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Producer Price Relationships During The Implementation of the Canada - United States Trade Agreement of 1989

by

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ABSTRACT

Is the Canada - United States Trade Agreement of 1989 working? Since market integration is a prerequisite to the realization of the benefits from trade liberalization, a free trade area model predicting producer price equalisation underlies the empirical approach used in this study. Producer price indexes in Canada and the United States are tested for trends, structural breaks, cointegration, and convergence prior to and over the period during which the trade agreement has been implemented. The findings are inconclusive in that while there is no strong evidence of producer price equalization, there is no compelling evidence that price convergence is not taking place. The research indicates that as there is no established method to test for price equalization during periods of economic disequilibrium, the indirect tests which are available may not provide a definitive answer as to whether trade agreements are producing the result predicted by economic theory.

To my parents

ACKNOWLEDGMENTS

I would like to thank Dr. Kerr for his patience and guidance especially given the long distance nature of this thesis. I would also like to thank Dr. Gordon for his commentary and guidance on a number of econometric issues. Furthermore I would like to thank Dr Randall for taking the time required to read this thesis and act as external examiner. Finally I would like to thank my parents who kept me healthy and focused on an important goal in my life.

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CHAPTER ONE: INTRODUCTION

1. The Canada - United States Trade Agreement

The Canada - US Trade Agreement (CUSTA) went into effect January 1, 1989 and set new standards and rules for trade in goods. It also dealt with a broad range of issues in international commercial relations such as trade in services, government procurement, non-tariff barriers to trade, and a dispute resolution system. Although wide in scope, one central component of the CUSTA was the removal of tariffs. For sectors judged ready to compete, tariffs on various commodities were eliminated immediately, while tariffs in other sectors would be reduced to zero over either a five-year or a ten-year period. This on-going process, along with the other measures in the agreement, had many practical and theoretical implications. Important practical implications or goals for Canada were securing a larger market for its products and assurances of greater certainty of access to that market (McLachlan, Apuzzo, and Kerr, 1989). One of the interesting theoretical implications which can be derived from these two goals is that commodity markets in Canada and the United States should become more integrated. Before addressing the issues surrounding such a general theoretical implication, it is worthwhile to examine some of the existing evidence regarding the effectiveness of the CUSTA.

1.1 Evidence Regarding the Effectiveness of the CUSTA

In part, this thesis is motivated by an attempt to improve upon the anecdotal evidence which is often used to suggest that a free trade area (FTA) is performing well,

but which is in fact limited in its usefulness. In this context, anecdotal evidence is meant to describe facts which might indicate successful performance of a FTA, but because this evidence lacks the testable hypothesis of a well defined economic theory, its cause and effect cannot be ascertained with reasonable certainty. Evidence in this form is used everyday in newspapers and other media as well as academic publications as anecdotal evidence to support or dismiss the effectiveness of trade agreements such as the CUSTA. This section provides some anecdotal evidence to suggest that the CUSTA is performing well, and as a result provides the motivation to test a more formal hypothesis concerning the progress of economic integration.

One example of anecdotal evidence regarding the CUSTA is presented in Tables 1.1, 1.2, and 1.3. This information was presented in Daniel Schwanen's (1993) trade policy commentary. Table 1.1 describes some Canadian and international trends from 1989 to 1992. Two major points can be derived from the information in this table. The first point is that even though the United States growth in GDP ranks last among the four international regions, the percentage growth in the value of merchandise exports from Canada to the United States has been over five times as high over the same period. The second point of note is that the growth of Canada's merchandise imports from the United States ranked only third (albeit a close third) among the four regions. Together, the two points could possibly suggest that the CUSTA has allowed Canada's strong export ties with the US to continue to grow without having to give up any import ties to other regions. Table 1.2 compares the growth in the value of Canadian merchandise exports which were liberalized by the CUSTA with those which weren't liberalized by the

CUSTA. Over the period 1989 to 1992, Canadian exports to the US in sectors liberalized by the CUSTA increased approximately 33% in value while the increase to the rest of the world in these same sectors was only about 2%. Furthermore, the growth in the value of exports in the liberalized sectors far outpaced that of the exports in the non-liberalized sectors. Table 1.3 makes the same comparison as Table 1.2 except that they are the values for Canadian merchandise imports rather than exports. Similar to the previous results, Table 1.3 shows once again that the growth in the value of imports from the US at 28% was far ahead of the growth in the value of imports from the rest of the world at 10%. Also, liberalized import sectors showed much higher growth in value than non-liberalized sectors. Schwanen uses this evidence to suggest that, "The general direction apparent in Canada's export and import data available four years into the FTA confirms the trends already evident in 1992. Many of Canada's goods and services industries seem to have met with success in the US market under free trade." (Schwanen, 1993, p.11) . The US has traditionally been Canada's largest trading partner and one might wonder whether these post-1989 values are significantly different, in a statistical sense, from the pre-1989 values. This is just one among many possible questions and criticisms the use of anecdotal evidence could raise.

1.2 The Problem

The anecdotal evidence appears to suggest that CUSTA may be working as it was intended. The problem is that a more rigorous approach based on sound economic theory is required to make such an assertion with reasonable certainty. A better understanding of

Table 1.1 Global Economic Trends in the Value of Canada's Exports and Imports by Region, 1989 to 1992

	Percentage Change 1989-1992			
	United States	Europe (OECD)	Japan	7 Southeast Asian Countries
Real GDP	+4.2	+8.8	+15.6	+30.9
Purchasing power of Canadian dollar	-1.8	-16.9	-4.2	-9.8
Value of merchandise exports from Canada	+24.3	+4.8	-15.1	+2.2
Value of merchandise imports into Canada	+11.9	-5.0	+16.1	+12.0

Schwanen, 1993, p.5

Table 1.2 Economic Trends in Sectors of Merchandise Exports Both Liberalized and Not Liberalized by CUSTA, 1989 to 1992

Type of Export	Value in 1992 ($ billions)	% Exported to the United States	% Change in Exports to the United States	% Change in Exports to Other Countries
Changes in Canada's Merchandise Exports-Not Liberalized by CUSTA, 1989-92				
Natural Gas	4.730	100	60.1	n.a.
Other energy	2.424	33	-13.3	-14.6
Other crude products	4.403	37	-15.1	-26.8
Lumber	6.544	65	22.3	18.2
Pulp & newsprint	11.371	64	-21.2	-10.5
Fertilizer	1.552	67	13.6	-31.4
Agric. machinery	0.561	87	-23.2	8.4
Ships, air, & parts	4.014	73	41.6	42.2
Other end products	3.282	86	63.1	78.8
Total	38.881	67	9.0	-8.2
Changes in Canada's Merchandise Exports-Liberalized by CUSTA, 1989-92				
Meat & Dairy	2.672	79	63.7	8.5
Fish	1.926	55	-13.3	-6.6
Other food	7.737	27	74.6	4.2
Beverages	0.773	91	62.9	5.0
Other crude material	3.832	35	112.8	-11.2
Wood fabricating material	1.360	87	30.8	-0.8
Paper, excluding newsprint	2.504	80	96.1	35.4
Textile materials	0.817	74	92.2	0.0
Chemicals	3.200	73	1.7	-33.5
Chemical products	3.421	79	63.9	-15.8
Iron & steel	2.952	83	16.1	56.9
Other basic products	15.582	72	3.9	2.4
Industrial machinery	4.352	74	14.7	44.4
Office & telecomm Equipment	10.187	80	85.0	16.9
Other eqt, tools	6.068	87	37.1	14.7
Other finish goods	4.316	74	41.1	-5.5
Total	71.699	69	33.4	1.9

Schwanen, 1993, pp 6,7

Table 1.3 Economic Trends in Sectors of Merchandise Imports Both Liberalized and Not Liberalized by CUSTA, 1989 to 1992

Type of Import	Value in 1992 ($ billions)	% Imported to the United States	% Change in Imports to the United States	% Change in Imports to Other Countries
Changes in Canada's Merchandise Imports-Not Liberalized by CUSTA, 1989-92				
Crude food & feed	1.350	50	12.7	19.0
Other crude materials	3.348	74	-7.1	1.9
Fabricated products	3.065	78	-14.9	-14.1
Industrial machinery	1.362	64	-32.5	-38.3
Agric machinery	1.387	75	-13.3	-26.8
Aircraft	3.667	66	-20.2	-16.8
Medical & safety eqt	1.051	76	19.4	52.5
Printed material	1.719	86	31.0	23.4
Other transactions	5.379	64	61.8	75.5
Total	22.328	70	0.7	4.9
Changes in Canada's Merchandise Imports-Liberalized by CUSTA, 1989-92				
Meat & dairy prods	1.088	61	94.1	2.1
Fresh fruit & veg	2.188	70	13.9	30.2
Processed food & bev	3.901	53	83.1	7.0
Crude materials	0.654	77	2.1	12.6
Textile material	2.362	55	29.5	-8.2
Chemicals	8.949	77	31.2	5.6
Petroleum products	1.641	51	5.8	7.4
Steel	2.266	62	27.5	-55.7
Basic fabricated metal	3.442	77	26.7	12.2
Oth fabric. material	5.448	75	26.8	-15.0
Indust machin	8.608	69	-1.0	-21.8
Non-auto transport equipment	3.160	73	29.5	-1.2
Office & Telecomm	17.885	57	29.7	59.0
Other equipment	10.551	73	21.0	24.3
Clothing	3.915	12	123.1	16.7
Furniture, furnishing	2.027	68	100.7	-2.1
Other household good	3.588	43	83.4	29.1
Other end products	6.514	63	48.9	11.2
Total	88.187	63	28.4	10.1

Schwanen, 1993, pp.9,10

the problem can be gained by specifying the definition of economic integration more closely.

In everyday language, integration is defined as bringing together of parts into a whole. In the economic literature, the term "economic integration" does not have such a clear cut meaning. At one extreme, the mere existence of trade relations between independent national economies is considered a form of economic integration. At the other extreme, it is taken to mean the complete unification of national economies. Economic integration is defined here as a process and as a state of affairs. As a process, it encompasses measures designed to eliminate preferential treatment between economic sectors that belong to different national states (e.g. quantitative restrictions, subsidies, and tariffs). As a state of affairs, it represents the general changes, due to the overall lower number of barriers effecting trade between national economies. This paper assumes that the CUSTA is a process which should have some effect on the general state of affairs. That is, the process of eliminating discriminatory tariffs between sectors in Canada and the US, and securing access to larger markets should have certain measurable effects on the general economy. By taking a rigorous approach to the modeling and measurement of these effects, one may be able to determine with greater surety whether or not CUSTA is working as it was intended.

1.3 The Research Hypothesis

It is the premise of this paper that CUSTA as a process has led to a state of affairs between Canada and United States in which the producer price index of each country is

both cointegrated and converging with the other. If such a state of affairs does exist, then it can be said that CUSTA has led to two more closely integrated economies, and as a result one of the prerequisites for the CUSTA working as it was intended has been attained.

1.4 Outline of Thesis

A free trade area (FTA) is essentially defined as one in which tariffs (and quantitative import restrictions) among participating countries are eliminated, while each country retains its own tariffs against non-members. There are many ways to analyse the performance of the trade agreements which establish free trade areas. Some researchers have looked at *ex-post* issues such as "upstream" productivity gains (Tybout and Westbrook, 1995), and "downstream" product market performance (Hazeldine and Murphy, 1996). Other studies have attempted, *ex-ante*, to model possible gains from goods market integration (de Groof and van Tuijl, 1993) or the possible effect on gains from nation size and transportation costs (Shachmurove and Spiegel, 1995). The goal of this thesis is to apply the economic theory of FTAs and make an interim statistical assessment of producer price equalization during the implementation of the CUSTA.

The first step in the assessment is the laying out of a model of a FTA which incorporates the basic structure of the CUSTA. The model allows one to build a theoretically acceptable measure of price equalization, a prerequisite for achieving the gains from trade expected from a FTA. This is the focus of Chapter 2. Chapter 3 builds on Chapter 2 by looking at how one might use the prediction of the theoretical FTA model

to give some statistically meaningful results. This chapter begins by relating the prediction of the FTA model to the theory of purchasing power parity (PPP). Purchasing power parity theory is then related to some existing literature on market integration and international commodity arbitrage. Chapter 4 picks up the theory of PPP and uses it to develop a testable econometric model. In Chapter 5, the econometric model is tested using producer price indexes from Canada and the United States. The tests first look at the trend properties of the data. The following tests search for structural breaks which might be compatible with a regime change in 1989. Next, tests search for cointegrating or long-term relationships between the price indexes of the two countries. With a long-term relationship established, a convergence test is then applied to see if the price indexes reflect two economies which are becoming more integrated over time. Finally, Chapter 6 concludes the thesis with a discussion of the results and their implications for the evaluation of the CUSTA.

CHAPTER TWO: THE THEORY OF FREE TRADE AREAS

2. Introduction

A review of various models which focus on price and quantity behaviour in different types of trading arrangements will provide insights into the appropriate methodology that should be applied to assess the CUSTA. Prior to the model review, the chapter begins with a short discussion of international trade and its facilitating institutions since World War II. The next section follows up on the institutional history by reviewing the General Agreement on Tariffs and Trade (GATT). Reviewing the GATT will allow the CUSTA to be understood with respect to the international guidelines under which such trade agreements are written. Given this introduction, the theory behind trading agreements may then be discussed. The chapter presents the theory behind customs unions before addressing the economic theory which underlies FTAs. Beginning with the customs union helps to draw out some important trade effects that accompany most multilateral trading agreements. Once the customs union model is developed, the discussion can progress to the theory of FTAs and the need for 'rules of origin'. Three FTA models are presented to show how a FTA with rules of origin might result in producer price equalisation. The first simple FTA model examines the effect of rules of origin on prices and quantities of some traded commodity. The second FTA model builds on the first model by suggesting that producer price differences can not be sustained in the long-run. The third model confirms the fact that it is producer prices, as opposed to consumer prices, that should equalize in a FTA in the long-run.

2.1 Historical Background

Immediately following World War II, Britain and the United States took the lead in setting in motion a plan for the reconstruction of Europe and the establishment of a new institutional framework for international economic relations. The framework for the new relationships was established at the Bretton Woods Conference (Bretton Woods, New Hampshire, 1944). The cornerstones of this framework were the International Monetary Fund (IMF), the International Trade Organization (ITO), and the International Bank for Reconstruction and Development (IBRD).

While negotiations on the ITO charter were taking place in 1944, a group of countries led by the United States felt that there was a need for more immediate action on tariff reductions. As a result the GATT (Geneva, 1944) was drawn up, with 23 countries agreeing to rules and procedures which would govern multilateral negotiations for mutual tariff reduction.

When the proposed ITO charter (Havana Charter, 1947/48) was not ratified, the GATT was left as the only framework for trade negotiations. Over 100 countries were signatories to the GATT. The GATT made provisions for the establishment of regional trade organizations. As Canada and the United States both belonged to the GATT, CUSTA had to be negotiated within the GATT framework.[1]

[1] With the completion of the Uruguay Round of GATT negotiations and the establishment of the World Trade Organization (WTO) in 1994, the GATT as an organization ceased to exist. The GATT protocals are now administered by the Goods Council of the WTO. This change has not meant any substantive changes for the section of the GATT which is important to this thesis. Hence, the term GATT will be used for both the GATT agreement and the organization which administers the agreement.

2.2 The General Agreement on Tariffs and Trade

The general summary of the GATT given here will focus on three aspects of the agreement: its objectives, its principles, and its exceptions. In response to the protectionism (high tariffs) of the 1930s, the GATT had three general objectives. The first was to create rules and procedures for trade negotiations. The second was to set up a framework for the progressive elimination of trade barriers, and the third was to put into place rules and procedures which would prevent countries from taking unilateral action to impose trade restrictions. The CUSTA provisions for the progressive elimination of tariffs in almost all sectors over ten years (1989 to 1999), are consistent with the first two objectives. Furthermore, the 'dispute resolution' mechanism set up in CUSTA establishes rules and procedures which address the third objective.

