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UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

EVALUATING A TRADE POLICY USING A REVEALED PREFERENCE APPROACH

A Dissertation

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirement for the

degree of

Doctor of Philosophy

By

DEERGHA RAJ ADHIKARI
Norman Oklahoma
2002

UMI Number: 3042504



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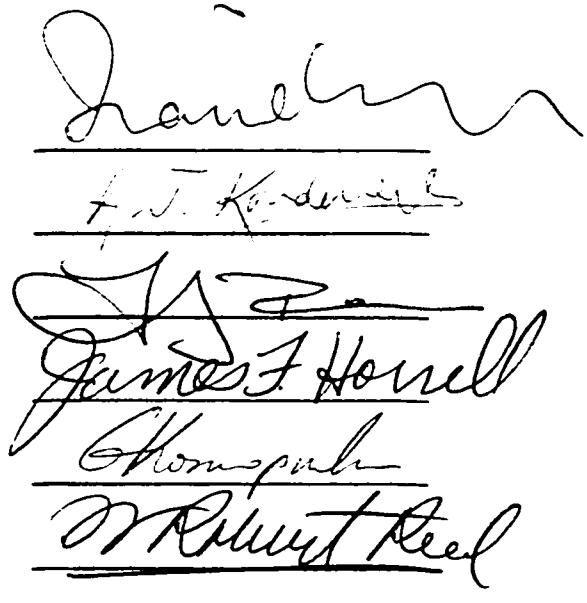
EVALUATING A TRADE POLICY USING A REVEALED PREFERENCE APPROACH

A Dissertation APPROVED FOR THE DEPARTMENT OF ECONOMICS

BY



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ACKNOWLEDGEMENT

I can never forget the morning of August 23, 1995 when I first arrived in Norman with my family. I didn't have any housing arrangement. So, I had no clue what to do and where to go. I first met with Dr. Bob Reed. He and his whole family not only helped me like their own family member, but also took so much pain for establishing me in a totally new environment. Dr. Reed's simple but effective way of teaching also built in me a strong foundation of econometric theory. I am deeply indebted to Dr. Reed and his family.

Dr. Alex Kondonassis was not only the chair of my dissertation committee but he also taught me economic development theory. As a chair he had been very kind to guide me through my whole dissertation work. As an instructor, he taught me many challenging issues of economic development in a very easy and interactive way. I always enjoyed his class and learned a lot. So, my sincere and deep appreciation goes to Dr. Kondonassis.

Dr. Jiandong Ju took too much trouble for me throughout my whole dissertation work. As a chair of my dissertation committee, he not only helped me understand some of the tough concepts involved, but also walked me through some of the toughest moment during my dissertation work. His door was always open to me. He never hesitated to give me sincere advice whenever I had a problem. I deeply and sincerely appreciate his help.

My dissertation was an attempt to use a non-parametric indicator to analyze the economic impact of a trade policy. Theoretical linking of a non-parametric model to an economic outcome was a tough job. Dr. Timothy Dunne's help in identifying and analyzing the possible theoretical links between an indicator and an economic result made my dissertation a worthwhile piece of work. So, I am indebted to Dr. Dunne.

I express my heartfelt appreciation to Dr. Georgia Kosmopoulou who took lot of trouble for me and helped me make my dissertation a success. I can never forget her untiring support during my work. I enjoyed working with her as a Research Assistant.

Dr. James Horrell's nice way of teaching strengthened my foundation of statistics. This foundation helped me a lot in completing my dissertation. As a member of my dissertation committee he gave me many valuable insights. In addition to that, I was greatly benefited from his advice with regard to my career. So, I express my heartfelt appreciation to him.

Working with Dr. William Clark, Dr. Tade Okediji, and Dr. Sangeeta Bishop was a pleasant experience. I not only had a chance to gain valuable work experience, but I also learned a lot about economic concepts while working with them. So, I am deeply indebted to them.

Dr. Zhen Zhu built my foundation of time series econometric analysis. This foundation helped me a lot in my dissertation work. His nice teaching style also further strengthened

my knowledge of macroeconomics. Similarly, Dr. James Hartigan's humorous teaching style not only helped me understand international trade theory in an easy way, but also motivated me to pursue my research in that filed. So, I am also deeply indebted to Dr. Zhu and Dr. Hartigan.

Dr. Daniel Shutter and Dr. Stephane Dunne's friendly way of teaching helped me understand tough concepts of game theory. I express my heartfelt appreciation for them. I also express my appreciation to Ms. Lin Goldston for her help during my final days of dissertation.

I am deeply indebted to my father Dev Raj Adhikari and mother Savitri Adhikari who took enormous pain to raise and educate me. Most of my achievements are the part of their contribution. My completion of the Ph.D. degree is the result of their continuous inspiration and encouragement. So, I pay my respect to them and pray the god for their happiness and good health.

I am lucky to have Anita as my wife. She sacrificed her days and nights and her happiness for me. In every walk of my life, she accompanied me like a shadow. She has greatest contribution in all my achievements and successes. My son Sumit and daughter Sweekriti have been the greatest inspiration of my life. Their innocence, smile and selfless love helped me overcome some of the toughest moments of my life. I am indebted to them and take this opportunity to express my deep and heartfelt appreciation to them.

At last, I would like to thank the University of Oklahoma and especially the Department of Economics for providing me with the opportunity to pursue my Ph.D. degree.

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ABSTRACT

The traditional theory of international trade suggests that, in perfectly competitive markets, international trade always increases welfare. The theory of second best suggests that, in the presence of multiple distortions, a reduction in a distortion may actually reduce the welfare. With the welfare consequences of trade reform still being debated, there have been very sparse empirical studies to test these results. Moreover, the empirical studies done so far on this issue are mostly based on ex-ante approach, which looks for a set of policy prescriptions, which yield welfare improvement. Ju and Krishna's model built upon that of Dixit and Norman has shown that Ohyama's conditions under the assumption of many consumers and small country case are sufficient to ensure that a trade reform is a Pareto improvement. However, their model has not yet been tested empirically. This study, therefore, attempts to develop an empirical method to test Ohyama's and others' revealed preference approach, which looks for some indicator to determine if welfare has risen due to a trade reform. This study also applies the empirical method to test welfare effect of a trade reform. The study chose U.S.A. and Mexico for observation and considers the signing of NAFTA by the two countries as a form of trade reform. It then applies two empirical approaches: linear regression model approach and intervention model approach to test the hypothesis that U.S. welfare has increased due to liberalization of its trade with Mexico under the NAFTA agreement. The test results from both the linear regression model and the intervention model confirm the hypothesis that U.S. welfare has increased due to the liberalization of its trade with Mexico.

CHAPTER - 1

INTRODUCTION

1.1 Statement of the Problem

From its very inception international trade has mostly been directed with the objective of improving the aggregate well being of the country initiating the trade. Similarly, all trading partners entering the trade are also assumed to have entered the trade with the expectation of increasing its welfare in a way or the other in a usual situation. But, do all trading partners really benefit from international trade? The traditional theory suggests that, in perfectly competitive markets, international trade always increases the welfare of trading partners by bringing about efficiency in resource allocation. It has further been argued that, in imperfectly competitive markets, trade liberalization will bring additional welfare gains by reducing the dead weight losses created by domestic monopolies and oligopolies by increasing competition and reducing price-marginal cost markups[1].

The welfare enhancing outcomes of theoretical models with the assumption of perfect competition have led to the belief that any step toward perfect competition by relaxing existing trade barriers could be welfare enhancing. This

[1] Helpman, E. and Paul Krugman (1989). Trade Policy and Market Structure, MIT Press, Cambridge, MA.

is the stand taken by GATT that requires its member countries to undertake policy reforms towards complete trade liberalization.

However, The theory of second best suggests that, in the presence of multiple distortions, a reduction in a distortion may actually reduce the welfare. Thus, there are debates still going on as to what condition can ensure a welfare improvement as a consequence of trade liberalization. Although the impact of trade liberalization is itself being debated and there have been very sparse empirical studies to support one side or the other, there is a branch of studies that has devoted itself to the argument on the proper form of trade reform. Regarding the welfare consequences of the different forms of trade reforms two basic results exist. The first one is called concertina rule[2,3] which shows that the policy that reduces the highest tariff rate to the level of the second highest rate, will improve welfare if (i) inferior goods do not exist, and (ii) the good on which the highest tariff rate is imposed is substitute to all other goods both in consumption and production. The other one shows that uniform proportional tariff reduction raises welfare[4]. However, there have been very sparse empirical studies to test these results. Since the United States signed NAFTA with Canada and Mexico in 1993 there has been an ongoing debate on the welfare consequences to the U.S of such

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[2] Hatta, Tatsuo. 1977. "A Recommendation for a Better Tariff Structure", Econometrica, vol. 45, No. 8, pp. 1859 – 1869.
[3] Hatta, Tatsuo and Takashi Fukushima (1979). " The Welfare Effect of Tariff Rate Reductions in a Many Country World.", Journal of International Economics, vol. 9, pp. 503 – 511.
[4] Fukushima, Takashi and Namdoo Kim, "Welfare Improving Tariff Changes: A Case of Many Goods and Countries." Journal of International Economics, vol. 26, pp. 383 – 388.

an agreement. While the welfare impact of such an agreement is still being debated an agreement signed by 34 American countries on the conclusion of their three-day summit[5] on April 22, 2001 in Quebec City, Canada to open a free trade zone called Free Trade Area of Americas (FTAA) by the end of year 2005 has put additional fuel to the debate. In the face of increasing temptation among the trading partners to open new free trading zones or to expand the existing ones has made any study aimed to evaluate the welfare impact of such an arrangement even more interesting. Most of the work in this area applies what is called ex-ante approach, which looks for a set of policy prescriptions that yields welfare improvement. The models developed under this approach mostly make use of explicit utility function. They either assume a representative consumer and develop aggregate utility function for a country or develop a utility function at individual consumer/household level and use some weight to derive an aggregate utility function to derive welfare implications of a trade policy or a trade reform policy. So far, there have been numerous studies on the welfare impact of bilateral and multilateral free trade agreements. Some of the studies have even developed very sophisticated welfare functions and have derived necessary conditions for welfare improvement. Others have put stringent restrictions on their models to make the models able to produce welfare results. However, no matter how sophisticated and strict those models are they still suffer from the problem of being unrealistic. Because some of the conditions set forth by those

[5] Daily Oklahoman, Monday. April 23, 2001.

models can not be realized or achieved in the real world. To the contrary, Ohyama[6] have applied ex-post approach for the measure of welfare improvement. His approach looks for the indicators, which can be examined in order to see if welfare has risen due to a reform. However, Ohyama's model is based on single representative consumer assumptions. As such, his model does not quite address the political economy problem arising due to the fact that a trade policy may affect different consumers in different ways. Some may gain from a trade reform while the others may lose. Grinols and Wong have extended Ohyama's results to many consumers case. But their model requires that the welfare weight of individuals be constant and be reciprocals to marginal utilities of income. Such problem has been avoided in Dixit and Norman's[7] model. With the assumption of constant return to scale, no joint production, continuous demand, and holding of the Weymark condition Dixit and Norman have derived conditions under which Pareto improvement is ensured by trade. However, their model derives the condition for Pareto improvement in terms of gains from trade. Their model does not address the issue of welfare impact of a trade reform policy. Ju and Krishna[8] on the other hand, extending Ohyama's results and building on that of Dixit and Norman have derived sufficient conditions for welfare improving trade reform.

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[6] Ohyama, M. (1972). " Trade and Welfare in General Equilibrium,", Kcio Economic Studies, 9(2), pp. 37-73.

[7] Dixit, Avinash, and Victor Norman (1980). Theory of International Trade (Cambridge: Cambridge University Press).

[8] Ju, Jiandong and Kala Krishna, " Evaluating Trade Reform With Many Consumers," Canadian Journal of Economics, August 2000, vol. 33, no. 3, pp. 787-798.

They have also developed a sufficient condition for a country's welfare improvement due to a trade reform in many-consumer case.

Ju and Krishna's model is simple and non-parametric and avoids the need of a functional form assumption on preferences. It also avoids the distributional problem arising from representative consumer assumptions. However, their model has not yet been tested empirically. The main problems associated with the testing of their model are two folds. First, the choice of any two periods: one before a trade reform and the other after the reform, for the sake of welfare comparison could be purely arbitrary. This is because the impact on welfare in any post-reform period could be the result of the cumulative effect of any policy change in previous years. Second, the change in the value of net import (a measure of welfare change in Ju and Krishna's model) could be the result of several other factors in addition to a trade reform policy. If such problems are avoided then their model will be far more simple and practical to use for testing welfare effect of a trade policy. In this study, we attempt to develop two empirical methods to test Ju and Krishna's model while avoiding the two problems associated with the testing of their model. So, the first motivation of this paper is to fill a gap in trade literature by developing simple and empirically testable model and technique to evaluate the welfare impact of a trade reform policy while avoiding functional form assumptions on preferences and the issue of income distribution.

