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# CATPRN

Canadian Agricultural Trade Policy And Competitiveness Research Network

## **REVEALED COMPARATIVE ADVANTAGE AND HALF-A-CENTURY COMPETITIVENESS OF CANADIAN AGRICULTURE: A CASE STUDY OF WHEAT, BEEF AND PORK SECTORS**

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## ABSTRACT

While the competitiveness of the Canadian agri-food sector attracted significant research attention since the mid 1980s, no study has measured competitiveness using longitudinal data and determined empirically the drivers of competitiveness. This article contributes to the competitiveness literature by measuring the international competitiveness of wheat, beef and pork sectors in Canada using data from 1961 to 2011 and by determining the drivers of competitiveness. Our results demonstrate that Canada enjoys competitiveness in the wheat sector but not in the beef or pork sectors. Empirical results also suggest that the competitiveness of the Canadian wheat sector can be enhanced if the cost seed in Canada relative to that in the United States is lower. Similarly, if the relative labour cost of meat processing is lower, the competitiveness of both beef and pork sectors in Canada will be enhanced. Exchange rates are important drivers of international competitiveness of beef and pork sectors in Canada. The decoupled farm policies in Canada do not have a significant impact on the competitiveness of wheat and pork sectors in Canada. Our empirical results also highlight cases of significant policy failures in Canada.

JEL Classification:

Keywords: Competitiveness, Measurement, Normalized Revealed Comparative Advantage, Wheat, beef and pork sectors, Drivers of Competitiveness.

## 1.0 INTRODUCTION

Competitiveness occupies a central role in stimulating policy discussions by economists, politicians, policy makers and in the popular press. Unfortunately, the parties engaged in fascinating competitiveness discussions often do not speak the same language. Despite significant research efforts being drawn into this area during the last two decades, considerable misunderstanding exists about the precise meaning of this concept, its scope and how it can be measured. As a consequence, the results from competitiveness analysis can be open to different interpretations.

As emphasized by Sharples (1990) and Ahearn et al., (1990), competitiveness is a fuzzy concept which does not have a widely acceptable definition in economics. This fuzziness allows researchers to introduce their own definition of competitiveness based on the perception of competitiveness they champion. Thus, depending on the purpose of the study, level of analysis and the commodity in question, a wide variety of definitions of competitiveness has been put forward in the literature (see Abbott and Bredahl, 1994; Ash and Brink, 1994 for different definitions of competitiveness). Partly because of this fuzziness, Krugman (1994) argued that countries' obsession with competitiveness may lead to misallocation of resources because governments' can put forward their self-serving type of competitiveness definition and introduce specific policy interventions to achieve them. These policies can do more harm than good to their economies in the long-run.<sup>1</sup> Despite the cautionary note from Krugman, there has been a

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<sup>1</sup> Recently, Aiginger (2006) defined competitiveness as the ability of a country or location to create welfare and argued that a comprehensive evaluation of competitiveness should consist of output evaluation and process evaluation. While Aiginger posits that such an approach to competitiveness will move countries away from the path of so called 'dangerous obsession' and prevent them from adopting wrong policies, one wonders how would this approach change the perception of welfare and prevent the introduction of 'green energy policy' in Ontario. This approach to competitiveness also ignores relative prices as well as trade both of which are important contributors to agri-food productivity in North America. Moreover, combining output evaluation and process evaluation in a single framework can invite additional challenges. We do not wish to delve too much into definitional aspects of competitiveness as it is not the primary focus of this research. However, interested readers may consult a special

sustained growth in studies involving competitiveness analysis and the literature on competitiveness grew substantially during the last two decades.

According to the Organization for Economic Cooperation and Development (OECD), competitiveness can be defined as the “ability of companies, industries, regions, nations and supranational regions to generate, while being and remaining exposed to international competition, relatively high factor employment levels on a sustainable basis” (Hatzichronologou, 1996). According to Agriculture Canada (1990), “a competitive industry is one that possesses the sustained ability to profitably gain and maintain market share in domestic and foreign markets”. Based on these two definitions, competitiveness can be viewed as the ability to produce and sell products in a competitive environment that meet consumer demand in terms of price, quality and quantity and at the same time, ensure sustained profits for the farms. Note, competition can be domestic, among farms or sectors within the country, or international, in which case, comparisons are made between countries. Therefore, competitiveness is a relative measure. Beyond this general understanding, however, there is no widely acceptable definition of competitiveness and how it should be measured.

While many studies adopt their own definition, a consensus appears to be gradually emerging on which indicators can be used to measure competitiveness given the definition adopted by the authors (Latruffe, 2010; Carraresi and Banterle, 2008). For example, if competitiveness is perceived as performance of a sector in a country relative to the same sector in another country, the measurement indicator would focus on trade success. On the other hand, if competitiveness is perceived as a process or potential, the measurement of competitiveness,

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issue of the *Journal of Industry, Competition and Trade*, 6(2): 2006 devoted to competitiveness analysis in addition to Abbott and Bredahl (1994) and Ash and Brink (1994).

based on the strategic management school of thought, should focus on cost-leadership and non-price supremacy of farms.

When the focus is on trade success, competitiveness can be measured with the real exchange rate, comparative advantage indices and export or import indices (dell'Aquila, Sarker and Meilke, 1999).<sup>2</sup> When competitiveness is viewed as a process or potential, cost competitiveness can be measured based on various cost indicators as well as productivity and efficiency measures. Since the primary focus of this study is to examine how well three important sectors in Canadian agriculture have performed over time relative to their rivals in trade, we rely on trade based measure of competitiveness in this article.