There are three general principles which underlie the GATT: the principle of 'non-discrimination', the principle of 'reciprocity', and the principle of 'transparency'. The non-discrimination principle is expressed in Article I in the *most-favoured-nation* (MFN) clause. By agreeing to this clause, a country cannot give preferential treatment to any other single country without extending this treatment to all contracting parties of the GATT. There are many exceptions to this clause, and regional trade agreements such as CUSTA are one example.

Unlike the principle of non-discrimination, the principle of reciprocity does not have any formal definition within articles of GATT. Reciprocity is, rather, an implied obligation which means that if a country receives a tariff reduction from another country, then the receiving country should offer some concession in return. This type of implied

obligation helps to convince unwilling governments to enter trade talks in which it is implied that there will be no outright "winner or loser" as long as reciprocal concessions are made.

Direct controls on trade are expressly forbidden by GATT (Article XI), except in a few circumstances. This prohibition against direct controls on the international movement of goods has arisen because of the imposition of direct controls on imports through quantitative restrictions and quotas. With these direct controls, it is less obvious or 'transparent' (relative to a tariff) as to how lowering trade barriers will effect trade. As a result, reciprocity is no longer a straightforward matter when one country is offering to lower tariffs while the concession from the other is in the form of lower quantitative restrictions. The effect of tariffs on prices and volumes is obvious and 'transparent'. Reciprocal and progressive tariff reduction is the cornerstone of the CUSTA.

There are many exceptions to the principles of GATT which relate to both the economics and politics of international trade. These can be categorized as the following: balance of payments problems, regional groupings, tariff preferences, dumping, textiles, agriculture, and services among others. The 'regional grouping' provisions in the GATT are important to the discussion of the CUSTA.

Article XXIV of the GATT describes regional groupings as the major exception to the MFN clause.[2] The article allows the formation of customs unions and free trade areas under the conditions that the groupings cannot increase tariffs and non-tariff-barriers (NTBs) on non-members of the regional grouping who are GATT signatories. More specifically, a free trade area is defined as the following:

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[2] See Appendix A.

> A free trade area shall be understood to mean a group of two or more customs territories in which the duties and other restrictive regulations of commerce (except, where necessary, those permitted under Articles XI, XII, XIII, XIV, XV, and XX) are eliminated on substantially all the trade between the constituent territories in products originating in such territories. (GATT Article XXIV, Section 8b)

The exceptions for regional groupings were originally made because it was believed that since freer trade was a good thing, any move toward it (e.g. a customs union or a free trade area) would also be a good thing. As economists would subsequently point out, the welfare economics of that argument are not as clear as was once thought (Viner, 1950).

In a customs union, members of the union reduce trade barriers with each other while a common external tariff (CET) is applied to non-members who trade with any country in the union. In a FTA, member countries also reduce trade barriers with each other, but there is no CET for the union as a whole. The next section in this paper presents the positive and negative trade effects of a simple customs union, and helps to begin the discussion on the theory of free trade areas and the need for rules of origin.

2.3 Theory of Customs Unions

Jacob Viner (1950) challenged the ideas in Article XXIV of GATT by stressing that Customs Union (CU) or FTA formation is by no means equivalent to a move towards free trade since it amounts to free trade between the members and protection vis-à-vis the outside world. This combination of free trade and protectionism could result in *trade creation* (TC) and/or *trade diversion* (TD). Trade creation is the replacement of

expensive domestic production by cheaper imports from a partner and TD is the replacement of cheaper initial imports from the outside world by more expensive imports from a partner. Viner stressed the point that TC is beneficial since it does not affect the rest of the world while TD is harmful, and it is therefore the relative strength of these two effects which determines whether or not CU formation will be welfare enhancing. It is therefore important to understand the implications of these concepts.

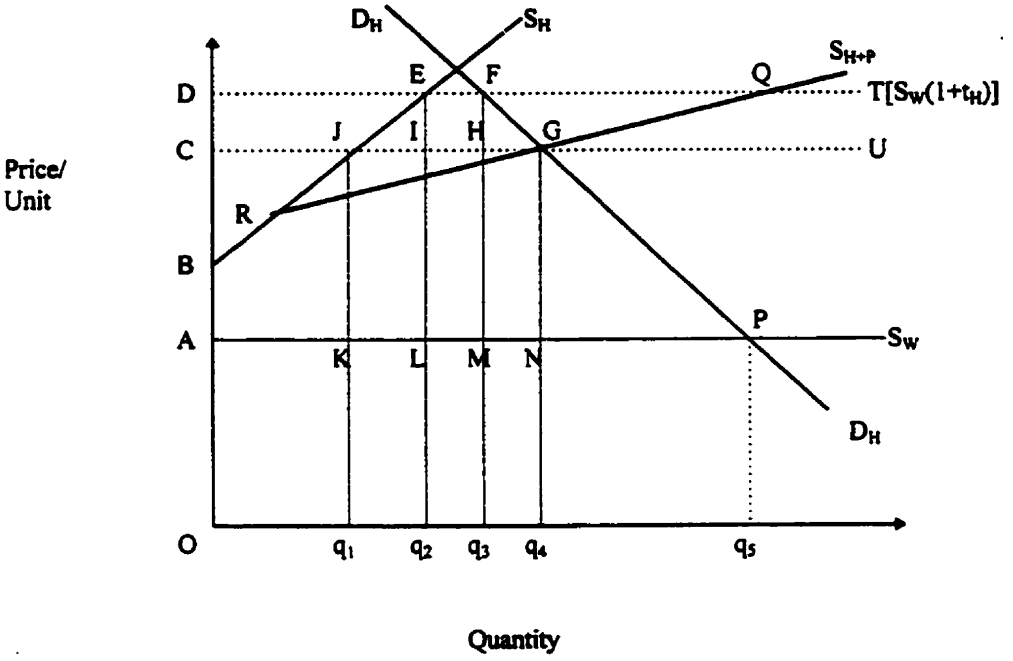

Figure 2.1 Trade Creation and Trade Diversion

The important assumptions for a model of a country entering into a customs union depicted in Figure 2.1 are: perfect competition in both the commodity and factor markets, automatic full employment of all resources; costless adjustment; perfect factor mobility among sectors nationally but perfect immobility across international boundaries; prices

determined by cost; country H (home country); country P (the potential CU partner); and W (the rest of the world).

In Figure 2.1 S_W is W's perfectly elastic tariff free supply curve for this commodity; S_H is H's supply curve; while S_{H+P} is the joint H and P tariff-free supply curve. With tariff t_H (=AD), the effective supply curve facing H is $BREFQT$. The domestic price is then OD, which gives domestic production of Oq_2, domestic consumption of Oq_3, and imports of q_2q_3. Country H pays q_2LMq_3 for these imports while the domestic consumer pays q_2EFq_3, with the difference ($LEFM$) being tariff revenue which accrues to the government in H.

If H and W form a CU, then the free trade position will be restored so that Oq_5 will be consumed in H and all of the consumed product will be imported from W. This free trade situation maximizes welfare. If, on the other hand, H and P form a CU, then the tariff will still apply to W while it is removed from imports from P. The effective supply curve in this case is $BRGQT$. Price of the imported product falls to OC resulting in a fall in domestic production to Oq_1, an increase in consumption to Oq_4, and an increase in imports to q_1q_4. These imports now come from P.

The welfare implications of these changes can be examined with consumer and producer surplus. The increased consumption in the H-P customs union leads to consumer surplus rising by $CDFG$. Part of this increase in consumer surplus ($CDEJ$) results from a decline in producer surplus due to the reduction in domestic production, and another part of the increase in consumer surplus ($IEFH$) is a portion of the previously

collected tariff revenue which is now transferred back to the consumer. This leaves triangles *JEI* and *HFG* as gains from CU formation.

The decline in domestic production from Oq_2 to Oq_1 leads to increased imports of q_1q_2. These cost q_1JIq_2 to import from *P* while they originally cost q_1JEq_2 to produce domestically. The saving is therefore *JEI*. The increase in consumption from Oq_3 to Oq_4 leads to new imports of q_3q_4 which cost q_3HGq_4 to import from *P*. These give a welfare increase to consumers equal to q_3FGq_4. There is therefore an increase in satisfaction of *HFG*. However, the initial imports of q_2q_3 originally cost the country q_2LMq_3 but these imports now come from *P* and cost q_2IHq_3. Therefore the new higher price of imports leads to a loss in government revenue equal to *LIHM*.

Overall then, area *JEI* plus area *HFG* represent gains from TC while area *LIHM* represents a loss from TD. It follows that the consumer surplus gains (*JEI* + *HFG*) have to be compared with the loss of tariff revenue (*LIHM*) before a definite conclusion can be made regarding whether the net effect of CU formation has been positive or negative. The relative size of these areas will depend on the price elasticity's of S_H, S_{H+P}, D_H, and on the divergence between S_W and S_{H+P} (i.e., cost differences).

The important point from this presentation of a simple customs union and the effects of TC and TD, is that the simple formation of a free trade area is by no means a guarantee that the net welfare effect of the CU will be positive or negative. Even though the welfare effects of CUSTA might be ambiguous, it is the empirical impact of the agreement on economic integration, through price convergence, which is addressed in the next sections.

2.4 Theory of Free Trade Areas with "Rules of Origin"

The first model, as presented in Shibata (1967), illustrates the possible effects of FTA rules of origin on the price and quantity of some traded commodity. There are several assumptions regarding notation, model set up, and trade theory which much first be addressed. All assumptions pertain to Figure 2.2. With respect to notation, there are two FTA partners (countries *H* and *L*) and the rest of the world (*W*). The following are model assumptions:

(i) both *H* and *L* import an identical product (or commodity) from *W*

(ii) both *H* and *L* produce wholly domestic perfect substitutes for this product

(iii) both *H* and *L* impose different specific tariffs such that $t_H > t_L$

Assumptions are also made regarding the state of the market:

(i) normally sloped supply and demand curves for *H* and *L* and a perfectly elastic *W* supply curve for this commodity

(ii) perfect competition in both the commodity and factor markets in *H*, *L*, and *W*

(iii) no transport costs

(iv) perfect factor mobility in each country, but no factor mobility across national frontiers

(v) the only trade impediment is tariffs

(vi) fixed exchange rates

Given these assumptions and starting from the point at which the two countries have not as yet formed a FTA, commodity price in country *L* is $P_W (1+t_L)$ and commodity price in country *H* is $P_W (1+t_H)$, where P_W is the import supply price from *W*.

When H and L form a FTA, the "rules of origin" dictate that the domestic substitute can be traded freely, while the identical import remains subject to tariffs.[3] Shibata (1967) claims that this differential treatment of the identical products may create an "artificial price differentiation" between the imported product and its identical domestic-substitute. He explains this as follows; if $t_H > t_L$ then $P_W(1+t_H) > P_W(1+t_L)$, which means that the formation of the FTA will result in H importing the product from L. This implies that the joint domestic-substitute supply curve for the two partners ($remS_{H+L}$) becomes the effective supply curve for H's market. Consumers in L will always import from W if the price in L rises above $P_W(1+t_L)$, and consumers in H can always import from W if the price in H rises above $P_W(1+t_H)$. So, from the point of view of consumers in H, the total supply curve is $remiS_W(1+t_H)$.

Under these conditions the artificial price differentiation can lead to three possible outcomes which depend on the size of H's demand relative to the size and slope of the total supply schedule $remiS_W(1+t_H)$, which in turn depends on the elasticities of L's and H's supply schedules and the height of L's and H's protective duties.

As a first possibility, let H's demand be D_{H1}. Then the price of the domestic substitute in the market of H is the same as H's original price. The amount zg is continuously being supplied by the producers in H, but now gi represents the part of the former supply from W which has been replaced by imports from L. At the same time, L's producers export their entire output to H, leaving xa of L's market to be filled by imports

[3] Rules of origin serve to identify goods which originally enter one of the FTA partners from a third country under a specific tariff classification. To be allowed FTA consideration under the CUSTA when moving into the other FTA partner, the good must undergo processing which would usually result in the finished good being reclassified for tariff purposes or containing at least 50% of parts which are of FTA origin.

from *W*. The net change in the output of *W* or *gi - xa* (= *gi - em*) represents the 'trade diversion' effect. This type of trade diversion can not be eliminated by 'rules of origin' in FTAs, but the rules do limit the overall deflection of trade to a level far below what it would be otherwise.

Now let *H*'s demand schedule be D_{H2}. Then the new price (P_{FTA}) is lower than *H*'s original price but higher than *L*'s original price. The higher price in *H*'s market for the domestic substitute induces the producers in *L* to increase output and export to *H*. The increased output corresponds to the quantity, *fk - xa*. At the same time *H*'s external tariff keeps *W*'s exports completely out of *H*'s market. *W*'s export loss to *H*, *gh*, is offset partly or fully by increased imports by *L* to fill the gap created by *L*'s exports of the domestic substitute to *H*.

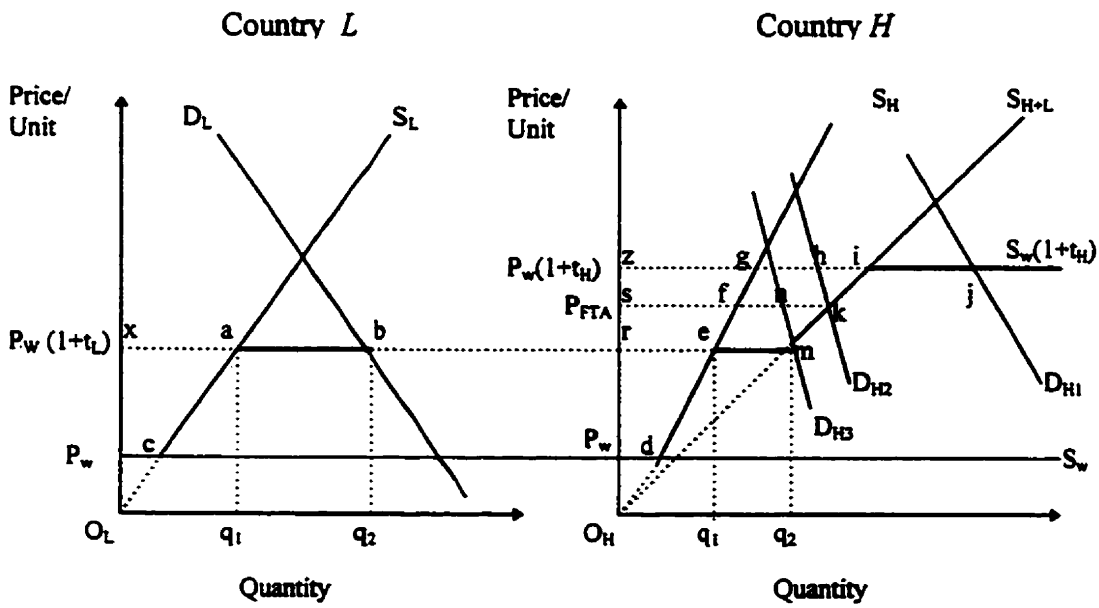

Figure 2.2 A Free Trade Area with 'Rules of Origin"

Depending on the relative size of gh and xa, we have three cases:

(i) $gh > xa$

In this case, W's output declines as a result of the net reduction of its exports to the two countries and there is an increase in L's output.

(ii) $gh = xa$

In this case there will be no change in the output of W.

(iii) $gh < xa$

In this case there will be a net increase in the output of W. The increased output of W supplements that of L in replacing marginal outputs formerly supplied by H's producers (which represents the trade creation effect), and in meeting the increased quantity demanded by H's consumers.

For the third possible outcome, let H's demand schedule be D_{H3}. Then the price of the domestic substitute is O_Hr, which is the same as L's original price (O_Lx) and also the same as the price of W's product in L. Therefore the output of L remains unchanged.

Although the third case constitutes an exception, the general outcome is that there will be an increase in output by L when a FTA is formed. This model has given some insight into the short-run product movement and product pricing possibilities in a FTA. Since the statistical analysis of CUSTA in this thesis is based on long-run price movements, the next step is to look into the theoretical long-run effects of setting up a FTA.

