PLAINS, NY	10607	106, 105, 107, 108, 109	0.60
112	BROOKLYN, NY	11227	112, 100, 101, 102, 103, 104, 110, 111, 113, 114, 115, 116, 117, 118, 119	4.32

* Percent refers to percent of country demand by market area (percent of population)

Source: Dialog Systems Division of A.T. Kearney, Inc., NETSIM II Documentation Manual, East Lansing, MI: 1990.

Table A1 (Cont'd.)

122	ALBANY, NY	12207	122, 052, 120, 121, 123, 128	0.47
126	POUGHKPSE, NY	12602	126, 124, 125, 127	0.30
132	SYRACUSE, NY	13201	132, 129, 130, 131, 133, 134, 135, 136	0.69
139	BINGHPTN, NY	13902	139, 137, 138, 148, 149	0.32
141	SLVER CRK, NY	14136	141, 140, 142, 143, 147	0.70
146	ROCHESTR, NY	14601	146, 144, 145	0.45
152	PITTSBRGH, PA	15238	152, 150, 151, 153, 154, 156, 160, 162, 161	0.99
158	DU BOIS, PA	15801	158, 163, 167, 168, 169	0.24
159	JOHNSTWN, PA	15904	159, 155, 157, 166	0.27
165	ERIE, PA	16512	165, 164	0.36
171	HARRISBRG, PA	17101	171, 170, 172, 173, 174, 175, 176, 178	0.77
181	ALLENTWN, PA	18105	181, 180, 182, 183	0.33
187	WLKS-BAR, PA	18704	187, 177, 184, 185, 186, 188	0.39
194	POTTSTOWN, PA	19464	194, 189, 190, 191, 192, 193	1.64
196	READING, PA	19610	196, 179, 195	0.20
198	WILMINGTN, DE	19802	198, 197, 199, 219	0.29
200	WASHINGTN, DC	20001	200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 220, 221, 222, 223, 224, 225, 227	1.54
212	BALTIMORE, MD	21227	212, 210, 211, 213, 214, 216, 217, 218	0.23
215	CUMBERLND, MD	21502	215, 226, 254, 267	0.16
229	CHARLTVIL, VA	22902	229, 228, 268	0.13
232	RICHMOND, VA	23201	232, 230, 231, 238, 239	0.47
235	NORFOLK, VA	23505	235, 233, 234, 236, 237, 279	0.58
240	ROANOKE, VA	24016	240, 241, 243, 244, 245	0.49
253	CHARLSTN, WV	25301	253, 246, 247, 248, 249, 250, 251, 252, 255, 256, 257, 258, 259, 266	0.51
265	FAIRMONT, WV	26554	265, 260, 261, 262, 263, 264	0.33
274	GRNSBORO, NC	27402	274, 270, 271, 272, 273	0.54
276	RALEIGH, NC	27601	276, 275, 277, 278	0.57

Table A1 (Cont'd.)

282	CHARLOTTE, NC	28214	282, 280, 281, 297	0.58
283	FAYTTEVIL, NC	28307	283, 284, 285	0.54
288	ASHEVILLE, NC	28802	288, 286, 287, 289	0.43
292	COLUMBIA, SC	29202	292, 290, 291, 295	0.55
294	CHRLESTON, SC	29411	294	0.22
296	GRNVILLE, SC	29602	296, 293	0.42
303	ATLANTA, GA	30324	303, 300, 301, 302	1.08
306	ATHENS, GA	30601	306, 305	0.23
309	AUGUSTA, GA	30901	309, 298, 308	0.20
312	MACON, GA	31201	312, 304, 310, 311	0.32
314	SAVANNAH, GA	31402	314, 299, 313	0.17
317	ALBANY, GA	31705	317	0.19
319	COLUMBUS, GA	31907	319, 318, 368	0.19
322	JKSNVILLE, FL	32201	322, 315, 316, 320, 321	0.65
323	TALLAHASS, FL	32300	323, 324, 325	0.43
328	ORLANDO, FL	32802	328, 326, 327, 329, 347	0.70
331	MIAMI, FL	33147	331, 330, 332, 333	1.19
334	W PLM BCH, FL	33401	334, 349	0.36
336	TAMPA, FL	33617	336, 335, 337, 338, 342, 346	1.07
339	FT MYERS, FL	33902	339	0.16
352	BRMGHAM, AL	35201	352, 350, 351, 353, 355	0.54
354	TSCALOOSA, AL	35401	354, 367	0.14
356	FLORENCE, AL	35630	356, 357, 358	0.25
359	GADSDEN, AL	35902	359, 362	0.18
361	MNTGOMERY, AL	36108	361, 360, 363	0.27
366	MOBILE, AL	36601	366, 364, 365	0.27
372	NASHVILLE, TN	37201	372, 370, 371, 384, 385	0.63
374	CHATTNOGA, TN	37401	374, 307, 373	0.37
376	JHNSN CTY, TN	37601	376, 242	0.24
379	KNOXVILLE, TN	37901	379, 377, 378	0.41
381	MEMPHIS, TN	38109	381, 380, 386, 723, 724	0.72
383	JACKSON, TN	38301	383, 382	0.16
387	GRNVILLE, MS	38701	387, 389	0.17
388	TUPELO, MS	38801	388, 397	0.17
392	JACKSON, MS	39201	392, 390, 391	0.30
393	MERIDIAN, MS	39301	393, 369, 394	0.23
402	LOUISVIL, KY	40201	402, 400, 401, 427, 471	0.59
405	LEXINGTON, KY	40505	405, 403, 404, 406, 407, 408, 409, 411, 412, 413, 414, 415, 416, 417, 418, 425, 426	0.64
421	BWLG GRN, KY	42101	421, 422	0.13

4
4
4

Table A1 (Cont'd.)

432	COLUMBUS, OH	43201	432, 430, 431, 437, 438, 456, 457, 433	0.93
436	TOLEDO, OH	43601	436, 434, 435	0.37
441	CLEVELAND, OH	44112	441, 440	0.99
442	RAVENNA, OH	44266	442, 439, 443, 446, 447	0.72
445	YOUNGSTWN, OH	44505	445, 444	0.37
449	MANSFLD, OH	44901	449, 448	0.26
452	CNCINNATI, OH	45202	452, 410, 450, 451, 470	0.75
454	DAYTON, OH	45401	454, 453, 455	0.48
458	LIMA, OH	45802	458	0.16
462	INDIANPLS, IN	46201	462, 460, 461, 478, 479	0.83
466	SOUTH BND, IN	46622	466, 465	0.22
468	FT WAYNE, IN	46801	468, 467	0.24
473	MUNCIE, IN	47302	473, 469	0.31
474	BLMINGTON, IN	47401	474, 472	0.17
477	EVANSVIL, IN	47711	477, 423, 424, 475, 476	0.33
482	DETROIT, MI	48203	482, 480, 481	2.07
485	FLINT, MI	48501	485, 484	0.28
486	SAGINAW, MI	48607	486, 487	0.28
489	LANSING, MI	48909	489, 488, 492	0.45
495	GRD RAPDS, MI	49501	495, 490, 491, 493, 494	0.78
497	S S MARIE, MI	49783	497, 496, 498, 499	0.29
503	DES MOINE, IA	50309	503, 500, 501, 502, 505, 508, 509, 514	0.43
511	SIOUX CTY, IA	51102	511, 510, 512, 513, 687	0.19
520	DUBUQUE, IA	52001	520, 504, 506, 507, 521	0.27
528	DAVENPORT, IA	52801	528, 522, 523, 524, 525, 526, 527	0.39
532	MILWAUKEE, WI	53219	532, 530, 531, 533, 534	0.88
537	MADISON, WI	53703	537, 535, 536, 538, 539	0.37
543	GREEN BAY, WI	54305	543, 541, 542, 544, 545, 549	0.56
546	LA CRSSE, WI	54601	546, 547	0.18
554	MNEAPOLIS, MN	55428	554, 540, 550, 551, 553, 562, 563	1.26
558	DULUTH, MN	55806	558, 548, 556, 557, 564, 566	0.30
559	ROCHESTER, MN	55901	559, 560, 561	0.27
571	SIOUX FLS, SD	57104	571, 570, 572, 573, 574, 576	0.22
577	RAPID CTY, SD	57701	577, 575, 827	0.11

Table A1 (Cont'd.)

581	FARGO, ND	58102	581, 565, 567, 580, 582, 583, 584	0.27
587	MINOT, ND	58701	587, 585, 586, 588	0.13
591	BILLINGS, MT	59101	591, 590, 592, 593, 824	0.13
594	GREAT FLS, MT	59401	594, 595	0.07
596	HELENA, MT	59601	596, 597	0.08
598	MISSOULA, MT	59801	598, 599	0.09
606	CHICAGO, IL	60632	606, 463, 464, 600, 601, 602, 603, 604, 605	3.59
611	ROCKFORD, IL	61108	611, 610, 613	0.29
612	ROCK ISLD, IL	61201	612	0.08
616	PEORIA, IL	61601	616, 614, 615, 617	0.34
618	CHAMPAIGN, IL	61820	618, 609, 619	0.24
627	SPRINGFLD, IL	62702	627, 624, 625, 626, 628	0.39
631	ST LOUIS, MO	63132	631, 620, 622, 630, 633, 636	1.21
634	HANNIBAL, MO	63401	634, 623, 635, 652	0.21
638	SIKESTON, MO	63801	638, 420, 629, 637, 639	0.34
641	KANS CTY, MO	64116	641, 640, 653, 660, 661, 662	0.75
645	ST JOSEPH, MO	64502	645, 644, 646	0.12
648	JOPLIN, MO	64801	648, 647, 667	0.17
658	SPRINGFLD, MO	65801	658, 650, 651, 654, 655, 656, 657	0.34
666	TOPEKA, KS	66601	666, 664, 665, 668	0.18
672	WICHITA, KS	67221	672, 669, 670, 671, 673, 674, 675, 676, 677	0.47
678	DODGE CTY, KS	67801	678, 679, 739	0.07
681	OMAHA, ONE	68101	681, 515, 516, 680	0.34
685	LINCOLN, ONE	68521	685, 683, 684, 686, 689	0.22
691	N PLATTE, ONE	69101	691, 688, 690, 692, 693	0.16
701	NEW ORLNS, LA	70121	701, 395, 700, 703, 704	0.90
708	BATON RGE, LA	70802	708, 396, 705, 707	0.53
711	SHREVEPRT, LA	71100	711, 710	0.20
712	MONROE, LA	71201	712	0.15
713	ALEXANDRI, LA	71301	713, 714	0.19
722	LTLE ROCK, AR	72203	722, 716, 719, 720, 721	0.45
727	FAYETTEVI, AR	72701	727, 725, 726	0.17
729	FT SMITH, AR	72901	729, 728, 749	0.15
731	OKLA CITY, OK	73101	731, 730, 734, 735, 736, 737, 738	0.65

Table A1 (Cont'd.)

741	TULSA, OK	74101	741, 740, 743, 746	0.41
745	MCALESTER, OK	74501	745, 744, 747, 748	0.14
752	DALLAS, TX	75235	752, 750, 751, 758	0.94
755	TEXARKANA, TX	75501	755, 717, 718	0.16
757	TYLER, TX	75701	757, 754, 756, 759	0.41
761	FT WORTH, TX	76101	761, 760, 762, 764	0.53
763	WICHI FLS, TX	76301	763, 792	0.10
767	WACO, TX	76707	767, 765, 766	0.22
769	SAN ANGLO, TX	76901	769, 768, 797	0.23
770	HOUSTON, TX	77017	770, 771, 772, 773, 774, 775	1.47
777	BEAUMONT, TX	77704	777, 706, 776	0.27
782	SAN ANTON, TX	78201	782, 780, 781, 788	0.66
784	CRPUS CHR, TX	78404	784, 779, 783, 785	0.50
787	AUSTIN, TX	78767	787, 778, 786, 789	0.37
791	AMARILLO, TX	79105	791, 790, 884	0.18
794	LUBBOCK, TX	79408	794, 793	0.15
796	ABILENE, TX	79604	796, 795	0.09
799	EL PASO, TX	79982	799, 798, 879, 880, 883	0.32
802	DENVER, CO	80216	802, 800, 801, 803, 804, 805, 806, 807	0.90
810	PUEBLO, CO	81002	810, 808, 809, 811, 812	0.28
815	GRD JUNC, CO	81501	815, 813, 814, 816	0.11
820	CHEYENNE, WY	82001	820, 821, 822, 823, 825, 826, 828, 829, 830, 831	0.17
832	POCATELLO, ID	83201	832, 833, 834	0.18
837	BOISE, ID	83707	837, 836, 979	0.16
841	SLT LKE C, UT	84104	841, 840, 842, 843, 844, 893, 898	0.54
846	PROVO, UT	84601	846, 845, 847	0.12
850	PHOENIX, AZ	85001	850, 851, 852, 853, 863	0.79
857	TUCSON, AZ	85702	857, 855, 856, 859, 860	0.39
871	ALBUQUERQ, NM	87101	871, 872, 865, 870, 873, 874, 875, 877, 878	0.40
881	CLOVIS, NM	88101	881, 882	0.10
891	LAS VEGAS, NV	89114	891, 864, 889, 890	0.24
895	RENO, NV	89501	895, 894, 896, 897, 961	0.15
900	LOS ANGEL, CA	90040	900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 926, 927, 928	4.41

Table A1 (Cont'd.)

921	SAN DIEGO, CA	92101	921, 920	0.83
924	SAN BRNDO, CA	92402	924, 922, 923, 925	0.56
933	BAKERSFLD, CA	93302	933, 930, 931, 932, 934, 935	0.77
937	FRESNO, CA	93721	937, 936, 938	0.27
946	OAKLAND, CA	94603	946, 940, 941, 942, 943, 944, 945, 947, 948, 949, 954	1.88
952	STOCKTON, CA	95203	952, 939, 950, 951, 953	1.03
958	SACRMNTO, CA	95814	958, 956, 957	0.53
960	REDDING, CA	96001	960, 955, 959	0.30
968	HONOLULU, HI	96803	968, 967	0.43
972	PORTLAND, OR	97210	972, 970, 971, 986	0.69
973	SALEM, OR	97308	973, 974, 977	0.44
975	GRNT PASS, OR	97526	975, 976	0.11
981	SEATTLE, WA	98134	981, 980	0.64
982	EVERETT, WA	98201	982	0.18
984	TACOMA, WA	98439	984, 983, 985	0.44
989	YAKIMA, WA	98901	989, 988	0.15
992	SPOKANE, WA	99220	992, 838, 990, 991, 994	0.27
993	WALLA WAL, WA	99362	993, 835, 978	0.18
996	ANCHORAGE, AL		995, 996, 997, 998,999	0.18

Figure A1

United States Market Areas Map



Table A2

Canadian Market Areas And Percent Of Country Demand By Market Area

Market Code	Location	Zip Code	Market Includes Zip Codes ...	Percent*
NEW FOUNDLAND				
A0H	GRAND FALLS	A0H	004	0.30
A1A	ST. JOHN	A1A	001-003, 005-007	1.94
PEI				
C1A	PRINCE EDWARD ISL	C1A	PRINCE EDWARD ISL	0.50
NOVA SCOTIA				
B3M	NOVA SCOTIA	B3M	NOVA SCOTIA	3.44
NEW BRUNSWICK				
E3A	NEW BRUNSWICK	E3A	NEW BRUNSWICK	2.80
QUEBEC				
G1N	QUEBEC CITY AREA	G1N	011, 032, 037, 039, 040, 047, 053, 054	3.02
G5R	RIVER DU LOOP	G5R	007, 022, 043, 057, 028, 005, 003, 015, 068, 046, 063, 004, 013, 009, 020, 056, 067, 062, 018, 055, 073	6.72
G7G	CHICOUTIMI AREA	G7G	014, 012, 027, 058 031	1.61
G9A	PORT CARTIER AREA	G9A	042, 001	0.67
G8Y	TROSS RIVERES	G8Y	069, 052, 006, 010 065, 071	1.76

* Percent refers to percent of country demand by market area (percent of population)

Source: Statistics Canada, Census Federal Electoral Districts, 1986, Representation Order, Part 2, Publication 94-126, Ottawa, Canada, 1988.

Table A2 (Cont'd.)