Early interest in competitiveness in North America can be traced back to the Canada-US Free Trade negotiations which led to the Canada-United States Free Trade Agreement that took effect in January 1989. This comprehensive free trade agreement raised questions about the international competitiveness of various economic sectors and became an important policy issue in Canada. Since the prosperity of Canadian agriculture critically depends on international trade, it was perceived to be very important to maintain and enhance the competitiveness of Canadian agriculture in the new economic and trade environment. Accordingly, a Task Force on Competitiveness in the Agri-Food Industry in Canada was formed by the Federal Government. The Task Force developed a working definition of competitiveness, a framework to assess an industry's competitiveness and came up with a blueprint to encourage competitiveness. The International Agricultural Trade Research Consortium (IATRC) sponsored a symposium on "Competitiveness in International Food Markets" in 1992. Papers presented at this symposium were compiled in a book edited by Bredahl, Abbott and Reed (1994). A grant from the Agro-

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<sup>2</sup> While the real exchange rate might be an indicator of competitiveness for the entire economy, it is not a good indicator for a particular sector because only one commodity sector of an economy will not drive the real exchange rate. More on this issue will be presented in the next section.

Industrial Research Program (AIR) of the European Commission funded early research on competitiveness in the agri-food sector in the EU and the results were compiled in a book edited by Wijnands, van der Meulen and Poppe (2006).

Competitiveness studies dealing with the agri-food sector in Canada include Brinkman (1987), Agriculture Canada (1990), Martin et al., (1991), van Duren et al., (1991, 1994), Coffin et al., (1993), Ash and Brink (1994), Hazeldine (1989) Hazeldine and Feely (1991), Chen and Duan (2000). In addition, a number of competitiveness studies have been commissioned recently by Agriculture and Agri-food Canada (Sparling and Thompson, 2011) and a number of studies conducted at the George Morris Centre (GMC) in Guelph. While the early studies were exploratory they laid the groundwork for future competitiveness analysis. However, they share two common weaknesses with the more recent studies on competitiveness. The conceptual framework mixes elements of performance and potential/process type competitiveness. Secondly, they all cite the limited availability of relevant data. As a consequence, the measurement of competitiveness has often been driven by researchers' judgements rather than by relevant data. In recent years, both commodity prices and energy costs have been moving upwards. While higher commodity prices translate into higher farm income in the short-run, it could also compromise the competitive position of agriculture in the long-run, if the farmers perceive high prices to be long lasting and over-commit resources to farming. How will the changing commodity and energy prices influence the global competitive position of Canadian agriculture? Did the North American Free Trade Agreement (NAFTA) enhance the international competitiveness of the Canadian agri-food sector? How did other policy interventions in Canadian agriculture alter the competitive position of different agri-food sectors? To the best of our knowledge, these issues have not been investigated for Canadian agriculture using longitudinal data. An attempt is made

in this article to bridge this gap by focusing on three important sectors of Canadian agriculture: wheat, beef and pork. The specific objectives of this study are: (i) to measure the international competitiveness of wheat, beef and pork sectors employing annual data from 1961 to 2011; (ii) to determine the drivers of international competitiveness of these sectors; and (iii) to assess the extent to which various agri-food policies and trade policies have influenced the international competitiveness of these sectors.

Section two focuses on the choice of commodity sectors, the measurement indicators and the data. Section three discusses trends in measured competitiveness of the three sectors and the changes over time. Section four concentrates on the drivers of competitiveness, relevant data, sources of data and specifies the empirical models. The results from econometric estimation are discussed in section five. This section also highlights the policy implications of the results. The final section summarizes the main findings and concludes the paper.

## **2.0 SECTORS AND THE MEASUREMENT INDICATORS**

This study focuses on three important sectors in Canadian agriculture: wheat, beef and pork sectors. All three are export-oriented sectors; about two-thirds of total wheat produced in Canada is exported and about 50% of total beef and hogs produced in Canada are exported to various export destinations. During the entire period considered in this study, the Canadian Wheat Board (CWB) acted as the single desk buying agency for wheat produced in the Prairie region of Canada and influenced the prices received by wheat growers in the Canadian Wheat Board's designated area. Since the vast majority of wheat and other grains are grown in the CWB designated area, its pricing policy may have influenced wheat prices in other regions of Canada as well. The single-desk buying and selling authority of the CWB was revoked by the

federal government on August 1<sup>st</sup>, 2012. While it is widely perceived that the single-desk authority allowed the CWB to fetch additional benefits (higher profit margins) for wheat growers in Canada, the issues related to the effect of CWB on the export price of wheat from Canada and the precise magnitude of CWB benefits to wheat farmers remain unresolved (Carter and Loynes 1996; Carter et al. 1998; Furtan et al. 1999; Schmitz and Furtan 2000; Clark 1995; Pedde and Loynes 2011).

Historically, the beef sector in Canada has been relatively less influenced by policy interventions. After the expiry of the National Tri-partite Stabilization Program (NTSP) in 1994, the beef sector received very little intervention nationally. Some provinces in Western Canada, however, pursued Crow Benefit Offset programs and other initiatives to stimulate the growth of the beef industry in Western Canada (Le Roy and Klein, 2005). Significant turbulence hit the Canadian beef sector after the discovery of BSE in Canada in May 2003. The discovery of BSE resulted in increased compliance costs associated with new regulations enforced by the Canadian Food Inspection Agency (CFIA) for handling, slaughtering and exporting beef from Canada. More importantly, due to border closures after the discovery of BSE, beef producers were shut out of the higher returns from the export market and had to settle for lower earnings from the domestic market. As the border situation improved, the volume of beef exported rose steadily but the returns to beef producers have not reached the pre-BSE level (Klein and Le Roy (2010), Weerahewa, Meilke and Le Roy (2008)).