2.5 Theory of Free Trade Areas in the Long-run

The following model, developed by Price (1982), extends Shibata's short-run model and shows that in the long-run price differences cannot persist in a FTA for tradable goods of FTA origin. Once again, many assumptions are required to demonstrate this proposition. All the assumptions made for Figure 2.2 apply to Figure 2.3. There are three countries: a high tariff country (H), a low tariff country (L), and the rest of the world (W). Furthermore, some new assumptions are made to describe long-run behaviour:

(i) short-run rising marginal cost curves

(ii) free entry and exit of firms

(iii) constant or slowly rising long-term costs as interfactoral substitution and technological advance permit escape from diminishing returns in the long-run

(iv) frictionless operation of a perfect rules of origin system which prevents trade deflection.[4]

Before the creation of a FTA, the following situation is depicted in Figure 2.3. With price t_H and a tariff being collected, country H produces Oa, consumes Ob, and imports ab from the lowest cost world supplier at world prices (P_W). With a tariff raising the price to t_L, country L produces Oc, consumes Od, and imports cd.

After the FTA is established, producers in L gain access to the high price market in H and will serve that market in preference to their own, gradually bringing down the price in H. Consumers in L need not fear for supplies however because world producers will always be prepared to export to L at P_W plus the tariff t_L. Theoretically, the entire

[4] When goods manufactured outside the FTA enter at the lowest point in the non-harmonised tariff wall and proceed free of duty to more protected markets within the FTA.

production of L could be freed for export to H (first possible outcome in Shibata model). If this analysis is accepted, then according to Shibata, the final price in country H is indeterminate and depends on (a) the relative size and elasticity of supply in L and (b) on the size and elasticity of demand in H. On one extreme, if L's supply is relatively small

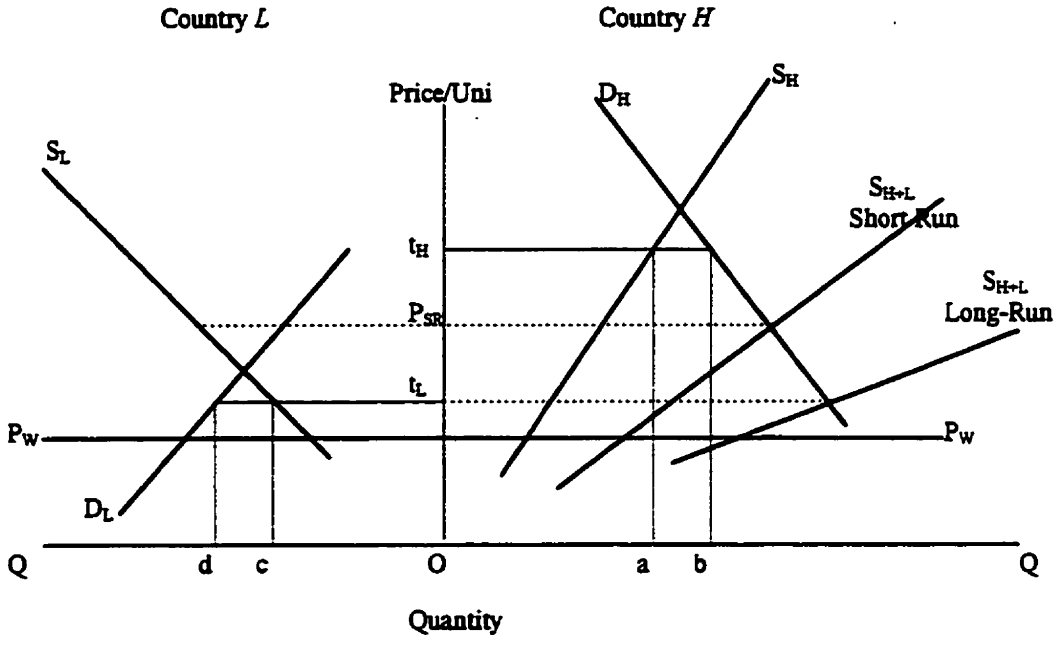

Figure 2.3 Free Trade in the Long-Run

and inelastic, and *H*'s demand is relatively large and elastic, it is clear that price will not fall much, if at all. Conversely, in the opposite case the price in *H* will fall close or all the way to the level in *L*. As a result, an extension of the model into the long-run is required to distinguish between these two extreme cases.

Price extends Shibata's work for a more definitive conclusion by looking at the long-run effects of a FTA. In this extension, "long-run" is meant to be a time span over which producers can increase or decrease capacity according whether or not the price they face in the market covers their long-term costs.

After the FTA is established, the two supply curves are added together (S_{H+L}, short-run) and applied to *H*'s demand curve to find short-run equilibrium price, P_{SR}. This short-run price turns out to be higher than the long-run equilibrium price in *L*, t_L. As long as this situation persists, entrepreneurs in *L* will be encouraged to expand capacity, since they were presumably meeting their long-run average costs at price t_L before the union, and are now making excess profits in *H*. This will cause the supply curve in *L* to shift left until the combined supply curve (S_{H+L}, long-run) wipes out the price difference between *L* and *H*, representing the end of the opportunity for producers in *L* to make excess profits in *H*. As a result, Price concludes that price differences cannot persist in a FTA for goods of FTA origin and that the price level of the most efficient producer will prevail (which obviously assumes perfect competition).

If price differences did persist in a FTA for goods of FTA origin and low cost producers could not take advantage of this difference then one could assume that significant non-tariff barriers to trade in these goods still existed. This result would

suggest that the agreement on freer trade was not working as it was proposed. On the other hand, if price differences began to erode between the FTA partners during the implementation of the agreement then it is possible that the change in prices is forcing a reallocation of resources in certain industries. Whether these reallocations translate into larger goods markets or greater certainty of access, and to whom any gains accrue is by no means a certainty. As a result, the existence of price convergence is a necessary but not sufficient condition for a FTA to be declared a success.

To this point, two simple models of trade theory have established that commodity price convergence is a necessary condition in a FTA in the long-run. This outcome gives the statistical analysis of the thesis a more well defined goal. The next logical step is to more clearly show why it is producer prices that should be tested for convergence rather than consumer prices.

2.6 Producer Price Equalisation in a Free Trade Area

In a paper on tariff revenue competition in a free trade area, Richardson (1995) shows why it is producer prices that will equalize rather than consumer prices. When "rules of origin" are effective and there are external tariff differences between FTA members, it is often assumed that differences in domestic prices exist for both consumers and producers. This assumption is contradicted by Richardson who notes that,

> "... even when trade deflection and consumer arbitrage are prevented, internal free trade implies that prices at which *producers* can sell are equated across members of a FTA, regardless of external tariff differences. This is because all intra-FTA production of a good can be sold anywhere within the FTA duty free" (p.1429)

The intuition behind why producer price equalisation must occur in a FTA can be explained with a simple model. As in the previous two models, assume three countries: H the high tariff country, L the low tariff country, and W as the rest of the world. Assume that H and L comprise the FTA and that there are no transport costs.

Consider X; a homogeneous good which H and L import from W subject to different tariffs. For notation,

let t^i = specific tariff

p^i = domestic price

$X^i(p^i)$ = supply in i

$D^i(p^i)$ = demand in i

where i = H, L.

Suppose $t^H > t^L$ so that $p^H > p^L$. Then all of L's production can be sold in H tariff-free. L's suppliers will get price p^H as long as:

(2.3.1) $$X^L(p^H) + X^H(p^H) < D^H(p^H)$$

That is, as long as total supply in H is less than total demand in H. If (2.3.1) does not hold, then H will import no X from W and p^H will be driven down until either:

(2.3.2) $$X^L(p^H) + X^H(p^H) = D^H(p^H)$$

at some $p^H > p^L$, or

(2.3.3) $$X^L(p^L) + X^H(p^L) > D^H(p^L)$$

where p^H will eventually be equal to p^L and producers in the FTA will be indifferent as to the destination of their sales. In each case producer prices will be equalised while only in case (2.3.3) will consumer prices be equalised. Under these conditions, deflection of sales

of domestic production within the FTA, from the low-tariff country to the high-tariff country, cannot be stopped so that producer price equalisation is inevitable. The argument against consumer price equalisation given by Richardson (1995, p.1431) is as follows:

> "FTAs are increasingly common and the evolution into what would effectively be customs unions, with common external tariffs, that such consumer arbitrage would imply is not apparent. In Canada, for example, proposals for greater integration with the US are roundly opposed. Second, trade deflection is closely monitored and prevented in FTAs so that consumer price differences due to tariff differences are not eroded by re-exporting. Third, travelers within FTAs are restricted in the value of goods they can transship. All in all, the extent of arbitrage that consumers can undertake is highly limited and is unlikely to erode consumer price differences due to external tariffs".

This chapter has shown that, given certain assumptions in a FTA, one outcome which can be expected is that producer prices for identical domestic products should equalise across member countries. This effect of producer prices converging to one price due to the creation of a FTA can then be used as one criteria by which the performance of a successful FTA can be established. The next step is to introduce the 'law of one price' and its relation to purchasing power parity models. Understanding this relationship will allow the development of valid statistical tests which can be used to search for the producer price equalisation effect and thereby help to assess the CUSTA.

CHAPTER THREE: LAW OF ONE PRICE AND PURCHASING POWER PARITY

3. Introduction

In the previous Chapter on the theory of Free Trade Areas, it was shown that one of the theoretical implications of creating such an area is that the producer prices should equalize between the FTA countries. The theoretical analysis from which this result is derived is comparative statics. To operationalize this result, however, requires that the relationship between prices be examined over time. Markets are not static and are continually changing subject to exogenous shocks. To determine if two or more markets are integrated, it is necessary to observe whether prices move together over time. This type of price analysis falls under the theoretical discussion relating to what is known as the Law of One Price (LOP).[5]

Imagine a world with two homogeneous goods, each in a different country. Barring transport costs, trade restrictions, and other transaction costs, perfect commodity arbitrage will ensure that the two goods share equal prices (taking into account the exchange rates) and the LOP will prevail. In fact, in a perfectly competitive market, with its assumptions of perfect knowledge, differences in relative prices would be eroded instantaneously. Many studies have shown however, that behaviour indicative of the LOP is not often observed. As early as 1921 Cassel noted many of the explanations for the failure to observe price convergence (Holmes, 1967). These ranged from the rigidities which arose from long-term effects like taxes and tariffs, to medium-term friction like

[5] The 'Law of One Price' is not usually attributed to any one individual.

shipping costs, and finally to short-term effects such as simple market disequilibria. When behaviour indicative of the LOP does extend from prices of individual goods to aggregate price levels, the term used to describe the situation is known as 'absolute purchasing power parity'.[6] The name purchasing power parity (PPP) was originally coined by Cassel (1918) while analyzing the state of exchange rates during World War I:

> The general inflation which has taken place during the war has lowered this purchasing power in all countries, though in a different degree, and the rates of exchange should accordingly be expected to deviate from their old parities in proportion to the inflation of each country. At every moment the real parity is represented by this quotient between the purchasing power of the money in the one country and the other. I propose to call this parity 'purchasing power parity'. As long as anything like free movement of merchandise and a somewhat comprehensive trade between the two countries takes place, the actual rate of exchange cannot deviate very much from this purchasing power parity (Cassel, 1918, p. 413).

This chapter is devoted to reviewing the theory of purchasing power parity and how it is has been related to market integration and international commodity arbitrage in the economics literature. This knowledge will provide insights into how PPP might be used to assess the performance of prices during the implementation of the CUSTA. The review will be divided into the following sections. The first section is an introduction to the theory of PPP. The second section relates the work of a number of authors to PPP and the objective of this paper. With the appropriate ground work laid, the next chapter introduces an econometric model which incorporates PPP and can be used to look for the presence of producer price convergence between Canada and the United States.

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[6] A formal definition of 'absolute' purchasing power parity will be given in the next section.

3.1 Theory of Purchasing Power Parity

Let p_i and p_i^* be the prices (in home currencies) of the ith commodity at home and abroad respectively. Let e be the nominal exchange rate between the two countries and let P and P^* be the overall price levels (i.e. some weighted index of prices) at home and abroad respectively.

The absolute or *strong* version of PPP is based on the LOP in a competitive market with no transaction costs. In such a case, the price of a good will be the same at all locations; $p_i = e\, p_i^*$. Now consider price indices at home and abroad such that $P = f(p_i)$ where $i = 1...n$ and $P^* = g(p_i^*)$ where $i = 1...n$. For absolute PPP to hold, the prices of similar goods must be the same, the same goods must be in each index, and the effective weighting within each index must be the same for each country. Under these circumstances the LOP also extends to aggregate price levels. As a result, the *strong* version of PPP can be stated as,

(3.1) $$e = P/P^*$$

(3.2) $$\ln e = \ln P - \ln P^*.$$

Assuming all variables are in log form, the most commonly tested version of (3.2) is,

(3.3) $$e_t = a + b\, P_t - b^*\, P_t^* + \varepsilon_t.$$

There are two common tests done on (3.3) which are derived from (3.1). The first test is for the 'symmetry condition'. This is a test which looks at whether or not $b = -b^*$. This is a test which looks at whether or not movements in the price indexes of the two countries are linked by their magnitude (an approximate test for the existence of commodity arbitrage). The second test is for the 'proportionality condition'. This is a

test to see if $b = -b^* = 1$. This test implies that the price indexes of two countries not only move together, but they move together in a one to one ratio. This, in turn, is supposed to suggest that commodity arbitrage is working perfectly. Since the proportionality condition requires greater restrictions on the coefficients (that they both equal 1) than the symmetry condition (which only requires that the coefficients are equal), the latter condition is considered the stronger or more restrictive condition. Although (3.2) is correct on theoretical grounds, empirical deviations resulting from testing for symmetry and proportionality conditions in (3.3) are common for a number of reasons. For example, spot prices of similar goods are not usually the same in different locations due to trade barriers such as tariffs and transport costs, and similar indexes may contain different goods or be weighted differently in different countries. Neither of these examples would allow one to make the assumption that the LOP extends to aggregate price levels or indexes. As a result, the many impediments to strict spatial price equalization can limit the use of the strong version of PPP.

The *weak* version of PPP restates (3.2) in terms of relative price levels and the exchange rate,[7]

(3.4) $$\Delta \ln e = \Delta \ln P - \Delta \ln P^*.$$

Going from (3.2) to (3.4) can be viewed as a way of avoiding the qualifications arising from transport costs, trade barriers, and transaction costs. The relative version of PPP, however, is still plagued by the same index measurement problems that have already been associated with the absolute version of PPP. Furthermore, recent advances in empirical

[7] This version was in fact the one Cassel had in mind when he coined the term 'purchasing power parity'.

research which look for long-run relationships in time series data suggest that first differencing of the data is probably not a good idea.[8]

Purchasing power parity theory is the basis of numerous economic models which have been used to study market integration and international commodity arbitrage. It is, therefore, important to examine the basic elements of PPP before moving on to look at its applications and how it might be used to examine price movements during the implementation of the CUSTA.

3.2 Literature Review

The objective of this thesis is to assess the performance of producer prices during the implementation of the CUSTA. The "performance" will depend on whether or not the CUSTA has resulted in a more integrated market. Such a market for Canada and the US has already been defined as one in which the prices of similar goods in each country are the same, barring all transaction costs (LOP). The idea of using price as a measure of market integration is common in economic literature. The approach can be found in papers which focus on topics such as agriculture and international trade. In almost all cases, the models used to make assessments employ some form of purchasing power parity.

This literature review focuses on five recent papers. The first two papers use purchasing power parity as a basis for models of market integration in agriculture. These papers focus on specific markets and specific products. The second two papers use

[8] This issue will be discussed in detail in Chapter 5. The simple explanation is that first-differencing data results in a loss of information.

purchasing power parity as a basis for models of international commodity arbitrage. These papers apply their models to relatively larger markets and they use a relatively higher level of price aggregation (e.g., price indexes as opposed to specific commodity prices). These four papers use varying types of econometric analysis.