QUEBEC (Cont'd.)				
J8T	GATINEAU AREA	J8T	070, 026, 029, 002 023, 025	1.85
H7G	MONTREAL AREA	H7G	MONTREAL	10.14
ONTARIO				
P7B	WESTERN AREA	P7B	034, 078, 079	0.82
P0N	CENTRAL TIMMONS	P0N	009, 080, 081	0.69
P6B	SAULT AREA	P6B	069, 001	0.56
P3A	SUDBURY AREA	P3A	049, 050, 060	1.19
K0A	OTTAWA AREA	K0A	054, 055, 057, 047 023, 076, 040, 039 056	2.66
K0L	PETERBOROUGH AREA	K0L	064, 083, 032, 062 051, 063, 036, 014	2.21
M1M	TORONTO AREA	M1M	052, 092, 091	14.72
L8G	HAMILTON AREA	L8G	030	2.19
L2M	ST. CATHERINES	L2M	017	1.62
N1C	GUELPH AREA	N1C	006, 024, 073, 074, 013, 025	2.09
N2A	KITCHNER AREA	N2A	033, 061	1.60
N4S	BRANT AREA	N4S	058, 004, 026	1.11
N5V	LONDON AREA	N5V	044, AND LONDON	1.70
N7S	SARNIA AREA	N7S	016, 038, 068	0.90
N8N	WINDSOR AREA	N8N	035, 018, 019	2.04
MANITOBA				
R2C	WINNIPEG	R2C	WINNIPEG	2.47
R7N	NORTH MANITOBA	R7N	002, 003, 007, 1/2 OF 006, 005	1.01
R7A	SOUTH MANITOBA	R7A	001, 004, 1/2 OF 006	0.71
SASKATCHEWAN				
S7H	SASKATOON	S7H	SASKATOON	0.79
S4N	REGINA	S4N	REGINA	0.73
S6W	PRINCE ALBERT	S6N	003, 006, 004, 013 002, 014	1.55
S6J	MOOSE JAW AREA	S6J	012, 005, 001, 007	0.90

Table A2 (Cont'd.)

ALBERTA				
T1Y	CALGARY	T1Y	CALGARY	2.65
T5L	EDMONTON	T5L	EDMONTON	3.10
T0G	NORTH ALBERTA	T0G	021, 016, 001, 017, 019	2.20
T0M	CENTRAL ALBERTA AREA	T0M	018, 020, 008	0.75
T0K	SOUTH ALBERTA AREA	T0K	002, 014, 015	0.63
BRITISH COLUMBIA				
V6H	VANCOUVER	V6H	VANCOUVER, 014 005, 006, 009	7.59
V1H	PRINCE GEORGE	V1H	021, 019, 007	0.97
V0A	KAMLOOPS AREA	V0A	004, 003, 010	0.96
V0H	KELONNA AREA	V0H	013, 008, 018, 017, 012, 011	1.85
YUKON TERRITORY				
Y1A	YUKON TERRITORY	Y1A	YUKON TERRITORY	0.09
NW TERRITORY				
X1A	NW TERRITORY	X1A	NW TERRITORY	0.21

Figure A2

Canadian Market Areas Map



Table A3-1

Mexican Market Areas And Percent Of Country Demand By Market Area

Market Code	Location	Percent*
1001	TIJUANA	0.96
1002	MEXICALI	0.76
1003	ENSENADA	0.27
1004	BAJA CALIFORNIA BALANCE	0.25
1005	BAJA CALIFORNIA SUR	0.33
1006	SONORA BALANCE	0.79
1007	HERMOSILLIO	0.99
1008	CAJEME	0.59
1009	CIUDAD JUAREZ	1.46
1010	NORTH CHIHUANHUA BALANCE	0.27
1011	CHIHUANHUA	1.08
1012	SOUTH CHIHUANHUA BALANCE	0.33
1013	NORTH COAHUILA	0.21
1014	MONCLOVA	0.59
1015	SALTILLO	0.86
1016	TORREON AREA	2.18
1017	NORTH NUEVO LEON	0.32
1018	MONTERREY	4.26
1019	SOUTH NUEVO LEON	0.32
1020	NUEVO LAREDO AREA	0.45
1021	REYNOSA AREA	1.40
1022	MATOMOROS AREA	0.42
1023	CIUDAD OBREGON AREA	0.50
1024	SOUTH TAMAULIPAS TAMPICO	0.89
1025	SAN LUIS POTOSI STATE	1.75
1026	NORTH ZALATECAS	0.33
1027	SOUTH ZACATECAS	0.62
1028	NORTH DURANGO STATE	0.22
1029	DURANGO AREA	0.72
1030	LOS MOCHIS	0.46
1031	CULIACAN	1.13
1032	MAZATLAN	0.75
1033	NAYARIT	0.93

* Percent refers to percent of country demand by market area (percent of population)

Source: Pick, James B., Edgar W. Butler and Elizabeth L. Lanzer (1989), Atlas of Mexico, Boulder, Colorado: Westview Press.

Table A3-1 (Cont'd.)

1034	SOUTH JALISCO	0.90
1035	GUADALAJARA AREA	5.55
1036	NORTH JALISCO	0.90
1037	AGUASCALIENTES	0.82
1038	LEON	1.97
1039	IRAPUATO	1.02
1040	CELEYA	0.96
1041	QUERETARO	0.78
1042	HIDALGO	1.13
1043	NORTH VERACRUZ AND POCA RICA DE HIDALGO	1.26
1044	JALAPA	1.12
1045	ORIZABA	0.70
1046	VERACRUZ	2.16
1047	COATZACOALCOS	1.24
1048	PUEBLA STATE	4.23
1049	TLAXCALA STATE	0.71
1050	MEXICO CITY	29.76
1051	MEXICO STATE BALANCE	3.31
1052	MORELOS STATE	1.56
1053	EAST MICHAOCAN	1.34
1054	WEST MICHAOCAN	2.07
1055	COLIMA STATE	0.58
1056	GUERRERO STATE	1.97
1057	OAXACA STATE	1.69
1058	CHIAPAS STATE	1.57
1059	TABASCO STATE	0.90
1060	CAMPELHE STATE	0.65
1061	YUCATAN STATE	1.74
1062	QUINTANA ROO STATE	0.30

Table A3-2

Mexican Urban Population By State

No.	State	Population Places 2500+
1	AGUASCALIENTES	365,545
2	BAJA CALIFORNIA	1,004,194
3	BAJA CALIFORNIA SUR	149,973
4	CAMPECHE	292,006
5	COAHUILA	1,204,971
6	COLIMA	258,586
7	CHIAPAS	702,969
8	CHIHUAHUA	1,410,799
9	DISTRITO FEDERAL	8,831,079
10	DURANGO	595,544
11	GUANAJUATO	1,771,604
12	GUERRERO	883,394
13	HIDALGO	506,275
14	JALISCO	3,304,635
15	MEXICO	6,007,404
16	MICHOACAN	1,503,083
17	MORELOS	699,331
18	NAYARIT	414,528
19	NUEVO LEON	2,197,288
20	OAXACA	757,871
21	PUEBLA	1,899,938
22	QUERETARO	350,623
23	QUINTANA ROO	133,511
24	SAN lUIS POTOSI	786,023
25	SINALOA	1,049,545
26	SONORA	1,067,861
27	TABASCO	405,950
28	TAMAULIPAS	1,445,960
29	TLAXCALA	320,480
30	VERACRUZ	2,743,286
31	YUCATAN	782,041
32	ZACATECAS	426,432

Source: 1980 Mexican Census of Population, Volume 2, Table 2, as cited in Pick, James B., Edgar W. Butler and Elizabeth L. Lanzer (1989), Atlas of Mexico, Boulder, Colorado: Westview Press.

Table A3-3

Mexican Urban Population By Major City

No.	City	State	Population 1980
1	Acapulco de Juarez	GUERRERO	301,901
2	Aguascalientes	AGUASCALIENTES	293,152
3	Campeche	CAMPECHE	128,434
4	Celeya	GUANAJUATO	141,675
5	Ciudad Juarez	CHIHUAHUA	544,496
6	Cajeme	SONORA	165,572
7	Ciudad Obregon/Victoria	TAMAULIPAS	140,161
8	Coatzacoalcos/Minatitlan	VERACRUZ	233,935
9	Cuernavaca	MORELOS	192,770
10	Culiacan	SINALOA	304,826
11	Chihuahua	CHIHUAHUA	385,603
12	Durango	DURANGO	321,148
13	Ensenada	BAJA CALIFORNIA	120,483
14	Guadalajara	JALISCO	2,192,557
15	Hermosillo	SONORA	297,175
16	Irapuato	GUANAJUATO	170,138
17	Jalapa	VERACRUZ	204,594
18	Leon	GUANAJUATO	593,002
19	Los Mochis/Ahome	SINALOA	122,531
20	Matamoros	TOMAULIPAS	188,745
21	Mazatlan	SINALOA	199,830
22	Merida	YUCATAN	400,142
23	Mexicali	BAJA CALIFORNIA	341,559
24	Mexico City	D.F./MEXICO	13,354,271
25	Monclova	COAHUILA	115,786
26	Monterrey	NUEVO LEON	1,913,075
27	Morelia	MICHOACAN	297,544
28	Nuevo Laredo	TAMAULIPAS	201,731
29	Oaxaca de Juarez	OAXACA	154,223
30	Orizaba	VERACRUZ	144,848
31	pachuca	HIDALGO	110,351
32	Poca Rica de Hidalgo	VERCRUZ	166,799
33	Puebla	PUEBLA	772,908
34	Queretaro	QUERETARO	215,976
35	Reynosa	TAMAULIPAS	194,693
36	Saltillo	COAHUILA	284,937
37	San Luis Potosi	SAN LUIS POTOSI	471,047

Source: Estadisticas Historicas de Mexico, (1985), as cited in Pick, James B., Edgar W. Butler and Elizabeth L. Lanzer (1989), Atlas of Mexico, Boulder, Colorado: Westview Press..

Table A3-3 (Cont'd.)

38	Tampico/Cuidad Madero	TAMAULIPAS	400,401
39	Tepic	NAYARIT	145,741
40	Tijuana	BAJA CALIFORNIA	429,500
41	Toluca	MEXICO	199,778
42	Torreon/Gomez Palacio	COAHUILA/DURANGO	445,053
43	Tuxtla	CHIAPAS	131,096
44	Uruapan	MICHOACAN	122,828
45	Veracruz	VERACRUZ	367,339
46	Villahermosa/Centro	TABSCO	158,216

Figure A3

Mexican Market Areas Map

APPENDIX B

SALES BY INDUSTRY BY COUNTRY

Appendix B

Sales By Industry By Country

FOOD INDUSTRY COMPANY SALES

UNITED STATES

1. United States industry size based on estimate relative to Canadian industry size (Statistics Canada 1986)

   Canadian Industry Size

Mayonnaise	US$245.6 Million
Margarine	US$297.3 Million
Mustard	US$ 20.1 Million
Olives	US$ 18.0 Million
Total	US$581.0 Million

2. United States industry size at four digit SIC code for relevant products is estimated as follows (United States Industrial Outlook 1990):

Canned Fruits and Vegetables	US$14.332 Billion
Pickles, Sauces and Salad Dressings	US$ 5.413 Billion
Vegetable Oil Mills	US$ .540 Billion
Food Preparations, NEC	US$12.530 Billion

3. Sales figures for some United States food processing companies (Standard and Poor's 1988).

4. If assume US$500 Million this would represent 8.6 percent share of industry size based on Canadian derived United States industry size.

5. US$500 Million sales at US$20/case equals 25,000,000 cases.

Appendix B (Cont'd.)

CANADA

1. Canadian industry size (Statistics Canada 1986)

Mayonnaise	US$245.6 Million
Margarine	US$297.3 Million
Mustard	US$ 20.1 Million
Olives	US$ 18.0 Million
Total	US$581.0 Million

2. Based on 11 percent market share a firm's sales would equal 63.9 Million.

3. Some Canadian food processing company sales are (Predicasts 1989):

Culinar Canada	C$ 347 Million
Labatt Ltd.	C$ 740 Million
Oshanna Group	C$2.635 Billion

4. Based on above point 3. and given sales of US$63.9 Million represent 12.7 percent of United States sales level, the US$63.9 Million figure is used.

5. US$63.9 Million sales at US$20/case equals 3,195,000 cases.

MEXICO

1. Mexican population with sufficient disposable income is assumed to equal 6.9 percent of United States population. This percentage is based on population considered to be moderate income in Mexico, or those earnings over 6610 pesos/month in 1980 at exchange of 23 pesos to 1 United States dollar (Pick, Butler, and Lanzer 1989).

2. United States industry size of US$5.81 Billion X Mexican population of comparable means equal to 6.9 percent results in Mexico industry size of US$400.9 Million.

Appendix B (Cont'd.)

3. Mexican food company sales (Predicasts 1989) Grupo Continental S.A. US$72.4 Million.

4. If a market share of 10 percent is assumed company sales equal US$40.9 Million.

5. Based on sales of US$40.9 Million Mexican sales would represent 8.1 percent of United States company sales.

6. US$40.9 Million of sales at US$20/case equals 2,045,000 cases.

Appendix B (Cont'd.)

WOMEN'S CLOTHING INDUSTRY

UNITED STATES

1. Model fictional product is based on following mix, volume, and unit price.

Dresses	182.0	Million Units
Skirts	97.0	Million Units
Blouses	37.0	Million Units
Total	316.0	Million Units

Dresses	57% of Volume X Net Price US$45 =	25.65
Skirts	31% of Volume X Net Price US$35 =	10.85
Blouses	12% of Volume X Net Price US$15 =	1.80
Total Average Manufacturers Net Price		38.00

US$38.00 Mfg. Net Price X 12 Garments per case = US$456/case

2. United States industry size of women's and children's clothing was US$116.5 Billion in 1989 (Predicasts 1990).

3. Production of women's clothing (Predicasts 1990).

Dresses	182.0	Million Units
Skirts	97.0	Million Units
Blouses	37.0	Million Units
Total	316.0	Million Units

4. Total production of 316 million units divided by 12 units per case equals 26,333,000 cases of industry demand at US$458 per case equals US$12.05 Billion in sales.

5. Assuming a 2.5 percent market share results in company sales of US$300 Million.

6. Sales of US$300 Million divided by US$456 per case equals 657,894 case units.

Appendix B (Cont'd.)

CANADA

1. Assume Canadian market size is proportional to United States based on population. So, 316 Million United States units X 11 percent (Canadian population relative to United States) equals Canadian market of 34,700,000 units or 2,896,000 cases.

2. Canadian demand of 2,896,000 cases X US$456 per case manufacturers net price equals US $1,303,200,000.

3. Assuming 3 percent market share, representing greater concentration than in United States, results in company sales of US$39.0 Million.

4. Total cases equal 85,526 using US$456 per case.

5. Demand represents 12.9 percent of United States demand.

MEXICO

1. Mexican population with sufficient disposable income is assumed to equal 6.9 percent of United States population. This percentage is based on population considered to be moderate income in Mexico, or those earnings over 6610 pesos/month in 1980 at exchange of 23 pesos to 1 United States dollar (Pick, Butler, and Lanzer 1989).

2. United States industry size of US$3.16 Million units X 6.9 percent equals 21,804,000 pieces of Mexican demand, or at 12 pieces per case, 1,817,000 cases.

3. Assuming a market share of four percent results in company case sales of 70,572 units, or at US$456 per case, US$ sales of 32,180,832.

4. Based on sales of US$32,180,832, Mexican sales represent 10.7 percent of United States sales.

Appendix B (Cont'd.)

CONSUMER APPLIANCE INDUSTRY (REFRIGERATORS)

UNITED STATES

1. United States industry size equals 7,000,000 units (Predicasts 1990), or at US$400 per unit, an industry size in US$ of 2.8 Billion.

2. Assuming a market share of 15 percent results in US$ sales of 420 million, or, 1,050,000 units.

CANADA

1. Canadian industry size equals 669,000 units (Predicasts 1989), or at US$400 per unit, an industry size in US$ of 267 Million.

2. Assuming a market share of 22 percent, reflecting considerably greater Canadian concentration, results in company sales of US$58.7 Million, or, 146,850 units.