Further, the empirical studies done so far on the impact of NAFTA on U.S. economy mostly deal with the impact of NAFTA on certain sectors of U.S. economy such as employment in agriculture, auto, and textile industries, U.S. trade balance, change in U.S. trade and industrial structure, etc. There is one study by Trela and Whalley(1994) which evaluates welfare gains to U.S. of liberalizing textile trade. However, none of these studies address the issue of welfare impact of NAFTA on U.S. economy at an aggregate level. So, the second motivation of this study is to fill a gap in NAFTA literature by evaluating the welfare impact of NAFTA on U.S. economy at aggregate level using a revealed preference approach. The objective and the hypotheses of the study have been set as following:

1.2 Objective of the Study

(a) To develop an empirical method to test welfare effect of a trade reform policy

(b) To apply the method to the case of NAFTA

1.3 Hypothesis of the Study

The study hypothesizes that the welfare of the United States has increased due to the liberalization of its trade with Mexico under the NAFTA agreement.

1.4 Organization of the Study

A review of literature related to trade and welfare has been presented in chapter-2. A detailed theoretical framework on which the study is based has been developed in chapter-3. Chapter-4 develops some empirical methods for the test of our hypothesis. It also outlines the methodology of the study and the data sources. Chapter-5 gives the empirical estimation and test results. Finally, chapter-6 summarizes the study.

CHAPTER – 2

REVIEW OF LITERATURE

The literature for this study has been confined to three major aspects of international trade: welfare effect of a trade policy, approaches to evaluate welfare effects of a trade policy, and effect of NAFTA on the U.S. economy.

2.1 Effect Of A Trade Policy

The literatures on the effect of a trade policy address various issues, such as economic growth, welfare, income distribution, and so on. But this study confines itself to the welfare effect of a trade policy.

2.1.1 Welfare Effect

Feenstra[9] has analyzed the welfare effect of a trade policy by decomposing the effect into four major components, viz. deadweight loss, terms of trade effect, economy of scale effect, and change in industry output effect. He has extended the framework of Rodrik[10], by treating imports and domestically

[9] Feenstra, Robert C., Handbook of International Economics, vol. III, Edited by G. Grossman and K. Rogoff, 1995, pp. 1554-1595.
[10] Rodrik, D. (1988), "Imperfect Competition, Scale Economies, and Trade Policy in Developing Countries," in R. E. Baldwin ed. , Trade Policy Issues and Empirical Analysis (University of Chicago and NBER, Chicago), pp. 109-137.

produced goods as imperfect substitutes. His analysis is based on the compensation principle.

He measures the welfare effect of a trade policy by the difference between total income received under the trade policies and consumer expenditure at the free trade utility level. This difference gives the amount to be compensated for keeping the consumer at the old utility level. According to his analysis the amount to be compensated is affected by four factors. The first factor is the deadweight loss that occurs due to change in import volume. If the domestic price is higher than the import price, then the higher is the consumption of imported goods the larger is the deadweight loss.

The second factor is the terms of trade effect. If the export price of domestically produced goods increases due to trade then there is net gain from the export. On the other hand, if the import price goes up after the opening/liberalization of trade then there is net loss due to import. So the terms of trade effect is given by excess of net export gain over net import loss. The third factor is the economies of scale. If the domestic industry is operating under increasing return to scale then the marginal costs of production are lower than the average cost and, therefore, an expansion of domestic output brought about by the opening/liberalization of trade increases the profits of domestic industry. The fourth factor is the profit effect. If the prices of domestically produced goods increase after the opening/liberalization of trade then there is a net profit gain to

the domestic firms. These are the four channels through which a trade policy can affect domestic welfare.

There are two other channels by which welfare is affected due to a trade policy. This is because an expansion of employment in the highest-wage industries increases welfare as the average costs of production in higher wage industry exceed the social opportunity costs of withdrawing workers from other industries (see Katz and Summers).[11]

The second is change in the number or range of differentiated products (see Feenstra).[12]

2.2 Approaches to Evaluate Welfare Effect

There have been developed numerous models to evaluate the welfare effect of a trade policy. But the models developed so far are basically static models. These models actually do welfare comparison between two points in time (before and after the implementation of a trade policy). These model completely ignore the dynamic elements which may be involved in the change in welfare between two points in time. Moreover, these models mostly rely on explicit utility function. This section summarizes some of the static models used in empirical analysis to evaluate welfare effect of a trade policy.

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[11] Katz, L. F. and L. H. Summers (1989), "Industry Rents: Evidence and Implications," Brookings Papers on Economic Activity: Microeconomics, pp. 209-290. economic Growth Center, Yale University, Dec. 1997.

[12] Feenstra, R. C. (1994). "New Product Varieties and the Measurement of International Prices," American Economic Review, vol. 84, pp. 157-177.

2.2.1 Ex-Ante Approach to Welfare Measurement

An ex-ante approach for evaluating welfare effect looks for a set of policy prescription which yields welfare improvement. This approach sets a sufficient and/or necessary condition for welfare improvement. It then tests on the available data to see if the condition has been satisfied. If the condition is satisfied the ex-ante approach concludes that welfare has improved following or due to the trade policy in question. This sub-section outlines some of the welfare indicators based on ex-ante approach and comparative static analysis.

For quite some time consumer's surplus had been the main measure of welfare effects of changes in prices and incomes brought about by a policy change.

(a) Measuring Welfare using Consumer's Surplus Approach

Slesnick[13] outlines the consumer's surplus approach by assuming that the consumer's surplus is single valued and ordinally equivalent to the change in utility, that demands are generated by a rational consumer who maximizes utility subject to limited resources, and that demands are integrable and consistent with a well-behaved utility function (see Hurwicz and Uzawa[14]). To show the welfare effect of a trade policy to a household he uses an indirect utility function

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[13] Slesnick, Daniel T., "Empirical Approaches to the Measurement of Welfare," Journal of Economic Literature, vol. XXXVI, (Dec. 1998), pp. 2108-2165.

[14] Hurwicz, Leonid and Hirofumi Uzawa (1971)."On the Integrability of Demand Functions," in Preferences, Utility and Demand, J. Chipman et. al eds. NY: Harcourt, Brace Jovanovich, pp. 114-148.

that represents the maximum attainable utility at certain price and expenditure levels. Applying the Roy's Identity, he then generates demand function for an individual good by dividing the negative of the derivative of the indirect utility function with respect to the price of the good by the derivative of the indirect utility function with respect to the expenditure of an individual household. Next, he derives the integral of the individual demand curve between two equilibrium prices: one before a trade policy and the other after the trade policy. Finally, he sums the negative of such integrals for each individual household to derive the effect of a trade policy on the national welfare.

The main drawbacks of this approach are that it assumes that the consumer's surplus is single valued, demands are generated by a rational consumer who maximizes utility subject to limited resource, and the demands are integrable and consistent with a well-behaved utility function. Above all this approach needs to make functional form assumption on preferences.

(b) Index Number Approach

This approach avoids the need of functional form assumptions on preferences and evaluates the relative levels of welfare using Samuelson's[15] principle of revealed preference. This method is nonparametric and makes unnecessary the assumption that individuals have identical preferences. Under

[15] Samuelson, Paul A. 1948. "Consumption Theory in Terms of Revealed Preference." Economica, vol. 15, no. 60, pp. 243-253.

the condition of internally consistent preferences it can be concluded that an individual is at least as well off in the base period if $p^{0\prime}X_k^0 \geq p^{0\prime}X_k^1$ and similarly in period 1 if $p^{1\prime}X_k^1 \geq p^{1\prime}X_k^0$. But if neither condition holds then the method is inconclusive. This limitation is an obvious impediment to practical applications of this approach. Further, this approach analyzes the welfare consequences to an individual of a change in price and income. But how can the indicators be used at aggregated level to rank social outcomes? The following four methods address the aggregation problem.

(i) Representative Agent Model

Under this model the market demands are assumed to be generated by a representative consumer. This model also assumes that the preferences of the consumer are revealed by aggregate demand patterns.

(ii) Pareto Principle

According to this criterion a socially preferable policy is the one under which everyone is better off relative to the alternative policy.

(iii) Compensation Principles

Under this criterion policy 1 is judged to be an improvement over policy 2 if it is possible to reallocate goods in 1 to yield an allocation that is Pareto superior to 2.

Kaldor-Hicks-Samuelson approach as explained by Chipman and Moore[16] provides a more stringent criterion for welfare comparison. Under this approach, if, for any allocation of goods under policy 1, it is possible to find an allocation under policy 2 that is Pareto superior to it, then policy 2 is preferable to policy 1.

(iv) Aggregate Surplus Measure

This approach avoids the need of using compensating variations or equivalent variations to make welfare comparisons. Rather than use the sum of the compensating or equivalent variations as indicators of potential welfare, an alternative approach is to define a function over the individual surplus measures as an explicit representation of the change in social welfare. As advocated by Harberger[17] such function exactly represents the change in welfare for each individual, and would serve to be an ideal candidate for the arguments of a social welfare function.

2.2.2 Revealed Preference Approach to Welfare Measurement

This approach avoids some of the weaknesses of ex-ante approach by making the use of an utility function unnecessary. Ohyama[18] applied revealed

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[16] Chipman, John S. and James Moore, 1971, "The Compensation Principle in Welfare Economics," in Papers in Quantitative Economics, A. Zarly and J. Moore, eds. Lawrence: U. Press of Kansas, pp. 1-77.

[17] Harberger, Arnold C., 1971, "Three Basic Postulates for Applied Welfare Economics," Journal of Economic Literature, vol. 9, no. 3, pp. 785-797.

[18] Ohyama, M. (1972). " Trade and Welfare in General Equilibrium.", Keio Economic Studies, 9(2), pp. 37-73.

preference approach for the measure of welfare improvement. Ohyama's approach avoids the weaknesses of ex-ante approach. His approach looks for the indicators which can be examined in order to see if welfare has risen due to a reform. However, Ohyama's model is based on single representative consumer assumptions. As such, his model does not quite address the political economy problem arising due to the fact that a trade policy may affect different consumers in different ways. Some may gain from a trade reform while the others may lose. Grinols and Wong (1991) have extended Ohyama's results to many consumers case. But their model requires that the welfare weight of individuals be constant and be reciprocals to marginal utilities of income. Such problem has been avoided in Dixit and Norman's[19] model. With the assumption of constant return to scale, no joint production, continuous demand, and holding of the Weymark condition Dixit and Norman have derived conditions under which Pareto improvement is ensured by trade. However, their model derives the condition for Pareto improvement in terms of gains from trade. Their model does not address the issue of welfare impact of a trade reform policy. Ju and Krishna[20] on the other hand, extending Ohyama's results and building on that of Dixit and Norman have derived sufficient conditions for welfare improving trade reform. They have also developed a sufficient condition for a country's welfare improvement due to a

[19] Dixit, Avinash, and Victor Norman (1980). Theory of International Trade (Cambridge: Cambridge University Press).
[20] Ju, Jiandong and Kala Krishna. " Evaluating Trade Reform Using Ex-Post Critcria," NBER W. P. No, 6152.

trade reform in many-consumer case. In case of many consumers, Ju and Krishna's[21] sufficient condition for welfare improvement requires that the import bundle be affordable at new (post-reform) prices.

Grinols and Wong[22] deal with many consumers case and show that if all individuals are given equal weight in welfare, then holding the condition that old consumption bundle should be affordable at new (post-reform) prices is sufficient for a Pareto improvement.

Ju and Krishna in their paper have extended Grinols and Wong's results to the case of small country with many consumers and with no restriction on the social welfare function. Their results in many consumers case can be summarized as following:

The condition that the old net import bundle must be affordable at post-reform price is sufficient for the change in tariffs to result in a potential Pareto improvement in welfare in a small country with many consumers, perfect competition, constant return to scale and no joint production, where lump-sum / taxes transfer are available as instruments. This condition ensures that no one is worse off from the reform.

Ju and Krishna's model is simple and non-parametric and avoids the need of a functional form assumption on preferences. It also avoids the

[21] Ju, Jiandong and Kala Krishna, (Aug. 2000). "An Exact Measure of Welfare Change, "Canadian Journal of Economics, vol. 33, no. 3, pp. 787-798.
[22] Grinols, E. L. and K. Wong (1991). "An Exact Measure of Welfare Change, "Canadian Journal of Economics, vol. 21, pp. 111-122.

distributional problem arising from representative consumer assumptions. However, their model has not yet been tested empirically. The main problems associated with the testing of their model are two folds. First, the choice of any two periods: one before a trade reform and the other after the reform, for the sake of welfare comparison could be purely arbitrary. This is because the impact on welfare in any post-reform period could be the result of the cumulative effect of any policy change in previous years. Second, the change in the value of net import (a measure of welfare change in Ju and Krishna's model) could be the result of several other factors in addition to a trade reform policy. If such problems are avoided then their model will be far more simple and practical to use for testing welfare effect of a trade policy. Therefore, in this study, we attempt to develop two empirical methods to test Ju and Krishna's model while avoiding the two problems associated with the testing of their model.