The pork sector in Canada did receive support from the federal and various provincial governments for a while. Because of Canada's alleged subsidies to hog producers under these programs and under the National Tri-Partite Stabilization Program (NTSP), considerable trade friction involving hogs and pork developed between Canada and the United States since the mid

1980s (Meilke and Scally (1998), Meilke and Sarker, 1997)). After several investigations, the United States imposed a countervailing duty on Canadian live hogs exported to the United States and subsequently on pork exported from Canada to the United States (Meilke and Moschini, 1992a provides details on Canadian hog stabilization programs and the U.S. CVDs on Canadian hogs and pork). The CVD imposed on Canadian live hog imports into the United States remained in place from April 3, 1985 to March 31, 1997, and have reduced hog prices in Canada relative to hog prices in the United States, as expected (Moschini and Meilke, 1992b). Note, however, the duties on pork prior to CUSTA were so low that they were not a significant barrier to pork trade between these two countries (Kerr et al., 1986). All minor trade restrictions on pork products were quickly phased out under CUSTA/NAFTA. The independent functioning of the dispute settlement mechanism under CUSTA/NAFTA eventually led the CVDs on Canadian hogs to be removed (Huff, 2001).

Why did we select these three sectors for this study? First, each of the selected sectors is large in terms of the number of producers, volume produced, the value of production and their contributions to total farm income in Canada. Secondly, these three sectors are representative of the non-supply managed part of Canadian agriculture. Finally, while these sectors have received government support of different sorts over the years, their export-orientation remained relatively stable over time. Note, however, wheat considered in this study is a raw commodity while beef and pork are processed. Therefore, the competitiveness of the Canadian processing sector is also an important feature of this study.

To measure competitive performance of these sectors, we use competitiveness measures which focus on trade success. As argued by Brinkman (1987), the real exchange rate can be used to measure international competitiveness. It is based on the premise that higher demand for the

currency of a competitive country strengthens the real value of its currency and hence, its international competitiveness. The RER is defined as the ratio of the price index of tradable commodities to the price of non-tradable commodities. While some analysts proposed modifications to the RER so as to make it a relative measure, Ball et al. (2006) argue that it is better to use the purchasing power parity (PPP) to measure and compare relative prices of different countries than the RER or the relative RER. While a strong RER might be a sign of increased competitiveness of an economy, it also lowers the competitiveness by making its products more expensive to foreign buyers. Therefore, it is not a good indicator of competitiveness of the export oriented agri-food sector in Canada. Secondly, since the introduction of the flexible exchange rate regime, currencies are traded as commodities in foreign exchange markets around the world. As a result, exchange rates reflect changes in economic fundamentals as well as speculative motives of currency traders. To reduce the effect of speculative attacks on their currencies, many countries routinely intervene in their foreign exchange markets. As countries manipulate RER, relative RER and the PPP, the use of these indicators to measure and compare international competitiveness is problematic (Sharples, 1990; Bureau et al. 1992; Harrison and Kennedy, 1997).

Export market shares (EMS) can also be used to measure international competitiveness of a sector or a country. One can also develop a net export index which is essentially a country's or sector's exports minus imports divided by the total value of trade. The competitiveness neutral value of this index is 0 and it is bounded by -1 and 1. As the EMS does not take into account a country's size, it is not appropriate to use this measure to compare international competitiveness between countries and for the same country over time (Pitts et al. 1995; Fischer and Schornberg, 2007; Banterle and Carraresi, 2007).

The most widely used measure of international competitiveness of a sector or a country has been revealed comparative advantage (RCA).<sup>3</sup> This measure was first formulated by Balassa (1965) and that is why it is sometimes called as the Balassa index. Balassa's revealed comparative advantage (BRCA) index defines country i's comparative advantage in commodity j as,

$$BRCA_j^i = \frac{\left(\frac{E_j^i}{E_j}\right)}{\left(\frac{E^i}{E}\right)} \quad (1)$$

Where,

$E_j^i$  denotes i's export of commodity j,

$E_j$  denotes total export of commodity j by all countries,

$E^i$  denotes i's export of all commodities and

$E$  denotes export of all commodities by all countries

Thus, the BRCA index compares country i's market share in the j<sup>th</sup> commodity export market relative to its market share in the world export market. The comparative advantage neutral value of this index is 1. A value greater than one indicates that country i's market share in commodity j's export market is greater than its market share in the world export market. Thus, country i has a comparative advantage in commodity j. Similarly, a value less than one indicates comparative disadvantage. The BRCA has a lower limiting value of zero but the upper limit is  $\infty$  or undefined. Therefore, as an index, it is asymmetric. The BRCA can only indicate whether or not a country has comparative advantage in a commodity or sector. Its magnitude has neither the

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<sup>3</sup> Following Agriculture Canada (1990), Competitiveness of a sector in this study is defined as its ability to profitably gain and maintain market share in international markets. Thus, the focus of our analysis is on trade success. Competitiveness defined in this manner is closely related to the issue of comparative advantage. According to the Heckscher-Ohlin-Vanek trade model, a country's comparative advantage in trade depends on its factor endowments. While comparative advantage is the outcome of relative factor endowments and various domestic and trade policies, actual export flows of a country reveals its comparative advantage or lack thereof in trade sectors. This is the idea behind the revealed comparative advantage proposed by Balassa (1965).

ordinal property nor the cardinal property and can generate misleading results particularly for countries with a small market share in the world export market. Due to these inadequacies, the same value of BRCA might signify different levels of comparative advantage for different countries or commodities. Consequently, the BRCA index cannot be used to compare comparative advantage across countries or commodities (Hoen and Oosterhaven, 2006).