3. Sales of US$58.7 Million represent 13.9 percent of United States sales.

MEXICO

1. Mexican population with sufficient disposable income is assumed to equal 6.9 percent of United States population. This percentage is based on population considered to be moderate income in Mexico, or those earnings over 6610 pesos/month in 1980 at exchange of 23 pesos to 1 United States dollar (Pick, Butler, and Lanzer 1989).

2. United States industry size of US$2.8 Billion X Mexican population of comparable means equal to 6.9 percent results in Mexico industry size of US$193.2 Million.

Appendix B (Cont'd.)

3. If a market share of 13 percent is assumed company sales equals US$25,116,000, or 62,790 units.

4. Based on sales of US$25.1 Million, Mexican sales would represent 6.0 percent of United States company sales.

APPENDIX C

PRODUCTION AND HANDLING COST BY INDUSTRY BY CITY

Table C1-1

Food Industry Variable Production Costs

1	2	3	4	5	6	7	8	9	10
Average U.S.	15.45	1.00							
Chicago		1.07	16.53	1.00	7.00	4.20	2.80	2.80	7.00
Kansas City		1.05	16.22	.98	7.00	4.20	2.80	2.74	6.94
Average Canada	13.81	1.00							
Toronto		1.04	14.36	.87	7.00	4.20	2.80	2.44	6.64
Average Mexico	1.57	1.00							
Monterrey		1.00	1.57	.09	7.00	4.20	2.80	.25	4.45

Table C1-1 (Cont'd.)

Explanation of Columns

Column 1 Country/City
Column 2 Average Manufacturing Hourly Compensation Costs By Country (US$ per hour)[1]
Column 3 Index of Costs By City Within Country[2,3]
Column 4 Average Manufacturing Hourly Compensation Costs By City (US$ per hour)
Column 5 Overall Index of Labor Costs By City
Column 6 Unadjusted Variable Production Cost Per Unit (US$ per unit)[4]
Column 7 Non-Direct Labor Portion of Variable Production Costs (US$ Unit)[5]
Column 8 Unadjusted Direct Labor Portion of Variable Production Costs (US$ per unit)[5]
Column 9 Adjusted Direct Labor Using City Labor Cost Index
Column 10 Variable Production Cost Percent Adjusted Direct Labor Cost Plus Non-Direct Labor Cost (US$ Per Unit)

[1] Source: Roberts, Karen D. and Philip R. Smith (1989), "The Canada-U.S. Free Trade Agreement and Spatial Decentralization of Manufacturing," at the Biennial Meeting of the Association for Canadian Studies in the United States, San Francisco, November.

[2] Source: Distribution Centers, Inc. (1989), Distribution Concepts and Issues, August.

[3] Source: Statistics Canada (1985), Employment, Earnings and Hours, Labor Division, Employment Survey Operations Section Catalog 72-002, Vol. 63, No. 5, Ottawa, May.

[4] Source: Based on unit price of US$ 20.00 and assumes cost of goods sold equals 70 percent of sales price and variable production cost equals 50 percent of cost of goods sold. Base price and costs assume a Chicago production point.

[5] Source: Assumes direct labor equals 20 percent of cost of goods sold and that 80 percent of cost of goods sold is not direct labor related.

Table C1-2

Women's Clothing Industry Variable Production Costs

1	2	3	4	5	6	7	8	9	10
Average U.S.	15.45	1.00							
Chicago		1.07	16.53	1.00	223.00	112.00	111.00	111.00	223.00
Kansas City		1.05	16.22	.98	223.00	112.00	111.00	109.00	221.00
Atlanta		.84	12.98	.79	223.00	111.00	111.00	88.00	200.00
Average Canada	13.81	1.00							
Toronto		1.04	14.36	.87	223.00	112.00	111.00	96.00	208.00
Average Mexico	1.57	1.00							
Monterrey		1.00	1.57	.09	223.00	112.00	111.00	10.00	122.00

Table C1-2 (Cont'd.)

Explanation of Columns

Column 1	Country/City
Column 2	Average Manufacturing Hourly Compensation Costs By Country (US$ per hour)[1]
Column 3	Index of Costs By City Within Country[2,3]
Column 4	Average Manufacturing Hourly Compensation Costs By City (US$ per hour)
Column 5	Overall Index of Labor Costs By City
Column 6	Unadjusted Variable Production Cost Per Unit (US$ per unit)[4]
Column 7	Non-Direct Labor Portion of Variable Production Costs (US$ Unit)[5]
Column 8	Unadjusted Direct Labor Portion of Variable Production Costs (US$ per unit)[5]
Column 9	Adjusted Direct Labor Using City Labor Cost Index
Column 10	Variable Production Cost Percent Adjusted Direct Labor Cost Plus Non-Direct Labor Cost (US$ Per Unit)

[1] Source: Roberts, Karen D. and Philip R. Smith (1989), "The Canada-U.S. Free Trade Agreement and Spatial Decentralization of Manufacturing," at the Biennial Meeting of the Association for Canadian Studies in the United States, San Francisco, November.

[2] Source: Distribution Centers, Inc. (1989), Distribution Concepts and Issues, August.

[3] Source: Statistics Canada (1985), Employment, Earnings and Hours, Labor Division, Employment Survey Operations Section Catalog 72-002, Vol. 63, No. 5, Ottawa, May.

[4] Source: Based on unit price of US$ 456.00 and assumes cost of goods sold equals 70 percent of sales price and variable production cost equals 70 percent of cost of goods sold. Base price and costs assume a Chicago production point.

[5] Source: Assumes direct labor equals 35 percent of cost of goods sold and that 65 percent of cost of goods sold is not direct labor related.

Table C1-3

Consumer Appliance Industry Variable Production Costs

1	2	3	4	5	6	7	8	9	10
Average U.S.	15.45	1.00							
Chicago		1.07	16.53	1.00	200.00	144.00	56.00	56.00	200.00
Kansas City		1.05	16.22	.98	200.00	144.00	56.00	55.00	199.00
Average Canada	13.81	1.00							
Toronto		1.04	14.36	.87	200.00	144.00	56.00	49.00	193.00
Average Mexico	1.57	1.00							
Monterrey		1.00	1.57	.09	200.00	144.00	56.00	5.00	149.00

Table C1-3 (Cont'd.)

Explanation of Columns

Column 1 Country/City
Column 2 Average Manufacturing Hourly Compensation Costs By Country (US$ per hour)[1]
Column 3 Index of Costs By City Within Country[2,3]
Column 4 Average Manufacturing Hourly Compensation Costs By City (US$ per hour)
Column 5 Overall Index of Labor Costs By City
Column 6 Unadjusted Variable Production Cost Per Unit (US$ per unit)[4]
Column 7 Non-Direct Labor Portion of Variable Production Costs (US$ Unit)[5]
Column 8 Unadjusted Direct Labor Portion of Variable Production Costs (US$ per unit)[5]
Column 9 Adjusted Direct Labor Using City Labor Cost Index
Column 10 Variable Production Cost Percent Adjusted Direct Labor Cost Plus Non-Direct Labor Cost (US$ Per Unit)

[1] Source: Roberts, Karen D. and Philip R. Smith (1989), "The Canada-U.S. Free Trade Agreement and Spatial Decentralization of Manufacturing," at the Biennial Meeting of the Association for Canadian Studies in the United States, San Francisco, November.

[2] Source: Distribution Centers, Inc. (1989), Distribution Concepts and Issues, August.

[3] Source: Statistics Canada (1985), Employment, Earnings and Hours, Labor Division, Employment Survey Operations Section Catalog 72-002, Vol. 63, No. 5, Ottawa, May.

[4] Source: Based on unit price of US$ 400.00 and assumes cost of goods sold equals 70 percent of sales price and variable production cost equals 70 percent of cost of goods sold. Base price and costs assume a Chicago production point.

[5] Source: Assumes direct labor equals 20 percent of cost of goods sold and that 80 percent of cost of goods sold is not direct labor related.

Table C2-1

Food Industry Variable Handling Costs

1	2	3	4	5	6	7	8	9	10
Average U.S.	15.14	1.00							
Chicago		1.07	16.20	1.00	.20	.08	.12	.120	.200
Seattle		1.18	17.87	1.10	.20	.08	.12	.132	.212
Buffalo		1.03	15.59	.96	.20	.08	.12	.115	.195
Syracuse		1.03	15.59	.96	.20	.08	.12	.115	.195
Pittsburgh		1.12	16.96	1.04	.20	.08	.12	.125	.205
Atlanta		.84	12.72	.78	.20	.08	.12	.094	.174
Houston		1.00	15.14	.93	.20	.08	.12	.111	.191
Phoenix		.85	12.87	.79	.20	.08	.12	.095	.175
Kansas City		1.05	15.90	.98	.20	.08	.12	.118	.198
Philadelphia		1.04	15.75	.97	.20	.08	.12	.117	.197
Laredo		.90	13.63	.84	.20	.08	.12	.101	.181
El Paso		.90	13.63	.84	.20	.08	.12	.101	.181
Dallas		.91	13.78	.85	.20	.08	.12	.103	.183
Detroit		1.28	19.38	1.20	.20	.08	.12	.144	.224
Los Angeles		1.12	16.96	1.04	.20	.08	.12	.125	.205
Minneapolis		1.12	16.96	1.04	.20	.08	.12	.125	.205
Denver		1.12	16.96	1.04	.20	.08	.12	.125	.205
Memphis		.83	12.57	.77	.20	.08	.12	.092	.172
New York		1.00	15.14	.93	.20	.08	.12	.111	.191
San Francisco		1.18	17.87	1.10	.20	.08	.12	.132	.212
Monroe		1.20	18.17	1.12	.20	.08	.12	.135	.215

Table C2-1 (Cont'd.)

Average Canada	11.13	1.00						
Montreal		1.04	11.57	.67	.20	.08	.12	.080	.160
Windsor		1.28	14.25	.88	.20	.08	.12	.106	.186
Toronto		1.04	11.57	.67	.20	.08	.12	.080	.160
Vancouver		1.11	12.35	.76	.20	.08	.12	.091	.171
Winnipeg		.90	10.02	.62	.20	.08	.12	.074	.154
Ottawa		.88	9.79	.61	.20	.08	.12	.073	.153
Calgary		.91	10.13	.63	.20	.08	.12	.076	.156
Average Mexico	1.57	1.00						
Mexico City		1.00	1.57	.10	.20	.08	.12	.012	.092
Guadalajara		1.00	1.57	.10	.20	.08	.12	.012	.092
Chihuahua		1.00	1.57	.10	.20	.08	.12	.012	.092
Monterrey		1.00	1.57	.10	.20	.08	.12	.012	.092
Torreon		1.00	1.57	.10	.20	.08	.12	.012	.092

Table C2-1 (Cont'd.)

Explanation of Columns

Column 1	Country/City
Column 2	Average Distribution Hourly Compensation Costs By Country (US$ per hour)[1]
Column 3	Index of Costs By City Within Country[2,3]
Column 4	Average Distribution Hourly Compensation Costs By City (US$ per hour)
Column 5	Overall Index of Labor Costs By City
Column 6	Unadjusted Variable Handling Cost Per Unit (US$ per unit)[4]
Column 7	Non-Direct Labor Portion of Variable Handling Costs (US$ Unit)[5]
Column 8	Unadjusted Direct Labor Portion of Variable Handling Costs (US$ per unit)[5]
Column 9	Adjusted Direct Labor Using City Labor Cost Index
Column 10	Variable Handling Cost Result Adjusted Direct Labor Cost Plus Non-Direct Labor Cost (US$ Per Unit)

[1] Source: Roberts, Karen D. and Philip R. Smith (1989), "The Canada-U.S. Free Trade Agreement and Spatial Decentralization of Manufacturing," at the Biennial Meeting of the Association for Canadian Studies in the United States, San Francisco, November.

[2] Source: Distribution Centers, Inc. (1989), Distribution Concepts and Issues, August.

[3] Source: Statistics Canada (1985), Employment, Earnings and Hours, Labor Division, Employment Survey Operations Section Catalog 72-002, Vol. 63, No. 5, Ottawa, May.

[4] Source: Based on unit variable handling cost of US$ .20 in Chicago per industry experience.

[5] Source: Assumes direct labor equals 60 percent of variable handling cost and that 40 percent of cost is not direct labor related.

Table C2-2

Women's Clothing Industry Variable Handling Costs

1	2	3	4	5	6	7	8	9	10
Average U.S.	15.14	1.00							
Chicago		1.07	16.20	1.00	.240	.096	.144	.144	.240
Seattle		1.18	17.87	1.10	.240	.096	.144	.158	.254
Buffalo		1.03	15.59	.96	.240	.096	.144	.138	.234
Syracuse		1.03	15.59	.96	.240	.096	.144	.138	.234
Pittsburgh		1.12	16.96	1.04	.240	.096	.144	.161	.257
Atlanta		.84	12.72	.78	.240	.096	.144	.112	.208
Houston		1.00	15.14	.93	.240	.096	.144	.134	.230
Phoenix		.85	12.87	.79	.240	.096	.144	.114	.210
Kansas City		1.05	15.90	.98	.240	.096	.144	.141	.237
Philadelphia		1.04	15.75	.97	.240	.096	.144	.140	.236
Laredo		.90	13.63	.84	.240	.096	.144	.121	.217
El Paso		.90	13.63	.84	.240	.096	.144	.121	.217
Dallas		.91	13.78	.85	.240	.096	.144	.122	.218
Detroit		1.28	19.38	1.20	.240	.096	.144	.173	.269
Los Angeles		1.12	16.96	1.04	.240	.096	.144	.161	.257
Minneapolis		1.12	16.96	1.04	.240	.096	.144	.161	.257
Denver		1.12	16.96	1.04	.240	.096	.144	.161	.257
Memphis		.83	12.57	.77	.240	.096	.144	.111	.207
New York		1.00	15.14	.93	.240	.096	.144	.134	.230
San Francisco		1.18	17.87	1.10	.240	.096	.144	.158	.254
Monroe		1.20	18.17	1.12	.240	.096	.144	.161	.257

Table C2-2 (Cont'd.)

Average Canada	11.13	1.00						
Montreal		1.04	11.57	.67	.240	.096	.144	.096	.192
Windsor		1.28	14.25	.88	.240	.096	.144	.127	.223
Toronto		1.04	11.57	.67	.240	.096	.144	.096	.192
Vancouver		1.11	12.35	.76	.240	.096	.144	.109	.205
Winnipeg		.90	10.02	.62	.240	.096	.144	.089	.185
Ottawa		.88	9.79	.61	.240	.096	.144	.088	.184
Calgary		.91	10.13	.63	.240	.096	.144	.091	.187
Average Mexico	1.57	1.00						
Mexico City		1.00	1.57	.10	.240	.096	.144	.014	.110
Guadalajara		1.00	1.57	.10	.240	.096	.144	.014	.110
Chihuhua		1.00	1.57	.10	.240	.096	.144	.014	.110
Monterrey		1.00	1.57	.10	.240	.096	.144	.014	.110
Torreon		1.00	1.57	.10	.240	.096	.144	.014	.110

Table C2-2 (Cont'd.)

Explanation of Columns

Column 1 Country/City
Column 2 Average Distribution Hourly Compensation Costs By Country (US$ per hour)[1]
Column 3 Index of Costs By City Within Country[2,3]
Column 4 Average Distribution Hourly Compensation Costs By City (US$ per hour)
Column 5 Overall Index of Labor Costs By City
Column 6 Unadjusted Variable Handling Cost Per Unit (US$ per unit)[4]
Column 7 Non-Direct Labor Portion of Variable Handling Costs (US$ Unit)[5]
Column 8 Unadjusted Direct Labor Portion of Variable Handling Costs (US$ per unit)[5]
Column 9 Adjusted Direct Labor Using City Labor Cost Index
Column 10 Variable Handling Cost Result Adjusted Direct Labor Cost Plus Non-Direct Labor Cost (US$ Per Unit)

[1] Source: Roberts, Karen D. and Philip R. Smith (1989), "The Canada-U.S. Free Trade Agreement and Spatial Decentralization of Manufacturing," at the Biennial Meeting of the Association for Canadian Studies in the United States, San Francisco, November.

[2] Source: Distribution Centers, Inc. (1989), Distribution Concepts and Issues, August.