2.3 Impact of NAFTA on U.S. Economy

There are two major concerns that NAFTA opponents raised against NAFTA. Their first concern was that a surging import from Mexico together with an increasing capital flows to Mexico would cause the United States suffer a drastic job loss and a trade deficit. The other concern was the fear that NAFTA through a labor market transition in Mexico would cause unskilled labor

migration to the United States (see Burfisher, Robinson and Thierfelder[23]). On the other hand, NAFTA supporters argued that imports from Mexico would help both U.S. consumers and producers by providing cheaper final goods and intermediate goods respectively. However, the general consensus was that the effect of NAFTA on the U.S. economy would be positive but small and that on the Mexican economy would be positive and large. The concerns raised against and in favor of NAFTA have initiated most of the research in these areas. Therefore, most of the literature on the impact of NAFTA on the U.S. economy is mainly confined to three areas, viz. labor market, trade balance, and structural change. Therefore, we review the literature on NAFTA in these three areas.

2.3.1 Impact on U.S. Labor Market

An analysis by the International Trade Commission[24] of 120 manufacturing industries found that only seven sectors had an adverse effect on employment whereas four sectors had positive effect on employment, and in rest of the sectors NAFTA did not have any effect on employment. A similar analysis by the U.S. Department of Agriculture[25] using a dynamic computable general equilibrium model found that U.S. rural employment in 1996 was 0.07 percent higher with NAFTA than it would be without NAFTA.

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[23] Burfisher, Mary E., Sherman Robinson, and Karen Thierfelder. Winter 2001. "The Impact of NAFTA on the United States." Journal of Economic Perspective, vol. 15, no., pp. 125-144.
[24] U.S. International Trade Commission. 1997. "Impact of the North American Free Trade Agreement on the U.S. Economy and Industries: A Three Year Review." Washington, D.C.
[25] U.S. Department of Agriculture. 1997. NAFTA, WRS-97-2. Washington, D.C.

2.3.2. Impact on U.S. Trade Balance

Faux and Rothstein[26] using a macroeconomic model predicted that U.S. would lose as investment and production would shift from the U.S. to Mexico. Hufbauer and Schott[27], on the other hand predicted potential benefits to the U.S. However, a post-NAFTA study by De Janvry[28] found that U.S. export to Mexico actually fell by 14 percent with NAFTA, which would have fallen by 28 percent without NAFTA.

2.3.3 Impact on U.S. Industrial Structure

The benefits of free trade are realized through structural adjustment brought about by resource reallocation to the sectors where the trading partners have comparative advantage. The three such sectors of U.S. economy that were predicted to be mostly affected by NAFTA were agriculture, automobiles, and textiles.

A post-NAFTA study by the U.S. Department of Agriculture[29] found that U.S. agricultural exports to NAFTA countries increased by 9.5 percent whereas those to non-NAFTA countries increased only by 2.8 percent per year.

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[26] Faux, J. and R. Rothstein. 1991. Fast Track, Fast Shuffle: The Economic Consequences of the Administration's Proposed Trade Agreement with Mexico. Economic Policy Institute. Washington, D.C.

[27] Hufbauer, G. and J. Schott. 1992. Prospects fro North American Free Trade. Institute for International Economics. Washington, D.C.

[28] De Janvry, A. 1996 "NAFTA and Agriculture, An Early Assessment," Working paper no. 807. Gianninni Foundation. University of California, Berkeley, California.

[29] U.S. Department of Agriculture. 1999. NAFTA. WRS-99-1. Washington, D.C.

The United States used to a net importer from Mexico of autos and parts before NAFTA. However, a study by the U.S. Department of Commerce[30] found that, since NAFTA, although auto imports from Mexico more than doubled, but U.S. export to Mexico rose 14 times.

Regarding the impact of NAFTA on U.S. textile industry, a study by Trela and Whalley[31] using a computable general equilibrium model found that both the United States and Mexico have realized welfare gains by liberalizing textile trade.

Mainly there are two approaches to analyzing the economic impact of a regional trade arrangement, viz. computable general equilibrium models and so called "gravity models. Of the two, computable general equilibrium models are most popular for empirical analyses. In case of NAFTA, most of the computable general equilibrium analyses had been done before the initiation of NAFTA. Since then, regression analysis using "gravity" models has been used to assess the impact of NAFTA on the member countries. These models mainly use national income, exchange rates, and trade figures as the control or independent variables.

The empirical studies on the impact of NAFTA on U.S. economy are mainly targeted to analyzing the impact on certain aspects and sectors of U.S.

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[30] U.S. Department of Commerce, International Trade Administration, Office of Automotive Affairs. 1999. Fifth Annual Report to Congress Regarding the Impact of the North American Free Trade Agreement Upon U.S. Automotive Trade With Mexico. July.

[31] Trela, Irene and Whalley. 1994. "Trade Liberalization in Quota Restricted Items: The United States and Mexico in Textiles and Steel," in Modeling Trade Policy. J. Francois and C. Shiells, eds. Cambridge: Cambridge University Press.

economy. Those studies do not analyze the welfare impact of NAFTA on the whole U.S. economy. As such, there seems to be the need of studies that analyze the impact of NAFTA on the U.S. economy as a whole. This is exactly what we attempt to do in this study.

CHAPTER – 3

THEORETICAL FRAMEWORK

3.1 The Theory

The sufficient condition for a welfare enhancing trade reform as led out by Ohyama and others is as following:

Let P_t, P_t^w and T_t denote the vector of domestic price, world price and tariff in time period t respectively. Then the price equations can be represented as following:

$$P_t = P_t^w + T_t$$

Suppose, the tariff revenue is distributed back to consumers in lump-sum fashion. Then the budget constraint for country h can be expressed as,

$$E^h (P^h, u^h) = R^h (P^h, V^h) + T^{h'} M^h \quad , \qquad (3.1)$$

where, $E (P^h, u^h)$ is the standard expenditure function of the country;

$R (P^h, V^h)$ is the revenue function;

u^h is the utility level;

V^h is the factor endowments vector; and

M^h is the import vector.

Mexico is assumed to be a small country compared to the U.S. such that a change in the traded goods from Mexico does not affect the market condition in the rest of the U.S.

Assuming that $E(.)$ and $R(.)$ possess all standard properties, the vector of demand and supply functions and import functions for country h can be expressed as,

$E_p^h(P^h, u^h) = C^h(P^h, u^h)$ = Demand function;

$R_p^h(P^h, V^h) = X^h(P^h, V^h)$ = Supply function; and

$M^h(P^h, u^h, V^h.)$ $= E_p^h(.) - R_p^h(.)$ = Import.

The market clearing condition for the world can be written as

$$\sum [E_p^h(P^h, u^h) - R_p^h(P^h, V^h)] = 0 \qquad (3.2)$$

Equation (3.1) and (3.2) can be solved for endogenous variables u and P. Suppose, $C(P^1, u^1)$ is the consumption bundle at price P^1 and utility level u^1 at which the expenditure function $E(P^1, u^1)$ is minimized such that

$$E(P^1, u^1) = P^{1'}C(P^1, u^1), \tag{3.3}$$

where the superscript 1 stands for period 1. Adding and subtracting $P^{1'}C(P^o, u^o)$ from the right hand side of (3.3) gives,

$$\begin{aligned} E(P^1, u^1) &= P^{1'}C(P^1, u^1) + P^{1'}C(P^o, u^o) - P^{1'}C(P^o, u^o) \\ &= P^{1'}[C(P^1, u^1) - C(P^o, u^o)] + P^{1'}C(P^o, u^o) \end{aligned} \tag{3.4}$$

Since $E(P^1, u^o)$ is the minimum value of the expenditure function at P^1 and utility level u^o, it is obvious that

$$P^{1'}C(P^0, u^0) \geq E(P^1, u^o) \tag{3.5}$$

Thus from (3.4) and (3.5),

$$\begin{aligned} E(P^1, u^1) &= P^{1'}[C(P^1, u^1) - C(P^o, u^o)] + P^{1'}C(P^o, u^o) \\ &\geq P^{1'}[C(P^1, u^1) - C(P^o, u^o)] + E(P^1, u^o) \end{aligned} \tag{3.6}$$

$$E(P^1, u^1) - E(P^1, u^o) \geq P^{1'}[C(P^1, u^1) - C(P^o, u^o)] \tag{3.7}$$

Now, since u^1 and u^o are utility level with and without trade reform, the sufficient condition for a welfare enhancing trade reform (i.e. $u^1 > u^o$) is

$$P^{1'} [\, C(P^1, u^1) - C(P^o, u^o) \,] > 0, \qquad (3.8)$$

where, P^1 = Row vector of price after trade reform

$C(P^1, u^1)$ = Vector of consumption bundle chosen price and utility level after trade reform.

$C(P^0, u^0)$ = Vector of consumption bundle price and utility level chosen before trade reform

If the above condition is satisfied then,

$$u^1 > u^o$$

that is welfare is increased after trade reform. Ju and Krishna in their paper have extended Grinols and Wang's results to the case of small country with many consumers and with no restriction on the social welfare function. Their analysis goes as following:

If $E^{*h}(P, W, u^h)$ is the minimum lump sum transfer or tax required to keep household h at utility level u^h, then

$$E^{*h}(P, W, u^h) = P'C^h(P, W, u^h) - W'V^h(P, W, u^h), \qquad (3.9)$$

Where **P**, C^h, **W**, and V^h are product price, consumption of the household, factor price, and factor supply of household **h** respectively. From firm's profit maximizing behavior the maximized value of profits is given by

$$R^*(P, W) = P'X(P, W) - W'V(P, W) \tag{3.10}$$

From the envelope results,

$$E^*_p{}^h(P, W, u^h) = C^h(P, W, u^h)$$

$$E^*_w{}^h(P, W, u^h) = -V^h(P, W, u^h)$$

$$R^*_p(P, W) = X(P, W)$$

$$R^*_w(P, W) = -V(P, W) \tag{3.11}$$

The excess supply of the rest of the world at price **P** and tariffs **T** is given by **M (P, T)**. Thus the country's equilibrium condition prior to the reform is given by

$$\Sigma^H_{h=1}E^*_p{}^h(P^0, W^0, u^{h0}) = R^*_p(P^0, W^0) + M(P^0, T^0)$$

$$= \Sigma^H_{h=1}C^h(P^0, W^0, u^{h0})$$

$$\Sigma^H_{h=1}E^*_w{}^h(P^0, W^0, u^{h0}) = -V(P^0, W^0)$$

$$E^{*h}(P^0, W^0, u^{h0}) = \frac{T^{0\prime}M(P^0, W^0)}{H}$$

= Lump-sum transfer that each household gets

Suppose that the government imposes lump-sum taxes/transfers required to keep each individual household h at the pre-reform utility level u^{h0}. Under this policy household h gets a lump-sum transfer of $E^{*h}(P^0, W^0, u^{h0})$ at product price P and factor price W. Now, suppose the government spends an equal amount of its revenue of $T^{1\prime}M(P, T^1) - \Sigma_h E^{*h}(P, W, u^{h0})$ on each good.

Suppose that expenditure on all goods is the same, so that

$$g^i = \frac{T^{1\prime}M(P, T^1) - \Sigma_h E^{*h}(P, W, u^{h0})}{np^i}, \qquad (3.12)$$

where the number of goods is denoted by n. Denoting the equilibrium price and wage by P^e and W^e respectively the equilibrium condition under this policy can be given by

$$\Sigma^H_{h=1} E^{*h}_p(P^e, W^e, u^{h0}) + g = R^*_p(P^e, W^e) + M(P^e, T^1) \qquad (3.13)$$

$$\Sigma^H_{h=1} E^{*h}_w(P^e, W^e, u^{h0}) = R^*_w(P^e, W^e) = -V(P^e, W^e) \qquad (3.14)$$

The above policy is feasible only if the following condition holds:

$$GNR = T^{1\prime}M(P^e, T^1)\,\Sigma^H_{h=1} - E^{*h}(P^e, W^e, u^{h0}) \geq 0, \qquad (3.15)$$

where GNR is government net revenue. The equilibrium condition can be written as

$$\begin{aligned}
\Sigma^{H}_{h=1}E^{*h}(P^{c}, W^{c}, u^{h0}) &\leq \Sigma^{H}_{h=1}[P^{c\prime}C^{*h}(P^{0}, W^{0}, u^{h0}) - W^{c\prime}V^{h}(P^{0}, W^{0}, u^{h0})] \\
&= P^{c\prime}[X(P^{0}, W^{0}) + M(P^{0}, T^{0})] - W^{c\prime}V(P^{0}, W^{0}) \\
&\leq P^{c\prime}X(P^{c}, W^{c}) - W^{c}V(P^{c}, W^{c}) + P^{c\prime}M(P^{0}, T^{0}) \\
&= R^{*}(P^{c}, W^{c}) + P^{c\prime}M(P^{0}, T^{0}) \\
&= P^{c}M(P^{0}, T^{0}) \qquad (3.16)
\end{aligned}$$

as $\mathbf{R^{*}(P^{c}, W^{c}) = 0}$ because firms make zero profit under constant return to scale.