The last paper is presented for a somewhat different reason. It represents a paper with almost the same objective as this thesis, but it uses an interest rate parity model instead of a purchasing power parity model to assess the performance of a trade agreement. The difference in models is related to the type of market integration one is attempting to address (e.g., a financial market and/or commodity market). A review of this paper complements the previous four by presenting a logical set of econometric tests which could be used to assess a trade agreement when employing a model based on a parity condition (e.g., purchasing power parity or interest rate parity).

The first paper by George Zanias (1993) looks for the existence of spatial market integration in European Community (EC) agricultural products. He uses his results as a measure of the performance of the EC's Common Agricultural Policy (CAP) which, among other things, was to lead to a set of common agricultural prices in the EC.

The model used in the paper is based on the Law of One Price. The basic testing equation is the following expression of absolute purchasing power parity:

(3.5) $p_{1t} = \alpha + \beta p_{2t} + \mu_t$

where p_{1t} is the logarithm of the exchange rate adjusted commodity price in one country, and p_{2t} is the logarithm of the exchange rate adjusted commodity price in another EC

country. This equation is equivalent to (3.3), except for the fact that in this case the exchange rate is explicitly built into the prices.

Zanias uses this equation to look for two things. First, he looks for a long-run relationship between prices of the following commodities: soft wheat, milk, potatoes, and pig carcasses. The long-run relationship is supposed to reflect the CAP, which has existed for over two and a half decades. He does this search by applying a cointegration test to equation (3.5) and looking for stationary residuals.[9] This is considered the unrestricted case.

The second thing Zanias does is explicitly test for the LOP. He does this by indirectly testing to see if $\beta = 1$ in the long run. This is done by checking to see if the difference between exchange rate adjusted prices in two countries is stationary. This is considered the restricted case since he has "imposed" symmetry on the model by testing the difference between comparable commodity prices. The data used for each of the four commodities is monthly and covers about ten years (about 1980 to 1990), and spans five EC countries.

By the cointegration criterion, Zanias concludes that many of the markets for these products are not integrated and the operation of the CAP has not resulted in a truly common market. He does note, however, that the non-integrated markets are in the minority when the prices are adjusted for monetary compensatory amounts (MCAs - equivalent in effect to export subsidies). Other non-integrated markets are attributed to non-tariff barriers and imperfectly competitive markets.

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[9] The concepts of cointegration and stationarity are explained in detail in Chapter 5.

This paper establishes some important points for the objective of this thesis. First, a model based on absolute purchasing power parity can be the framework for tests of market integration. Second, producer prices are used for these types of tests. Third, by reducing transaction costs (discounting the MCAs) market integration might be more likely. Lastly, market integration tests of this nature can be related to formal policy arrangements between countries (e.g., the EC's Common Agricultural Policy).

The second paper is also an examination of market integration as it pertains to commodity prices (Diakosavvas, 1995). The objective of this paper is "to examine market integration between Australian and US beef prices at the farmgate level" (Diakosavvas, 1995, p.37). In so doing, the author is able to determine whether or not Australian beef prices can be used as a world price or reference price to measure the level of support accorded to the U.S. beef sector.

The approach used is based on absolute purchasing power parity and the LOP, but the econometric model employed is an autoregressive distributed lag model. This is different from the usual testing model, but it's relevance is not the important aspect of this paper, as it relates to this thesis. The monthly data used includes 5 different types of beef prices for Australia and the US, and it spans the time period 1972:1 to 1993:2.

Like many other papers, the cointegration testing done to look for the presence of any long-run relationship is based on the residuals from the autoregressive distributed lag model. Unlike many other papers, Diakosavvas takes the testing one step further by looking for the presence of convergence in price pairs over time. He does this time varying examination using the Kalman filter, and describes the exercise as being "able to

describe both the extent and timing of the process of convergence as it occurs, as opposed to the co-integration analysis which is only able to measure convergence once it has taken place" (Diakosavvas, 1995, p.49).[10]

The conclusion of the paper notes that although cointegration of prices is weak at best, there is a definite tendency towards convergence. Relative to this thesis, the idea that time varying parameter analysis can allow one to investigate convergence as it is occurring is a key point. Since tariff barriers in the CUSTA are being reduced over a ten year period (scheduled to be completed in 1999), it is likely that convergence is in the process of taking place rather than having already occurred.

The third paper focuses on the "empirical examination of long-run purchasing power parity as a theory of international commodity arbitrage" (Fraser, Taylor, and Webster, 1991; p.1749). The objective of the paper is to use recently developed cointegration techniques to examine findings by Frenkel (1981) and Taylor (1988) that PPP has collapsed during the recent floating exchange rate period. These papers had used aggregate prices (price indexes). Fraser, Taylor, and Webster note this as the major problem and propose to disaggregate the data for 35 manufacturing industries in the US and the UK The assumption is that different industries will have different speeds of price adjustment and that this fact could bias tests which aggregate the data.

The PPP assumption built into their LOP approach is that of absolute purchasing power parity. Therefore their econometric model is similar to equation (3.5). The data set employed is the same as Webster (1987) and is made up of monthly producer prices

[10] Time varying parameter analysis and the Kalmam filter will be fully explained in Chapter 5.

from the UK for 1975 to 1980, and monthly wholesale prices from the US for 1975 to 1980. The prices cover 35 different manufacturing industries.

The cointegration testing done for each of the manufacturing industries was based on the stationarity of the residual in an equation (3.5). The results with the symmetry assumption relaxed were only slightly better than those results with the symmetry condition imposed. Further to the point, not one industry exhibited a long-run relationship between the two countries when symmetry was imposed. The authors conclude that the results are generally unfavourable to the long-run proportionality of prices between industries in the two countries.

Relative to this thesis there are a couple of comments to be made. First, the assumption that absolute purchasing power parity can be used as the basis for a model of international commodity arbitrage is not uncommon. Second, "long-run" data for any cointegration test across countries must span more than five years. Third, disaggregating data might not be the answer to the question of why PPP has, in some sense, failed during the recent float. Therefore two key problems this thesis must address when building a testable model of international commodity arbitrage, are that of price aggregation and measurement, and that of the econometric testing of long-run data.

The next paper by Cheung and Lai (1993) answers some of the key modeling and testing problems. The objective of this paper is to "examine the relevance of long-run purchasing power parity, which allows for measurement errors, during the recent floating exchange rate period" (Cheung and Lai, 1993; p. 181).

The econometric model used incorporates measurement error in prices (e.g., the type of error that might arise when including non-traded goods in price indexes used to test for international commodity arbitrage).[11] The data used was comprised of monthly consumer price indexes (CPIs) from 1974 to 1989 and monthly wholesale price indexes (WPIs) from 1974 to 1986, for 5 countries.

Two cointegration tests were compared: the more recently developed maximum likelihood (ML) approach; and the usual test for stationarity in the residuals. The results indicate that the ML approach showed significantly different results from the residual-based approach. The residual-based tests consistently showed little evidence of any long-run relationship between the nominal exchange rate and prices, while the ML approach indicated that there is a significant probability of a long-run relationship in all cases (when using WPIs). Furthermore, Cheung and Lai give theoretical evidence of the superiority of the ML approach for testing for cointegration, and they show why "symmetry and proportionality restrictions need not hold empirically in the presence of measurement errors in prices" (Cheung and Lai, 1993, p.187).

The key results of this paper were the following. First, the paper refutes previous evidence which suggests that PPP had collapsed during the recent floating exchange rate period. Second, the paper addresses the problem of measurement error in prices and shows that WPIs perform much better than CPIs when examining them for cointegration (as the model in Chapter two predicts). Third, the authors show the superiority of the ML approach over the residual approach both theoretically and empirically. These results can be applied to the choice of data, the choice of an econometric model, and the choice of a

[11] The details of the model are left to the next Chapter of the thesis.

cointegration test when examining the performance of producer prices during the implementation of the CUSTA.

To this point all the papers have shown that it is possible to apply the interpretation of market integration or international commodity arbitrage when testing a model which is based on absolute purchasing power parity. Furthermore, a good econometric model and a superior cointegration test have been mentioned. Also, it has been indicated that a convergence test might be superior to a cointegration test if the process which is being investigated has not yet been completed. The tools to measure the performance of the CUSTA seem to be evident, but the application of these tools to find an answer to the objective this thesis is not as yet clear.

A final paper is discussed which shares almost exactly the same objective as this thesis, but which is applied with a different model and to a different trade agreement. Moosa and Bhati (1995) attempt to examine whether or not the Closer Economic Relations agreement (CER) of 1983 has resulted in more integrated financial and goods markets between Australia and New Zealand.

The model employed is based on the theory of interest rate parity. This theory implies that if two financial markets are fully integrated then they must share the same general level of interest rates.

The econometric methodology used to examine the interest rate parity relationship and then relate it to the enactment of CER included a couple of steps. The first thing done was to break up the data into three periods: the whole data set (1974:1 to 1993:3); the pre-CER period (1974 to 1982); and the post-CER period (1982 to 1993). Each of

these periods was tested for cointegration in interest rates using the ML approach. Second, a structural break test was done by applying the CUSUM test to the data for the whole sample period.[12] Finally, the authors examine the possibility that the convergence of interest rates between New Zealand and Australia may be in the process of occurring rather than completed, by doing time varying parameter analysis using the Kalman Filter.

Their results can be summarized as follows: cointegration was evident in the post-CER period and not evident in the pre-CER period; the CUSUM test suggested that there was a structural break around the time of the CER and this was confirmed when a dummy variable (to represent the post-CER period) was included and caused the structural instability to disappear; and time varying parameter analysis indicated that the interest rates had been moving towards each other over time.

The authors interpret these and other results as indicating that they are in favour of the proposition that implementation of the CER and other financial deregulations has resulted in more integrated financial markets between Australia and New Zealand.

Regardless of the validity of the results and the authors' interpretation of them, the important aspect of their paper for this thesis is the establishment of a logical set of tests which one might apply to a parity model of integrated or integrating markets.

The papers presented in this literature review have established a number of points for this thesis:

1. Purchasing power parity may be used as a basis for the estimation of a model which attempts to assess the level of integration of international commodity markets.

[12] The CUSUM test is explained in detail in Chapter 5.

2. A properly structured model may be able to address the problems of price measurement which are associated with aggregate prices and price indexes.
3. A logical set of econometric tests may be applied to a model of market integration which might shed light on the underlying influence of any international agreements which have attempted to make these markets more integrated.

With these points established, the next chapter describes the econometric model of Cheung and Lai (1995). This model of PPP with measurement error in prices will be the model which this thesis will using as a basis for the econometric assessment of goods market integration between Canada and the US.

CHAPTER FOUR: AN ECONOMETRIC MODEL

4. Introduction

With the idea that absolute purchasing power parity may be used as the basis of a model which is employed to assess market integration, it is possible to move to the next step of the thesis. This chapter presents the econometric model that will be applied and tested. The results of these tests should reflect both the degree of goods market integration between the U.S. and Canada, and the extent to which the timing of the CUSTA has had an effect on producer prices in the two countries.

Prior to presenting the econometric model, a short but detailed review is done of how the concepts of symmetry and proportionality apply to a testable econometric equation of absolute PPP. This presentation provides the necessary background to understand the ideas supporting the econometric model presented in this chapter, and the subsequent testing of that model in the next chapter.

4.1 Symmetry and Proportionality

The concepts of symmetry and proportionality were first described in the section on the theory of PPP, where they were defined as two types of testing restrictions on a model of PPP. This discussion is on the same topic, but differs because it takes the explanation one step further. It shows the econometric and testing implications (e.g. data manipulation) which occurs when one "imposes" these restrictions on a model of absolute PPP.

The absolute version of PPP presented in chapter three is shown in equation (3.3). The same equation with logarithms explicitly shown is:

(4.1) $\ln e_t = a + b \ln P_t - b^* \ln P_t^* + \varepsilon_t$

A trivariate cointegration test of the variables e_t, P_t, and P^*_t as proposed by Johansen and Juselius (1990) allows a dynamic interaction without any restriction on the coefficients or any causal assumptions. This is the most general case of testing without symmetry or proportionality assumptions imposed.

If symmetry is imposed, that is the assumption that $b = -b^*$, then the equation derived from (4.1) is:

(4.2) $\ln e_t = c \ln P_t^{**} + \eta_t$

where the series $P_t^{**} = P_t/P_t^*$. This is a test which has imposed the assumption that the nominal exchange rate is equivalent to the relative price ratio (Enders, 1988). Imposing the symmetry restriction results in a bivariate model where the two variables being tested for cointegration are e_t and P_t^{**}.

If the proportionality condition is imposed, that is the assumption that $b = -b^* = 1$, then the equation to be tested is:

(4.3) $\ln r_t = \delta_t$

where the series $\ln r_t = \ln e_t - \ln P_t + \ln P_t^*$ (which makes r_t equal to the real exchange rate). This equation is in fact testing to see if the real exchange rate is stationary or non-stationary. As a result, the imposition of the proportionality condition builds in the assumption that PPP will hold only as long as the real exchange rate is stationary. This univariate model can be simply tested by examining whether on not the series $\ln r_t$

contains a unit root.[13] Since this is the most restrictive test, it would imply that e_t, P_t, and P_t^* are cointegrated along with the proper coefficients if $\ln r_t$ is found to contain a unit root. This most restrictive of PPP tests has most often found that the behaviour of the real exchange rate is not significantly different from a random walk, thereby refuting absolute PPP.

4.2 A Model of Purchasing Power Parity with Measurement Error

The goal here is to build a model which gives good reason for taking a logical approach in assessing PPP. Such an approach begins with tests which are the least restrictive in nature (a trivariate model) and ends with those that are the most restrictive (a univariate model). The proposed model is set out in Cheung and Lai (1993) and is one which examines the relevance of long-run PPP when incorporating the measurement error that arises from using price indexes to proxy actual individual prices.

We begin by specifying the PPP model in its absolute form:

(4.4) $s_t = d + \alpha_1 p_t - \alpha_2 p_t^* + \mu_t,$

where d is some constant, s_t is the logarithm of the spot exchange rate (domestic price of foreign currency), p_t is the logarithm of the domestic price index, and p_t^* is the logarithm of the foreign price index. The next step is to build in the measurement error arising from the use of price indexes.

Suppose that long-run PPP holds for some theoretical prices indexes, denoted by g_t and g_t^*, so that:

[13] Testing for trends and unit roots is explained in Chapter 5.

(4.5) $s_t = h + g_t - g_t^* + v_t$

where v_t is a stationary process. Depending on how the observed indexes are constructed, a 1 % change in the observed indexes could correspond to a percentage change in the theoretical price indexes which is greater than or less than 1 %. This measurement error can be captured by allowing the observed price series p_t and p_t^* to be related to the theoretical indexes through the following equations:

(4.6) $p_t = a_1 + b_1 g_t + \varepsilon_{1t}$

(4.7) $p_t^* = a_2 + b_2 g_t^* + \varepsilon_{2t}$

where the parameters a_1, a_2, b_1, and b_2 capture the systematic measurement errors; and ε_{1t} and ε_{2t} are stationary stochastic terms capturing non-systematic measurement errors. The stationarity in ε_{1t} and ε_{2t} implies that the observed prices will not drift too far apart from the theoretical price indexes, which is a requirement for a meaningful test of absolute PPP. The parameters b_1 and b_2 can differ from each other due to the differences between countries in the composition of goods and services and in the weighting scheme used for index construction. Combining equations (4.5), (4.6), and (4.7) yields:

(4.8) $s_t = (h - a_1/b_1 + a_2/b_2) + (1/b_1)p_t - (1/b_2)p_t^* + (v_t - \varepsilon_{1t}/b_1 + \varepsilon_{2t}/b_2)$.