[3] Source: Statistics Canada (1985), Employment, Earnings and Hours, Labor Division, Employment Survey Operations Section Catalog 72-002, Vol. 63, No. 5, Ottawa, May.

[4] Source: Based on unit variable handling cost of US$ .24 in Chicago per industry experience.

[5] Source: Assumes direct labor equals 60 percent variable handling cost and that 40 percent of cost is not direct labor related.

Table C2-3

Table C2-3

Consumer Appliance Industry Variable Handling Costs

1	2	3	4	5	6	7	8	9	10
Average U.S.	15.14	1.00							
Chicago		1.07	16.20	1.00	5.48	2.19	3.29	3.29	5.48
Seattle		1.18	17.87	1.10	5.48	2.19	3.29	3.62	5.81
Buffalo		1.03	15.59	.96	5.48	2.19	3.29	3.16	5.35
Syracuse		1.03	15.59	.96	5.48	2.19	3.29	3.16	5.35
Pittsburgh		1.12	16.96	1.04	5.48	2.19	3.29	3.42	5.61
Atlanta		.84	12.72	.78	5.48	2.19	3.29	2.56	4.75
Houston		1.00	15.14	.93	5.48	2.19	3.29	3.06	5.25
Phoenix		.85	12.87	.79	5.48	2.19	3.29	2.60	4.79
Kansas City		1.05	15.90	.98	5.48	2.19	3.29	3.22	5.41
Philadelphia		1.04	15.75	.97	5.48	2.19	3.29	3.19	5.38
Laredo		.90	13.63	.84	5.48	2.19	3.29	2.76	4.95
El Paso		.90	13.63	.84	5.48	2.19	3.29	2.76	4.95
Dallas		.91	13.78	.85	5.48	2.19	3.29	2.80	4.99
Detroit		1.28	19.38	1.20	5.48	2.19	3.29	3.94	6.13
Los Angeles		1.12	16.96	1.04	5.48	2.19	3.29	3.42	5.61
Minneapolis		1.12	16.96	1.04	5.48	2.19	3.29	3.42	5.61
Denver		1.12	16.96	1.04	5.48	2.19	3.29	3.42	5.61
Memphis		.83	12.57	.77	5.48	2.19	3.29	2.53	4.72
New York		1.00	15.14	.93	5.48	2.19	3.29	3.06	5.25
San Francisco		1.18	17.87	1.10	5.48	2.19	3.29	3.62	5.81
Monroe		1.20	18.17	1.12	5.48	2.19	3.29	3.68	5.87

Table C2-3 (Cont'd.)

Average Canada	11.13	1.00						
Montreal		1.04	11.57	.67	5.48	2.19	3.29	2.20	4.39
Windsor		1.28	14.25	.88	5.48	2.19	3.29	2.90	5.09
Toronto		1.04	11.57	.67	5.48	2.19	3.29	2.20	4.39
Vancouver		1.11	12.35	.76	5.48	2.19	3.29	2.50	4.69
Winnipeg		.90	10.02	.62	5.48	2.19	3.29	2.04	4.23
Ottawa		.88	9.79	.61	5.48	2.19	3.29	2.01	4.20
Calgary		.91	10.13	.63	5.48	2.19	3.29	2.07	4.26
Average Mexico	1.57	1.00						
Mexico City		1.00	1.57	.10	5.48	2.19	3.29	.33	2.52
Guadalajara		1.00	1.57	.10	5.48	2.19	3.29	.33	2.52
Chihuhua		1.00	1.57	.10	5.48	2.19	3.29	.33	2.52
Monterrey		1.00	1.57	.10	5.48	2.19	3.29	.33	2.52
Torreon		1.00	1.57	.10	5.48	2.19	3.29	.33	2.52

Table C2-3 (Cont'd.)

Explanation of Columns

Column 1	Country/City
Column 2	Average Distribution Hourly Compensation Costs By Country (US$ per hour)[1]
Column 3	Index of Costs By City Within Country[2,3]
Column 4	Average Distribution Hourly Compensation Costs By City (US$ per hour)
Column 5	Overall Index of Labor Costs By City
Column 6	Unadjusted Variable Handling Cost Per Unit (US$ per unit)[4]
Column 7	Non-Direct Labor Portion of Variable Handling Costs (US$ Unit)[5]
Column 8	Unadjusted Direct Labor Portion of Variable Handling Costs (US$ per unit)[5]
Column 9	Adjusted Direct Labor Using City Labor Cost Index
Column 10	Variable Handling Cost Result Adjusted Direct Labor Cost Plus Non-Direct Labor Cost (US$ Per Unit)

[1] Source: Roberts, Karen D. and Philip R. Smith (1989), "The Canada-U.S. Free Trade Agreement and Spatial Decentralization of Manufacturing," at the Biennial Meeting of the Association for Canadian Studies in the United States, San Francisco, November.

[2] Source: Distribution Centers, Inc. (1989), Distribution Concepts and Issues, August.

[3] Source: Statistics Canada (1985), Employment, Earnings and Hours, Labor Division, Employment Survey Operations Section Catalog 72-002, Vol. 63, No. 5, Ottawa, May.

[4] Source: Based on unit variable handling cost of US$ 5.48 in Chicago per industry experience.

[5] Source: Assumes direct labor equals 60 percent variable handling cost and that 40 percent of cost is not direct labor related.

Table C3

Distribution Center Fixed Costs By City

Country/ City	Unadjusted Distributn. Center Fixed Cost (Total US$) (000's)	Non-Space Related Fixed Cost (Total US$) (000's)	Unadjusted Space Related Fixed Cost (Total US$) (000's)	Space Cost Index By City	Adjusted Space Related Fixed Cost (Total US$) (000's)	Total Adjusted Fixed Cost By City (Total US$) (000's)
United States						
Chicago	100	40	60	1.00	60	
Seattle	100	40	60	.78	47	100
Buffalo	100	40	60	.56	34	74
Syracuse	100	40	60	.56	34	74
Pittsburgh	100	40	60	.88	53	93
Atlanta	100	40	60	.75	45	85
Houston	100	40	60	.50	30	75
Phoenix	100	40	60	.70	42	82
Kansas City	100	40	60	.69	41	81
Philadelphia	100	40	60	.79	47	87
Laredo	100	40	60	.50	30	70
El Paso	100	40	60	.50	30	70
Dallas	100	40	60	.69	41	81
Detroit	100	40	60	.69	41	81
Los Angeles	100	40	60	1.05	63	103
Denver	100	40	60	.75	45	85
Memphis	100	40	60	.66	40	80
New York	100	40	60	1.25	75	115
San Francisco	100	40	60	1.05	63	103
Monroe	100	40	60	.69	41	81
Minneapolis	100	40	60	.75	45	85

Table C3 (Cont'd.)

Canada						
Montreal	100	40	60	.73	44	84
Windsor	100	40	60	.69	41	81
Toronto	100	40	60	1.01	61	101
Vancouver	100	40	60	.75	45	85
Winnipeg	100	40	60	.54	32	72
Ottawa	100	40	60	.73	44	84
Calgary	100	40	60	.54	32	72
Mexico						
Mexico City	100	40	60	.45	25	65
Guadalajara	100	40	60	.45	25	65
Chihuhua	100	40	60	.45	25	65
Monterrey	100	40	60	.45	25	65
Torreon	100	40	60	.45	25	65

APPENDIX D

FOOD INDUSTRY TARIFF CALCULATIONS

CANAD

At fu

At ha

Sourc

Appendix D

Food Industry Tariff Calculations

CANADIAN IMPORTS FROM THE UNITED STATES

Margarine	17.5% of net price
Mushrooms	20.0% of net price
Mustard	15.0% of net price
Mayonnaise	17.5% of net price
	70.0%/4 = 17.5% of net price average

At full tariff:
- o US$ 20.00 unit price X .175 = US$ 3.50 per unit case
- o Equals US$ 17.50 per hundredweight at five 20 pound cases per hundredweight

At half tariff:
- o US$ 20.00 unit price X .875 = US$ 1.75 per unit case
- o Equals US$ 8.75 per hundred weight at five 20 pound cases per hundredweight

Source: Canada-U.S. Free Trade Agreement (1987), Tariff Schedule of Canada and Tariff Schedule of the United States, Annex 401.2, 1987.

UNITE

Marga

Mushr

Musta

Mayor

Avera

At fu

At ha

Sourc

UNITED STATES IMPORTS FROM CANADA

Margarine:	7.0% of net price (20 pound case/2.205 pounds per kilo equals 9.07 kilos per case unit X 15.4 USc per kilo equals US$ 1.40 per case/US$ 20.00 per case price = 7.0%)
Mushrooms:	3.6% of net price (20 pound case/2.205 pounds per kilo equals 9.07 kilos per case unit X 8.0 USc per kilo equals US$ .726 per case/US$ 20.00 per case price = 3.6%)
Mustard	2.0% of net price (20 pound case/2.205 pounds per kilo equals 9.07 kilos per case unit X 4.4 USc = .399 USc per case/US$ 20.00 per case price = 2.0%)
Mayonnaise	2.7% of net price (20 pound case/2.205 pounds per kilo equals 9.07 kilos per case unit X assumed 6.0 USc = .544 USc per case/US$ 20.00 per case price = 2.7%)

Average Tariff = (7.0% + 3.6% + 2.0% + 2.7%)/4 or 3.8%

At full tariff:
- o US$ 20.00 unit price X .038 = US$ .76 per unit case
- o Equals US$ 3.80 per hundredweight at five 20 pound cases per hundredweight

At half tariff:
- o US$ 20.00 unit price X .019 = US$ .38 per unit case
- o Equals US$ 1.90 per hundred weight at five 20 pound cases per hundredweight

Source: Canada-U.S. Free Trade Agreement (1987), Tariff Schedule of Canada and Tariff Schedule of the United States, Annex 401.2, 1987.

MEXICO IMPORTS FROM THE UNITED STATES

Margarine	15.0% of net price
Mushrooms	20.0% of net price
Mustard	20.0% of net price
Mayonnaise	20.0% of net price
	75.0%/4 = 18.75% of net price average

At full tariff:
- o US$ 20.00 unit price X .1875 = US$ 3.75 per unit case
- o Equals US$ 18.75 per hundredweight at five 20 pound cases per hundredweight

At half tariff:
- o US$ 20.00 unit price X .09375 = US$ 1.87 per unit case
- o Equals US$ 9.38 per hundred weight at five 20 pound cases per hundredweight

Source: United States Department of Commerce, Mexican Tariff Schedules, 1990.

UNITED STATES IMPORTS FROM MEXICO

United States Customs advised that the tariff levels on food products imported from Mexico vary considerably depending on exact product specifications and levels of local content. The degree to which General Systems of Preferences (GSP) applies, and the degree to which Section 806 and 807 governing Maquiladoras applies, also has a substantial impact. For food products in general they advised that a tariff level of 10 percent is approximately average assuming the item does not qualify for GSP treatment. As such, a 10 percent tariff level is applied.

At full tariff:
- o US$ 20.00 unit price X .100 = US$ 2.00 per unit case
- o Equals US$ 10.00 per hundredweight at five 20 pound cases per hundredweight

At half tariff:
- o US$ 20.00 unit price X .050 = US$ 1.00 per unit case
- o Equals US$ 5.00 per hundred weight at five 20 pound cases per hundredweight

Source: United States Customs Service, Telephone Interview with Import Specialist, Detroit, Michigan, October, 1990.

CANADIAN IMPORTS FROM MEXICO

Margarine	00.0% of net price
Mushrooms	12.5% of net price
Mustard	15.0% of net price
Mayonnaise	11.5% of net price
	39.0%/4 = 9.75% of net price average

At full tariff:
- o US$ 20.00 unit price X .0975 = US$ 1.95 per unit case
- o Equals US$ 9.75 per hundredweight at five 20 pound cases per hundredweight

At half tariff:
- o US$ 20.00 unit price X .04875 = US$ .975 per unit case
- o Equals US$ 4.88 per hundred weight at five 20 pound cases per hundredweight

Source: Revenue Canada, Customs and Excise Division, Telephone Interview with Import Specialist, Toronto, Canada, September 18, 1990.

APPENDIX E

MEXICAN FREIGHT RATE CALCULATIONS

Table E2

Table E1

Mexican Freight Rates Over 20,000 Pounds

Source	Destination	Distance	>20 Rate
MC	Norales	1424	11.200
MC	El Paso	1130	8.560
Chihuahua	San Diego	900	8.064
004	El Paso	743	6.720
MC	Nuevo Lar	734	5.600
Nuevo Lar	MC	734	5.600
Nuevo Lar	Guad	615	6.000
Herm	San Diego	600	5.376
Nuevo Lar	Queratano	550	5.200
Chihuahua	Norales	500	4.480
Herm	El Paso	500	4.480
Nuevo Lar	Potosi	476	5.200
Herm	Norales	200	1.792
Chihuahua	El Paso	200	1.792
004	Nuevo Lar	143	1.296
Nuevo Lar	Monterrey	143	1.296

Regression

Regression Output:

Constant	0.592120
Std Err of Y Est	0.532629
R Squared	0.965014
No. of Observations	16
Degrees of Freedom	14
X Coefficient(s)	0.007629
Std Err of Coef.	0.000388

Source: Telephone interview with Yellow Freight and fax, Laredo, Texas Office.

APPENDIX F

SIMULATION RESULTS

Appendix F

Appendix F

Table 1
United States Separate Market
Simulation RQ1A1

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	30.653	9.755	171.742	4.782	1.625	218.558
1	850	30.661	9.757	171.742	4.737	1.543	218.440
2	946	30.696	9.752	171.742	4.691	1.440	218.322
3	142	30.706	9.753	171.742	4.643	1.366	218.210
4	191	30.725	9.757	171.742	4.594	1.279	218.097
5	799	30.762	9.759	171.742	4.544	1.209	218.016
6	554	30.822	9.758	171.742	4.492	1.124	217.938
7	381	30.878	9.768	171.742	4.438	1.044	217.851
8	780	30.926	9.769	171.742	4.383	.974	217.781
9	132	30.981	9.771	171.742	4.324	.900	217.707
10	481	30.981	9.771	171.742	4.325	.900	217.707
11	482	30.981	9.771	171.742	4.325	.900	217.707
12	770	31.080	9.769	171.742	4.264	.830	217.673
13	802	31.190	9.767	171.742	4.201	.754	217.640
14	981	31.332	9.763	171.742	4.135	.658	217.624
15	761	31.491	9.776	171.742	4.065	.577	217.646

Appendix F

Table 2
Canadian Separate Market
Simulation RQ1A2

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	5.655	1.013	21.003	.610	.494	28.774
1	N8N	5.687	1.013	21.003	.592	.413	28.708
2	T1Y	5.751	1.013	21.003	.573	.341	28.680
3	K0A	5.751	1.013	21.003	.573	.341	28.680
4	V6H	5.854	1.008	21.003	.552	.256	28.672
5	R2C	6.037	1.013	21.003	.528	.184	28.763
6	H7G	6.289	1.013	21.003	.500	.100	28.904

Appendix F

Table 3
Integrated United States - Canada Markets
Simulation RQ1A3

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	36.340	10.768	192.745	5.386	2.119	247.357
1	N8N	36.341	10.768	192.745	5.348	2.038	247.239
2	850	36.349	10.770	192.745	5.309	1.956	247.128
3	946	36.384	10.765	192.745	5.270	1.853	247.017
4	142	36.418	10.761	192.724	5.230	1.779	246.911
5	191	36.437	10.765	192.724	5.189	1.692	246.806
6	799	36.474	10.767	192.724	5.147	1.622	246.734
7	554	36.534	10.766	192.724	5.104	1.537	246.664
8	381	36.590	10.776	192.712	5.060	1.457	246.595
9	780	36.638	10.777	192.712	5.015	1.387	246.528
10	132	36.702	10.778	192.703	4.969	1.313	246.465
11	T1Y	36.766	10.777	192.703	4.921	1.241	246.409
12	481	36.766	10.777	192.703	4.921	1.241	246.409
13	482	36.766	10.777	192.703	4.921	1.241	246.409
14	K0A	36.766	10.777	192.703	4.921	1.241	246.409
15	V6H	36.789	10.772	192.703	4.872	1.156	246.382
16	770	36.477	10.770	192.703	4.821	1.086	246.358
17	802	37.088	10.769	192.710	4.769	1.001	246.337
18	981	37.230	10.764	192.710	4.715	.914	246.332
19	761	37.389	10.778	192.710	4.659	.833	246.368
20	R2C	37.562	10.782	192.710	4.600	.761	246.415
21	H7G	37.814	10.782	192.710	4.539	.677	246.522