Since the value of net trade at world prices is zero, it follows from (3.16) that

$$\begin{aligned}
GNR = T^{1\prime}M(P^{c}, T^{1}) - \Sigma_{h}E^{*h}(P^{c}, W^{c}, u^{h0}) \\
&\geq T^{1\prime}M(P^{c}, T^{1}) - P^{c\prime}M(P^{0}, T^{0}) \\
&= P^{c\prime}[M(P^{c}, T^{1}) - M(P^{0}, T^{0})] \qquad (3.17)
\end{aligned}$$

Since $\mathbf{P^{c}}$ is an equilibrium price under a hypothetical policy of redistribution it is not readily observable in general. However, for a small country case, world prices are given and denoted by $\mathbf{P^{w}}$, so that

$$P^e = P^{we} + T^1 = P^{w1} + T^1 = P^1$$

Therefore, in the small country case, if

$$P^1 [M (P^1, T^1) - M (P^0, T^0)] > 0, \qquad (3.18)$$

then it can be ensured that no one is worse off from the reform. The condition that the old import bundle must be affordable at post-reform price is sufficient for the change in tariffs to result in a potential Pareto improvement in welfare in a small country with many consumers, perfect competition, constant return to scale and no joint production, where lump-sum taxes / transfer are available as instruments.

Based on the theoretical model developed by Ju and Krishna as above this study attempted to develop an empirically testable model as following.

3.2 The Static Model

The inequality (3.8) can be rewritten as,

$$P^{1'}C (P^1, u^1) - P^{1'}C (P^e, u^o) > 0$$

From profit maximizing behavior we know that

$$P^1X^1 - P^1X^0 > 0,$$

where P^1 is the vector of after-reform prices and X (.) is the supply vector where each supply function is a function of price and factors of production. As usual P^o and P^1 are vectors of prices before and after trade reform whereas V^o and V^1 are vectors of factors of production before and after trade reform respectively.

If the above condition is added to the left hand side of the condition (3.8), it still remains the sufficient condition. Adding the profit maximizing condition to (3.8) gives the following:

$$[P^{1'}C(P^1, u^1) - P^{1'}X^1(P^1, V^1)] - [P^{1'}C(P^o, u^o) - P^{1'}X^0(P^o, V^o)] > 0$$

Since import (M) is defined as excess of consumption over domestic supply and Since V^o and V^1 are same by assumption, both V^o and V^1 can be represented by V only. The above condition in terms of import can be written as

$$P^{1'}[M(P^1, u^1, V) - M(P^o, u^o, V)] > 0 \qquad (3.19)$$

It means value of net import evaluated at post-reform price should increase with trade reform, or equivalently, the old import bundle must be affordable at the new price after the trade reform for a Pareto improvement.

Let $Y^1 = P^{1'}M(P^1, u^1, V)$ = Value of import with reform evaluated at post-reform price; and

let $Y^o = P^{1'}M(P^o, u^o, V)$ = Value of import without reform evaluated at post-reform price

Then the welfare improving condition (3.9) can be rewritten as

$$Y^1 - Y^o > 0 \qquad (3.20)$$

that is, if the value of import after a trade reform is greater than the value of import before the trade reform when both of the values evaluated at post trade reform prices, then the welfare of the importing country has increased.

Suppose, the independent variables affecting the Y_t series and their effect on the Y_t series remain constant, then the two Y_t series can be expressed as ,

$Y_t^1 = a_0 + \alpha D + X\beta + u$ and

$Y_t^0 = a_0 + X\beta + u,$

where, X is the vector of all relevant variables, a_0 is the intercept terms, α is a coefficient and β is a coefficient vector, and u is an error term respectively. D is a dummy variable which takes value 0 for each year before nth year (i.e. the year of trade reform) and 1 otherwise. Then the inequality (3.20) implies the following:

$$Y_t^1 - Y_t^o = \alpha D > 0 \quad \text{or} \quad \alpha = 0 \qquad (3.21)$$

Therefore, testing the condition (3.20) is equivalent to testing condition (3.21) i.e.

$\alpha D > 0$

Since Y_t^1 and Y_t° are same up to period **n** (i.e. period without trade reform), Y_t^1 and Y_t° are also same after period **n** if $\alpha D = 0$. Therefore, if the Y_t series evaluated at post-reform price is regressed on all other relevant variables plus the dummy variable and it is found that the coefficient of the dummy variable is positive (i.e. $\alpha > 0$) and statistically different from zero then it can be concluded that condition (3.20) is satisfied and welfare has improved after trade reform.

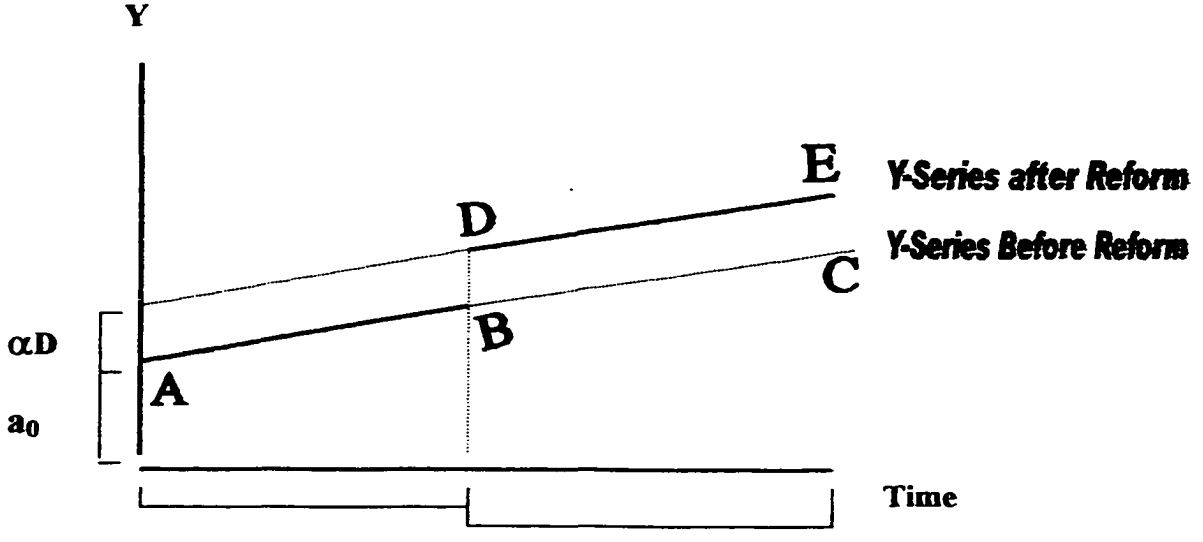

Figure – 1

In terms of **figure-1** if it is found that $\alpha > 0$ which means $\alpha D > 0$ then the actual path of Y_t series is **ABDE** rather than **ABC** and the Y_t series has shifted by α since the year of reform.

3.3 The Inter-Temporal Model

Let U^o and U^1 be life-time utility levels of the representative consumer without and with reform respectively; let u_i^o and u_i^1 be the ith year utility level of the representative consumer without and with trade reform respectively; and let δ^i be the discount rate for the ith year then U^o and U^1 can be expressed as,

$$U^o = \sum_{i=0}^{n} \delta^i u_i^0 \quad (3.22)$$

$$U^1 = \sum_{i=0}^{n} \delta^i u_i^1 \quad (3.23)$$

Suppose t is the year of trade reform then U^o and U^1 can be rewritten as,

$$U^o = \sum_{i=0}^{t} \delta^i u_i^0 + \sum_{i=t+1}^{n} \delta^i u^0_i \quad (3.24)$$

$$U^1 = \sum_{i=0}^{t} \delta^i u_i^1 + \sum_{i=t+1}^{n} \delta^i u^1_i \quad (3.25)$$

Since the utility level with and without trade reform is same for all the years before the year of reform, it implies that

$$\sum_{i=0}^{t} \delta^i u_i^0 = \sum_{i=0}^{t} \delta^i u_i^1$$

Therefore, from equations (3.24) and (3.25) we can write the welfare improving condition can be written as,

$$\sum_{i=t+1}^{n} \delta^I (u^1_i - u^0_i) \geq 0 \quad (3.26)$$

which implies that $U^1 > U^0$, i.e. the lifetime welfare has increased after trade reform. Condition (3.26) holds if for every year i,

$$u^1_i \geq u^0_i \qquad (3.27)$$

Using welfare improving condition given in (3.19) this requirement implies that the welfare improvement condition (3.27) can be rewritten as

$$P^{1'}_i M_i (P^1, u^1, V) - P^{1'}_i M_i (P^0, u^0, V) \geq 0 \qquad (3.28)$$

for every year i.

Let $Y^1_i = P^{1'}_i M_i(P^1, u^1, V)$ = Value of import with reform, in ith period after trade reform, evaluated in after reform price; and

$Y^0_i = P^{1'}_i M_i(P^0, u^0, V)$ = Value of import without reform, in ith period after trade reform, evaluated at post- reform price.

Then condition (3.28) boils down to the following:

$$Y^1_i \geq Y^0_i \quad \text{for every year i} \qquad (3.29)$$

The time path of Y_i^1 and Y_i^0 are shown in figure-2 below. For condition (3.29) to be satisfied for every year i, αD must be grater than zero (i.e. $\alpha > 0$).

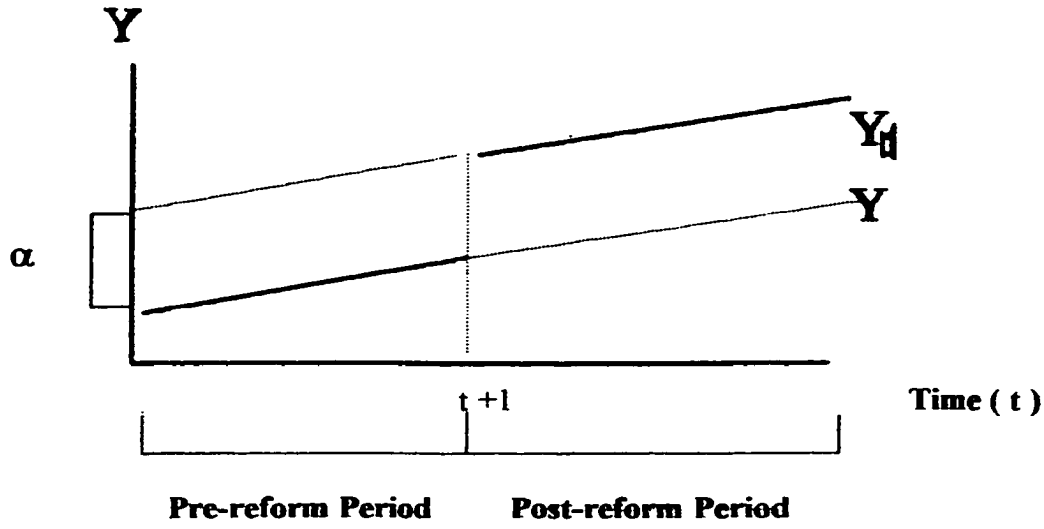

Figure - 2

Therefore, testing condition (3.20) for the static model and condition (3.29) for the inter-temporal model both amounts to estimating the time series Y_t by regressing it on all other relevant independent variables plus a dummy variable taking value 1 if the observation comes from post-reform period and zero otherwise; and testing the condition whether the coefficient of the dummy is positive and statistically significant. However, the time series Y_t for each period has to be evaluated at a post-reform price.

CHAPTER – 4

METHODOLOGY AND DATA

This chapter outlines the methodology of the study, identifies the sources of data, and lays down the techniques of measurement of the variables included in the models.

4.1 Methodology

The study has employed some linear regression models as well as a time series model to test the hypothesis.