This is equation (4.4) with:

(4.9) $d = (h - a_1/b_1 + a_2/b_2)$,

(4.10) $\alpha_1 = 1/b_1$,

(4.11) $\alpha_2 = 1/b_2$, and

(4.12) $\mu_t = (v_t - \varepsilon_{1t}/b_1 + \varepsilon_{2t}/b_2)$.

Since either α_1 or α_2 can differ from unity, equation (4.4) in contrast to equation (4.5) can be viewed as a PPP relationship with measurement error in prices. So equation (4.4) will be tested in a stepwise fashion from the trivariate form (no restrictions), to the bivariate form (symmetry restriction), and finally to the univariate form (proportionality restriction).

It is important to note that the PPP relationship does not account for any international factors (e.g., globalization, multilateral reductions in trade barriers, etc.) that might effect the relationship between producer prices in Canada and the United States. Therefore the usual assumption of *ceteris paribus* as it relates to the testing of the PPP relationship is assumed rather than formally tested. Hence, the assumption will be made that these "non-bilateral" effects on the PPP relationship between Canada and the United States will not significantly effect the results.

This chapter has presented an absolute purchasing power parity model which incorporates measurement error in prices. The specific equation to be tested is (4.4). It will be subject to a number of tests. The theory behind these tests, and their results are explained in the next chapter.

CHAPTER FIVE: MODEL TESTING AND RESULTS

5. Introduction

This chapter describes, in detail, the set of econometric tests which should help to assess the degree of goods market integration between Canada and the U.S. Each section of this chapter is devoted to one of the three following econometric issues: structural breaks, cointegration, and convergence. For each section the discussion and presentation of the tests and results will be organized in the following manner. First, a brief review will be given of how the issue relates to the goal of this thesis. Second, the theory behind the relevant tests will be provided (with an emphasis on keeping the explanations intuitive). Finally, the tests and results will be presented and summarized. A brief overview of the data is presented prior to reviewing the econometric issues and the relevant test results.

5.1 The Data

Monthly producer price index (PPI) data and monthly exchange rate data from 1974:1 until 1996:1 are used to undertake the econometric analysis for Canada and the US. The source of the data is *OECD Main Economic Indicators*. Consumer Price Index data is ignored since the theory pertaining to FTAs with rules of origin suggests that it is producer prices that should equalise rather than consumer prices.

5.2 Tests of Model Stability

The CUSTA represented a significant change in trade policy between the US and Canada. This policy change may have had a significant effect on the relationship between producer prices in the two countries. The PPP relationship between these prices is represented by the following equation:

(5.1) $s_t = d + \alpha_1 p_t - \alpha_2 p_t^* + \mu_t$,

If the PPP model underlying this equation changed significantly with the implementation of the CUSTA, then the change might be expressed as model instability. The CUSUM (cumulative sum) and CUSUMSQ (cumulative sum squared) tests presented in this section look for the presence of model instability.

The CUSUM and CUSUMSQ tests use recursive residuals to check the stability of the regression coefficients in the PPP model (equation 5.1). These two tests of structural change are based on the model's ability to predict correctly outside of the range of observations used to estimate it. The ability of the model to predict correctly is influenced by the stability of the coefficients in the model. The CUSUM test is aimed mainly at detecting systematic movements in coefficients while the CUSUMSQ test is better at showing when random movements in coefficients are occurring.

The technique first requires the estimation of the recursive residuals, which are derived as follows. The tth recursive residual, e_t, is the *ex post* prediction error for y_t when the regression is estimated using only the first $t-1$ observations:

(5.2) $e_t = y_t - x_t' b_{t-1}$,

where x_t is the vector of regressors associated with observation y_t, and b_{t-1} is the least squares coefficient computed using the first $t-1$ observations. The rth scaled recursive residual, w_r, is then calculated as:

$$(5.3) \quad w_r = \frac{e_r}{\sqrt{1 + x_r'(x_{r-1}'x_{r-1})^{-1}x_r}}$$

Under the null hypothesis for both the CUSUM and CUSUMSQ tests, the model is stable with coefficients that remain constant during the full sample period.

The first test statistic, W_t, calculates the cumulative sum (CUSUM) of the recursive residuals:

$$(5.4) \quad W_t = \sum_{r=K+1}^{r=t} \frac{w_r}{\hat{\sigma}}$$

Under the null, W_t has a mean of zero and a variance of approximately the number of residuals being summed. The test is performed by plotting W_t against t. The results of the CUSUM test are on Figure 5.1. The upper and lower limits represent 5% significance level boundaries. When the CUSUM statistic deviates beyond the boundary, there is a 95% probability that there is structural instability in the coefficients. In Figure 5.1, the point at which the statistic deviates beyond the 95% confidence interval is indicated by almost the exact month when CUSTA went into effect (January 1989).

The second test statistic, S_t, calculates the square of the cumulative sum (CUSUMSQ) of recursive residuals:

$$(5.5) \quad S_t = \frac{\sum_{r=K+1}^{r=t} w_r^2}{\sum_{r=K+1}^{r=T} w_r^2}$$

The results of the CUSUMSQ test are on Figure 5.2. Once again, the upper and lower limits represent 5% significance level boundaries. As before, if the cumulated sum strays outside the confidence bounds, doubt is cast on the hypothesis of parameter stability. Figure 5.2 seems to confirms the CUSUM results. That is, the hypothesis of parameter stability in the PPP relationship can be rejected.

Overall, the cumulative sum tests of model stability suggest that there is a structural break in the PPP relationship represented by equation (5.1), and that the instability may be due to the inability of the model to correctly predict the coefficient values after 1989:1.

5.3 Tests for Cointegration

The second test done is one which looks for the existence of a long run relationship, otherwise known as the existence of cointegration, between producer prices in Canada and the US. If the test indicates cointegration only after the implementation of the CUSTA, then there is evidence to suggest that the trade agreement may have had a significant effect on the goods markets in the two countries. A strong precondition for cointegration to exist, is that the data series should be integrated of the same order (i.e., the series should share the same trend properties).

The following subsection gives a brief review of the trend properties of the data and then goes on to discuss the results of stationarity tests of the relevant data series.

Figure 5.1 CUSUM Test of Recursive Residuals

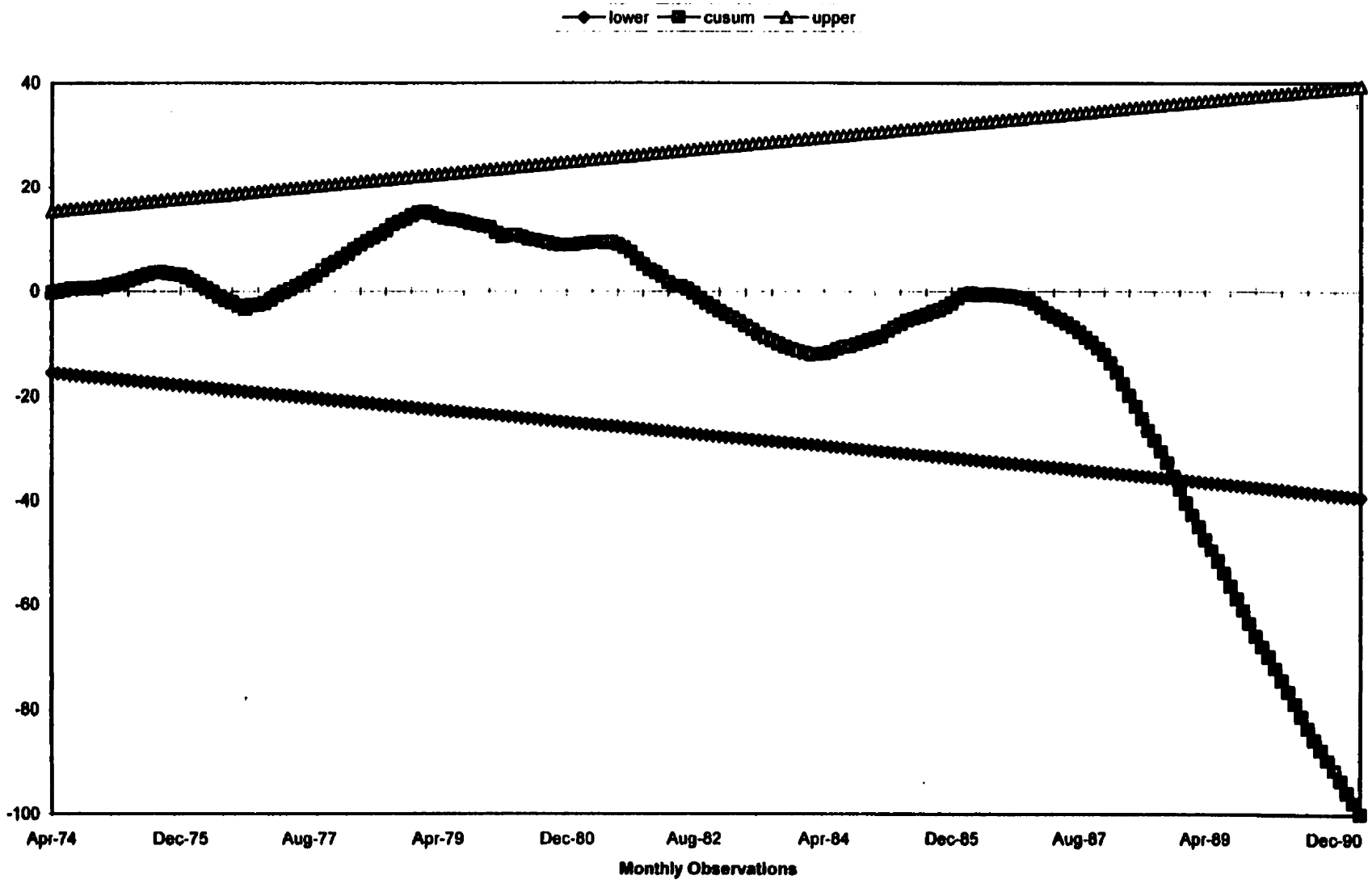
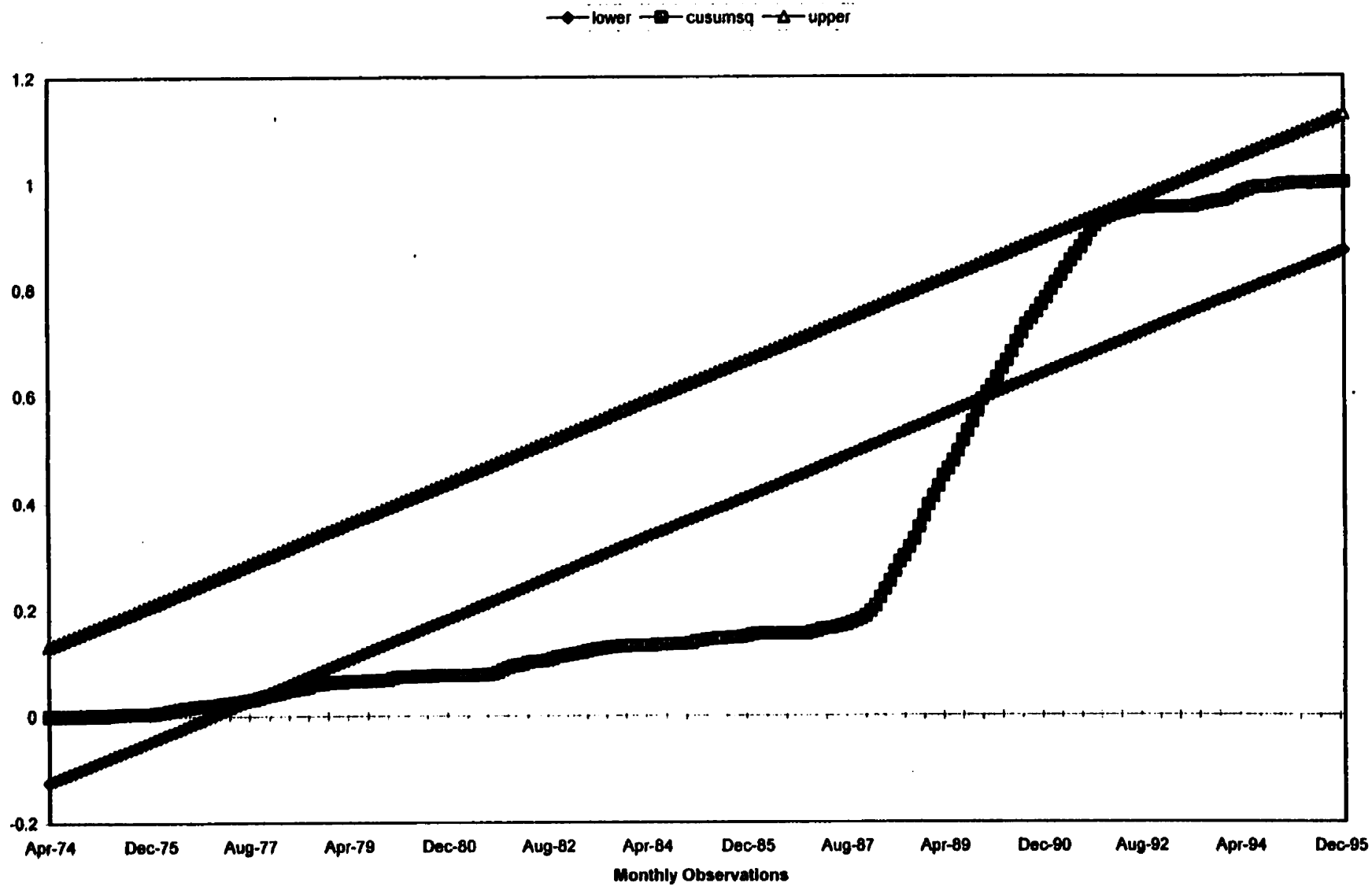


Figure 5.2 CUSUMSQ Test of Recursive Residuals



5.3.1 Trend Properties of the Data

In order for cointegration to be interpreted correctly, the variables used in the tests should be integrated of the same order (or have the same number of roots). The relevant variables tested for cointegration are: the Canada-US exchange rate (s_t); the Canadian producer price index (p_t); and the American producer price index (p_t^*).

There are important differences between a stationary time series and nonstationary time series.[14] Shocks to a stationary time series are temporal. That is, the effect of the shock dissipates, and over time the series reverts to its long-run mean level. Also, the variance of such a series is finite and not time dependent. In contrast, a nonstationary series, when shocked, has no long-run mean to which it returns, and it has a time dependent variance which goes to infinity as time approaches infinity.

Consider the simplest of nonstationary processes, a random walk without drift:

(5.6) $x_t = x_{t-1} + \varepsilon_t$

where ε_t is a white noise error term with zero mean and constant variance (δ^2). The variance of x_t is:

(5.7) $Var(x_t) = t\delta^2$,

and becomes infinite as time approaches infinity. The series can be made stationary by first differencing:

(5.8) $x_t - x_{t-1} = \varepsilon_t$.

Now the mean is constant and the variance (δ^2) is finite. So the x_t series can be described as a difference stationary series. Since this series required one round of differencing to be

[14] The discussion on trends, unit roots, and stationarity is based on Chapter 5 of Cuthbertson, Hall, and Taylor (1992), and Chapter 4 of Enders (1995).

made stationary, it can also be described as being integrated of order one (I(1)), or it can be described as containing a unit root.

There are a number of tests available to determine the order of integration of each of the series of interest. A common test is the Augmented Dickey-Fuller test (Dickey and Fuller, 1981). This test has the following form:

$$(5.9) \quad x_t = \alpha_0 + \alpha_1 t + \alpha_2 x_{t-1} + \sum_{j=1}^{k} \beta_j \Delta x_{t-j} + \varepsilon_t$$

where x_t is the log of the series, and k is chosen so that the residuals are white noise. This test assumes that the errors, ε_t, must be statistically independent and have a constant variance.