Appendix F

Table 4
United States - Canada
50 Percent Tariff Reduction
Simulation RQ1B1

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	36.690	10.675	192.318	5.386	2.119	247.186
1	850	36.697	10.677	192.318	5.348	2.037	247.076
2	946	36.732	10.672	192.318	5.309	1.934	246.966
3	142	36.737	10.672	192.318	5.270	1.860	246.857
4	191	36.814	10.664	192.268	5.230	1.773	246.750
5	N8N	36.847	10.663	192.269	5.189	1.692	246.659
6	802	36.882	10.663	192.273	5.147	1.607	246.571
7	132	36.921	10.661	192.265	5.104	1.533	246.484
8	799	36.958	10.664	192.265	5.060	1.463	246.410
9	554	37.018	10.662	192.265	5.015	1.378	246.338
10	381	37.075	10.673	192.253	4.969	1.298	246.267
11	780	37.122	10.673	192.253	4.921	1.228	246.197
12	T1Y	37.185	10.673	192.253	4.872	1.156	246.139
13	481	37.185	10.673	192.253	4.872	1.156	246.139
14	482	37.185	10.673	192.253	4.872	1.156	246.139
15	K0A	37.185	10.673	192.253	4.872	1.156	246.139
16	V6H	37.289	10.670	192.258	4.821	1.071	246.110
17	770	37.387	10.667	192.258	4.769	1.010	246.084
18	981	37.539	10.660	192.252	4.715	.914	246.082
19	761	37.698	10.674	192.252	4.659	.833	246.117
20	R2C	37.877	10.679	192.253	4.600	.761	246.170
21	100	38.325	10.653	192.057	4.539	.646	246.221

Appendix F

Table 5
United States - Canada
100 Percent Tariff Reduction
Simulation RQ1B2

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	35.969	10.484	191.353	5.348	2.047	245.201
1	V6H	35.969	10.484	191.353	5.309	1.962	245.077
2	850	35.977	10.486	191.353	5.270	1.880	244.965
3	946	36.013	10.481	191.352	5.230	1.777	244.853
4	191	36.030	10.483	191.352	5.189	1.690	244.744
5	132	36.063	10.481	191.331	5.147	1.616	244.639
6	N8N	36.073	10.481	191.339	5.104	1.535	244.532
7	802	36.108	10.480	191.343	5.060	1.450	244.442
8	799	36.145	10.483	191.343	5.015	1.380	244.366
9	554	36.205	10.481	191.343	4.969	1.295	244.293
10	381	36.262	10.492	191.331	4.921	1.215	244.221
11	780	36.309	10.492	191.331	4.872	1.145	244.150
12	481	36.309	10.492	191.331	4.872	1.145	244.150
13	482	36.309	10.492	191.331	4.872	1.145	244.150
14	K0A	36.309	10.492	191.331	4.872	1.145	244.150
15	T1Y	36.309	10.492	191.331	4.872	1.145	244.150
16	142	36.265	10.482	191.462	4.821	1.071	244.102
17	770	36.365	10.480	191.462	4.769	1.001	244.076
18	100	36.560	10.485	191.445	4.715	.886	244.091
19	761	36.719	10.499	191.445	4.659	.805	244.126
20	981	37.005	10.488	191.446	4.600	.718	244.258
21	152	37.664	10.411	191.174	4.539	.625	244.414
22	H7G	37.769	10.452	191.358	4.474	.541	244.594
23	303	38.107	10.503	191.321	4.406	.456	244.792

Appendix F

Table 6
United States - Canada
10 Percent Freight Rate Reduction
Simulation RQ1B3

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	36.551	10.733	192.583	5.386	2.119	247.373
1	850	36.559	10.735	192.583	5.348	2.037	247.262
2	946	36.594	10.731	192.583	5.309	1.934	247.152
3	142	36.599	10.731	192.583	5.270	1.860	247.043
4	191	36.618	10.735	192.583	5.230	1.773	246.939
5	N8N	36.651	10.734	192.583	5.189	1.692	246.849
6	802	36.686	10.734	192.587	5.147	1.607	246.761
7	799	36.723	10.736	192.587	5.104	1.537	246.687
8	132	36.790	10.733	192.568	5.060	1.463	246.615
9	554	36.850	10.732	192.568	5.015	1.378	246.543
10	381	36.907	10.742	192.556	4.968	1.298	246.472
11	780	36.954	10.743	192.556	4.921	1.228	246.402
12	T1Y	37.018	10.742	192.556	4.872	1.156	246.345
13	481	37.018	10.742	192.556	4.872	1.156	246.345
14	482	37.018	10.742	192.556	4.872	1.156	246.345
15	K0A	37.018	10.742	192.556	4.872	1.156	246.345
16	V6H	37.131	10.737	192.556	4.821	1.071	246.317
17	770	37.230	10.735	192.556	4.769	1.001	246.291
18	981	37.371	10.730	192.556	4.715	.941	246.287
19	761	37.530	10.744	192.556	4.659	.833	246.322

Appendix F

Appendix F

Table 7
United States - Canada
20 Percent Freight Rate Reduction
Simulation RQ1B4

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	36.619	10.708	192.468	5.386	2.119	247.299
1	850	36.626	10.710	192.468	5.348	2.037	247.189
2	946	36.662	10.706	192.468	5.309	1.934	247.078
3	142	36.667	10.706	192.468	5.270	1.860	246.970
4	191	36.686	10.709	192.468	5.230	1.773	246.865
5	N8N	36.718	10.709	192.468	5.189	1.692	246.775
6	802	36.753	10.708	192.472	5.147	1.607	246.687
7	132	36.817	10.704	192.452	5.104	1.533	246.609
8	799	36.853	10.707	192.452	5.060	1.463	246.535
9	554	36.914	10.705	192.452	5.015	1.378	246.463
10	381	36.970	10.716	192.439	4.968	1.298	246.392
11	780	37.017	10.716	192.439	4.921	1.228	246.322
12	T1Y	37.081	10.716	192.439	4.872	1.156	246.265
13	481	37.081	10.716	192.439	4.872	1.156	246.265
14	482	37.081	10.716	192.439	4.872	1.156	246.265
15	K0A	37.081	10.716	192.439	4.872	1.156	246.265
16	V6H	37.194	10.711	192.439	4.821	1.071	246.237
17	770	37.293	10.709	192.439	4.769	1.001	246.211
18	981	37.435	10.704	192.439	4.715	.914	246.207
19	761	37.594	10.718	192.439	4.659	.833	246.242

Appendix F

Table 8
United States - Canada
15 Percent Canadian Demand Increase
Simulation RQ1B5

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	37.193	10.920	195.895	5.478	2.119	251.605
1	N8N	37.194	10.920	195.895	5.439	2.038	251.486
2	850	37.202	10.922	195.895	5.400	1.956	251.374
3	946	37.237	10.917	195.895	5.360	1.853	251.263
4	142	37.271	10.913	195.874	5.319	1.779	251.156
5	191	37.290	10.917	195.874	5.278	1.692	251.050
6	799	37.327	10.919	195.874	5.235	1.622	250.977
7	554	37.388	10.918	195.874	5.191	1.537	250.907
8	381	37.444	10.928	195.862	5.146	1.457	250.837
9	780	37.491	10.929	195.862	5.100	1.387	250.769
10	132	37.556	10.930	195.854	5.053	1.313	250.705
11	481	37.556	10.930	195.854	5.053	1.313	250.705
12	482	37.556	10.930	195.854	5.053	1.313	250.705
13	K0A	37.556	10.930	195.854	5.053	1.313	250.705
14	T1Y	37.629	10.929	195.854	5.005	1.241	250.658
15	770	37.727	10.926	195.854	4.955	1.171	250.634
16	802	37.838	10.926	195.861	4.904	1.086	250.614
17	V6H	37.967	10.920	195.861	4.851	1.001	250.599
18	981	38.109	10.915	195.861	4.796	.941	250.594
19	761	38.268	10.929	195.861	4.738	.833	250.629
20	R2C	38.467	10.934	195.861	4.679	.761	250.701
21	H7G	38.758	10.934	195.861	4.616	.677	250.846
22	100	39.073	10.958	195.861	4.551	.562	251.004

Appendix F

Table 9
United States - Canada
30 Percent Canadian Demand Increase
Simulation RQ1B6

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	38.046	11.072	199.046	5.570	2.119	255.852
1	N8N	38.048	11.072	199.046	5.531	2.038	255.733
2	850	38.056	11.074	199.046	5.491	1.956	255.620
3	946	38.091	11.069	199.046	5.450	1.853	255.508
4	142	38.124	11.065	199.024	5.408	1.779	255.401
5	191	38.143	11.069	199.024	5.366	1.692	255.295
6	799	38.180	11.071	199.024	5.322	1.622	255.220
7	554	38.240	11.070	199.024	5.278	1.537	255.150
8	381	38.270	11.080	199.012	5.232	1.457	255.079
9	780	38.344	11.080	199.012	5.186	1.387	255.010
10	132	38.409	11.081	199.004	5.138	1.313	254.945
11	481	38.409	11.082	199.004	5.138	1.313	254.946
12	482	38.409	11.082	199.004	5.138	1.313	254.946
13	K0A	38.409	11.082	199.004	5.138	1.313	254.946
14	T1Y	38.491	11.087	199.004	5.089	1.241	254.907
15	770	38.590	11.078	199.004	5.038	1.171	254.882
16	802	38.700	11.077	199.011	4.986	1.086	254.861
17	981	38.842	11.073	199.011	4.932	.999	254.857
18	V6H	38.989	11.066	199.011	4.876	.914	254.856
19	761	39.148	11.080	199.011	4.818	.833	254.890
20	R2C	39.373	11.086	199.011	4.757	.761	254.988
21	100	39.688	11.110	199.011	4.694	.646	255.149
22	303	39.998	11.158	198.981	4.627	.561	255.325

Appendix F

Table 10
United States - Canada
"Most Likely" Research Environment
Simulation RQ1C1

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	35.777	10.353	190.836	5.386	2.119	244.471
1	V6H	35.781	10.360	190.836	5.348	2.034	244.359
2	850	35.789	10.362	190.836	5.309	1.952	244.248
3	946	35.824	10.357	190.836	5.270	1.849	244.137
4	132	35.853	10.355	190.815	5.230	1.775	244.028
5	T1Y	35.857	10.355	190.815	5.189	1.703	243.919
6	N8N	35.865	10.355	190.822	5.147	1.622	243.811
7	191	35.889	10.354	190.822	5.104	1.535	243.704
8	802	35.924	10.354	190.826	5.060	1.450	243.614
9	152	36.131	10.331	190.699	5.015	1.357	243.534
10	799	36.168	10.334	190.699	4.969	1.287	243.457
11	100	36.490	10.312	190.484	4.921	1.172	243.379
12	554	36.550	10.310	190.484	4.872	1.087	243.304
13	381	36.607	10.321	190.472	4.821	1.007	243.228
14	780	36.654	10.321	190.472	4.769	.937	243.154
15	481	36.654	10.322	190.472	4.769	.937	243.154
16	482	36.654	10.322	190.472	4.769	.937	243.154
17	K0A	36.654	10.322	190.472	4.769	.937	243.154
18	770	36.752	10.319	190.472	4.715	.867	243.126
19	761	36.911	10.333	190.472	4.659	.786	243.161
20	981	37.140	10.323	190.473	4.600	.699	243.236
21	H7G	37.379	10.334	190.477	4.539	.615	243.343

Appendix F

Table 11
United States - Canada
Cross Industry Comparisons - Consumer Appliances
Simulation RQ1D1

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	23.063	11.926	232.310	4.572	2.119	273.991
1	946	23.087	11.921	232.310	4.540	2.016	273.874
2	850	23.087	11.923	232.310	4.507	1.934	273.762
3	100	23.121	11.926	232.310	4.474	1.819	273.649
4	152	23.193	11.916	232.262	4.440	1.726	273.536
5	191	23.204	11.915	232.262	4.405	1.639	273.425
6	132	23.207	11.915	232.262	4.369	1.565	273.318
7	T1Y	23.210	11.915	232.262	4.333	1.493	273.213
8	N8N	23.216	11.915	232.268	4.296	1.412	273.107
9	V6H	23.228	11.928	232.268	4.257	1.327	273.008
10	802	23.256	11.927	232.271	4.218	1.242	272.913
11	381	23.267	11.939	232.273	4.178	1.162	272.820
12	554	23.304	11.937	232.273	4.136	1.077	272.728
13	799	23.333	11.940	232.273	4.093	1.007	276.647
14	780	23.368	11.941	232.273	4.049	.937	272.569
15	770	23.438	11.937	232.273	4.003	.867	272.519
16	481	23.438	11.937	232.273	4.003	.867	272.519
17	482	23.438	11.937	232.273	4.003	.867	272.519
18	K0A	23.438	11.937	232.273	4.003	.867	272.519
19	981	23.552	11.926	232.274	3.955	.780	272.487
20	303	23.604	11.959	232.302	3.905	.695	272.466
21	761	23.701	11.976	232.302	3.853	.614	272.446
22	H7G	23.859	11.992	232.309	3.798	.530	272.489
23	R2C	24.168	12.003	232.230	3.740	.458	272.599

Appendix F

Appendix F

Table 12
United States - Canada
Cross Industry Comparisons - Women's Clothing - Three Plants
Simulation RQ1D2A

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	1.762	.300	152.317	3.142	1.936	159.458
1	100	1.765	.300	152.317	3.118	1.821	159.320
2	946	1.767	.300	152.317	3.092	1.718	159.194
3	606	1.769	.301	152.317	3.066	1.618	159.070
4	900	1.781	.300	152.317	3.040	1.515	158.953
5	191	1.781	.299	152.317	3.013	1.428	158.839
6	981	1.786	.299	152.317	3.040	1.508	158.950
7	V6H	1.788	.299	152.317	3.013	1.423	158.840
8	554	1.792	.299	152.317	2.985	1.338	158.730
9	850	1.792	.299	152.317	2.905	1.341	158.734
10	802	1.791	.299	152.317	2.056	1.256	158.620
11	482	1.792	.299	152.317	2.927	1.175	158.507
12	303	1.795	.300	152.317	2.895	1.090	158.398
13	N8N	1.794	.300	152.317	2.845	1.009	158.287
14	H7G	1.802	.300	152.317	2.865	1.009	158.283
15	K0A	1.804	.301	152.317	2.833	.925	158.179
16	381	1.808	.301	152.317	2.799	.845	158.069
17	641	1.815	.301	152.317	2.764	.764	157.960
18	481	1.823	.299	152.317	2.727	.683	157.849
19	132	1.824	.299	152.317	2.688	.609	157.737

Table 12 (Continued)

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
20	761	1.833	.299	152.317	2.647	.528	157.624
21	T1Y	1.835	.299	152.317	2.604	.456	157.511
22	780	1.832	.299	152.317	2.557	.386	157.396
23	R2C	1.843	.299	152.317	2.506	.314	157.270
24	797	1.854	.299	152.317	2.449	.244	157.163
25	770	1.873	.299	152.317	2.385	.174	157.048
26	152	1.873	.299	152.317	2.385	.174	157.048
27	M1M	1.927	.303	147.903	2.243	.74	152.455

Appendix F

Table 13
United States - Canada
Cross Industry Comparisons - Women's Clothing - Atlanta Plant
Simulation RQ1D2B