Several modifications to the BRCA have been proposed to address the asymmetric property. For example, Vollrath (1991) suggested a log BRCA to make the index symmetric. Note, however, the BRCA for a commodity with no exports would be undefined under this approach. A few other versions of the RCA measure have also been proposed by Laursen (1998), Proudman and Redding (1998) and other researchers. Table 1 provides a brief description of these RCA measures and highlights the strengths and weaknesses of each of these measures.

Since the primary focus of this study is to measure international competitiveness and compare those across sectors and over time, we employed the Normalized Revealed Comparative Advantage (NRCA) proposed by Yu et al. (2009) to measure international competitiveness of the selected agri-food sectors in this study. This measure starts with the comparative-advantage-neutral point and determines how a country's actual export of a particular commodity deviated from the comparative-advantage-neutral point. Thus, if the comparative-advantage-neutral condition of country  $i$ 's export of commodity  $j$  is denoted by,

$$\hat{E}_j^i = E^i E_j / E$$

But country  $i$ 's exports of commodity  $j$  in the real world is  $E_j^i$ . The difference between these two measures can be defined as,

$$\Delta E_j^i = E_j^i - \hat{E}_j^i = E_j^i - E^i E_j / E$$

If we normalize this difference by total world exports, we obtain the normalized RCA as,

$$NRCA_j^i = \left( \frac{E_j^i}{E} \right) - \left( \frac{E_j E^i}{EE} \right) \quad (2)$$

Thus, the  $NRCA_j^i$  index measures the degree to which country  $i$ 's actual exports of commodity  $j$  deviates from its comparative-advantage-neutral level in terms of its relative scale with respect to the world export market. Hence, it provides a proper indication of the underlying comparative advantage.<sup>4</sup> If the value of  $NRCA_j^i > 0$ , it indicates that country  $i$ 's exports of  $j$  is higher than its comparative-advantage-neutral level and hence, it has comparative advantage in commodity  $j$ . The greater (lower) the  $NRCA_j^i$  score, the stronger the comparative advantage (or disadvantage). Since comparative advantage is a relative concept, the magnitude of the NRCA provides a more meaningful economic interpretation in a comparative context. The comparative-advantage-neutral value of the NRCA is zero and it has a symmetric distribution (Table 1). The symmetrical property of this index facilitates the comparison of comparative advantage across commodities, countries and over time. It also facilitates regression analysis to determine the drivers of comparative advantage by preserving the normality assumption maintained in classical regression analysis (Laursen, 1998; Hoen and Oosterhaven, 2006).

### 3.0 COMPETITIVENESS OF WHEAT, BEEF AND PORK SECTORS

To measure NRCA for the wheat, beef and pork sectors, we collected annual trade data for wheat (SITC:041-Wheat (including spelt) and Meslin Unmilled), Beef (SITC:011- Meat of Bovine

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<sup>4</sup> Note that NRCA index can also be derived through the probability approach proposed by Leamer and Stern (1970). Under this framework,  $(E^i/E)(E_j/E)$  measures the expected probability that commodity  $j$  is exported by country  $i$  in the comparative-advantage-neutral situation. On the other hand,  $(E_j^i/E)$  measures the actual probability that commodity  $j$  is exported by country  $i$ . Thus, the NRCA index measures the extent of comparative advantage in terms of the difference between the actual to expected probability that country  $i$  has in exporting the  $j^{\text{th}}$  commodity (Bowen, 1983).

Animals, Fresh, Chilled or Frozen) and Pork (SITC:012.2-Meat of swine, fresh, chilled or frozen and SITC:016.1-Bacon, ham and other salted, dried or smoked meat of swine) from 1961 to 2011 from FAO and the Global Trade Atlas.<sup>5</sup> In particular, we obtained total value of wheat, beef and pork exports from Canada to all destination (in US \$). Similarly, we obtained total value of wheat, beef and pork exports from the United States to all destinations (in US \$). We also obtained total value of wheat, beef and pork exports from all countries (in US \$) and the total value of agricultural exports from Canada, the United States and from all countries (in US \$). Special efforts were made to ensure that all export data obtained from these two sources are comparable and reliable.

The formula for NRCA presented in the previous section is used to measure the international competitiveness of the wheat, beef and pork sectors in Canada. We also measured international competitiveness of these sectors based on BRCA for comparative purposes, although, this measure has some serious weaknesses as highlighted in the previous section and in Table 1. Table 2 presents the characteristics of the BRCA and NRCA for the selected sectors. Clearly, the BRCA has higher dispersion than the NRCA distribution. Based on the Heckscher-Ohlin-Vanek model of comparative advantage and trade, technological coefficients are country and sector specific and sticky over time. Thus, a good measure of comparative advantage should not vary a lot over time (De Benedictis and Tamberi, 2004). Both features support our choice of the NRCA index over the BRCA index in this study. The NRCA and BRCA indicators obtained for the selected sectors are presented in Figures 1-3.

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<sup>5</sup> Although the export of live hogs and live cattle from Canada to the United States increased steadily during the last two decades, we decided not to include them in this study because not many countries outside of North America are involved in live hogs and live cattle trade. Also, the study period would have been shorter than the period covered in this study. This is an important area for future research.