Phillips and Perron (1988) have developed a more general procedure which allows for milder assumptions concerning the distribution of the errors. The Phillips-Perron test can be motivated by expanding on equation (5.6):

$$(5.10) \quad x_t = \theta_1 x_{t-1} + \omega_t$$

$$(5.11) \quad x_t = \phi_0 + \phi_1 x_{t-1} + \eta_t$$

$$(5.12) \quad x_t = \alpha_0 + \alpha^* x_{t-1} + \beta(t - T/2) + \mu_t$$

where T = the number of observations, and the disturbance term μ_t behaves such that $E\mu_t = 0$, but there is no requirement that the disturbance term is serially uncorrelated or homogeneous. Equation (5.10) serves as the null hypothesis against the alternative equations (5.11) and (5.12), where (5.11) contains a drift term (ϕ_0), and (5.12) contains a drift term (α_0) and a trend term ($\beta(t - T/2)$). The Phillips-Perron test statistic, $Z(t\alpha^*)$, is used to test the hypothesis that $\alpha^* = 1$. Table 5.1 displays $Z(t\alpha^*)$ for the Canadian

producer price series, the American producer price series, and the Canada-US exchange rate series.

The results for the Phillips-Perron test on log-levels indicates that it is not possible to reject the null hypothesis of a unit root for any variable, in any period. That is, all the variables are at least I(1). By running the same test in first differences, one can test the null hypothesis of I(2) against the alternative of I(1). The results indicate that for each variable and each period it is possible to reject the null hypothesis of I(2) with 99% level of confidence.

The CUSUM and CUSUMSQ tests suggest the presence of a structural break in the PPP relationship. When there are structural breaks, the Dickey-Fuller and Phillips-Perron test statistics are biased toward the non-rejection of a unit root (Enders, 1995). Perron (1989) develops a formal procedure to test for the presence of a unit root over the whole data set when the point of the structural break is known.

In this case, Perron's test will be applied to the Canadian producer price series, the American producer prices series, and the Canada-US exchange rate series. Consider the following null and alternative hypotheses:

(5.13) $H_o: y_t = a_0 + a_1 y_{t-1} + \mu_1 D_P + \varepsilon_t$

(5.14) $A_o: y_t = a_0 + a_2 t + \mu_2 D_L + \varepsilon_t$

where $D_L = 1$ for all t greater than 1989 and zero otherwise, and $D_P = 1$ for t equal to 1989 and zero otherwise. The null hypothesis assumes a one time jump in the level of a unit root process versus the alternative hypothesis of a one time change in the intercept of

Table 5.1 Phillips-Perron Unit Root Tests on The Variables of the Trivariate Model (s_t, p_t, p_t^*)

		Log-levels		First Differenced	
Null:	I(1)	$x_t = \theta_1 x_{t-1} + \omega_t$		I(2)	$\Delta x_t = \pi \Delta x_{t-1} + \varpi_t$
Alternative:	I(0)	$x_t = \alpha_0 + \beta(t-T/2) + \alpha^* x_{t-1} + \mu_t$		I(1)	$x_t = \alpha^* x_{t-1} + \omega_t$
Test Statistic:		$Z(t\alpha^*)$			$Z(t\alpha^*)$
Variable:		s_t	p_t^*		p_t
			Period: 1974:1 to 1996:1		
Log-levels		-1.7171	-2.1503		-2.2767
1st Differenced		-17.1030[a]	-13.6880[a]		-11.4460[a]
			Period: 1974:1 to 1988:12		
Log-levels		-0.24007	-0.78430		-1.2258
1st Differenced		-14.666[a]	-11.917[a]		-9.6102[a]
			Period: 1989:1 to 1996:1		
Log-levels		-2.3582	-1.2704		-1.1216
1st Differenced		-10.069[a]	-7.6843[a]		-6.8518[a]

Note: The critical value for the $Z(t\alpha^*)$ statistic is -4.04 for a 99% confidence level, and the superscript "a" indicates rejection of the null hypothesis.

a trend stationary process. The test is carried out by detrending the series of interest while taking into account the structural break (i.e., estimating the alternative hypothesis), and then testing the detrended series (i.e., the residuals from the alternative hypothesis) for unit root behaviour. If we let the $\hat{y}_t$ represent the residuals from the estimation of the alternative hypothesis, then the detrended series is estimated using the following equation:

$$(5.15)\quad \hat{y}_t = a_1\hat{y}_{t-1} + \sum_{i=1}^{k} \beta_i \Delta\hat{y}_{t-i} + \varepsilon_t \,.$$

Lag length, k, is chosen so that the residuals in (5.15) are serially uncorrelated (white-noise). The results of the estimation for the three variables are displayed in Table 5.2. The t statistic on a_1 for all of the variables does not exceed the critical value of -4.42. As a result, the null hypothesis that these series represent unit root processes with a one time jump in the level can not be rejected. In fact, Flynn and Boucher (1993) carry out this same test for the Canadian exchange rate, and the Canadian-U.S. price level differential assuming structural breaks at 1971, 1979, and 1985.[15] Regardless of when the break was assumed, neither of the series could reject the null hypothesis of a unit root process with a one time jump in the level of the series.

The results suggest that each of the variables in each period are integrated of order one (I(1)). These results establish the possibility that the proposed equilibrium relationship described in equation (5.1) may also represent a long-run relationship. This

[15] The first event constitutes a regime change from fixed to flexible exchange rates. The second event reflects a change in monetary policy by the U.S. Federal Reserve. The third event reflects the Plaza Accord which was a coordinated effort to devalue the dollar against key currencies.

is the first step in testing for cointegration between the American producer price series, the Canadian producer price series, and the Canada-US exchange rate series.

5.3.2 Multivariate Cointegration

Taking first differences of all nonstationary variables to remove any stochastic trend that might arise in a univariate model, is not an uncommon procedure in time series analysis. More recently, it has been recognized that the appropriate way to deal with nonstationary variables may not be so straightforward in a multivariate context. It is quite possible that there exists a linear combination of integrated variables that is nonstationary. Such a combination of variables is said to be cointegrated.

In the long-run PPP model presented here,

(5.16) $s_t = d + \alpha_1 p_t + \alpha_2 p_t^* + \mu_t$

behavioural assumptions about the model require the testing of the parameter restriction that $\alpha_1 = \alpha_2 = 1$. Furthermore, if the theory is to make any sense at all, the unexplained portion of relationship, μ_t, must represent short run deviations from purchasing power parity which are only temporary in nature. Clearly, if μ_t has a stochastic trend, the errors in the model will be cumulative so that deviations from PPP will be permanent in nature. Hence a key assumption of the theory is that μ_t is stationary.

The problem which now arises is that we have already shown that, for each period of interest, the various series s_t, p_t, and p_t^* are all I(1). This means that over time, the value of each variable can change without any tendency to return to a long-run mean. However, the theory expressed in (5.16) asserts that there exists a linear combination of

Table 5.2 Perron Unit Root Tests on Canadian PPI, American PPI,and the Canada-US Exchange Rate (1974:1 to 1996:1)

Regression: $\hat{y}_t = a_1 \hat{y}_{t-1} + \sum_{i=1}^{k} \beta_i \Delta \hat{y}_{t-i} + \varepsilon_t$

Series	k[1]	a_1	t_{a1}	Q(12)	Q(23)	λ^2
Cdn PPI	8	0.9725	-0.5382	1.36	2.45	0.7
US PPI	9	0.9813	-1.937	10.98	19.57	0.7
Cdn-US ER	3	0.9189	-0.7151	9.22	16.05	0.7

[1]The lag length was chosen using minimum AIC values. Chosen lengths were checked for serial correlation using the Lung-Box-Pierce ('Q') statistic reported by the SHAZAM statistical program. The critical Q statistic for a 0.10 significance level is distributed as $\chi 2$ with 23 degrees of freedom, and it is equal to 32.069.

[2]The critical t values reported by Perron (1989 - Table IV.B) depend on the ratio of the pre-break sample size to the total sample size. For this test, the ratio is 0.7, and the critical t value at 1% significance is -4.42.

these nonstationary variables which is stationary. Another way of looking at this problem is to rewrite (5.16) as,

(5.17) $\mu_t = s_t - d - \alpha_1 p_t + \alpha_2 p_t^*$.

Since μ_t must be stationary, it must be true that the linear combination of right-hand-side variables must also be stationary. So in general, a cointegrated system describes an equilibrium theory in which a combination of nonstationary variables is in fact stationary (Engle and Granger, 1987).

Engle and Granger (1987) provided the first method by which one could test the residuals of an equilibrium relationship for stationarity. The method involved the following steps. Assume that one wanted to test for the existence of a long-run relationship between some variables x and y, such that:

(5.18) $y_t = \alpha_1 + \beta_1 x_t + \lambda_{1t}$.

The first requirement for the test to be carried out was that the two data series be integrated of the same order. Tests such as those done in the previous section on trend properties can be used to establish orders of integration. Assuming that both variables are I(1), the first step in the cointegration test involved estimating, by ordinary least squares (OLS), the regression described in (5.18).

The next step involved taking the residuals from that regression and running the following auto-regression:

(5.19) $\Delta\hat{\lambda}_t = k\hat{\lambda}_{t-1} + \varepsilon_t$.

If the residuals from (5.19) were white noise, then Dickey-Fuller tables could be used to test the null hypothesis that $k = 0$. If the null hypothesis could not be rejected one could

conclude that the residual series contained a unit root (i.e., they were non-stationary) and that the y and x series were not cointegrated. In most cases, equation (5.19) is tested in the Augmented Dickey-Fuller form (see equation 5.12) because the OLS estimation of the long-run regression in (5.18) results in a bias towards the finding of stationarity in equation (5.19).

Two key weaknesses in the Engle-Granger methodology have been identified and improved upon by other tests for cointegration. The first weakness follows from equation (5.18). By construction, this equation implies that the researcher has chosen the dependent and independent variables. It is very often the case that testing the residuals from:

(5.20) $x_t = \alpha_2 + \beta_2 y_t + \lambda_{2t}$

instead of (5.18) gives different results. The presence of cointegration should be indifferent to the choice of dependent and independent variable. Since equation (5.16) represents a three variable equilibrium relationship, using this test could result in ambiguous results. Furthermore, the Engle-Granger procedure has no systematic method of testing for multiple cointegrating relationships in the multivariate context.

The second weakness in the methodology is that it is a two step procedure. That is, a long-run OLS regression must be run first and then an auto-regression of the residuals from that initial OLS regression must be carried out. As a result, any mistakes from the first regression will be carried over to the second regression.

Several alternate methods have since been established which can be used to test a system of variables for cointegration. Hargreaves (1994) compares six methods (OLS,

Augmented OLS, Fully-Modified, Three-Step, Johansen Maximum Likelihood Estimator(JMLE), Box-Tiao) via Monte Carlo simulation and concludes that the Johansen estimator is best as long as the sample is reasonably large (around 100 observations).

The Johansen procedure (Johansen, 1989,1991; Johansen and Juselius, 1990,1992) is a generalized version of the Engle-Granger methodology. Consider the case of testing a single variable (x_t) for stationarity given the following equations:

(5.21) $x_t = a_1 x_{t-1} + \delta_t$

or

(5.22) $\Delta x_t = (a_1 - 1)x_{t-1} + \delta_t$

If $(a_1 - 1) = 0$, then the x_t series has a unit root. If $(a_1 - 1) \neq 0$, then the x_t series is stationary. This is a simplified (univariate) example of the Engle-Granger approach where the Dickey-Fuller tables provide the statistics to test the null hypothesis that $(a_1 - 1) = 0$. One can expand equations (5.21) and (5.22) to consider many variables with the following equations:

(5.23) $x_t = A_1 x_{t-1} + \delta_t$

or

(5.24) $\Delta x_t = (A_1 - I)x_{t-1} + \delta_t$

where x_t and δ_t are $(nx1)$ vectors, A_1 is an (nxn) matrix of parameters, and I is an (nxn) identity matrix. The matrix $(A_1 - I)$ is often referred to as the π matrix, and the rank of that matrix is equal to the number of cointegrating vectors. Intuitively, if the rank of $\pi = 0$ then there is no linear combination of variables in x_t that is stationary (i.e., there are no

cointegrating vectors). At the other extreme, if π is of full rank then the system is fully cointegrated. The great advantage of this methodology is that it allows one to test for cointegrating vectors while applying various restrictions on coefficients in the equation. This key feature which allows tests of proportionality and symmetry with respect to PPP without having to manipulate the data has resulted in relatively more success for PPP (Cheung and Lai, 1993; Crowder, 1996; Kugler and Lenz, 1993; MacDonald, 1993; Pippenger, 1993; and Serlitis, 1994).

Note that the number of characteristic roots of π, different from zero, is also the rank of π. It is the significance of these characteristic roots (sometimes referred to as eigenvalues) which determines the number of cointegrating vectors in the equilibrium relationship. Johansen and Juselius (1990) provide the critical values for such a significance test when using the following test statistics:

$$(5.25)\quad \lambda_{trace}(r) = -T\sum_{i=r+1}^{n}\ln(1-\hat{\lambda}_i)$$

$$(5.26)\quad \lambda_{\max}(r,r+1) = -T\ln(1-\hat{\lambda}_{r+1})$$

where $\hat{\lambda}_i$ are the estimated values of the characteristic roots obtained from the estimated π matrix, and where T is the number of usable observations. The first statistic, λ_{trace}, tests the null hypothesis that the number of cointegrating vectors is less than or equal to r, against the general alternative. The second statistic, λ_{max}, tests the null hypothesis that the number of cointegrating vectors is equal to r, against the alternative that the number of vectors is equal to $r + 1$.

The results of the cointegration tests appear in Table 5.3. Tests for cointegration where organized in the following manner. For each period the trivariate model, which includes Canadian producer prices (p_t), American producer prices (p_t^*), and the Canada-US exchange rate (s_t), were tested for cointegrating vectors. For each period, the trivariate model was also for cointegration with two restrictions. The first restriction on the cointegrating regression imposes the symmetry condition by requiring that the coefficients on the producer price series of both countries be equal and opposite in sign. The second restriction on the model imposes the proportionality condition, which requires that the absolute value of both of the producer price coefficients be equal to one.

For the unrestricted trivariate model, λ_{max} and λ_{trace} tests results suggest that there was one cointegrating vector over the whole data period and one cointegrating vector over the later data period (after CUSTA). In the data period before the CUSTA, the test results are ambiguous. That is, the λ_{trace} test is not able to reject the null of no cointegrating vectors against the general alternative, while the λ_{max} test rejects the null of zero cointegrating vectors against the specific alternative of one cointegrating vector.

In testing for the symmetry restriction for the overall data period and the 'post-CUSTA' data period, the results suggest that one can not reject the existence of this condition. For the pre-CUSTA period the test was not valid.

The results for the tests of the proportionality restriction suggest that the condition holds over the whole period but not in the sub-period after the CUSTA. Once again the testing for the period before the CUSTA did not yield valid results.

The objective of the thesis is to assess the performance of price movements during the implementation of the CUSTA through the application of a model of absolute purchasing power parity. The cointegration tests have established the following results. Prior to the implementation of the CUSTA, the evidence for the existence of a long-run relationship between producer prices in the US and Canada is mixed. That is, one test statistic suggests that a relationship exists, while another test statistic suggests that there was no relationship during this period. After the implementation of the CUSTA, the evidence from both test statistics suggest that there is a long-run relationship between producer prices in the US and Canada. Finally, cointegration tests for the whole period (1974 to 1996) suggest that producer prices in both countries have shared a long-run relationship.