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	1.251	.311	146.458	3.231	2.119	153.370
1	100	1.255	.311	146.458	3.207	2.004	153.236
2	946	1.256	.311	146.458	3.182	1.901	153.109
3	M1M	1.257	.312	146.458	3.156	1.801	152.903
4	406	1.260	.311	146.458	3.130	1.701	152.861
5	V6H	1.260	.311	146.458	3.104	1.616	152.750
6	802	1.261	.311	146.458	3.076	1.531	152.637
7	K0A	1.261	.311	146.458	3.048	1.447	152.526
8	554	1.263	.311	146.458	3.020	1.362	152.414
9	850	1.263	.311	146.458	2.990	1.280	152.302
10	641	1.263	.311	146.458	2.960	1.199	152.192
11	191	1.272	.310	146.458	2.928	1.112	152.080
12	381	1.272	.309	146.458	2.896	1.032	151.968
13	981	1.281	.310	146.458	2.862	.945	151.856
14	481	1.283	.309	146.458	2.862	.945	151.857
15	761	1.287	.309	146.458	2.837	.864	151.745
16	482	1.291	.308	146.458	2.791	.783	151.631
17	H7G	1.300	.309	146.458	2.752	.699	151.519
18	142	1.303	.309	146.458	2.752	.718	151.540
19	152	1.303	.309	146.458	2.715	.625	151.408
20	708	1.304	.309	146.458	2.670	.555	151.296

Table 13 (Continued)

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
21	799	1.307	.309	146.458	2.625	.485	151.184
22	770	1.310	.308	146.458	2.576	.415	151.068
23	900	1.350	.305	146.458	2.524	.312	150.949
24	N8N	1.376	.306	146.458	2.465	.231	150.837
25	820	1.412	.306	146.458	2.465	.231	150.872
26	132	1.691	.303	146.458	2.377	.157	151.009
27	T1Y	1.114	.267	134.525	2.052	.85	133.047
28	303	1.114	.267	134.525	2.052	.85	133.047

Appendix F

Table 14
Mexican Separate Market
Simulation RQ2A1

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	3.085	.373	9.009	.416	.325	13.208
1	002	3.086	.373	9.009	.401	.260	13.129
2	005	3.089	.373	9.009	.384	.195	13.049
3	001	3.094	.373	9.009	.364	.130	12.970
4	003	3.121	.373	9.009	.341	.65	12.909

Appendix F

Table 15
Integrated United States - Canada - Mexico Markets
Simulation RQ2A2

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	56.791	9.862	180.623	5.730	2.292	255.299
1	946	56.802	9.860	180.623	5.695	2.189	255.170
2	V6H	56.803	9.860	180.623	5.660	2.104	255.050
3	132	56.831	9.858	180.602	5.624	2.030	254.945
4	T1Y	56.836	9.858	180.602	5.587	1.958	254.841
5	N8N	56.843	9.858	180.610	5.550	1.877	254.738
6	191	56.867	9.857	180.610	5.512	1.790	254.636
7	002	56.868	9.857	180.610	5.473	1.725	254.534
8	005	56.871	9.857	180.610	5.434	1.660	254.431
9	001	56.876	9.857	180.610	5.394	1.595	254.331
10	003	56.903	9.857	180.610	5.352	1.530	254.252
11	152	57.110	9.835	180.482	5.310	1.437	254.174
12	100	57.432	9.813	180.267	5.267	1.322	254.101
13	554	57.493	9.812	180.267	5.223	1.237	254.031
14	802	57.458	9.812	180.368	5.177	1.152	253.968
15	381	56.593	9.859	181.252	5.131	1.072	253.907
16	481	56.593	9.859	181.252	5.131	1.072	253.907
17	482	56.593	9.859	181.252	5.131	1.072	253.907
18	770	56.593	9.859	181.252	5.131	1.072	253.907
19	850	56.593	9.859	181.252	5.131	1.072	253.907
20	KOA	56.593	9.859	181.252	5.131	1.072	253.907
21	761	56.426	9.873	181.550	5.083	.991	253.922
22	799	56.093	9.896	182.000	5.033	.921	253.943
23	981	55.589	9.919	182.730	4.982	.834	254.054

Appendix F

Table 16
United States - Canada - Mexico
50 Percent Tariff Reduction
Simulation RQ2B1

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	83.134	8.233	137.982	5.695	2.373	237.418
1	946	83.145	8.231	137.982	5.660	2.270	237.288
2	V6H	83.145	8.231	137.984	5.624	2.185	237.169
3	N8N	83.194	8.229	137.940	5.587	2.104	237.055
4	002	83.196	8.229	137.940	5.550	2.039	236.954
5	005	83.198	8.229	137.940	5.512	1.974	236.853
6	001	83.203	8.229	137.940	5.473	1.909	236.754
7	142	83.223	8.230	137.940	5.434	1.835	236.662
8	T1Y	83.251	8.230	137.940	5.394	1.763	236.578
9	003	83.279	8.230	137.940	5.352	1.698	236.499
10	481	83.355	8.217	137.940	5.352	1.698	236.562
11	132	83.227	8.221	138.124	5.310	1.624	236.506
12	H7G	83.362	8.220	138.063	5.310	1.624	236.580
13	K0A	83.441	8.219	137.994	5.267	1.540	236.461
14	802	83.524	8.214	137.994	5.223	1.455	236.411
15	770	83.525	8.214	137.994	5.223	1.455	236.411
16	850	83.525	8.214	137.994	5.223	1.455	236.411
17	482	83.552	8.206	138.058	5.177	1.374	236.367
18	554	83.651	8.200	138.058	5.131	1.289	236.329
19	152	83.462	8.184	138.427	5.083	1.196	236.352
20	100	83.553	8.194	138.517	5.033	1.081	236.377
21	799	83.706	8.194	138.517	4.982	1.011	236.410
22	606	83.665	8.168	138.796	4.929	.911	236.469
23	761	83.867	8.166	138.796	4.873	.830	236.532

Appendix F

Table 17
United States - Canada - Mexico
100 Percent Tariff Reduction
Simulation RQ2B2

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	62.035	8.132	132.595	5.730	2.538	211.029
1	946	62.046	8.130	132.595	5.695	2.435	210.900
2	V6H	62.048	8.130	132.595	5.660	2.350	210.782
3	482	62.051	8.128	132.595	5.624	2.269	210.666
4	K0A	62.053	8.131	132.595	5.587	2.185	210.549
5	N8N	62.068	8.128	132.595	5.550	2.104	210.444
6	002	62.069	8.128	132.595	5.512	2.039	210.343
7	005	62.071	8.128	132.595	5.473	1.974	210.242
8	001	62.076	8.128	132.595	5.434	1.909	210.142
9	T1Y	62.105	8.128	132.595	5.394	1.837	210.058
10	003	62.132	8.128	132.595	5.352	1.772	209.978
11	802	62.215	8.123	132.595	5.310	1.687	209.930
12	132	62.288	8.124	132.595	5.267	1.613	209.887
13	770	62.288	8.124	132.595	5.267	1.613	209.887
14	850	62.288	8.124	132.595	5.267	1.613	209.887
15	152	62.390	8.122	132.595	5.223	1.520	209.849
16	554	62.489	8.117	132.595	5.177	1.435	209.813
17	H7G	62.613	8.127	132.595	5.131	1.351	209.817
18	100	62.798	8.138	132.595	5.083	1.236	209.849
19	799	62.952	8.138	132.595	5.033	1.166	209.883
20	606	63.168	8.117	132.595	4.982	1.066	209.927

Appendix F

Table 18
United States - Canada - Mexico
10 Percent Freight Rate Reduction
Simulation RQ2B3

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	57.561	9.801	179.338	5.730	2.292	254.722
1	946	57.572	9.798	179.338	5.695	2.189	254.593
2	V6H	57.570	9.799	179.340	5.660	2.104	254.473
3	132	57.599	9.796	179.320	5.624	2.030	254.369
4	T1Y	57.603	9.796	179.320	5.587	1.958	254.264
5	N8N	57.611	9.796	179.327	5.550	1.877	254.161
6	191	57.635	9.796	179.327	5.512	1.790	254.059
7	002	57.636	9.796	179.327	5.473	1.725	253.957
8	005	57.638	9.796	179.327	5.434	1.660	253.854
9	001	57.642	9.796	179.327	5.394	1.595	253.753
10	003	57.667	9.796	179.327	5.352	1.530	253.672
11	152	57.874	9.773	179.199	5.310	1.437	253.594
12	100	58.196	9.752	178.984	5.267	1.322	253.521
13	554	58.257	9.750	178.984	5.223	1.237	253.451
14	802	58.224	9.750	179.085	5.177	1.152	253.389
15	381	57.409	9.796	179.932	5.131	1.072	253.340
16	481	57.409	9.796	179.932	5.131	1.072	253.340
17	482	57.409	9.796	179.932	5.131	1.072	253.340
18	770	57.409	9.796	179.932	5.131	1.072	253.340
19	850	57.409	9.796	179.932	5.131	1.072	253.340
20	K0A	57.409	9.796	179.932	5.131	1.072	253.340

Appendix F

Table 19
United States - Canada - Mexico
20 Percent Freight Rate Reduction
Simulation RQ2B4

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	58.046	9.756	178.300	5.730	2.292	254.124
1	946	58.057	9.753	178.300	5.695	2.189	253.995
2	V6H	58.056	9.753	178.302	5.660	2.104	253.874
3	132	58.084	9.751	178.281	5.624	2.030	253.770
4	T1Y	58.089	9.751	178.281	5.587	1.958	253.665
5	N8N	58.096	9.751	178.288	5.550	1.877	253.563
6	191	58.120	9.750	178.288	5.512	1.790	253.461
7	002	58.121	9.750	178.288	5.473	1.725	253.358
8	005	58.123	9.750	178.288	5.434	1.660	253.256
9	001	58.127	9.750	178.288	5.394	1.595	253.154
10	003	58.148	9.750	178.288	5.352	1.530	253.069
11	152	58.470	9.724	178.051	5.310	1.437	252.992
12	100	58.792	9.702	177.836	5.267	1.322	252.919
13	554	58.852	9.701	177.836	5.223	1.237	252.848
14	802	58.881	9.698	177.879	5.177	1.152	252.787
15	481	58.881	9.698	177.879	5.177	1.152	252.787
16	482	58.881	9.698	177.879	5.177	1.152	252.787
17	770	58.881	9.698	177.879	5.177	1.152	252.787

Table 19 (Continued)

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
18	850	58.881	9.698	177.879	5.177	1.152	252.787
19	K0A	58.881	9.698	177.879	5.177	1.152	252.787
20	381	58.038	9.746	178.762	5.131	1.072	252.750
21	761	57.682	9.769	179.251	5.083	.991	252.776
22	799	57.586	9.781	179.485	5.033	.921	252.806
23	H7G	57.824	9.792	179.489	4.982	.837	252.924
24	981	57.167	9.822	180.387	4.929	.750	253.055
25	303	58.456	9.811	179.384	4.873	.665	253.189

Appendix F

Table 20
United States - Canada - Mexico
25 Percent Mexican Demand Increase
Simulation RQ2B5

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	57.562	9.956	182.876	5.827	2.292	258.513
1	946	57.573	9.953	182.876	5.792	2.189	258.383
2	V6H	57.574	9.953	182.875	5.756	2.104	258.262
3	132	57.603	9.951	182.855	5.719	2.030	258.157
4	T1Y	57.607	9.951	182.855	5.682	1.958	258.052
5	N8N	57.615	9.951	182.862	5.644	1.877	257.949
6	191	57.638	9.950	182.862	5.606	1.790	257.846
7	002	57.640	9.950	182.862	5.566	1.725	257.744
8	005	57.643	9.950	182.862	5.526	1.660	257.641
9	001	57.649	9.950	182.862	5.485	1.595	257.542
10	152	57.857	9.928	182.734	5.443	1.502	257.464
11	003	57.891	9.928	182.734	5.400	1.437	257.390
12	100	58.213	9.906	182.519	5.357	1.322	257.316
13	554	58.273	9.905	182.519	5.312	1.237	257.245
14	802	58.238	9.905	182.621	5.265	1.152	257.181
15	381	57.374	9.952	183.504	5.218	1.072	257.120
16	481	57.374	9.952	183.504	5.218	1.072	257.120
17	482	57.374	9.952	183.504	5.218	1.072	257.120
18	770	57.374	9.952	183.504	5.218	1.072	257.120

Table 20 (Continued)

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
19	850	57.374	9.952	183.504	5.218	1.072	257.120
20	K0A	57.374	9.952	183.504	5.218	1.072	257.120
21	761	57.206	9.966	183.802	5.169	.991	257.134
22	799	56.873	9.989	184.253	5.119	.921	257.154
23	981	56.370	10.012	184.982	5.066	.834	257.265
24	H7G	56.608	10.023	184.986	5.012	.750	257.380
25	303	57.865	10.020	184.032	4.956	.665	257.538
26	R2C	58.312	10.033	183.966	4.897	.593	257.802

Appendix F

Table 21
United States - Canada - Mexico
50 Percent Mexican Demand Increase
Simulation RQ2B6

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	58.333	10.049	185.128	5.925	2.292	261.727
1	946	58.345	10.046	185.128	5.889	2.189	261.597
2	V6H	58.345	10.046	185.128	5.852	2.104	261.475
3	132	58.374	10.044	185.107	5.815	2.030	261.370
4	T1Y	58.378	10.044	185.107	5.777	1.958	261.264
5	N8N	58.386	10.044	185.114	5.738	1.877	261.160
6	191	58.409	10.044	185.114	5.699	1.790	261.056
7	002	58.412	10.044	185.114	5.659	1.725	260.954
8	005	58.415	10.044	185.114	5.618	1.660	260.851
9	001	58.422	10.044	185.114	5.577	1.595	260.752
10	152	58.630	10.021	184.987	5.534	1.502	260.674
11	100	58.952	9.999	184.771	5.491	1.387	260.601
12	554	59.012	9.998	184.771	5.446	1.320	260.530
13	003	59.053	9.998	184.771	5.400	1.237	260.460
14	802	59.018	9.998	184.873	5.353	1.152	260.395
15	381	58.154	10.046	185.757	5.305	1.072	260.333
16	481	58.154	10.046	185.757	5.305	1.072	260.333
17	482	58.154	10.046	185.757	5.305	1.072	260.333
18	770	58.154	10.046	185.757	5.305	1.072	260.333
19	850	58.154	10.046	185.757	5.305	1.072	260.333
20	K0A	58.154	10.046	185.757	5.305	1.072	260.333
21	761	57.987	10.059	186.054	5.255	.991	260.346
22	799	57.653	10.082	186.505	5.204	.921	260.365
23	981	57.150	10.106	187.234	5.151	.834	260.475

Appendix F

Table 22
United States - Canada - Mexico
"Most Likely" Research Environment
Simulation RQ2C1

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	57.876	8.219	134.847	5.896	2.690	209.527
1	946	57.877	8.218	134.847	5.862	2.587	209.390
2	482	57.879	8.216	134.847	5.827	2.506	209.275
3	850	57.880	8.217	134.847	5.792	2.424	209.159
4	K0A	57.882	8.219	134.847	5.756	2.340	209.044
5	V6H	57.886	8.227	134.847	5.682	2.255	208.934
6	N8N	57.900	8.226	134.847	5.682	2.174	208.828
7	002	57.901	8.226	134.847	5.644	2.109	208.727
8	005	57.903	8.226	134.847	5.606	2.044	208.625
9	001	57.908	8.226	134.847	5.566	1.979	208.526
10	770	57.933	8.223	134.847	5.526	1.909	208.438
11	003	57.960	8.223	134.847	5.485	1.844	208.359
12	802	58.027	8.219	134.847	5.443	1.759	208.295
13	132	58.099	8.220	134.847	5.400	1.685	208.251
14	152	58.201	8.218	134.847	5.357	1.592	208.214
15	554	58.300	8.212	134.847	5.312	1.507	208.178
16	T1Y	58.398	8.215	134.847	5.265	1.435	208.160
17	H7G	58.522	8.225	134.847	5.218	1.351	208.163
18	100	58.707	8.236	134.847	5.169	1.236	208.194
19	606	58.923	8.215	134.847	5.119	1.136	208.239
20	142	59.113	8.210	134.847	5.066	1.062	208.298
21	761	59.308	8.208	134.847	5.012	.981	208.355

Appendix F

Table 23
United States - Canada - Mexico
Cross Industry Comparisons - Consumer Appliances
Simulation RQ2D1