Canada enjoyed international competitiveness in the wheat sector but not in the pork sector because the value of NRCA has always been greater than zero for wheat but less than zero for pork (Figure 1 and Figure 3). The competitiveness of the beef sector in Canada improved slowly and in a sustained manner during the 1970s and 1980s. The beef sector's competitiveness improved sharply beginning in 1993 and became positive from 1997 to 2002 and then came crashing down due to the discovery of BSE in Canada in 2003. While the competitiveness of the beef sector is improving, it is yet to reach the pre-BSE level (Figure 2). How did the international competitiveness of wheat, beef and pork change during different policy regimes? Have the Canadian wheat, beef and pork sectors been more competitive than their counterparts in the United States? These issues are addressed in the following section.

Figure 4 compares the competitiveness of the wheat sectors in Canada and in the United States based on the NRCA indices. The international competitiveness of the U.S. wheat sector was very high in the 1970s. But since the 1980s, the competitiveness of the wheat sectors in Canada and in the United States became very similar; both declined steadily but remained in positive territory. While decoupled safety net programs, the Uruguay Round Agreement on Agriculture and NAFTA all have contributed to improve the international competitiveness of the beef and pork sectors, they somehow failed to stimulate the international competitiveness of the wheat sector in Canada (Table 3). Our results also reveal that the Canadian wheat sector is less competitive than the wheat sector in the United States, although the gap has been narrowed since the implementation of NAFTA in 1993. However, the beef and pork sectors in Canada are relatively more competitive than their counterparts in the United States. Note, however, the gaps are becoming narrower in the post-NAFTA period which may be a reflection of gradual market integration under the NAFTA (Table 4). Before we turn our attention to specific efforts needed

to improve the international competitiveness of the wheat, beef and pork sectors in Canada, we need to know what factors are driving the competitiveness of these sectors. The next section focuses on the drivers and how to measure their impacts on the competitiveness of each of these sectors.

#### **4.0 DRIVERS OF COMPETITIVENESS**

For a meaningful policy dialogue and informed policy choices, it is important to identify the drivers of competitiveness and to determine the relationship between the drivers and the state of competitiveness of the sector under study. For competitiveness studies focussed on trade performance, this requires a significant investment to collect the relevant secondary data. Once the data availability issue is addressed, one can examine the determinants of competitiveness using an econometric model in which the competitiveness scores are regressed on a set of explanatory variables. This approach has been widely used in efficiency and productivity literature of competitiveness. It has also been used to investigate the drivers of cost competitiveness (Makki et al. 1999 and Ball et al. 2001). Some researchers have also compared competitiveness scores across periods to determine the effects of policy reforms on productivity or technical efficiency (Morrison-Paul et al. 2000 and Lambarra et al. 2009). A few authors have also examined the effects of farm size and other structural characteristics on efficiency, productivity and competitiveness (Weersink et al. 1990; Hallam and Machado, 1996; Latruffe et al. 2005). While regression analysis has been routinely used in productivity and efficiency related studies, to the best of our knowledge, no study investigating international competitiveness of agri-food sectors using either RCA or NRCA measures has used the regression framework to

determine the drivers of competitiveness (Fertő and Hubbard, 2003; Bojnec and Fertő, 2008, 2009, 2012; Jambor, 2013; Shohibul, 2013; and Ullah and Kazuo, 2012).

What factors are driving the international competitiveness of the wheat, beef and pork sectors in Canada? To address this issue, we use the predictions of the Heckscher-Ohlin-Vanek (H-O-V) trade model. According to this model, factor prices differ across countries due to differences in their endowments in those factors. Given the state of technology, the cost-minimizing input requirements to produce one unit of a particular commodity may also differ across countries due to differences in relative factor endowments. Thus, the H-O-V model predicts that a country will specialize in production and export the services of its abundant factors. Leamer (1984) estimated a large set of H-O-V models using trade in goods as the dependent variable and national factor endowments as the explanatory variables. He found limited support for the H-O-V model and discovered the reversing role of labour and capital as drivers of manufacturing trade over time. Despite the criticism it received for not having enough empirical power, the H-O-V model remains the most widely used theoretical framework for explaining comparative advantage (Leamer, 1995). Trefler (1993) modified the H-O-V model by incorporating factor-augmenting productivity differences and demonstrated that empirical evidence fully support the predictions of the H-O-V model. Morrow (2010) developed a Ricardian-Heckscher-Ohlin comparative advantage model and shows that both the Ricardian and the H-O-V models possess significant explanatory power in determining the international pattern of production and trade. Similarly, Chor (2010) demonstrates that comparative advantage and international trade flows are determined by factor endowments, country and industry characteristics and the institutions. Finally, Peterson and Valluru (2000) argue that government intervention in agri-food markets can also have an impact on trade patterns. Based on these

studies, we focus on three groups of explanatory variables: factors related to cost of production, relevant exchange rates and relevant policy variables to determine the sources of revealed comparative advantage for the selected sectors.