4.1.1 The Linear Regression Model

(a) The Theory

As shown in chapter-3, in case of both the static and the dynamic models, testing the hypothesis that the welfare of the importing (reference) country has increased after a trade reform, is equivalent to testing under some assumptions the hypothesis that the net value of import of the reference country evaluated at post-reform price has increased after the trade reform. The model assumes that there is perfect competition in the market; there is constant return to scale in production; there is no joint production; the utility function of the representative consumer is increasing and strictly quasi-concave; and the demand function of the

representative consumer is continuous. The model considers the United States as the reference country. The model also assumes that Mexico a trading partner of the United States is a small country and, therefore, it does not have any influence on export prices. Since the United States and Mexico are two of the three signatories of North America Free Trade Area (NAFTA) signed in 1993 which required its signatories to lower or eliminate tariffs, subsidies, and quotas on the imports from the other signatory countries, this study attempts to test the hypothesis that the net value of U.S. import from Mexico (represented by the variable Y) with the signing of NAFTA is greater than the net value of the import without the signing of NAFTA when both imports are evaluated at with NAFTA prices. Therefore, 1993 will be the break point for the test of the linear regression model. To test for a shift in the Value of net Import function the dummy variable technique has been used as following:

Suppose, there is a shift in the Value of net Import (VONI) function with the signing of NAFTA such that there are two VONI functions; one without NAFTA i.e. for the years until 1993 and the other with NAFTA i.e. for the years since 1993,e.g.

VONI function before 1993: $Y_t = \alpha_0 + \alpha_1 X_{1t} + \ldots\ldots\ldots\ldots + \alpha_n X_{nt} + u_{1t}$ (4.1)

VONI function since 1993: $Y_t = \alpha_0 + \beta_0 + \alpha_1 X_{1t} + \ldots. + \alpha_n X_{nt} \ldots. + u_{1t}$ (4.2)

If β_0 is zero then the equation (4.2) will be equal to (4.1) and it will be concluded that there is no structural break in the VONI function. But if $\beta_0 > 0$ then it implies that there is a change in the intercept term and the NVOI function has shifted upward or downward depending on the sign of β_0 after 1992. Now, the function (4.2) will be transformed as following to make it more general:

$$Y_t = (\alpha_0 + \beta_0 D) + \alpha_1 X_{1t} + \alpha_2 X_{2t} + \ldots\ldots\ldots + \alpha_n X_{nt} + u_{2t} \qquad (4.3)$$

where, D is a dummy variable which takes the value 1 for each year since 1993 and the value zero otherwise. For the years before 1993, since D takes on value 0, by estimating equation (4.3) one will be estimating equation (4.1). However, for the years since 1993, D takes on value 1 and, therefore, by estimating the equation (4.3) one will actually be estimating the equation (4.2). After the estimation, if it is found that β is statistically significant then it will be concluded that there is a shift in the VONI function. For the estimation purpose equation (4.3) has been decomposed as following:

$$Y_t = \alpha_0 + \beta_0 D + \alpha_1 X_{1t} + \alpha_2 X_{2t} + \ldots\ldots\ldots + \alpha_n X_{nt} + u_{2t} \qquad (4.4)$$

To make more sense the Y_t variable and X_{it} variables have been named as following:

$$NIMFRMX_t = \alpha_0 + \beta_0 D + \alpha_1 USGDP_t + \alpha_2 MXGDP_t + \alpha_3 PESOEX_t$$

$$+ \alpha_4 IMPENRAT_t + u_t \qquad (4.5)$$

where, $NIMFRMX_t$ = Net value of U.S. import from Mexico in the tth year evaluated at post- reform (NAFTA) prices;

$USGDP_t$ = U. S. gross domestic product in the tth year;

$MXGDP_t$ = Mexico's gross domestic product in the tth year;

$PESOEX_t$ = Average annual exchange rate of a Mexican peso in the tth year (Annual average number of Mexican peso per U.S. dollar in the tth year)

$IMPENRAT_t$ = U. S. import penetration ratio in the tth year;

D = A dummy variable which takes on a value of 1 if the observation is from the year 1993 or after and a value of zero otherwise;

u_t = an error term.

The rationale of including the above variables is as following:

(a) U. S. GDP($USGDP_t$)

The Gravity model advocates that trading country's GDP is the important

determinant of a country's import (see Frankel et. al[32]). This is because an aggregate consumption is a positive function of a country's gross domestic product. Therefore, if the marginal propensity to consume remains the same and other determining factors do not change then with the increased GDP people tend to consume more. Now, if the domestic supply along with the other determining factors remains the same then a trading country tends to import more with the increase in its GDP. Therefore, U. S. GDP has been hypothesized to have positive effect on its value of net import from Mexico.

(b) Mexican GDP($MXGDP_t$)

As the Gravity model predicts the increase in the GDP of a country is likely to increase both its import and exports. If the growth rate in Mexican export to the U.S. dominates its growth rate in import from the U.S. then Mexican GDP will have positive effect on U.S. net import from Mexico. But if the opposite happens to be true then Mexican GDP will have negative impact on the net U.S. import from Mexico. For this study Mexico's GDP is hypothesized to have positive effect on the value of net U. S. imports from Mexico.

(c) Peso's Exchange Rate($PESOEX_t$)

The higher is the exchange rate of Mexican peso in terms of U. S. dollar

[32] Frankel, J. A.; D. Roamer; and Teresa Cyrus (Aug. 1996,. "Trade and Growth in East Asian Countries: Cause and Effect?," NBER working paper no. 5732.

the cheaper will be the U. S. imports from Mexico. As such the greater will be U.S. import from Mexico. Therefore, Mexican peso's exchange rate in U. S. dollar has been hypothesized to have positive effect on the value of net U. S. imports from Mexico.

(d) Import Penetration Ratio ($IMPENRAT_t$)[33]

Import penetration ratio of an economy measures its degree of openness. The more open an economy is the more likely it is to import from other countries. Therefore, the import penetration ratio has been hypothesized to have positive effect on the value of net U. S. import from Mexico.

4.1.2 The Time Series Models

One of the problems of using a linear regression model is that of spurious regression. In regressing a time series variable on another time series variable, one often obtains a very high R^2 although there is no meaningful relationship between the two. This problem arises because if both the time series exhibit strong trends. A spurious regression can arise if time series are not stationary. To avoid these problems, some researchers prefer to use time series techniques to estimate a time series. This study also proposes a time series technique called the intervention model technique to test the hypothesis.

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[33] I would like to thank Dr. Timothy Dunne for his advice to include IMPENRAT as on of the control variables.

4.1.2.1 Intervention Analysis

(a) The Theory

This study aims at measuring the effect of NAFTA on the net value of U. S. import from Mexico. If Y_t represents the annual net value of U. S. import from Mexico, one might be tempted to take the mean value of Y_t for all $t < 1993$ and compare it to the mean value of Y_t for all $t \geq 1993$. However, such a test is inappropriate in time-series analysis. Since successive values of Y_t are serially correlated, some of the effects of the pre-NAFTA regime could carryover to the post-NAFTA regime (post-intervention) date. For example, good understanding developed between the U. S. and Mexico before the intervention (NAFTA) regime could have encouraged both of the countries to liberalize their trade (e. g. to eliminate or lower tariff and quota barriers on their trade) with each other before the countries actually signed NAFTA agreement. Intervention analysis allows for a formal test of a change in the mean of a time series. This analysis also allows for a formal test of a change in the intercept term of a function due to a policy intervention during each of the year following the intervention. In the line of the model used by Enders, Sanders, and Cauly (1990)[34] to study the impact of the metal detector technology on the number of skyjacking incidents this study develops the intervention model to test the hypothesis set under the static and

[34] Enders, Walter. Applied Econometric Time Series. (John Wiley and Sons: New York). 1995.

inter-temporal models outlined in chapter-3. The intervention model is laid out as following:

$$Y_t = a_0 + a_1 Y_{t-1} + c_0 Z_t + \varepsilon_t \qquad |a_1| < 1, \tag{4.6}$$

where, Y_t = value of net U. S. import from Mexico in tth year evaluated at post reform (NAFTA) prices;

Y_{t-1} = one year lagged value of net U. S. import from evaluated at post reform (NAFTA) prices;

Z_t = the intervention (dummy) variable that takes on the value zero prior to year 1993 (without NAFTA)) and unity beginning the year 1993 (with NAFTA);

ε_t = a white-noise disturbance.

To explain the nature of the model it has been transformed as following:

$(1-a_1L)\, Y_t = a_0 + c_0 Z_t + \varepsilon_t$ or

$$Y_t = a_0 / (1 - a_1 L) + (c_0 Z_t) / (1 - a_1 L) + \varepsilon_t / (1 - a_1 L) \tag{4.7}$$

For $t < 1993$, the value of Z_t is zero. As such, the intercept term is a_0 and the long-run mean of the series is $a_0 / (1 - a_1)$. Beginning in 1993, the intercept term jumps to $a0 + c0$ (since for $t \geq 1993$, $Z_t = 1$); and the long-run mean is $(a_0+c_0)/(1-a_1)$. Thus, the long-run effect of the intervention is given by $(a_0+c_0)/(1-a_1) - a_0/(1 - a_1)$ which equals to $c_0 / (1 - a_1)$. If $a_1 < 1$, the term $(1- a_1) > 0$. Therefore, to test if the long-run mean of Y_t series for $t \geq 1993$ (with intervention) is greater than that for $t < 1993$ one simply needs to test if c_0 is statistically positive. If $c_0 > 0$, it could be concluded that U. S. entry into NAFTA has increased the long-run mean of the value of net U.S. import from Mexico for $t \geq 1993$ (with reform) and, therefore, on the average U.S. welfare due to NAFTA has increased.

The additional advantage of using intervention analysis is that one can also trace out the impulse responses to the intervention (initiation of NAFTA) of Y_t (value of net U.S. import from Mexico at post-reform prices) series for each of the year following U.S. entry into NAFTA. The equation (4.7) can be rewritten as following:

$$Y_t = a_0 / (1 - a_1) + c_0 \Sigma^{\infty}_{i=0} a^i_1 Z_{t-i} + \Sigma^{\infty}_{i=0} a^i_1 \varepsilon_{t-i}, \qquad (4.8)$$

where i is the exponential value of the coefficient of a_1. Differentiating (4.8) with respect to Z_{t-i} and updating by one period yields

$$dY_{t+1} / dZ_t = c_0 + c_0 a_1 \qquad (4.9)$$

Continuing in this fashion, the entire impulse (or impact) response function can be traced out as,

$$dY_{t+j} / dZ_t = c_0[1 + a_1 + \ldots\ldots (a_1)^j]$$

Since t = 1993 and thereby $Z_{t+1} = Z_{t+2} = \ldots\ldots = 1$. Taking limits as $j \to \infty$, it can be reaffirmed that the long-run impact is given by $c_o / (1-a_1)$. If it is assumed that $0 < a_1 < 1$ which means the lagged effect of intervention is less than 100% then the absolute value of the magnitude of the impact of NAFTA becomes an increasing function of **j**. The farther one moves away from the date in which NAFTA was introduced (i.e. 1993), the greater is the absolute value of the magnitude of the policy response. If $-1 < a_1 < 0$, the policy has a damped oscillating effect on the Y_t sequence. After the initial jump of c_0, the successive values of Y_t oscillate above and below the long-run level of $c_0 / (1 - a_1)$.

(b) <u>The Model</u>

The variables in the model (4.10) are renamed as following:

$$NIMFRMX_t = a_0 + a_1 NIMFRMX_{t-1} + c_0 D + \varepsilon_t, \qquad (4.10)$$

where, $NIMFRMX_t$ = value of net U.S. import from Mexico in tth year evaluated at post-reform(intervention) prices;

$NIMFRMX_{t-1}$ = one year lagged value of net U.S. import from Mexico evaluated at post reform (intervention) prices

D = dummy variable which equals to 1 for $t \geq 1993$ and zero otherwise; and

ε_t = white-noise error term.

Next the model (4.10) will be estimated and the significance of the coefficient c_0 will be tested.. A conclusion about the effect of NAFTA on U.S. welfare will be drawn along the line of argument given in the theory of the intervention analysis as above.

4.2 Data

4.2.1 Sources of Data

The data on U. S. GDP, Mexican GDP, exchange rate of Mexican peso in U.S. dollar, total U. S. imports, U. S. import price, and U. S. export prices have directly been collected from the annual series of "International Financial Statistics" published by IMF (International Monetary Fund) and the data on U.S. import from Mexico have been collected from different annual series of IMF's publication called "Direction of Trade". However, the data on the value of net U.S. import from Mexico evaluated at post reform (intervention) prices is not observable. Therefore, some adjustments have been made to the data on the value

of net U. S. import from Mexico before using them in the model. The adjustment technique used is outlined in the Measurement section below.