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	35.302	9.352	186.787	4.850	2.609	238.900
1	946	35.304	9.350	186.787	4.821	2.506	238.770
2	850	35.303	9.355	186.787	4.729	2.424	238.662
3	K0A	35.306	9.358	186.787	4.762	2.340	238.554
4	N8N	35.317	9.356	186.787	4.732	2.259	238.452
5	002	35.318	9.356	186.787	4.701	2.194	238.357
6	005	35.319	9.356	186.787	4.670	2.129	238.261
7	001	35.321	9.356	186.787	4.638	2.064	238.166
8	V6H	35.333	9.369	186.787	4.605	1.979	238.074
9	770	35.348	9.366	186.787	4.572	1.909	237.982
10	003	35.359	9.366	186.787	4.538	1.844	237.895
11	802	35.401	9.361	186.787	4.504	1.759	237.812
12	481	35.488	9.351	186.787	4.504	1.759	237.849
13	132	35.489	9.351	186.787	4.468	1.685	237.781
14	554	35.547	9.348	186.787	4.432	1.600	237.715
15	152	35.643	9.334	186.787	4.395	1.507	237.666
16	T1Y	35.712	9.333	186.787	4.357	1.435	237.625
17	H7G	35.786	9.342	186.787	4.317	1.351	237.584

Table 23 (Continued)

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
18	482	35.891	9.321	186.787	4.277	1.270	237.547
19	100	36.004	9.329	186.787	4.235	1.155	237.511
20	761	36.127	9.327	186.787	4.192	1.074	237.507
21	M1M	36.270	9.349	186.787	4.147	.974	237.528
22	641	36.447	9.335	186.787	4.101	.893	237.563
23	606	36.695	9.280	186.787	4.052	.793	237.608
24	981	37.111	9.252	186.787	4.001	.706	237.858
25	381	37.507	9.260	186.787	3.948	.626	238.129

Appendix F

Table 24
United States - Canada - Mexico
Cross Industry Comparisons - Women's Clothing - Four Plants
Simulation RQ2D2A

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	1.858	.263	97.964	3.475	2.256	105.816
1	100	1.864	.264	97.964	3.453	2.141	105.685
2	946	1.864	.264	97.971	3.453	2.138	105.689
3	M1M	1.864	.264	97.971	3.475	2.207	105.780
4	606	1.871	.263	97.971	3.453	2.107	105.665
5	152	1.875	.263	97.971	3.430	2.014	105.553
6	V6H	1.875	.263	97.971	3.407	1.929	105.445
7	K0A	1.875	.263	97.971	3.407	1.929	105.445
8	H7G	1.875	.263	97.971	3.407	1.926	105.442
9	802	1.877	.263	97.971	3.384	1.841	105.336
10	850	1.877	.263	97.971	3.360	1.759	105.230
11	554	1.881	.262	97.971	3.336	1.674	105.124
12	N8N	1.881	.262	97.971	3.311	1.593	105.019
13	482	1.881	.262	97.971	3.286	1.512	104.912
14	761	1.887	.262	97.971	3.260	1.431	104.812
15	303	1.897	.262	97.971	3.234	1.346	104.710
16	T1Y	1.897	.262	97.971	3.207	1.274	104.611
17	132	1.900	.263	97.971	3.179	1.200	104.512
18	481	1.913	.261	97.971	3.150	1.119	104.414
19	770	1.914	.261	97.971	3.121	1.049	104.315
20	002	1.914	.261	97.971	3.090	.984	104.220
21	005	1.914	.261	97.971	3.059	.919	104.123
22	001	1.914	.261	97.971	3.026	.854	104.026
23	003	1.915	.261	97.971	2.992	.789	103.928
24	641	1.935	.260	97.971	2.957	.708	103.831

Table 24 (Continued)

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
25	R2C	1.933	.260	97.919	2.880	.636	103.628
26	900	1.981	.258	97.919	2.839	.533	103.529
27	191	2.019	.257	97.919	2.795	.446	103.436
28	780	2.074	.257	97.919	2.748	.376	103.373
29	381	2.178	.260	97.919	2.697	.296	103.350
30	799	2.630	.270	97.919	2.640	.226	103.685
31	981	2.704	.260	95.364	2.509	.139	100.975
32	004	2.599	.245	86.754	2.215	.74	91.886

Appendix F

Table 25
United States - Canada - Mexico
Cross Industry Comparisons - Women's Clothing - Atlanta Plant
Simulation RQ2D2B

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
0	---	1.459	.334	160.573	3.554	2.444	168.363
1	100	1.463	.334	160.573	3.532	2.329	168.230
2	946	1.464	.334	160.573	3.509	2.226	168.106
3	M1M	1.465	.334	160.573	3.485	2.126	167.983
4	606	1.468	.334	160.573	3.461	2.026	167.862
5	V6H	1.468	.334	160.573	3.437	1.941	167.753
6	802	1.469	.334	160.573	3.412	1.856	167.644
7	K0A	1.469	.334	160.573	3.387	1.772	167.535
8	554	1.471	.333	160.573	3.361	1.687	167.425
9	850	1.471	.333	160.573	3.335	1.605	167.317
10	641	1.472	.333	160.573	3.308	1.524	167.210
11	191	1.480	.332	160.573	3.280	1.437	167.102
12	381	1.480	.332	160.573	3.252	1.357	166.994
13	981	1.489	.331	160.573	3.223	1.270	166.886
14	481	1.492	.331	160.573	3.223	1.270	166.889
15	761	1.495	.331	160.573	3.193	1.189	166.781
16	482	1.499	.330	160.573	3.162	1.108	166.672
17	H7G	1.509	.331	160.573	3.130	1.024	166.567
18	142	1.511	.331	160.573	3.130	1.043	166.588
19	152	1.512	.331	160.573	3.097	.950	166.463
20	780	1.512	.331	160.573	3.063	.880	166.359
21	799	1.515	.331	160.573	3.028	.810	166.257
22	770	1.518	.331	160.573	2.991	.740	166.153
23	900	1.558	.328	160.573	2.952	.637	166.047
24	005	1.558	.328	160.573	2.912	.572	165.943

Table 25 (Continued)

Deletion	Facility	Freight/ Tariff	Handling	Production	ICC	Fixed	Total Cost
25	002	1.561	.328	160.573	2.869	.507	165.837
26	003	1.566	.328	160.573	2.823	.442	165.732
27	001	1.577	.328	160.573	2.774	.377	165.628
28	N8N	1.603	.328	160.573	2.721	.296	165.521
29	R2C	1.639	.328	160.573	2.721	.296	165.556
30	132	1.918	.325	160.573	2.662	.222	165.700
31	004	1.691	.303	146.458	2.366	.157	150.976
32	T1Y	1.115	.269	129.526	2.029	.85	133.023

LIST OF REFERENCES

LIST OF REFERENCES

Adidas (1990), Telephone Interview with staff, November, 1990.

Alderson, Wroe (1957), Marketing Behavior and Executive Action, Homewood, Ill.: Richard D. Irwin, Inc.

Anderson, David L. (1988), Logistics Strategies for Competing in Global Markets, Temple, Barker and Sloane, Inc.

Arcelus, F. J. (1989), "On the Selection of Industry Location Alternatives," Engineering Costs and Production Economics, Vol. 16, Iss. 3, (June), 213-219.

Artman, Les B. and David A. Clancy (1990), "Distribution Follows Consumer Movement," Transportation and Distribution, (June), 17-20.

A.T. Kearney, Inc., Dialog Systems Division, NETSIM II Documentation Manual, East Lansing, MI, 1990.

Atkins, Robert M. (1952), "A Program for Locating New Plants," Harvard Business Review, 30 (November-December), 113-121.

Ballou, Ronald H. (1987), "Information Considerations for Logistics Network Planning," International Journal of Physical Distribution and Materials Management, Vol. 17, No. 7, 3-14.

Ballou, Ronald H. (1989), "Heuristics: Rules of Thumb for Logistics Decision Making," Journal of Business Logistics, Vol. 10, No. 1, 122-132.

Barrett, William P. (1990), "Monterrey's Revenge," Forbes, (June 11), 100-102.

Baumol, W. J. and P. Wolfe (1958), "Warehouse Location Problems," Operations Research, Vol. 6, (March), 252-263.

Bender, P. S. (1985), "Logistics System Design," in Robeson, J. F. and R. G. House (eds.), The Distribution Handbook, New York: The Free Press.

Bowersox, Donald A., Patricia J. Daugherty, et. al. (1989), Leading Edge Logistics: Competitive Positioning for the 1990s, Oak Brook, Ill.: Council of Logistics Management.

Bowersox, Donald J. (1958), A Study of Theoretical and Practiced Procedures in Plant Location and Analysis of Highway Locational Influences, A Dissertation, East Lansing, Michigan: Michigan State University.

Bowersox, Donald J. (1960), Evaluation of Alternative Solutions to the Food Distribution Center Location Problem, A Dissertation, East Lansing, Michigan, Michigan State University.

Bowersox, Donald J. (1972), "Planning Physical Distribution Operations with Dynamic Simulation," Journal of Marketing, Vol. 36, (January), 17-25.

Bowersox, Donald J. and David J. Closs (1989), "Simulation in Logistics: A Review of Present Practice and a Look to the Future," Journal of Business Logistics, Vol. 10, No. 1, 133-148.

Bowersox, Donald J. and Jay U. Sterling (1982), "Multinational Logistics," Journal of Business Logistics, Vol. 3, No. 2, 15-23.

Bowersox, Donald J., David J. Closs and Omar K. Helferich (1986), Logistical Management, New York: Macmillan Publishing Co.

Bowersox, Donald J., Edward W. Smykay and Bernard J. LaLonde (1968), Physical Distribution Management, Rev. Ed., London: The Macmillan Company.

Bowersox, Donald J., Omar K. Helferich and Edward J. Marien (1971), "Physical Distribution Planning with Simulation," International Journal of Physical Distribution Management, (October), 38-42.

Bowman, Robert J. (1990), "Easing of Delays, Restrictions Raising Great Expectations," Traffic World, Vol. 222, No. 11, (June 11), 13-14.

Brink, Edward, L. (1957), "A Simplified Solution for the Location of Marketing Outlets Using an Analog Computer," Marketing's Role in Scientific Management, as cited in Bowersox, Donald J. (1960), Evaluation of Alternative Solutions to the Food Distribution Center Location Problem, A Dissertation, East Lansing, Michigan, Michigan State University.

Brown, Drusilla K. and Robert M. Stern (1987), "A Modeling Perspective," in Perspectives on U.S.-Canadian Free Trade Agreement, Stern, Robert M., Philip H. Trezise and John Whalley, eds., Washington D.C.: The Brookings Institution.

Buckley, Peter J. and Mark Casson (1985), The Economic Theory of the Multinational Enterprise, New York: St. Martin's Press.

Bucklin, Louis P. (1965), "Postponement, Speculation and the Structure of Distribution Channels," Journal of Marketing Research, Vol. 2 (February), 26-33.

Burbridge, John J., Jr. (1986), "Logistics Information System for Distribution Management Goes Beyond Total Cost Approach," Industrial Engineering, Vol. 18, No. 8 (August), 42-49.

C. H. Robinson, Interview with executives September 18, 1990.

Calvet, A. L. (1981), "A Synthesis of Foreign Direct Investment Theories and Theories of the Multinational Firm," Journal of International Business Studies, (Spring/Summer), 43-59.

Canada Facts (1990), 1990 Canada Facts: An International Business Comparison, Toronto, Canada: Prospectus Publications, Ltd.

Canada-U.S. Free Trade Agreement (1987), Tariff Schedule of Canada and Tariff Schedule of the United States, Annex 401.2.

Cecchini, Paolo (1988), The European Challenge: 1992. Brookfield, Vermont: Gower Publishing Company.

Chamberlin, Edward H. (1956), The Theory of Monopolistic Competition, 7th Ed., Cambridge: Harvard University as cited in Bowersox, Donald J. (1960), Evaluation of Alternative Solutions to the Food Distribution Center Location Problem, A Dissertation, East Lansing, Michigan, Michigan State University.

Chrysler Corporation, Interview with executives September 17, 1990.

Closs, David J. (1978), Simulated Product Sales Forecasting: Mathematical Model, Computer Simulation and Validation, A Dissertation, East Lansing, Michigan: Michigan State University.

Consolidated Freightways, Inc. (1990), Interview with executives, September 18, 1990.

Consolidated Freightways, Inc. (1990), Omnirate Rate Diskette.

Cook, Robert Lorin (1980), An Examination of Safety Stock Policies in Multi-Echeloned Distribution Systems, A Dissertation, East Lansing, Michigan: Michigan State University.

CP Freight and Express, Ltd. (1990), Canada Rate Diskette.

CP Freight and Express, Ltd. (1990), Interview with Rate Personnel, September 19, 1990.

Darragh, Alexander J. (1989), "Industrial Site Decisions in the 1990s," Commercial Investment Real Estate Journal, Vol. 8, Iss. 2 (Spring), 3-7.

Davies, G. J. (1987), "The International Logistics Concept," International Journal of Physical Distribution and Materials Management, Vol. 17, No. 2, 20-27.

Distribution Centers, Inc. (1989), Distribution Concepts and Issues, August.

Dunning, John H. (1988), "The Eclectic Paradigm of International Production: A Restatement and Some Possible Extensions," Journal of International Business Studies, (Spring), 1-19.

Dunning, John H. (1989), The Study of International Business: A Plea for a More Interdisciplinary Approach, Academy of International Business Speech, (October).

Epping, G. Michael (1986), "Tradition in Transition: The Emergence of New Categories in Plant Location," Arkansas Business and Economic Review, Vol. 19, Iss. 3, 16-25.

Flaks, Marvin (1963), "Total Cost Approach to Physical Distribution," Business Management, Vol. 24 (August), 55-61.

Forrester, Jay W. (1958), "Industrial Dynamics," Harvard Business Review, Vol. 36 (July-August), 37-66.

Fulton, Maurice (1972), "New Factors in Plant Location," Harvard Business Review in Bartlett, Hale C. (ed.), Readings in Physical Distribution, Chicago: The Interstate Publishers and Printers, Inc., 132-149.

Gabe, Vernon D. (1984), "Outline of a Corporate Site Location Procedure," Site Selection Handbook, Vol. 29, No. 2 (May), 318-319.

Gage, John C., Jr. (1987), "Changing Site Selection Requirements," Economic Development Review, Vol. 5, Iss. 1, (Winter), 33-35.

Garland, John, Richard N. Farmer and Marilyn Taylor (1990) International Dimensions of Business Policy and Strategy, Boston, Massachusetts: PWS-Kent Publishing Company.

Geoffrion, Arthur M. (1975), "A Guide to Computer-Assisted Methods for Distribution Systems Planning," Sloan Management Review, Vol. 16, No. 2 (Winter), 17-42.

Geoffrion, Arthur M. (1976), "Better Distribution Planning with Computer Models," Harvard Business Review, Vol. 54 (July-August), 92-99.

Global Trade (1988), "Southern Border Trade Increases, But Not Without Growing Pains," Global Trade, April, 34-35.

Gordon, Geoffrey (1969), System Simulation, Englewood Cliffs, N.J.: Prentice-Hall, Inc.

Green, Paula L. (1990), "Mexico to Seek U.S. Barrier Cut," Journal of Commerce, (June 25), 12.

Greene, Walter E. (1989), "The Maquiladora-Japan's New Competitive Weapon," Business 39(4), (October-December) 52-56

Greenhut, M. L. and H. Ohta (1975), Theory of Spatial Pricing and Market Areas, Durham, N.C.: Duke University Press.

Greenhut, Melvin L. (1952), "Integrating the Leading Theories of Plant Location," Southern Economic Journal, 28 (April), 526-538.

Greenhut, Melvin L. (1956), Plant Location, Chapel Hill: University of North Carolina Press.

Greenhut, Melvin L., George Norman and Chao-shun Hung (1987), The Economics of Imperfect Competition, Cambridge: Cambridge University Press.

Gruben, William C. (1990), "Mexican Mequiladora Growth: Does it Cost U.S. Jobs?," Economic Review, (January), 15-28.

Hanjoul, Pierre and Dominique Peeters (1987), "A Facility Location Problem with Clients' Preference Orderings," Regional Science and Urban Economics, Vol. 17, (August), 451-473.

Hanjoul, Pierre; Pierre Hansen; Dominique, Peeters and Jacques-Francois Thisse (1990), "Uncapacitated Plant Location Under Alternative Spatial Price Policies," Management Science, Vol. 36, (January), 41-57.

Hawkins, Chuck and William J. Holstein (1989), "The North American Shakeout Arrives Ahead of Schedule," Business Week, (April 17), 34-35.