Since international competitiveness examined in this paper is a relative measure, we consider major production costs for wheat, beef and pork sectors in Canada relative to those for the wheat, beef and pork sectors in the United States. Canada competes with the United States on the world market for wheat. However, more than 70 percent of beef and about 60 percent of pork exported from Canada are destined for the U.S. market. These factors motivated us to develop relative costs of production for wheat, beef and pork sectors and use them in the regression analysis.<sup>6</sup>

The equations we estimate to determine the drivers of comparative advantage for the wheat, beef and pork sectors in Canada are specified as follows:

$$NRCA_{Wheat} = f[RC_F, RC_S, RC_E, ER_{CAN-US}, ER_{CAN-FR}, WGSA, WGTA, AGPOL] \quad (3)$$

Where,  $RC_F$ =Relative Cost of Fertilizer,  $RC_S$ = Relative Cost of Seed,  $RC_{E.W}$ =Relative Cost of Energy in the production of wheat,  $ER_{CAN-US}$ =Canada-US Exchange Rate,  $ER_{CAN-FR}$ =Canada-France Exchange Rate,  $WGSA$ =Western Grain Stabilization Act,  $WGTA$ =Western Grain Transportation Act and  $AGPOL$ =Decoupled Agricultural Policy.

$$NRCA_{Beef} =$$

$$f[RC_{FD.B}, RC_{E.B}, RC_{MPL}, ER_{CAN-US}, ER_{CAN-FR}, WGSA, AGPOL, NTPSP, BSE] \quad (4)$$

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<sup>6</sup> The costs of labour and capital in United States have also been used by Treffer (1993) to develop measures for relative factor endowments and used to test the predictions of the H-O-V trade model.

Where,  $RC_{FD,B}$ = Relative Cost of Feed in beef production,  $RC_{MPL}$ =Relative Cost of Meat Processing Labour,  $NTSP$ = National Tri-partite Stabilization Program, and,  $BSE$ =the time period during which the beef industry confronted the effects of the Mad Cow Disease (Bovine Spongiform Encephalopathy).

$$NRCA_{Pork} = f[RC_{FD,P}, RC_{E,P}, RC_L, RC_{MPL}, ER_{CAN-US}, ER_{CAN-EU}, ER_{CAN-CHI}, WGT A, AGPOL, NTSP, NAFTA] \quad (5)$$

Where,  $RC_{FD,P}$ = Relative Cost of Feed in pork production,  $RC_{E,P}$  = Relative Cost of Energy in pork production,  $RC_L$ = Relative Cost of Hired Labour in pork production,  $ER_{CAN-EU}$  =Canada-European Union Exchange Rate,  $ER_{CAN-CHI}$  =Canada-China Exchange Rate and,  $NAFTA$  =North American Free Trade Agreement.

Table 5 provides a brief description of the explanatory variables along with their summary statistics.<sup>7</sup> These variables were constructed using relevant data from Statistics Canada and from the Economic Research Services, United States Department of Agriculture. Appendix 1 contains a more detailed description of data used to construct these explanatory variables.

How should the explanatory variables be related to the competitiveness scores obtained for each sector? While the H-O-V trade model guides us in determining the set of explanatory variables, it does not tell us if the explanatory variables are linearly related to the NRCA scores for each of the sectors or if the underlying relationship is nonlinear. Ignoring nonlinearity can lead to problematic regression results (Leamer, 1984). Thus, the choice of an appropriate

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<sup>7</sup> We use both domestic income support policy such as the decoupled farm policy and the trade policy variable such as NAFTA in our regression analysis. While the primary objective of the decoupled farm policy is to protect farm income which may enhance competitiveness and economic sustainability, trade policy such as NAFTA exposes domestic producers to foreign competition. We make no distinction between these effects in our analysis.

functional form is an important issue in econometric estimation and an inappropriate choice could lead to erroneous results. To avoid functional form misspecification, a flexible functional form based on the Box-Cox transformation is employed in this paper. Note, however, the estimated variance-covariance matrix of a Box-Cox model is conditional on the optimum value of the Box-Cox parameter and is biased downward (Spitzer 1982). To address this issue, a scaling procedure suggested by Spitzer (1984) has been applied to the data set prior to estimation. This scaling procedure makes the t-ratios of the estimated  $\beta$  coefficients scale-invariant. Because of this scaling procedure, the estimated coefficients are point elasticities, evaluated at the geometric means (Spitzer, 1984). All equations were estimated using SHAZAM version 11.

## 5.0 ESTIMATION RESULTS AND DISCUSSION

The maximum likelihood estimates for the wheat sector are presented in Table 6. The estimated model fits the data well as indicated by the value of  $R^2_{adj}$  ( $=0.687$ ). The F-value is significant at 5 percent level of error probability. The Jarque-Bera Normality test suggests that the residuals are normally distributed and the Durbin-Watson statistic and the Breusch-Godfrey test demonstrate that there is no autocorrelation. Therefore, the empirical estimates are statistically satisfactory and reliable.<sup>8</sup>

While the relative cost of fertilizer and the relative cost of seed both have a negative impact on the international competitiveness of the wheat sector, only the coefficient of the seed cost is statistically significant. The relative cost of energy has no significant impact on competitiveness of the wheat sector. The two exchange rate variables included in this regression

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<sup>8</sup> These are standard regression diagnostics. If the null hypotheses of normally distributed error terms and non-autocorrelation are violated, the reliability of the estimated coefficients will be questioned.