4.2.2 Measurement of Variables

(a) Value of Net U.S. Import from Mexico at Post Reform Prices (NIMFRMX)

The value of net U. S. import from Mexico evaluated at post-reform price (i.e. Y_t) series is constructed as $Y_t = P_t'M_t$ where P_t is tth year's post-reform price and M_t is the $_t$th year's net U. S. import from Mexico. But P_t is a post-reform equilibrium price under hypothetical system of lump-sum revenue transfers. For $t < 1993$, Y_t is not readily observable. Therefore, an equilibrium (actual) import price of a year following the year of trade reform (signing of NAFTA) has been chosen as the proxy for the post-reform equilibrium price required by the theory. Since NAFTA was signed in January 1993 and because price data used in this study are available at 1995 base year prices, the equilibrium import price for the year 1995 has been chosen as the proxy for the post-reform equilibrium import price. As such, the Y_t series has been computed as following:

$$Y_t = P_{1995}M_t,$$

where, P_{1995} is import price for the year 1995 and M_t is the net import volume for the tth year. Since the net import M_t is the excess of import (I_t) over the export (E_t) the Y_t series can be constructed as following:

$$Y_t = P^I_{1995} M_t = P^I_{1995} (I_t - E_t)$$

$$= P^I_{1995} ((P_t^I I_t / P_t^I) - (P_t^E E_t / P_t^E)),$$

where, P_{1995} = import price for the year 1995;

The Y_t series can be expressed in a simple form as following:

$$Y_t = A (B/C - D/E),$$

where, $A = P^I_{1995}$ = import price for the year 1995

$B = P_t^I I_t$ = value of U.S. import from Mexico in tth year evaluated at the tth year's import prices

$C = P_t^I$ = import price for the tth year

$D = P_t^E E_t$ = value of U.S. export to Mexico in the tth year evaluated at the tth year's export prices

$E = P_t^E$ = export price for the tth year

The observations on the expressions **A**, **C**, and **E** have been obtained directly from the IMF (International Monetary Fund) publications called "International Financial Statistics" and those on the expressions **B** and **D** have been obtained directly from the IMF publications called "Direction of Trade".

(b) Import Penetration Ratio ($IMPENRAT_t$)

The U. S. import penetration ratio has been constructed as following:

$$IMPENRAT_t = \frac{\text{Total U. S. Import for the tth year}}{\text{Total U. S. GDP for the tth year}}$$

The data on all other variables has been obtained directly from IMF's publication called "International Financial Statistics".

CHAPTER – 5

ESTIMATION AND EMPIRICAL RESULTS

The estimation results of each of the econometric models explained in chapter-4 are reported in this chapter. Following this, economic analyses of the findings have been carried out. Finally, the welfare implication of the findings for the United States has been drawn.

5.1 Linear Regression Models

The empirical analyses start with the estimation of the model (4.5). The estimation results are as following:

$$\begin{aligned} NIMFRMX_t = & -3792.6 - 1.3279\ USGDP_t - 0.0046881\ MXGDP_t \\ & \quad (-0.4125) \quad (-0.8996) \qquad (-0.7973) \\ & + 4.2383\ PESOEX_t + 826.55\ D + 86074\ IMPENRAT_t \qquad (5.1) \\ & \quad (1.752) \qquad (0.1613) \qquad (0.5949) \end{aligned}$$

$R^2 = 0.5541$

$F = 5.220$ p-value $= 0.003$

where, $NIMFRMX_t$ = Value of net U.S. import from Mexico in tth year at post-reform (NAFTA) prices;

$USGDP_t$ = U. S. gross domestic product in the tth year;

$MXGDP_t$ = Mexico's gross domestic product in the tth year;

$PESOEX_t$ = Average annual exchange rate of a Mexican peso in U. S. dollar in the tth year;

D = A dummy variable which takes the value 1 for the year > 1992 and zero otherwise;

$IMPENRAT_t$ = U. S. import penetration ratio.

The values in the parentheses are the corresponding t-values. From the results, although the model as such has been found to be significant (as p-value associated with F-statistics is nearly zero), but all independent variables have turned out to be insignificant. This is the indication of the presence of multi-co-linearity among the independent variables.

To check out the seriousness of the multi-co-linearity problem a correlation matrix of the variables included in this model has been computed. The correlation matrix is given in table-1. The matrix clearly shows a very high correlation between different pairs of independent variables. However, there could be some other reasons as well. For example, the independent variables included in this model are mostly dynamic. If the time paths of the dynamic variables are the same, their time series values exhibit co-linearity. Moreover, if the time path of the dependent and independent variables are the same, they may show a high degree of association although they may not be associated, and this situation is called spurious correlation. To avoid such a problem it is advised that

some kind of time variable as an independent variable be included in the model to capture the time trend. Therefore, the following model was re-estimated including a time-variable called "TIMEV" as an independent variable. The TIMEV variable takes value 1 for the year 1972, 2 for year 1973, and so on.

$$\begin{aligned} NIMFRMX_t = {} & 7810.6 - 10.09\ USGDP_t - 0.003209\ MXGDP_t \\ & (0.3866) \quad (-0.741) \quad (-0.5025) \\ & + 4.7636\ PESOEX_t + 2279.4\ TIMEV + 1584\ D \\ & (1.844) \quad (0.6474) \quad (0.2974) \\ & - 1705.3\ IMPENRAT_t \\ & (-0.00854) \end{aligned} \tag{5.2}$$

$R^2 = 0.5633$
$F = 4.3$ p-value $= 0.006$

The results show that all independent variables are still insignificant. As the next step, therefore, rather than using the U.S. GDP (USGDP) and Mexico's GDP (MXGDP) in their raw form they have been divided by their corresponding population values to get the GDPs in per capita form. The transformed variables have been named as USPCGDP (U.S. per capita GDP) and MXPCGDP (Mexico's per capita GDP) respectively. The reason for doing these transformations is not only statistical, but also due to the fact that some of the Gravity Models have also used the GDP variable in per capita form rather than

using in its raw form (e.g. see Frankel, et. al[35]). With this transformation the model (4.5) has been estimated,

$$NIMFRMX_t = \underset{(-0.2998)}{-\ 2673.9} - \underset{(-0.7678)}{285.52\ USPCGDP_t} - \underset{(-1.381)}{0.89669\ MXPCGDP_t}$$

$$+ \underset{(2.201)}{5.6370\ PESOEX_t} + \underset{(0.3803)}{1932.3\ D} + \underset{(0.4663)}{67313\ IMPENRAT_t} \qquad (5.3)$$

$R^2 = 0.5761$

$F = 5.709$ p-value = 0.002,

where, $USPCGDP_t$ = U.S. per capita GDP in the tth year;

$MXPCGDP_t$ = Mexican per capita GDP in the tth year;

Other variables have already been defined before. The values in the parentheses are corresponding t-values. The overall p-value is nearly zero which means the overall model is significant. But except for PESOEX all other independent variables are insignificant. A model with high R^2 and insignificant coefficients indicates the possibility of multi-co-linearity problem. Therefore, a correlation matrix of variables were computed which is given in table-2. The correlation matrix indicates that the most of the independent variables are highly

[35] Frankel, Jeffrey, et. al. "Trade and Growth in East Asian Countries: Cause and Effect?," 1996. NBER working paper no. 5732.

correlated. However, if the time-path of dynamic variables is the same their time-series values exhibit co-linearity although they may not be associated. As the next step, therefore, a time variable called TIMEV was included and the model (5.3) has been re- estimated.

$$\begin{aligned} NIMFRMX_t = &- \underset{(-0.1629)}{3649.4} - \underset{(-0.0308)}{112.30\ USPCGDP_t} - \underset{(-1.346)}{0.8997\ MXPCGDP_t} \\ &+ \underset{(2.087)}{5.6095\ PESOEX_t} - \underset{(0.0477)}{170.94\ TIMEV_t} + \underset{(0.3742)}{1961.2\ D} \\ &+ \underset{(0.4098)}{71792\ IMPENRAT_t} \end{aligned} \qquad (5.4)$$

$R^2 = 0.5762$

$F = 4.532$ p-value = 0.005

The results show that, although the model is significant only one variable (i.e. PESOEX) has been found to be statistically significant. Finally, a linear-log model was estimated with the dependent variable in linear form and all independent variables except for the import penetration ratio variable **IMPENRAT**$_t$ dummy variable **D** in natural log form. The estimation results are reported as the following:

$$\begin{aligned} NIMFRMX_t = &- \underset{(-2.784)}{180300} + \underset{(3.211)}{38961\ LUSGDP_t} - \underset{(-5.295)}{24339\ LMXGDP_t} \\ &+ \underset{(5.611)}{21087\ LPESOEX_t} + \underset{(3.770)}{10841\ D} + \underset{(0.3729)}{55826\ IMPENRAT_t} \end{aligned} \qquad (5.5)$$

$R^2 = 0.7670$

$F = 13.828$ p-value $= 0.000$,

where, $LUSGDP_t$, $LMXGDP_t$, and $LPESOEX_t$ ate the tth year's natural log values of USGDP, MXGDP, and PESOEX respectively. Other variables are already defined before. The figure in the parentheses are corresponding t-values. The results show that the model is significant and all the independent variables except $IMPENRAT_t$ are statistically significant and have sign as expected. The variable $IMPENRAT_t$ (Import Penetration Ratio) has turned out to have no effect on the dependent variable, $IMFRMX_t$ (value on net U. S. import from Mexico). Therefore, finally the variable $IMPENRAT_t$ has been dropped from model (5.5) and the model has been re-estimated. The estimation results are as following:

$$\begin{aligned} NIMFRMX_t = & - 196070 + 41945\ LUSGDP_t - 24732\ LMXGDP_t \\ & \quad (-4.080) \quad (4.692) \quad (-5.639) \\ & \quad \{0.000\} \quad \{0.000\} \quad \{0.000\} \\ & + 21113\ LPESOEX_t + 11311\ D \\ & \quad (5.732) \quad (4.463) \\ & \quad \{0.000\} \quad \{0.000\} \end{aligned} \qquad (5.6)$$

$R^2 = 0.7655$

$F = 17.953$ p-value $= 0.000$,

where $LUSGDP_t = \log(USGDP_t)$,

$LMXGDP_t$ = $\log(MXGDP_t)$,

$LPESOEX_t$ = $\log(PESOEX_t)$, and

D = a dummy variable which takes value 1 for years 1993-1998 and zero otherwise.

The figures in the parentheses are the corresponding t-values and those in the braces are the corresponding p-values. The p-values associated with the coefficients indicate that even at significance level of one percent, all coefficients are significant. Further, the R^2 value is also very high which indicates that the model fits the data very well. This result is also confirmed by the p-value associated with the F-statistics, which is nearly zero.

All of the above tested models have the same dependent variable and the same number of observations. Therefore, all these models can be compared on the basis of their corresponding R^2–values. Based on the above findings the model (5.6) was found to be the most plausible model among the ones that were tried. The plausibility of the model has been judged on the basis of overall significance of the model, highest value of R^2, and sign and significance of the independent variables included in the model rather than choosing the model arbitrarily. Further, in each of the estimated model the inclusion of the independent variables have been done in accordance with the theories.

From the analysis of the estimation results it is obvious that all these models are statistically significant and, therefore, fit the data well. However,

except for model (5.6) none of these models have more than one statistically significant independent variables. Moreover, model (5.6) and (5.5) have the highest R^2 value of all the models. Based on the above criteria model (5.6) has been found to be the most plausible model. Therefore, model (5.6) has been chosen to test the hypothesis of this study. An observation of the test results shows that all variables are significant. The sign and t-statistics of the coefficients of model (5.6) exhibit that except for Mexican GDP (i.e. LMXGDP) all other independent variables are statistically significant and have positive sign which is as hypothesized and expected. Regarding the Mexican GDP, it was argued that it could go either way depending upon its relative effect on export and import. Therefore, the finding that Mexican GDP has negative effect on the value of net U.S. import from Mexico is not surprising. From the estimation results of model (5.6) the following relationship between the dependent variable and the independent variables have been found. The increase in U. S. gross domestic product causes an increase in the value of net U. S. import from Mexico. Similarly, the increase in peso's exchange rate (number of Mexican peso per U. S. dollar) causes an increase in the value of net U. S. import from Mexico. To the contrary, an increase in Mexican gross domestic product causes a decrease in the value of net U. S. import from Mexico.

The next step is to examine the coefficient and t-statistics of the dummy variable D. Since the coefficient of the variable D is positive and statistically significant, one cannot reject the hypothesis that the whole NIMFRMX (value of

net U.S. import from Mexico) function has moved up following the liberalization of U.S. trade with Mexico under the NAFTA agreement. This finding fulfills the welfare enhancing condition laid down by inequality (3.10). Therefore, it can fairly be concluded that the U.S. welfare has increased due to the trade liberalization under NAFTA.

5.2 Intervention Analysis

The purpose of this analysis is to use a formal test of a change in the mean of a time series. In this study, it has been attempted to test a change in the mean of the variable NIMFRMX (value of net U.S. import from Mexico at post reform (NAFTA) prices. Therefore, the intervention model (4.10) has been estimated, which is in line of the intervention model used by Enders, Sandler, and Cauley[36] (1990). The estimation results are given below.

$$\underset{}{NIMFRMX_t} = \underset{(0.0009)\ \{0.999\}}{0.874} + \underset{(5.612)\ \{0.000\}}{0.74445\ NIMFRMX_{t-1}} + \underset{(3.038)\ \{0.006\}}{6354.1\ D} \qquad (5.7)$$

$R^2 = 0.7294$

$F = 30.999$ p-value $= 0.000$

[36] Enders, Walter. Applied Econometric Time Series. (John Wiley and Sons: New York), 1995.