Table 5.3 Johansen-Juselius Cointegration Tests of the PPP Relationship Between Canadian Producer Prices, U.S. Producer Prices, and the Canada-US Exchange Rate

Model	Period: 1974:1 to 1988:12	Period: 1989:1 to 1996:1	Period: 1974:1 to 1996:1
Trivariate	lags in VAR = 13	lags in VAR = 7	lags in VAR = 15
	The Number of Cointegrating vectors (r)		
Hypothesis	λ_{trace} Test		
Ho: r = 0 vs r = 1,2,3	29.97	34.81[b]	33.43[b]
Ho: r ≤ 1 vs r = 2,3	15.00	16.98	17.59
	λ_{max} Test		
Ho: r = 0 vs r = 1	14.97[b]	17.83[b]	15.84[b]
Ho: r = 1 vs r = 2	11.31	11.21	9.89
Conclusion:	r = 0 or 1	r = 1	r = 1
	Test for Symmetry Restriction (Bivariate Model)		
Hypothesis	Likelihood Ratio Test is $\chi^2(1)$ (with p value)		
Ho: β = (*, 1, -1)	no test	1.24 (0.27)	0.01 (0.91)
Conclusion:		can't reject Ho	can't reject Ho
	Test for Proportionality Restriction (Univariate Model)		
	Likelihood Ratio Test is $\chi^2(2)$ (with p value)		
Ho: β = (1, -1, 1)	no test	4.00 (0.14)	5.56 (0.06)
Conclusion:		can't reject Ho	reject Ho

[a]Indicates significance at 0.01 level
[b]Indicates significance at 0.10 level

5.4 Time Varying Parameter Analysis

Our question regarding the enactment of CUSTA in 1989 really asks if the markets for traded commodities (for which tariffs are being, or have been phased out) in the two countries are any more integrated or efficient than they were before the agreement. The theory on FTAs says that we should expect producer prices to be equalised in such an area, and we are applying the LOP to find if this is true. The application of the LOP is taking the form of a test for absolute PPP in the producer price indexes of the US and Canada. The results from cointegration tests of absolute PPP can give only limited answers. That is, they will tell us that PPIs in Canada and the US are either related or not related over the various time periods of interest. It is clear that there is no guarantee that PPP will hold at all over the various data periods. The question we really want to address is put into perspective by Hall, Robertson, and Wickens (1992):

> "Testing for cointegration is a powerful way of assessing whether convergence has occurred before the data sample being used. But if we believe that convergence is in the process of taking place over the sample we are examining, then any tests which assume structural stability will almost certainly reject convergence for the whole period...We see the dynamic process of convergence as still continuing and we need a measure of convergence which allows for this dynamic structural change." (p.102)

As the elimination of tariffs according to the CUSTA schedule set out in 1989 is to continue until 1999 for certain commodities, the integration or convergence we are trying to measure should, theoretically, not be complete until after 1999. The methodology proposed to investigate such a process is a form of time-varying parameter analysis which uses the Kalman filter (Haldane and Hall, 1991). This type of convergence test will give

an idea as to whether integration is in the process of occurring (in the PPP sense), as opposed to the 'yes' or 'no' answers we would get from cointegration tests. The application of Haldane and Hall's convergence analysis to assess the level of integration of two international markets after trade liberalisation has been attempted by Moosa and Bhatti (1995) for Australia, New Zealand, and the United States. Although the assessment in that paper employed an interest rate parity model, the analysis done here reproduces their methodology for the purchasing power parity model.

The most important assumption underlying most regression models is that coefficients of the explanatory variables remain constant over time, for all observations. Some regression models have considered this assumption to be too restrictive and have set up systems of regression equations which allow variation in the coefficients.

Some of these models are based on economic theory and as a rule, involve nonstochastic, systematic coefficient variation (e.g., personal changes in behaviour or changes due to technological progress). At the macroeconomic level, the idea of coefficient variation was enhanced by the Lucas (1981) critique.

The Lucas critique is based on the idea that policy changes influence macroeconomic coefficients through the changing expectations of economic agents. As policies change, expectations and macroeconomic variables are thought to adjust accordingly.

This thesis implies that the CUSTA can be viewed as both a structural change (e.g., through lower tariff barriers) and a policy change (e.g., promotion of a more open economy) at the macroeconomic level. By allowing the coefficients to vary in the

absolute PPP equation, it may be possible to see if the structural and political change initiated by the CUSTA has had the desired effect on the coefficients.

5.4.1 Econometrics of the Kalman Filter

The econometrics of the Kalman filter presented here will be kept as simple and brief as possible.[16] The presentation will relate OLS results to the estimation of recursive least squares, and then address the details of the Kalman filter using information already presented to explain recursive least squares estimation.

First we begin with the general matrix representation of the general (k variable) linear regression model:

(5.27) $y_t = X_t\alpha + \mu_t$

where y is a $(nx1)$ vector of n observations on the dependent variable, X is a (nxk) matrix of k independent variables, a is a $(nx1)$ vector of unknown parameters, and μ is a $(nx1)$ vector of disturbances. The well known OLS formula for the vector of unknown parameters is:

(5.28) $\alpha = (X_t'X_t)^{-1}X_t'y_t$.

Assume that observations on y and all X variables are available from period 1 through to period t. One period later, there will be another observation, y_{t-1}, on the dependent variable, and another set of observations on the k independent variables. Let the original coefficient estimate be a_t and the let the one period forward coefficient estimator be a_{t+1}.

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[16] Three detailed and complete sources are: Cuthbertson, Hall, and Taylor. 'State-space models and the Kalman filter.'in *Applied Econometric Techniques*. 1992 (Chapter 7); Harvey, Andrew C. 'Applications of the Kalman Filter in Econometrics.' *ESM 13, Advances in Econometrics, 5th World Congress*, 1987, Vol. I. (Chapter 8); and Hamilton, James D. 'State-Space Models.' *Handbook of Econometrics*. 1994. Vol IV. (Chapter 50).

One way to estimate a_{t+1} is by updating the X and y matrices with the new information in period $t+1$ and then calculate (5.28). In fact, it is also possible to calculate a_{t+1} by using a_t as a base and adding an adjustment which is based on the new observations such that:

(5.29) $$\alpha_{t+1} = \alpha_t + K_{t+1}(y_{t+1} - x'_{t+1}\alpha_t).$$

The expression in the brackets is equal to the residual of a regression-based forecast for period $t+1$, computed on the basis of the coefficient estimate, a_t, that reflects all the data up to and including period t. This recursive residual is then multiplied by the vector K in order to compute the necessary adjustment to the parameter vector a. K is time dependent and is computed as follows:

(5.30) $$K_{t+1} = \frac{(X'_t X_t)^{-1} x_{t+1}}{1 + x'_{t+1}(X'_t X_t)^{-1} x_{t+1}}.$$

Equation (5.29) together with equation (5.30) together form a recursive algorithm for updating estimates of the coefficient vector a. When all available observations have been processed, the final estimate of a_t will be equal to the least squares estimate. The next step is to reformulate the recursive least squares algorithm in the context of the Kalman filter.

If the disturbances in an OLS regression are normally distributed, then coefficient estimates meet two criteria. They represent the minimization of the sum of the squared residuals, and they also represent the coefficient estimates which maximize the likelihood of the observations on y, given X. The Kalman filter methodology reflects the second of these two criteria. That is, each period we have a prior belief about the distribution of the unknown parameters, a, and we update this prior belief based on new observations in this period.

The Kalman filter specification requires two equations, as in the case of recursive least squares. The first matrix equation is called the observation or measurement equation:

(5.31) $y_t = x_t \alpha_t + u_t$.

This equation is extremely similar to the general formulation of the k variable linear model in (5.27) except that the coefficient vector, a, is now time dependent. The second matrix equation is used to describe how the "state vector", a_t, adjusts in each period. For our purposes, the true value of a is constant over time so its dynamics can be described by:

(5.32) $a_t = a_{t-1}$.

The measurement and state equations of the Kalman filter are both required to make estimates of a feasible. Where the Kalman filter departs from the recursive least squares approach is in the almost unlimited number of possible adjustment dynamics that could be described by the state equation (5.32). For example, if the unknown parameters are thought to exhibit autoregressive behaviour, then the state equation could be represented by the following:

(5.33) $a_t = 0.9\, a_{t-1} + v_t$.

where v_t is an independent disturbance term.

Using standard Kalman filter notation, (5.31) and (5.32) can be rewritten as follows:

(5.34) $z_t = H_t x_t + u_t$, $\text{var}(u) = R$

(5.35) $x_t = x_{t-1}$

where x now stands for the unknown parameters, and H represent the matrix of current observations on the explanatory variables. If we let $P_t = \sigma^2 (X_t' X_t)^{-1}$, then the algorithm for this application of the Kalman filter is as follows:

(5.36) $K_t = P_{t-} H_t' [H_t P_{t-} H_t' + R_t]^{-1}$

(5.37) $P_{t+} = [I - K_t H_t] P_{t-}$

(5.38) $x_{t+} = x_{t-} + K_t [z_t - H_t x_{t-}]$

(5.39) $P_{(t+1)-} = P_{t+}$

(5.40) $x_{(t+1)-} = x_{t+}$.

The system of equations from (5.36) to (5.40) can be explained intuitively. Like the gain or adjustment factor calculated for recursive least squares in equation (5.30), equation (5.36) represents the vector which needs to be applied to the current recursive residuals in order to compute an adjustment to the vector of regression coefficients: x. Hence, equation (5.38) is equivalent to equation (5.29) and represents the calculation of the updated x. Finally equation (5.37) represents the update to the covariance matrix of the coefficient estimates, P. These three equations correspond exactly to the recursive ordinary least squares algorithm and are standard for the discrete-time Kalman filter equations. Equations (5.39) and (5.40) represent the special case of a constant coefficient vector, but are slightly different due to their time subscripts. The notation $t-$ indicates estimated values for the parameter vector and its associated covariance matrix at time t just prior to observing the value of the variable z_t and the explanatory variables H_t. One then computes the residual error ($z_t - H_t x_{t-}$) and proceeds to adjust the parameter vector x,

the new estimate of which is denoted x_{t+1}. The covariance matrix is updated in the same way from P_{t-} to P_{t+}.

Consider the following simple numerical example which assumes a Kalman filter when the state vector is constant. Let x be the sample mean for a growing number of observations on the variable z. The observation equations and the state-update equation for this case of a single constant and unknown state variable are as follows:

(5.41) $z_t = x_t + u_t$, $\text{var}(u) = 1$

(5.42) $x_t = x_{t-1}$

(5.43) $x_{1-} = 0$

(5.44) $P_{1-} = 100.$

We assume an arbitrary initial estimate of the mean equal to 0, and 100 for the associated variance. Let the initial observation, z_1, be equal to 1.

In step one we compute the gain vector:

(5.45) $k_1 = (100/101).$

The initial estimate of x can then be adjusted for the first time, given the error and the adjustment factor with which to multiply the forecast error.

(5.55) $x_{1+} = 0 + 0.99(1-0) = 0.99$

The uncertainty of the new estimate is drastically reduced as follows:

(5.56) $P_{1+} = (1-0.99)\ 100 = 1.0$

Due to the simplicity of the state update equation, the values of x_{1+} and P_{1+} apply without change to the position of the system just before the second observation becomes

available. If we let the second observation, z_2, be 4, then the following results are derived:

(5.57) $k_2 = 0.5$

(5.58) $x_{2+} = 0.99 + 0.5(4-0.99) = 2.49$

(5.59) $P_{2+} = (1-0.5)\ 1.0 = 0.5$

The example is quite straightforward, and should show a familiar pattern. In each period, a prior distribution on x is combined with an observation on z to produce a posterior estimate of the distribution for x, which in turn serves as a prior distribution for the next observation. The application of the Kalman filter in this paper considers a slightly more complicated example where the state equation assumes an autoregressive form.

5.4.2 Application of the Kalman Filter

As in Moosa and Bhatti (1995) and Diakosavvas (1995), the methodology used here is to allow time varying coefficients through the application of the Kalman filter. For simplicity, the Kalman filter notation will not be changed from the usual OLS notation as in the previous section. Assume the following measurement equation:

(5.60) $y_t = \beta_t x_t + \mu_t$

where y_t is the exchange-rate-adjusted Canadian producer price index, x_t is the US producer price index, and the variance of μ_t is n_t. The change in the state vector, β_t, follows the process:

(5.61) $\beta_t = \beta_{t-1} + \nu_t$

where the variance of v_t is m_t, μ_t and v_t are independent, and n_t and m_t are assumed to be known. Equations (5.60) and (5.61) are the respective 'measurement' and 'state' equations which make up the state space model which defines time varying parameter models.

If we have an estimate of β_{t-1} and its covariance matrix Σ_{t-1}, then the updated estimate, β_t, given y_t and x_t is found using the following system of equations:

(5.62) $s_t = \Sigma_{t-1} + m_t$

(5.63) $\Sigma_{t-1} = s_t - s_t x_t'(x_t s_t x_t' + n_t)^{-1} x_t s_t$

(5.64) $\beta_t = \beta_{t-1} + \Sigma_t X_t' n_t^{-1}(y_t - x_t \beta_{t-1})$

These last three equations make up the 'updating' algorithm which allows β_t to vary over time. To use this algorithm, the following information was supplied: β_0, the initial state vector; Σ_0, the initial covariance matrix of the states; n_t, the variance of the measurement equation; and m_t, the variance of the change in the state vector. The initial information for Σ_0 and n_t was supplied by an OLS regression of equation (5.60). The initial state vector was set to zero, and the initial variance of the change in the state vector was set to 0.001 times n_t.[17]

The results of the application of the Kalman filter algorithm to equation (5.60) are shown in Figure 3. This chart shows both the change in the constant and the change in the coefficient over time. It is evident that the coefficient vector approaches 1 over time while the constant vector approaches 0. The coefficient vector seems to approach one

[17] The initial information was chosen according to the RATS users manual and its suggestion for the use of the Kalman filter in a time varying framework.

around 1985, while the constant vector appears to breaks towards zero between 1988 and 1990.

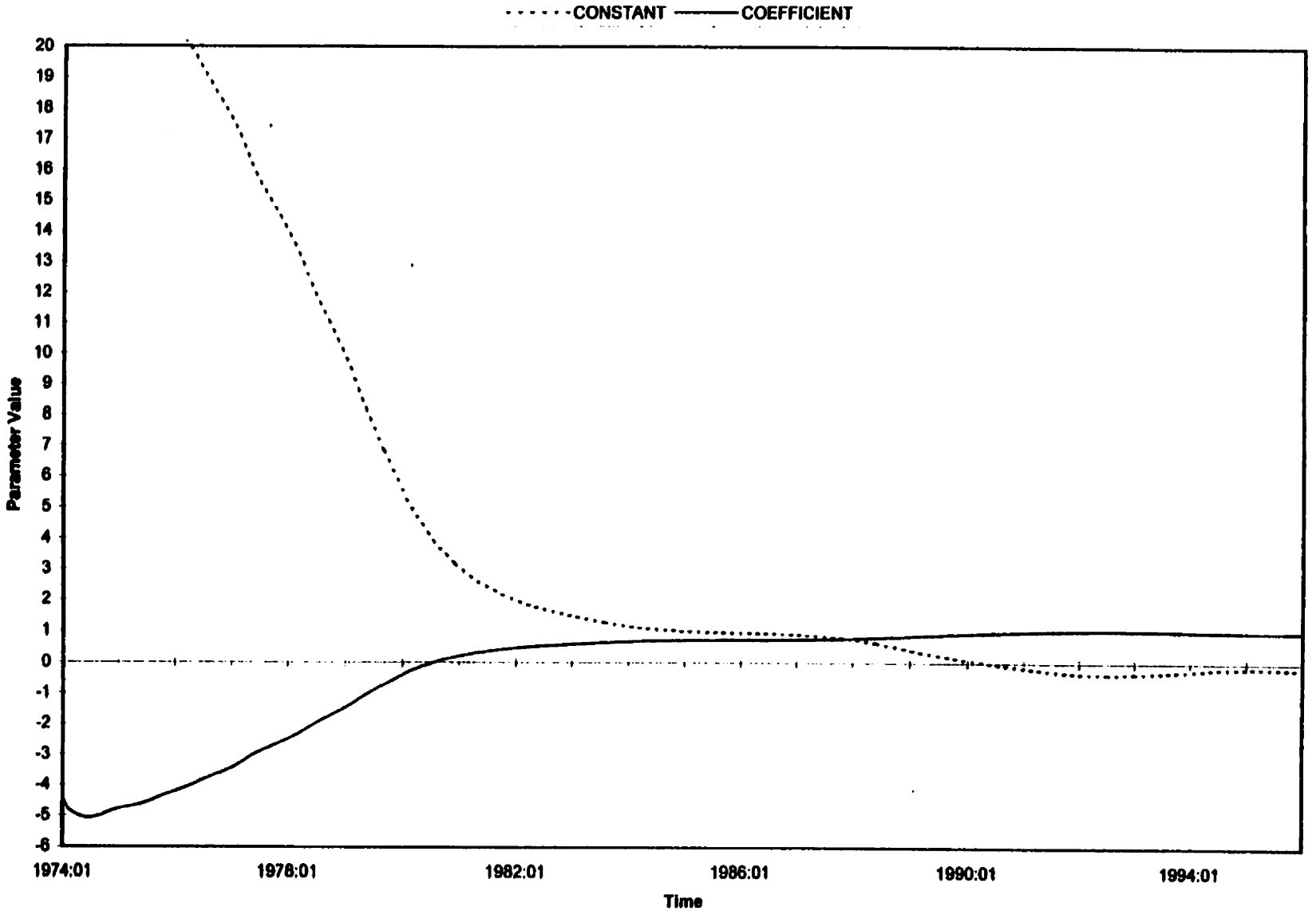
5.5 Summary of Results

The CUSUM and CUSUMSQ tests suggest structural instability in the PPP relationship between Canada and the United States. From the results of the CUSUM test, the instability seems to be due to observations which occur immediately after January, 1989.