have negative coefficients but none is statistically significant. Of the three policy variables included in this regression, two have negative impacts while the third has a positive effect on the competitiveness of the wheat sector. Our results demonstrate that the Western Grain Stabilization Act introduced in 1976 based on the recommendation of a Federal Task Force on Agriculture to stabilize the income of grain farmers in the CWB designated area and dismantled in 1991 under the Farm Income Protection Act (FIPA), did little to stabilize the income of Prairie grain farmers and has adversely affected the competitiveness of the wheat sector in Canada.<sup>9</sup> The Western Grain Transportation Act was enacted in 1983 to replace the “Crow Benefit or Crow Transportation subsidy” program which was introduced in 1925 to populate and develop agriculture in western Canada and to ship grains to central and eastern Canada and to various export destinations at subsidized rates. The benefits received under this policy was identified as an export subsidy during the Uruguay round of trade negotiations and was repealed on August 1995 as part of the cost cutting measure aimed at eliminating the Federal budget deficit. The results from our regression analysis demonstrate that the WGTA has a statistically significant positive impact on the competitiveness of the wheat sector. A decoupled safety-net program was introduced in Canada in 1991 under the FIPA which repealed all agricultural programs existed at that time and introduced two new programs, Gross Revenue Insurance Program (GRIP) and the Net Income Stabilization Account (NISA). While all provinces pulled out of GRIP by 1995, NISA survived, underwent some changes and grew in stature in the Canadian Agricultural Income Stabilization (CAIS) and in Business Risk Management programs. The decoupled farm safety-net programs were designed to protect whole farm income from both small and large drops and the benefits are counter-cyclical in nature. Although enhancing international competitiveness of Canadian agriculture has not been stated explicitly as an objective of this

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<sup>9</sup> Additional details on these programs can be found in Schmitz et al. 2010.

program, some analysts argue that by stabilizing farm production margins, this program can potentially enhance international competitiveness of the major export-oriented sectors of Canadian agriculture. The results of our regression analysis suggest that such a presumption is unfounded for the wheat sector. On the contrary, the decoupled safety-net program has a negative but statistically insignificant coefficient. So, the decoupled safety-net program does not matter for international competitiveness of the wheat sector in Canada.

The estimated model for the beef sector also fits the data well as indicated by the value of  $R^2_{adj}$  (=0.778) and the F-value is statistically significant at 1 percent level. There is no autocorrelation and the residuals are normally distributed. Therefore, the estimated results are satisfactory and reliable (Table 7). The relative feed cost has a negative but insignificant impact on the competitiveness of the Canadian beef sector. While the relative energy cost has a positive effect on the competitiveness of the beef sector, it not significant either. However, the relative cost of labour used in meat processing has a statistically significant effect on the competitiveness of the beef sector in Canada. This result suggest that if the cost of meat processing in Canada relative to that in the United States is reduced, it will enhance international competitiveness of the beef sector in Canada. The Canada-US exchange rate has a significant positive impact on the competitiveness of the beef sector. Since more than 70 percent of beef exported from Canada is destined to the US market, this result is informative and important. It substantiates the widely held belief that a low value of Canadian dollar relative to the US dollar provides an incentive to the buyers in the U.S. to purchase Canadian beef which helps Canadian beef exports to the United States. Our results also demonstrate that WGTA had a negative but insignificant effect on the competitiveness of the beef sector in Canada. This result is also interesting because it is contrary to a widely held perception in Canada that the WGTA was detrimental to the growth of

beef industry in Western Canada and hence detrimental to international competitiveness of the beef sector in Canada. Note, however, the decoupled safety-net policy and the NTSP both have a statistically significant positive effect on international competitiveness of the beef sector in Canada. Finally, BSE in Canada has a positive coefficient but it is not statistically significant. This result suggests that while the discovery of BSE resulted in severe financial hardship for beef producers in Canada for a few years, it has no long-term effect on international competitiveness of the beef sector in Canada.

The goodness of fit measured by the  $R^2_{adj}$  is 0.475 for the pork model and the F-value is statistically significant at 5 percent level (Table 8). The results of regression diagnostics suggest that there is no autocorrelation and the residuals are normally distributed. Therefore, the results are satisfactory from a statistical point of view and are reliable. The relative cost of feed has a negative effect while the relative cost of energy has a positive effect on the competitiveness of the pork sector. But none is statistically significant. While the relative cost of hired labour at the farm-level has a negative effect on competitiveness of the pork sector, it is not significant. However, the relative cost labour used in meat processing has a statistically significant effect on the competitiveness of the pork sector. This result suggests that efforts aimed at reducing the cost of meat processing in Canada will enhance international competitiveness of the pork sector in Canada. Among the three exchange rate variables, only two have significant effect on the competitiveness of the pork sector. The NTSP, WGTA and NAFTA all have positive effects on the competitiveness of the pork sector in Canada but none is statistically significant. While the decoupled safety-net policy has a negative effect on the competitiveness of the pork sector, it is not statistically significant. Thus, none of the four policy variables has any effect on the international competitiveness of the pork sector in Canada.

Our results provide limited empirical support to the predictions of the H-O-V model although not all factors were found to be significant in each model. Based on the results from our regression analysis, the competitiveness of the Canadian wheat sector can be enhanced if the cost of seed in Canada relative to those in the United States is lower. For the beef sector, however, lower meat processing costs, a low value of the Canadian dollar relative to the U.S. dollar and the continuation of the decoupled safety-net program will lead to improved competitiveness in the future. Finally, for the pork sector, the lower the relative labour cost of meat processing, the higher would be the international competitiveness. Our results also suggest that Canada-U.S., and Canada-Euro exchange rates are also important drivers of international competitiveness of the pork sector in Canada. While it is extremely difficult for any country to ensure stability of the relative value of its currency, policy makers should be aware of the impacts of exchange rate changes on the competitiveness of the agri-food sector in Canada.