All of the slope coefficients in this model are significant.. The R^2 value is also high. It means the model fits the data well. This is also confirmed by a nearly zero p-value associated with the F-statistics. Comparing the estimated equation (5.7) with the corresponding equation (4.10) the values of the associated coefficients can be written as following:

$a_0 = 0.874$

$a_1 = 0.74445$

$c_0 = 6354.1$

Therefore, the long-term means before and after the intervention (i.e. U.S. entering in NAFTA in January 1, 1993) can be expressed as,

Intercept-term without Intervention: a_0

Intercept-term with Intervention: $a_0 + c_0$

Change in Intercept due to Intervention: $(a_0 + c_0) - a_0 = c_0 = 6354.1$

Long-run Mean without Intervention : $a_0 / (1 - a_1)$

Long-run Mean with Intervention: $(a_0 + c_0) / (1 - a_1)$

Change in Long-run Mean due to Intervention $= (a_0 + c_0) / (1 - a_1) - a_0 / (1 - a_1)$

$= c_0 / (1 - a_1)$

$= 6354.1/0.25555$

$= 24864.41$

Differentiating the function (4.10) or (5.7) with respect to $NIMFRMX_{t-1}$ and updating the derivatives successively by one period yield the following impulse response functions:

$$d(NIMFRMX_{1994}) / d(NIMFRMX_{1993}) = c_0 [1 + a_1]$$

$$d(NIMFRMX_{1995}) / d(NIMFRMX_{1993}) = c_0 [1 + a_1 + a_1^2]$$

. . .

. . .

. . .

$$d(NIMFRMX_j) / d(NIMFRMX_{1993}) = c_0 [1 + a_1 + \ldots\ldots + a_1^j]$$

From the estimation results it is obvious that both a_1 and c_0 are positive and statistically significant. Therefore, the change in long-run mean due to the intervention is positive. Moreover, each of the impulse response function following the policy intervention (i.e. U.S. entering in NAFTA in January 1, 1993) is positive. It means the whole Y_t (value of net U.S. import from Mexico at post reform price) function has shifted upward following the intervention. This finding satisfies the welfare improvement condition outlined in section (3.2) and (3.3) respectively which means old import bundle is affordable at post-reform prices. Therefore, if all the underlying assumptions hold, then it can fairly be concluded that there is potential U.S. welfare improvement due to the liberalization of its trade with Mexico due to the intervention (i.e. signing of NAFTA).

Chapter – 6

SUMMARY AND CONCLUSIONS

6.1 Summary

International trade has mostly been directed with the objective of improving the aggregate well-being of the country. The traditional theory suggests that, in perfectly competitive markets, international trade always increases the welfare of trading partners by bringing about efficiency in resource allocation. The endogenous growth theory argues that trade can potentially spur innovation by increasing industrial learning as it facilitates international exchange of technical information. The welfare enhancing outcome of theoretical models with the assumption of perfect competition have led to the belief that any step towards perfect competition by relaxing existing trade barriers could be welfare enhancing. However, the theory of second best suggests that, in the presence of multiple distortions, a reduction in a distortion may actually reduce the welfare. Regarding the welfare consequences of different forms of trade reforms two basic results exist. The first one so called the Concertina rule shows that the policy, which reduces the highest tariff rate to the level of second highest rate, will improve welfare. The other one shows that uniform proportional tariff reduction raises welfare. With the welfare consequences of trade reform still being debated, there have been very sparse empirical studies to test these results. Whatever

empirical studies on these issues have been done so far is mostly based on ex-ante approach, which looks for a set of policy prescription, which yields welfare improvement. The models developed with ex-ante approach mostly make use of an explicit utility function. Ohyama, on the other hand, has applied a revealed preference approach, which looks for some indicator to determine if welfare has risen due to a trade reform. Ohyama's model avoids the need of using explicit utility function. However, his model is based on representative consumer assumption and, therefore, does not address the problem arising due to the fact that a trade policy may affect different consumers in different ways. Grinols and Wong's model addresses the many consumers issue, but their model requires that the welfare weights of individual be constant and be reciprocals to marginal utilities of income. Dixit and Norman eliminate such requirements and derives the conditions under which Pareto improvements are ensured. However, their model addresses the issue of gains from trade rather than the welfare impact of a trade reform. Ju and Krishna, on the other hand, have shown that Ohyama's conditions in many consumers case with a small country assumption are also sufficient for a trade reform to be welfare improving. However, their model has not yet been tested empirically. Therefore, this study went further and developed an empirical method to test their model in two-country setting (i.e. the United States and Mexico). This study also developed a dynamic model for welfare comparison before and after a trade reform.

The sufficient condition for welfare improvement in both of the Static and the Dynamic models requires that the value of net import function evaluated at post-reform price be shifted upward after a reform. This study chose the United States and Mexico as the two trading partners in the two-country model and considered the signing of NAFTA agreement by the two countries in January 1, 1993 as a form of trade reform or policy intervention. Therefore, after evaluating all the net imports (imports – exports) by the United States from Mexico at post reform (NAFTA) prices it was attempted to see if U.S. welfare had improved or equivalently the U.S. VONI (value of net import from Mexico at with-NAFTA prices) function had shifted upward after the signing of NAFTA agreement. To test the shift in the NIMFRMX (Value Of net U.S. Import from Mexico at Post-reform Price) function two different approaches were applied: linear regression model approach and intervention model approach.

Under linear regression model approach various regression equations were estimated with NIMFRMX as the dependent variable and other variables, affecting the NIMFRMX as the independent variables. A dummy variable taking value for the **year > 1992** and zero otherwise was also included as an independent variable. Among the various linear regression models estimated, one with relatively high $\mathbf{R^2}$ and with all significant independent variables was chosen for testing the underlying hypothesis. Then the sign and significance of the dummy variable in the chosen model (5.6) was examined. The coefficient associated with the dummy variable was found to be positive and statistically

significant. Based on this it was concluded that the NIMFRMX function had shifted upward following the signing of NAFTA.

Under intervention model approach, an intervention model with current value of NIMFRMX as the dependent variable, and one year lagged value of NIMFRMX, and a dummy D (taking value 1 for the year > 1992 and zero otherwise) as the independent variables was estimated. Then an impulse response function for each year since 1993 was derived to see if the impact effects of NAFTA on the U.S. NIMFRMX variable are positive in each year since 1993. It was found that each of the impulse response functions was positive. This finding confirmed that the NIMFRMX function for the United States had permanently shifted upward following the signing of NAFTA.

6.2 Conclusion

Under the sufficient condition for welfare improvement due to a trade reform both under the Static model and the Inter-temporal model as outlined in chapter-3 it was required that the NIMFRMX (value of net U. S. import from Mexico evaluated at post-reform price) function of the reference country be shifted upward. From the estimation results of both the linear regression model and the intervention model it was found that the United States' NIMFRMX function had shifted upward following the trade reform (signing of NAFTA) and therefore U.S. welfare had increased due to the liberalization of its trade with Mexico under the NAFTA agreement.

The sufficient condition laid out by Ju and Krishna and applied in this study ensures that if underlying conditions hold then there is potential Pareto improvement in the sense that even if the government revenue is redistributed among the consumers in a fashion such that the consumers remain at the old utility level after the price change brought about by the reform, the government still has a portion of the revenue left.

However, this study has a limited scope. It does not address political economy problem. For example, suppose a foreign company with its subsidiary firm initially in the U. S. decides to relocate the firm in Mexico after a trade reform between the U. S. and Mexico. The post-reform data may exhibit that the value of net U. S. import from Mexico has increased. But, on the other hand, many U. S. workers might have lost their jobs due to the relocation.

Similarly, value of net U. S. import from any other country for example Brazil might have increased as well during the same period (period after signing of NAFTA) although NAFTA does not include Brazil. It means value of net U. S. import from Mexico might as well have increased due to the factors other than NAFTA.

Further, the theory underlying this study assumes that the conditions of perfect competition in the market and constant return to scale in the production hold. It also assumes that the U. S. government redistributes its revenue among the households in a fashion that every household remains at old utility level after the reform. However, in real world these conditions rarely hold.

As such this study suffers from many limitations like many other studies. However, the only purpose of this study was to develop a simple tool to test the welfare consequence of a trade policy amid the attempts by numerous researchers and scholars to develop very sophisticated models with very stringent restrictions.

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APPENDIX

Table – 1

CORRELATION MATRX OF VARIABLES – 1

NIMFRMX98	1.0000				
USGDP	0.62043	1.0000			
MXGDP	0.69315	0.86411	1.0000		
PESOEX	0.72598	0.89898	0.98094	1.0000	
IMPENRAT	0.56650	0.86654	0.72977	0.76158	1.0000
	NIMFRMX	USGDP	MXGDP	PESOEX	IMPENRAT

Table – 2

CORRELATION MATRX OF VARIABLES – 2

NIMFRMX98	1.0000				
USPCGDP	0.60692	1.0000			
MXPCGDP	0.68511	0.85348	1.0000		
PESOEX	0.72598	0.87604	0.98597	1.0000	
IMPENRAT	0.56650	0.87246	0.73851	0.76158	1.0000
	NIMFRMX	USPCGDP	MXPCGDP	PESOEX	IMPENRAT

Table – 3

DEFINITION OF THE VARIABLES AND TERMS

Variable or Term		Definition
NIMFRMX	=	Value of United States Net Import from Mexico evaluated at post-reform (NAFTA) Prices in millions of U.S. dollars
USGDP	=	United States Gross Domestic Product at current prices in billions of dollar
LUSGDP	=	Log(USGDP)
MXGDP	=	Mexico's Gross Domestic Product at current prices in millions of U. S. dollar
LMXGDP	=	Log(MXGDP)
USPCGDP	=	United States Per Capita Gross Domestic Product at current prices
LUSPCGD	=	Log(USPCGDP)
MXPCGDP	=	Mexico's Per Capita Gross Domestic Product at current prices
LMXPCGD	=	Log(MXPCGDP)
PESOEX	=	Mexican Peso's Exchange Rate in U. S. dollar
LPESOEX	=	Log(PESOEX)
USPOP	=	U.S. Population measured in millions

Variable or Term		Definition
MXPOP	=	Mexican Population measured in millions
D	=	1 if the observation is from year ≥ 1993, and zero otherwise.
TIMEV	=	A time variable which takes value 1 for the year 1972, 2 for the year 1973, and so on up to 1998.
IMFRMX	=	U.S. Import from Mexico at current prices in millions of dollar
EXTOMX	=	U.S. Export to Mexico at current prices in millions of dollar
NETIM	=	Net U.S. Import from Mexico in millions of dollar
IMPORTPRICE	=	U.S. Import Price Computed at Base Year 1995
EXPORTPRICE	=	U. S. Export Price Computed at Base year 1995.