The Johansen-Juselius multivariate cointegration tests suggest that there was a long-run relationship between Canadian producer prices, American producer prices, and the Canada-US exchange rate over the period 1974 to 1996. The data set was also broken into two subsets representing the time periods 1974-1988, and 1989 to 1996. Cointegration tests on the pre-CUSTA sub-period were ambiguous. One test statistic suggested no cointegration in PPP relationship, while another test statistic suggested that the variables of interest were cointegrated. For the post-CUSTA sub-period, both test statistics suggested that the variables in the PPP model were cointegrated.

The Kalman filter was used to analyse the behaviour of the constant and the coefficient in the PPP relationship over the time period of the data set. The constant seemed to approach zero around implementation date of the CUSTA(1989). The time varying coefficient vector seemed to approach one, but it did so in the early eighties.

Figure 5.3 Time Varying Parameter Analysis: P(Cdn) =a + b P(US)



CHAPTER 6: DISCUSSION AND CONCLUSION

In Chapter 2, product price convergence was presented as a necessary outcome of a successful FTA. This expected outcome was based on a number of assumptions in the various models of market integration. The empirical examination of product price convergence involved three econometric tests. Overall, the tests led to mixed results with respect to the success of the CUSTA. The following discussion reviews the results of each test and then attempts to address the following key questions. The first question asks whether or not the statistical identification of price convergence is possible. The second question asks whether or not complete price convergence is a reasonable expectation. This section then concludes with some comments on the thesis.

In the process of examining the movements of producer prices during the implementation of the CUSTA, the first result was derived from structural break tests. The structural break tests suggested a significant change in the stability of the coefficients in the PPP equation around the time of the CUSTA. This instability could be interpreted as the effect of the CUSTA on some existing PPP relationship between producer prices in Canada and the US. Although the result does not imply success of the CUSTA, it does allow one to attribute some significance to the time it was implemented in relation to the PPP equation. If the equation in some way reflects any convergence of producer prices in the two countries, then it might be the case that the CUSTA had a significant influence on this movement. The next test would hopefully establish whether or not this significant influence was positive.

The second test used to examine price movements attempted to look for the presence of a long-term PPP relationship between Canada and the US. For this cointegration test the full data set was broken into 'pre' and 'post' CUSTA periods. If it was found that producer prices were only cointegrated after the CUSTA, then this would be evidence to suggest that the CUSTA had a significant effect on product market integration through producer prices. The cointegration tests gave mixed results. Two test statistics indicated that producer prices were cointegrated after the CUSTA, while these same two test statistics gave mixed results for cointegration in the pre-CUSTA period. Furthermore, when using the full data set, both test statistics gave evidence for cointegration over the whole period. Overall, the cointegration rests could not establish a long-term relationship in producer prices between Canada and the US.

The third analysis used to examine price movements attempted to address the shortcomings of the 'all or none' approach implied by the previous cointegration tests. If it is the case, as in the CUSTA agreement, that price convergence of some kind is not expected to be complete until some point in the future, then tests which assume structural stability (e.g., the cointegration tests) would be biased against rejecting cointegration over the period of interest. The application of the Kalman filter was an attempt to bridge this gap. This filter assumes that the PPP relationship is undergoing structural change over the period of interest. When the time varying values of the PPP coefficients were plotted the results were suggestive of price convergence, but this convergence seemed to begin before the CUSTA was implemented. As a result, the convergence in producer prices could not be attributed specifically to the CUSTA.

Overall, these results lead to two questions. First, even when acknowledging some price dispersion as inevitable can one detect market integration over time as demonstrated by a gradual move towards greater price convergence? The answer is possibly. The results of the Kalman filter indicate price convergence is occurring. However, there are two problems with this result. First, the analysis is subjective in that it simply involves visual interpretation of a trend in a graph. Second, the trend does not seem applicable to the CUSTA since the move towards convergence seems to have begun before the implementation date of the CUSTA. To answer the question definitively, there needs to be a formal convergence test. The analysis done here was a subjective interpretation of trend lines on a graph. Haldane and Hall (1992) have presented a hypothesis test that could be implemented using this filter, but the methodology has yet to be widely applied or critiqued. Other techniques are available and have been applied to addressing the question of price convergence in the context of market integration. For instance, Langhammer (1987) examined the European goods market integration via price convergence by looking at cost of living indexes for a number of capital cities. He found "modest" price convergence, but his approach was not applicable in this examination due to, among other reasons, a lack of data. It seems that a formal and widely applied test to detect increasing market integration may not be far off, but even if one existed, there would inevitably be issues regarding the quality of the data.

Assuming that there was a well established econometric technique, the next requirement to be able to search for evidence of the price convergence would be a proper data set. The data set here was made up of producer price indexes which were aggregated

at the national level. To keep in line with the assumptions of the Shibata (1967), Price (1982), and Richardson (1995) models, the data should reflect two characteristics. Products for which prices are measured in different locations should be perfect substitutes and the level of disaggregation of the data should be at as high a level as possible.

It was indicated that the mixed results in this paper lead to two questions. The second question is about expectations, and asks whether or not the CUSTA should be expected to bring about complete price convergence, and if not, why not? The answer is no. The reasons can be examined by looking at some of the factors that lead to deviations in PPP in the presence of economic shocks.

Dornbusch (1976, 1982, 1987a, 1987b) proposes that deviations in PPP reflect speed of adjustment differences in wages, asset markets, and goods markets. In his words,

> "These [deviations] can arise from divergent speeds of adjustment of the exchange rate compared with wages and prices. Particularly when flexible exchange rates behave like contracts, there is room for relative prices to show relatively persistent deviations from PPP...Theoretical approaches to support the relative stickiness of prices can rely on the presence of long term contracts combined with oligopolistic pricing in goods markets. A model of imperfect competition is a key ingredient in PPP deviations. Less-than-perfect substitution means that we are not dealing with law of one price and arbitrage, but with the firm's decision to set relative prices" (Dornbusch, 1987b, p. 1079).

Based on the comments of Dornbusch, absolute product price convergence could be said to depend on three factors: the degree of market integration in a specific industry, the extent of substitution between domestic and foreign variants of products in a specific industry, and the degree of market imperfection (ranging from perfectly competitive to monopolistic) within an industry.

These three factors have a direct effect on the mixed results for the CUSTA. The models in this paper have suggested that a small country, by opening up, can take advantage of world markets and enjoy price reductions in proportion to tariff reductions. This assumption assumes perfectly competitive markets. If markets are less than fully competitive, then absolute price convergence is an unreasonable expectation and the industrial organization approach proposed by Dornbusch becomes relevant to the trade liberalization issue. Furthermore, if absolute price convergence is unreasonable, then it may be the case that a statistical test need only show "partial" price convergence. In any case, the CUSTA cannot be expected to bring about absolute price convergence in producer prices or consumer prices.

In conclusion, there are a number of models with which one could approach the study of market integration via trade liberalization. This paper used a PPP econometric model to examine the relationship between producer prices in Canada and the US. The results could not establish with statistical significance that the CUSTA has resulted in, or is the cause of, producer price convergence between Canada and the US. Therefore the interim statistical assessment of the performance of the CUSTA is inconclusive.

There is, however, relatively strong evidence that the two markets are integrated in the period which the CUSTA has been in force. This suggests that transportation costs, transaction costs and the remaining trade barriers are not of sufficient importance to prevent prices from acting as appropriate signaling mechanisms upon which resource reallocations must be made in order to capture gains from trade. It has been suggested that one of the major Canadian motives for negotiating a FTA with the US was to ensure the existing high level of market access which already existed in the 1980s in the face of

rising US protectionism. This thesis provides evidence that this objective has been achieved since the advent of the CUSTA.

Appendix A: GATT Article XXIV

Territorial Application -Frontier Traffic - Customs Unions and Free Trade Areas

1. The provisions of this Agreement shall apply to the metropolitan customs territories of the contracting parties and to any other customs territories in respect of which this Agreement has been accepted under Protocol of Provisional Application. Each such customs territory shall, exclusively for the purpose of the territorial application of the Agreement, be treated as though it were a contracting party; *Provided* that the provisions of the paragraph shall not be construed to create any rights or obligations as between two or more customs territories in respect of which this Agreement has been accepted under Article XXIV or is being applied under Article XXXIII or pursuant to the Protocol of Provisional Application by a single contracting party.

2. For the purpose of this Agreement a customs territory shall be understood to mean any territory with respect to which separate tariffs or other regulations of commerce are maintained for a substantial part of the trade to such territory with other territories.

3. The provisions of this Agreement shall not be construed to prevent:

a) Advantages accorded by any contracting party to adjacent countries in order to facilitate frontier traffic.

b) Advantages accorded to the trade with Free Territory of Trieste by countries contiguous to that territory, provided that such advantages are not in conflict with the Treaties of Peace arising out of the Second World War.

4. The contracting parties recognize the desirability of increasing freedom of trade by the development, through voluntary agreements, of closer integration between

the economies of the countries parties to such agreements. They also recognize that the purpose of a customs union or of a free trade area should be to facilitate trade between the constituent territories and not to raise barriers to the trade of other contracting parties with such territories.

5. Accordingly, the provisions of this Agreement shall not prevent, as between the territories of contracting parties, the formation of a customs union or of a free trade area or the adoption of an interim agreement necessary for the formation of a customs union or of a free trade area; *Provided* that:

a) with respect to a customs union, or an interim agreement leading to the formation of a customs union, the duties and other regulation of commerce imposed at the institution of any such union or interim agreement with respect to trade with contracting parties not parties to such a union or agreement shall not on the whole be higher or more restrictive than the general incidence of the duties and regulation of commerce applicable in the constituent territories prior to the formation of such union or the adoption of such interim agreement, as the case may be;

b) with respect to a free trade area, or an interim agreement leading to the formation of a free trade area, the duties and other regulations of commerce maintained in each of the constituent territories and applicable at the formation of such free trade area or adoption of such interim agreement to the trade of contracting parties not included in such area or not parties to such agreement shall not be higher or more restrictive than the corresponding duties and other regulation of commerce existing the same constituent

territories prior to the formation of the free trade area, or interim agreement, as the case may be; and

c) any interim agreement referred to in sub-paragraphs (a) and (b) shall include a plan and schedule for the formation of such a customs union or of such a free trade area within a reasonable length of time.

6. If, in fulfilling the requirements of sub-paragraphs 5(a), a contracting party proposes to increase any rate of duty inconsistent with the provisions of Article II, the procedure set forth in Article XXVIII shall apply. In providing for compensatory adjustment, due account shall be taken of the compensation already afforded by the reductions brought about in the corresponding duty of the other constituents of the union.

7.

a) Any contracting party deciding to enter into a customs union or a free trade area, or an interim agreement leading to the formation of such a union or area, shall promptly notify the contracting parties and shall make available to them such information regarding the proposed union or area as will enable them to make such reports and recommendations to contracting parties as they may deem appropriate.

b) If, after having studied the plan and schedule included in an interim agreement referred to in paragraph 5 in consultation with the parties to the agreement and taking due account of the information made available in accordance with the provisions of sub-paragraph (a), the contracting parties find that such agreement is not likely to result in the formation of a customs union or a free trade area within the period contemplated by the parties to the agreement or such a period is not a reasonable one, the contracting parties shall make

recommendations to the parties to the agreement. The parties shall not maintain or put into force, as the case may be, such agreement if they are not prepared to modify it in accordance with these recommendations.

c) Recommendations shall be communicated to the contracting parties, which may request the contracting parties concerned to consult with them if the change seems likely to jeopardize or delay unduly the formation of the customs union or of the free trade area.

8. For the purposes of this Agreement:

a) A customs union shall be understood to mean the substitution of a single customs territory for two or more customs territories, so that

i) duties and other restrictive regulations of commerce (except where necessary, those permitted under Articles XI, XII, XIII, XIV, XV, and XX) are eliminated on substantially all the trade between the constituent territories and the union or at least with respect to substantially all the trade in products originating in such territories, and

ii) subject to the provision of paragraph 9, substantially the same duties and other regulations of commerce are applied by each of the members of the union to the trade of territories not included in the union;

b) A free trade area shall be understood to mean a group of two or more customs territories in which the duties and other restrictive regulations of commerce (except where necessary, those permitted under Articles XI, XII, XIII, XIV, XV, and XX) are eliminated on substantially all the trade between the constituent territories in products originating in such territories.

9. The preferences referred to in paragraph 2 of Article I shall not be affected by the formation of a customs union or free trade area but may be eliminated or adjusted by means of negotiations with contracting parties affected. This procedure of negotiations with affected parties shall, in particular, apply to the elimination of preferences required to conform with the provisions of paragraph 8 (a)(i) and paragraph 8(b).

10. The contracting parties may by a two-thirds majority approve proposals which don not fully comply with the requirements of paragraph 5 to 9 inclusive, provided that such proposals lead to the formation of a customs union or a free trade area in the sense of this Article.

11. Taking into account the exceptional circumstances arising out of the establishment of India and Pakistan as independent States and recognizing the fact that they have long constituted an economic unit, the contracting parties agree that provision of the Agreement shall not prevent the two countries from entering into special arrangements with respect to the trade between them, pending the establishment of their mutual trade relations on a definitive basis.

12. Each contracting party shall take such reasonable measures as may be available to ensure observance of the provisions of this Agreement by the regional and local governments and authorities within its territory.

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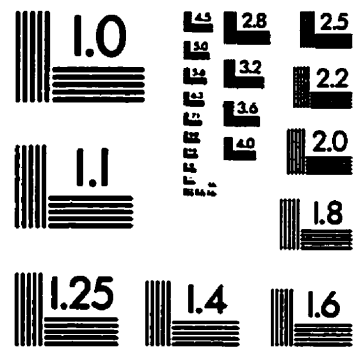
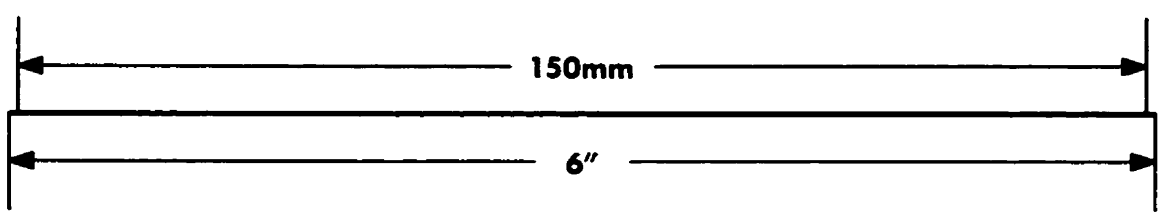
TEST TARGET (QA-3)





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