Helferich, Omar K. (1983), "Logistics Decision Support Systems," Computers in Manufacturing, Vol. V, New Jersey: Auerbach Publishing Co., 4.

Helferich, Omar K. and David J. Closs (1979), Strategic and Operations Logistics Planning with Computer Simulation, International Physical Distribution Conference, Tokyo, Japan, June 4-7.

Heskett, James L. (1966), "A Missing Link In Physical Distribution System Design," Journal of Marketing, Vol. 30, (October), 37-41.

Hirsch, John (1990), "The FTA Isn't Keeping It's Promise," Global Trade, 110, 3 (March), 18-20.

Hodder, James E. and James V. Jucker (1985), "International Plant Location Under Price and Exchange Rate Uncertainty," Engineering Costs and Production Economics, Vol. 9 (April), 225-229.

Hodder, James E. and M. Cemal Dincer (1986), "A Multifactor Model for International Plant Location and Financing Under Uncertainty," Computers and Operations Research, Vol. 13, Iss. 5, 601-609.

Holmes, Gerald E. (1930), Plant Location, New York: McGraw-Hill Book Co.

Holstein, William J. and Amy Borrus (1990), "Inching Toward a North American Market," Business Week, (June 25), 40-41.

Hoover, Edgar M. (1937), Location Theory and the Shoe and Leather Industry, Cambridge: Harvard University Press, as cited in Richards, Hoy A. (1972), "Transportation Costs and Plant Location: A Review of Principal Theories," in Bartlett, Hale C. (ed.), Readings in Physical Distribution, Chicago: The Interstate Publishers and Printers, Inc., 124-131.

Horowitz, Rose A. (1990), "Maquiladoras Welcome Trade Accord: Predict Lower Traffic Costs in Mexico," Traffic World, (July 23), 54-57.

Hotelling, Harold (1929), "Stability in Competition," Economic Journal, 39, 41-57.

Ingram, F. Jerry, James Bayne and Fred J. Gassaway (1986), "M.A.P.S.- Market Area Plant Strategy," Economic Development Review, Vol. 4, Issue 1 (Winter), 25-29.

Journal of Commerce Staff Report (1989), "DuPont's Canada Unit to Make CFC Substitutes," Journal of Commerce, (June 28), 25.

Journal of Commerce Staff Report (1990), "Canada Seeks to Join Mexico, U.S. in Talks," Journal of Commerce, (September 26), 4A.

Kallock, Roger W. (1988), "The Challenge of Managing Logistics in a Global Environment," Proceedings of the Council of Logistics Management, Vol. 1, Boston, Ma., October 9-12.

Keefer, K. B. (1934), "Easy Ways to Determine the Center of Distribution," Food Industry, as cited in Bowersox, Donald J. (1960), Evaluation of Alternative Solutions to the Food Distribution Center Location Problem, A Dissertation, East Lansing, Michigan, Michigan State University.

Kolbe, Jim (1988), "U.S.-Mexico Relations: Building a Golden Age," Economic Development Review, 6(3)(Fall), 14-17.

Kuehn, A. A. and M. J. Hamburger (1963), "A Heuristic Program for Locating Warehouses," Management Science, Vol. 9 (July), 543-666.

Langer, Saul and Ken Hitzig (1990), "The FTA Beckons 'Go North-Go South,' Young Man," Bobbin, Vol. 31, No. 10, 56-60.

Lary, Banning Kent (1989), " North American Neighbors Are Tearing Down Their Fences," Management Review, (September), 47-51.

Lawrence, Richard (1989), "U.S., Mexico Envision New Customs Facility," Journal of Commerce, (October 3).

LeKashman, Raymond and John F. Stolle (1965), "The Total Cost Approach to Distribution," Business Horizons in Bowersox, Donald J., LaLonde, Bernard J. and Edward A. Smykay, (eds.), Readings in Physical Distribution Management, (1969), London: The Macmillan Company, 33-46.

LeMay, Stephen A. and Wallace R. Wood (1989), "Developing Logistics Decision Support Systems," Journal of Business Logistics, Vol. 10, No. 2, 1-23.

Levitt, Theodore (1983), "The Globalization of Markets," Harvard Business Review, 61 (May-June), 92-102.

Lewis, Ronald J. (1968), "Strengthening Control of Physical Distribution Costs," Management Services, in Bowersox, Donald J., LaLonde, Bernard J. and Edward A. Smykay, (eds.), Readings in Physical Distribution Management, (1969), London: The Macmillan Company, 316-330.

Lewis, Howard T., James W. Culliton and Jack D. Steele (1956), The Role of Air Freight in Physical Distribution, Boston: Division of Research, Graduate School of Business Administration, Harvard University, as cited in Bowersox, Donald J., Edward W. Smykay and Bernard J. LaLonde (1968), Physical Distribution Management, Rev. Ed., London: The Macmillan Company.

Litvak, Isaiah A. (1988), "Free Trade Strategies with Canada," The Journal of Business Strategy, (November/December), 34-39.

Logendran, Rasaratnam and Palmer M. Terrell (1988), "Uncapacitated Plant Location-Allocation Problems with Price Sensitive Stochastic Demands," Computers and Operations Research, Vol. 15, Iss. 2, 189-198.

Lopez, Rigoberto A. and Nona R. Henderson (1989), "The Determinants of Location Choices for Food Processing Plants," Agribusiness, Vol. 5, Iss. 6, (November), 619-632.

Losch, August (1954), The Economics of Location, New Haven: Yale University Press.

Magee, John F. (1960), "Operations Research in Making Marketing Decisions," Journal of Marketing, 25 (October), 18-23.

Maggs, John (1990), "First Step Near on US-Mexican Free Trade Treaty," Journal of Commerce, (September 17), 14A.

McConnell, James E. and Alan MacPherson (1990), Canadian Direct Investment in Western New York: A Preliminary Analysis of Corporate Strategy, Business Performance, and Regional Development Impact, State University of New York, U.S. Trade Center, Buffalo, New York, (March 22-24).

McCray, John P. and Juan J. Gonzalez (1989), "Increasing Global Competitiveness with U.S.-Mexican Maquiladora Operations," SAM Advanced Management Journal, 54(3)(Summer), 4-48.

McRae, Nancy, U.S. Department of Transportation, Interview on September 19.

Michigan Intra-State Motor Tariff Bureau, Inc. (1988), Docket # 1-88 before the Michigan Public Service Commission, Lansing, MI, April 1, 1988.

Miller, H. G. (1961), "Accounting for Physical Distribution," Transportation and Distribution Management, in Bowersox, Donald J., LaLonde, Bernard J. and Edward A. Smykay, (eds.), Readings in Physical Distribution Management, (1969), London: The Macmillan Company, 150-159.

Mossman, Frank H., Paul Bankit and Omar K. Helferich (1977), Logistics Systems Analysis, Washington D.C.: University Press of America.

Nabisco Foods (1990), Telephone Interviews with staff, October, 1990.

Ohmae, Kenichi (1987), Beyond National Borders (Dow Jones-Irwin).

Palander, Tord (1935), Bertrage zur Slandort Stheorie, Uppsula, as cited in Bowersox, Donald J. (1960), Evaluation of Alternative Solutions to the Food Distribution Center Location Problem, A Dissertation, East Lansing, Michigan, Michigan State University.

Parker, Donald D. (1962), "Improved Efficiency and Reduced Cost in Marketing," Journal of Marketing, Vol. 26, No. 2 (April), 15-21.

Payne, Joseph E., Paul Dacher, et. al. (1990), "Western Hemisphere: The Outlook Is Bullish in Canada as Companies Respond to the FTA," Business America, Vol. 111, Iss. 8 (April 23), 22-27.

Peters, Douglas D. (1986), "The Branch Plant in a Freer Trade Environment," Economic Development Review, 4(2)(Summer), 30-32.

Pick, James B., Edgar W. Butler and Elizabeth L. Lanzer (1989), Atlas of Mexico, Boulder, Colorado: Westview Press.

Powers, Richard F. (1989), "Optimization Models for logistics Decisions," Journal of Business Logistics, Vol. 10, No. 1, 106-121.

Powers, Thomas L. (1985), An Examination of the Effects of Trade Incentives on Logistical Performance in the Grocery Products Industry, A Dissertation, East Lansing, Michigan: Michigan State University.

Powers, Thomas L. and David J. Closs (1987), "An Examination of the Effects of Trade Incentives on Logistical Performance in a Consumer Products Channel," Journal of Business Logistics, Vol. 8, No. 2, 1-28.

Predicasts (1989) Predicasts F and S Index International Annual, Annual Edition, Vol. 1, Cleveland, OH: Predicasts.

Predicasts (1990) Predicasts Forecasts, 1990, Issue No. 120, Cleveland, OH: Predicasts, August 3.

Predicasts (1990) Predicasts F and S Index, Vol. 31, No. 1-39, Cleveland, OH: Predicasts.

Rand McNally & Company (1983), Rand McNally Zip Code Atlas, Chicago, Illinois, 1983.

Rayburn, L. Gayle (1967), "Setting Standards for Distribution Costs," Management Services in Bowersox, Donald J., LaLonde, Bernard J. and Edward A. Smykay, (eds.), Readings in Physical Distribution Management, (1969), London: The Macmillan Company, 160-178.

Revenue Canada, Customs and Excise Division, Telephone Interview with Import Specialist, Toronto, Canada, September 18, 1990.

Richards, Hoy A. (1972), "Transportation Costs and Plant Location: A Review of Principal Theories," in Bartlett, Hale C. (ed.), Readings in Physical Distribution, Chicago: The Interstate Publishers and Printers, Inc., 124-131.

Roberts, Karen D. and Philip R. Smith (1989), "The Canada-U.S. Free Trade Agreement and Spatial Decentralization of Manufacturing," at the Biennial Meeting of the Association for Canadian Studies in the United States, San Francisco, November.

Rockart, John F. and James E. Short (1989), "IT in the 1990s: Managing Organizational Interdependence," Sloan Management Review, (Winter), 7- 17.

Royal Bank of Canada (1990), "Mexico-U.S. Free Trade Talks: Why Canada Should Get Involved," Econoscope, Special Edition (September), Montreal, Canada, 1-12.

Schulz, John D. and Ira Rosenfeld (1990), "U.S.-Canada Free Trade Agreement; Savior or Satan? Debate Replacing Tariffs," Traffic World, (March 26), 8-10.

Shackleford, J. Cooper (1984), "Preliminary Site Studies," Site Selection Handbook, Vol. 29, No. 2 (May).

Shycon, Harvey N. and Richard B. Maffei (1960), "Simulation-Tool for Better Distribution," Harvard Business Review, (November-December), 65-75.

Sims, Jeffrey R. (1974), Simulated Product Sales Forecasting: An Analysis of Forecasting and Operating Discrepancies in the Physical Distribution System, A Dissertation, East Lansing, Michigan: Michigan State University.

Smith, George C. (1966), "Knowing your P.D. Costs," Distribution Age, in Bartlett, Hale C. (ed.), Readings in Physical Distribution, Chicago: The Interstate Publishers and Printers, Inc., 72-82.

Smith, Guy C. (1989), "The United States-Mexico Framework Agreement: Implications for Bilateral Trade," Law and Policy in International Business, 20(4), 655-81.

Smykay, Edward W. (1959), Formula to Check for a Plant Site," Distribution Age, 63 (January), 32-34.

Smykay, Edward W., Donald J. Bowersox and Frank H. Mossman (1961), Physical Distribution Management, London; The Macmillian Company.

Speh, Thomas W. (1974), The Performance of a Physical Distribution Channel System Under Various Conditions of Demand Uncertainty: A Simulation Experiment, A Dissertation, East Lansing, Michigan: Michigan State University.

Standard and Poor's Corporation (1988), Standard and Poor's Industry Surveys, New York: Standard and Poor's Corporation, January 16.

Statistics Canada (1985), Employment, Earnings and Hours, Labor Division, Employment Survey Operations Section, Catalog 72-002, Vol. 63, No. 5, Ottawa, May.

Statistics Canada (1988), Census Federal Electoral Districts 1986, Representation Order, Part 2, Publication 94-126, Ottawa, Canada, August, 1988.

Statistics Canada (1986), Food Industries Catalog 32-250 Annual, Ottawa, Canada, 1986.

Statistics Canada (1990), Bilateral Trade for Canada - U.S. Import and Export for 1989.

Steltzer, Theresa M. (1990), "A Model Way to Make Decisions," Distribution, January, 49-54.

Tariff Schedule of Canada (1987), The Canada - U.S. Free Trade Agreement, Annex 401.2, (October 27).

Tausz, Andrew (1989), "Cabotage Rules: Playing Fair on the Border," Chilton's Distribution, 88, 12 (December), 36-40.

Tausz, Andrew (1990), "Backups at the Border Slow U.S./Canada Trade," Chilton's Distribution, 89 (May), 60-64.

Taylor, John C. (1988), Michigan/Ontario Trade and Transborder Transportation: Current Levels, Forecasts, and Problems and Opportunities, Michigan Department of Transportation, Lansing, Michigan, October 24.

Taylor, John C. (1990), "The U.S./Canada Free Trade Agreement: Facility Location Implications for Michigan," in The Canada-United States Free Trade Agreement: Perspectives and Implications, Canadian Studies Center, Michigan State University, East Lansing, Michigan, January 8.

Thompson, Robert W. and Ford Harding (1985), "Product Life and Plant Location: How Four Stages in a Product's Life Cycle Influence Site Selection," Dun's Business Month, Vol. 126, Iss. 5 (November), 73-94.

Traffic Management (1985), "A Pioneers Perspective," Traffic Management, (June).

Transport Topics (1989), "Transborder Costs Provoke Rate Increase Filings," Transport Topics, August 28.

United Nations (1987), Economic Survey of Latin America and the Caribbean, Table 149.

United States Customs Service, Telephone Interview with Import Specialist, October, 1990.

United States Department of Commerce (1990), 1990 U.S. Industrial Outlook, 34.2-34-18, January, 1990.

United States Department of Commerce (1990), Mexican Tariff Schedules (Sistemas Dinamicos Internationales), 1990.

United States International Trade Commission (USITC) (1990), Operation of the Trade Agreements Program (Publication 2317), September.

Van der Hoop, Hans (1988), "Europhobia or Europhoria?," Distribution, (October), 38-46.

Von Thunen, Johann Heinrich (1826), Der Isolurte Staat in Benziehung auf Landwirtschaft und Nationalokonomie, Hamburg, as cited in Richards, Hoy A. (1972), "Transportation Costs and Plant Location: A Review of Principal Theories," in Bartlett, Hale C. (ed.), Readings in Physical Distribution, Chicago: The Interstate Publishers and Printers, Inc., 124-131.

Wassmansdorf, Paul A. (1960), Management of the Physical Distribution Function, Management Report No. 49, New York: American Management Association, in Bartlett, Hale C. (ed.), Readings in Physical Distribution, Chicago: The Interstate Publishers and Printers, Inc., 65-71.

Weber, Alfred (1929), Theory of the Location of Industry, Chicago: University of Chicago Press as cited in Richards, Hoy A. (1972), "Transportation Costs and Plant Location: A Review of Principal Theories," in Bartlett, Hale C. (ed.), Readings in Physical Distribution, Chicago: The Interstate Publishers and Printers, Inc., 124-131.

Whitney, Michele (1989), "Experts Match Businesses and Sites," Journal of Commerce, (November 20), 5A.

Whirlpool (1990), Telephone Interviews with staff, November, 1990.

Wickens, Barbara (1990), "A Giant Marketplace," MacLean's 103(26)(June 25) 20-21.

World Almanac (1990), New York: World Almanac Publishing.

Yaseen, Leonard D. (1956), Plant Location, New York: American Research Council, as cited in Bowersox, Donald J. (1960), Evaluation of Alternative Solutions to the Food Distribution Center Location Problem, A Dissertation, East Lansing, Michigan, Michigan State University.

Yellow Freight System, Inc. (1990), United States Zip Disk, Overland Park, KS.

Yellow Freight System, Inc. (1990), Interview with executives, September 17, 1990.

Yellow Freight System, Inc. (1990), Laredo Office, Internal Mexican freight rates fax.

MICHIGAN STATE UNIV. LIBRARIES
31293005945666