Table – 4

DATA SET FOR MODEL – 5.1

YEAR	NIMFRMX	USGDP	MXGDP	PESOEX	D	IMPENRAT
1972	495.9991	1237.3	564.7	12.5	0	0.0475867
1973	16.07204	1382.6	690.9	12.5	0	0.0532273
1974	-2545.17	1496.9	899.7	12.5	0	0.0721571
1975	-3768.56	1630.6	1100.1	12.5	0	0.0634227
1976	-2160.39	1819	1371	15.43	0	0.0712293
1977	99.58225	2026.9	1849	22.57	0	0.0777276
1978	-749.624	2291.4	2337	22.77	0	0.0811949
1979	-1879.4	2557.5	3068	22.81	0	0.0868954
1980	-5469.99	2784.2	4470	22.95	0	0.0922919
1981	-6535.71	3115.9	6137	24.51	0	0.0877278
1982	3561.573	3242.1	9770	56.4	0	0.0786163
1983	9470.133	3514.5	17882	120.09	0	0.0767904
1984	7170.691	3902.4	29402	167.83	0	0.0874257
1985	6956.488	4180.7	47168	256.87	0	0.0864975
1986	7133.514	4422.2	78787	610	0	0.08753
1987	6751.77	4692.6	193162	1380	0	0.0903695
1988	3566.992	5049.6	416305	2270	0	0.0910518
1989	2910.339	5438.7	548858	2460	0	0.0907062
1990	1886.814	5743.8	738898	2810	0	0.0900136
1991	-1996.44	5916.7	949148	3020	0	0.0860782
1992	-5853.44	6244.4	1125334	3090	0	0.0884951
1993	-1373.07	6558.1	1256196	3120	1	0.091491
1994	-784.762	6947	1420159	3380	1	0.0992241
1995	17346	7265.4	1837019	6420	1	0.1061121
1996	16954.76	7661.6	2503813	7600	1	0.1067381
1997	16395.43	8110.9	3178954	7920	1	0.1107967
1998	21368.04	8510.7	3791191	9140	1	0.1109949

Table – 5

DATA SET FOR MODEL – 5.2

YEAR	NIMFRMX	USGDP	MXGDP	PESOEX	TIMEV	D	IMPENRAT
1972	495.9991	1237.3	564.7	12.5	1	0	0.0475867
1973	16.07204	1382.6	690.9	12.5	2	0	0.0532273
1974	-2545.17	1496.9	899.7	12.5	3	0	0.0721571
1975	-3768.56	1630.6	1100.1	12.5	4	0	0.0634227
1976	-2160.39	1819	1371	15.43	5	0	0.0712293
1977	99.58225	2026.9	1849	22.57	6	0	0.0777276
1978	-749.624	2291.4	2337	22.77	7	0	0.0811949
1979	-1879.4	2557.5	3068	22.81	8	0	0.0868954
1980	-5469.99	2784.2	4470	22.95	9	0	0.0922919
1981	-6535.71	3115.9	6137	24.51	10	0	0.0877278
1982	3561.573	3242.1	9770	56.4	11	0	0.0786163
1983	9470.133	3514.5	17882	120.09	12	0	0.0767904
1984	7170.691	3902.4	29402	167.83	13	0	0.0874257
1985	6956.488	4180.7	47168	256.87	14	0	0.0864975
1986	7133.514	4422.2	78787	610	15	0	0.08753
1987	6751.77	4692.6	193162	1380	16	0	0.0903695
1988	3566.992	5049.6	416305	2270	17	0	0.0910518
1989	2910.339	5438.7	548858	2460	18	0	0.0907062
1990	1886.814	5743.8	738898	2810	19	0	0.0900136
1991	-1996.44	5916.7	949148	3020	20	0	0.0860782
1992	-5853.44	6244.4	1125334	3090	21	0	0.0884951
1993	-1373.07	6558.1	1256196	3120	22	1	0.091491
1994	-784.762	6947	1420159	3380	23	1	0.0992241
1995	17346	7265.4	1837019	6420	24	1	0.1061121
1996	16954.76	7661.6	2503813	7600	25	1	0.1067381
1997	16395.43	8110.9	3178954	7920	26	1	0.1107967
1998	21368.04	8510.7	3791191	9140	27	1	0.1109949

Table – 6

DATA SET FOR MODEL – 5.3

YEAR	NIMFRMX	USPCGDP	MXPCGDP	PESOEX	D	IMPENRAT
1972	495.9991	5.894712	10.405381	12.5	0	0.0475867
1973	16.07204	6.524468	12.302350	12.5	0	0.0532273
1974	-2545.17	6.999766	15.480041	12.5	0	0.0721571
1975	-3768.56	7.550123	18.289277	12.5	0	0.0634227
1976	-2160.39	8.342506	22.120039	15.43	0	0.0712293
1977	99.58225	9.203142	28.976649	22.57	0	0.0777276
1978	-749.624	10.294263	35.592446	22.77	0	0.0811949
1979	-1879.4	11.363636	45.438389	22.81	0	0.0868954
1980	-5469.99	12.224271	64.168820	22.95	0	0.0922919
1981	-6535.71	13.550926	86.012614	24.51	0	0.0877278
1982	3561.573	13.964336	133.799000	56.4	0	0.0786163
1983	9470.133	15.000000	239.4804	120.09	0	0.0767904
1984	7170.691	16.511805	385.2968	167.83	0	0.0874257
1985	6956.488	17.531346	605.1835	256.87	0	0.0864975
1986	7133.514	18.375301	990.1596	610	0	0.08753
1987	6751.77	19.325426	2378.8424	1380	0	0.0903695
1988	3566.992	20.606407	5025.4104	2270	0	0.0910518
1989	2910.339	21.987871	6496.1297	2460	0	0.0907062
1990	1886.814	22.977957	8576.8775	2810	0	0.0900136
1991	-1996.44	23.419490	10805.4190	3020	0	0.0860782
1992	-5853.44	24.448534	12567.947	3090	0	0.0884951
1993	-1373.07	25.407175	13772.569	3120	1	0.091491
1994	-784.762	26.652599	15267.244	3380	1	0.0992241
1995	17346	27.620894	20300.796	6420	1	0.1061121
1996	16954.76	28.862686	25924.757	7600	1	0.1067381
1997	16395.43	30.275849	31976.701	7920	1	0.1107967
1998	21368.04	31.455869	37821.139	9140	1	0.1109949

Table – 7

DATA SET FOR MODEL – 5.4

YEAR	NIMFRMX	USPCGDP	MXPCGDP	PESOEX	TIMEV	D	IMPENRAT
1972	495.9991	5.894712	10.405381	12.5	1	0	0.0475867
1973	16.07204	6.524468	12.302350	12.5	2	0	0.0532273
1974	-2545.17	6.999766	15.480041	12.5	3	0	0.0721571
1975	-3768.56	7.550123	18.289277	12.5	4	0	0.0634227
1976	-2160.39	8.342506	22.120039	15.43	5	0	0.0712293
1977	99.58225	9.203142	28.976649	22.57	6	0	0.0777276
1978	-749.624	10.294263	35.592446	22.77	7	0	0.0811949
1979	-1879.4	11.363636	45.438389	22.81	8	0	0.0868954
1980	-5469.99	12.224271	64.168820	22.95	9	0	0.0922919
1981	-6535.71	13.550926	86.012614	24.51	10	0	0.0877278
1982	3561.573	13.964336	133.799000	56.4	11	0	0.0786163
1983	9470.133	15.000000	239.4804	120.09	12	0	0.0767904
1984	7170.691	16.511805	385.2968	167.83	13	0	0.0874257
1985	6956.488	17.531346	605.1835	256.87	14	0	0.0864975
1986	7133.514	18.375301	990.1596	610	15	0	0.08753
1987	6751.77	19.325426	2378.8424	1380	16	0	0.0903695
1988	3566.992	20.606407	5025.4104	2270	17	0	0.0910518
1989	2910.339	21.987871	6496.1297	2460	18	0	0.0907062
1990	1886.814	22.977957	8576.8775	2810	19	0	0.0900136
1991	-1996.44	23.419490	10805.4190	3020	20	0	0.0860782
1992	-5853.44	24.448534	12567.947	3090	21	0	0.0884951
1993	-1373.07	25.407175	13772.569	3120	22	1	0.091491
1994	-784.762	26.652599	15267.244	3380	23	1	0.0992241
1995	17346	27.620894	20300.796	6420	24	1	0.1061121
1996	16954.76	28.862686	25924.757	7600	25	1	0.1067381
1997	16395.43	30.275849	31976.701	7920	26	1	0.1107967
1998	21368.04	31.455869	37821.139	9140	27	1	0.1109949

Table – 8

DATA SET FOR MODEL – 5.5 & 5.6

YEAR	NIMFRMX	LUSGDP	LMXGDP	LPESOEX	D	IMPENRAT
1972	495.9991	3.0925	2.7518	1.0969	0	0.0475867
1973	16.07204	3.1407	2.8394	1.0969	0	0.0532273
1974	-2545.17	3.1752	2.9541	1.0969	0	0.0721571
1975	-3768.56	3.2123	3.0414	1.0969	0	0.0634227
1976	-2160.39	3.2598	3.1370	1.1884	0	0.0712293
1977	99.58225	3.3068	3.2669	1.3535	0	0.0777276
1978	-749.624	3.3601	3.3687	1.3574	0	0.0811949
1979	-1879.4	3.4078	3.4869	1.3581	0	0.0868954
1980	-5469.99	3.4447	3.6503	1.3608	0	0.0922919
1981	-6535.71	3.4939	3.7880	1.3893	0	0.0877278
1982	3561.573	3.5108	3.9899	1.7513	0	0.0786163
1983	9470.133	3.5459	4.2524	2.0795	0	0.0767904
1984	7170.691	3.5913	4.4684	2.2249	0	0.0874257
1985	6956.488	3.6212	4.6736	2.4097	0	0.0864975
1986	7133.514	3.6456	4.8965	2.7853	0	0.08753
1987	6751.77	3.6714	5.2859	3.1399	0	0.0903695
1988	3566.992	3.7033	5.6194	3.3560	0	0.0910518
1989	2910.339	3.7355	5.7395	3.3909	0	0.0907062
1990	1886.814	3.7592	5.8686	3.4487	0	0.0900136
1991	-1996.44	3.7721	5.9773	3.4800	0	0.0860782
1992	-5853.44	3.7955	6.0513	3.4900	0	0.0884951
1993	-1373.07	3.8168	6.0991	3.4942	1	0.091491
1994	-784.762	3.8418	6.1523	3.5289	1	0.0992241
1995	17346	3.8613	6.2641	3.8075	1	0.1061121
1996	16954.76	3.8843	6.3986	3.8808	1	0.1067381
1997	16395.43	3.9091	6.5023	3.8987	1	0.1107967
1998	21368.04	3.9300	6.5788	3.9609	1	0.1109949

Table – 9

DATA SET FOR MODEL – 5.7

YEAR	NIMFRMX	LAGNIMFRMX	D
1972	495.9991	0	0
1973	16.07204	495.9991	0
1974	-2545.17	16.07204	0
1975	-3768.56	-2545.17	0
1976	-2160.39	-3768.56	0
1977	99.58225	-2160.39	0
1978	-749.624	99.58225	0
1979	-1879.4	-749.624	0
1980	-5469.99	-1879.4	0
1981	-6535.71	-5469.99	0
1982	3561.573	-6535.71	0
1983	9470.133	3561.573	0
1984	7170.691	9470.133	0
1985	6956.488	7170.691	0
1986	7133.514	6956.488	0
1987	6751.77	7133.514	0
1988	3566.992	6751.77	0
1989	2910.339	3566.992	0
1990	1886.814	2910.339	0
1991	-1996.44	1886.814	0
1992	-5853.44	-1996.44	0
1993	-1373.07	-5853.44	1
1994	-784.762	-1373.07	1
1995	17346	-784.762	1
1996	16954.76	17346	1
1997	16395.43	16954.76	1
1998	21368.04	16395.43	1

Table – 10

Regression Results – 1

Dependent Variable: NIMFRMX

Independent Variable	**Model-5.1**	**Model-5.2**
CONSTANT	-3792.6 (-0.4125)	7810.6 (0.3866)
USGDP	-1.3279 (-0.8996)	-10.09 (-0.741)
MXGDP	-0.004688 (-0.7973)	-0.003209 (-0.5025)
PESOEX	4.2383 (1.752)	4.7636 (1.844)
TEMEV		2279.4 (0.6474)
D	826.55 (0.1613)	1584 (0.2974)
IMPENRAT	86074 (0.5949)	-1705.3 (-0.008536)
R^2	0.5541	0.5633
F-statistics	5.22	4.3
p-value	0.003	0.006

Note:

Figures in the parentheses are corresponding t-values.

Table – 11

Regression Results – 2

Dependent Variable: NIMFRMX

Independent Variable	Model-5.3	Model-5.4
CONSTANT	-2673.9 (-0.2998)	-3649.4 (-0.1629)
USPCGDP	-285.52 (-0.7678)	-112.3 (-0.03076)
MXPCGDP	-0.89669 (-1.381)	-0.89971 (-1.346)
PESOEX	5.6374 (2.201)	5.6095 (2.087)
TEMEV		-170.94 (-0.0477)
D	1932.3 (0.3803)	1961.2 (0.3742)
IMPENRAT	67313 (0.4663)	71792 (0.4098)
R^2	0.5761	0.5762
F-statistics p-value	5.709 0.002	4.532 0.005

Note:

Figures in the parentheses are corresponding t-values.

Table – 12

Regression Results – 3

Dependent Variable: $NIMFRMX_t$

Independent Variable	Model-5.5	Model-5.6
CONSTANT	-180300 (-2.784)	-196070 (-4.08)
LUSGDP	38961 (3.211)	41945 (4.692)
LMXGDP	-24339 (-5.295)	-24732 (-5.639)
LPESOEX	21087 (5.611)	21113 (5.732)
D	10841 (3.77)	11311 (4.463)
IMPENRAT	55826 (0.3729)	
R^2	0.7670	0.7655
F-statistics	13.828	17.953
p-value	0.000	0.000

Note:

Figures in the parentheses are corresponding t-values.

Table – 13

Regression Results – 4

Dependent Variable: $NIMFRMX_t$

Independent Variable	**Model-5.7**
CONSTANT	0.874 (0.0009)
$NIMFRMX_{t-1}$	0.74445 (5.612)
D	6354.1 (3.038)
R^2	0.7294
F-statistics	30.999
p-value	0.000

Note:

Figures in the parentheses are corresponding t-values.