Our empirical results also highlight cases of significant policy failures in Canada (also termed as “nonmarket failure” by Wolf, 1979 or “government failure” by Coase, 1964).<sup>10</sup> For example, the Western Grain Stabilization Act designed to stabilize income of grain farmers in the CWB designated area ended up reducing the international competitiveness of the Canadian wheat sector. Similarly, the WGTA or its predecessor, the Crow benefit did not help beef and pork sectors’ competitiveness. Finally, the decoupled farm policy was designed to support income of grain farmers initially in 1991 and beef and pork sectors were added to it in 1994 after

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<sup>10</sup> For most policies considered in this paper, the initial conditions during which the policies were introduced have changed and we do not delve into the counterfactuals of “what would have happened if these policies were not put in place”. All we can say, based on our regression results that if a policy did not lead to improvement in international competitiveness of a sector, it was not a wise decision to introduce that policy (Coase, 1964). The named policies may have served some other objectives but a detailed analysis of those objectives and how a policy have or have not achieved those objectives is beyond the scope of this study.

the removal of NTSP. Based on our regression analysis, this policy does not have a significant impact on the competitiveness of wheat and pork sectors in Canada.<sup>11</sup>

What can be done to enhance international competitiveness of wheat beef and pork sectors in Canada? The results from our regression analysis suggest that producers and processors need to be more cost-efficient relative to their counterparts in other countries. How cost-competitive and productive are Canadian producers and processors relative to their counterparts in other countries? This is an important issue and can be addressed in a future research using panel data for each sector. The scope of this line of research can be expanded to evaluate the effects of size and other structural characteristics on farm level productivity, efficiency and competitiveness for each of the three sectors considered in this study. While governments have little control over exchange rates in an era of flexible exchange rates, they can enhance the competitive performance of various agri-food sectors through the reduction or removal of some policy interventions. While most of the policy interventions considered in this study have been dismantled, close attention to our empirical results would inform policy choices in the future to enhance the competitiveness of a particular sector.

## **VI. CONCLUDING REMARKS**

Competitiveness is a popular but fuzzy concept used in agri-food policy and trade policy discussions and debates since 1990s. The literature on competitiveness contains different definitions of competitiveness based on the purpose of the study, the commodity in question and the level of analysis. Since the prosperity of the agri-food sector in Canada critically depends on

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<sup>11</sup> The decoupled safety net program in Canada is a whole farm income support program. Therefore, competitiveness enhancing benefits of such program may not show up when we consider those for a particular sector. Also, wheat prices were very high in the early 1970s and since 2007 both of which may have contributed to the insignificant result for the wheat sector. The significant positive impact on the beef sector may be reflecting the support received in post-BSE era.

international trade, issues related to measuring, maintaining and enhancing the competitiveness of major agri-food sectors in Canada assumed the centre stage since the mid 1980s. While the early contributions to competitiveness analysis were exploratory and laid the groundwork for future competitiveness analysis, to the best of our knowledge, no study has investigated how the competitiveness of Canadian agriculture evolved through time employing longitudinal data. An attempt is made in this article to bridge this gap by measuring the international competitiveness of the wheat, beef and pork sectors in Canada employing data from 1961 to 2011. In addition, we use the H-O-V trade model (also known as the factor content theory of trade) to determine the relative contributions of different factors, domestic policy and trade policy variables to the competitiveness of the selected agri-food sectors in Canada.

The results demonstrate that Canada enjoyed international competitiveness in the wheat sector but not in the pork sector during the period of our study. The competitiveness of the beef sector improved rapidly since 1992, ventured into the positive territory between 1997 and 2002 and then experienced a significant drop after the discovery of the BSE in Canada in 2003. Despite gradual improvements since 2005, the beef sector is yet to recover fully from the BSE-induced effect. Our results also reveal that the competitiveness of the wheat sector in Canada is comparable to that in the United States, although the U.S. wheat sector enjoys a slight edge over its Canadian counterpart. The beef and pork sectors in Canada appear to be more competitive than their U.S. counterparts. However, the sector specific differences between these two countries have become narrower in the post-NAFTA period. This result may be indicative of gradual market integration under the NAFTA.

The results of our regression analysis demonstrate that the relative cost of seed has a negative and significant impact on the competitiveness of the wheat sector in Canada. The

relative costs of fertilizer, energy, Canada-U.S. exchange rate and Canada-Euro exchange rate have no significant impact on competitiveness. The WGTA had a significant positive impact while the WGSA had a significant negative impact on the competitiveness of the wheat sector in Canada. While the relative cost of feed has negative coefficients in the beef and pork models, none is statistically significant. Similarly, the relative cost of energy has no significant effect on the competitiveness of either the beef or the pork sectors in Canada. However, the relative labour cost of meat processing has a significant negative effect on the competitiveness of both the beef and pork sectors in Canada. Thus our regression results provide limited empirical support for the H-O-V model of international trade. While decoupled safety net programs and the NTSP have significant positive effects on the competitiveness of the beef sector, these policies do not matter for the international competitiveness of the pork sector. Finally, changes in exchange rates matter for the international competitiveness of beef and pork sectors but not for the wheat sector in Canada.

Some analysts would argue that the decoupled safety net programs such as the Net Income Stabilization Account (NISA), Canadian Agricultural Income Stabilization (CAIS) and Business Risk Management (BRM) programs in Canada have been designed to provide whole-farm income support and therefore, should have little or no impact on the international competitiveness of any particular commodity sector. While our regression results for the wheat and pork sectors seem to support this view, the results for the beef sector do not. Could there be sector-specific productivity or other factors contributing to these effects? This remains an interesting topic for future research. Also, significant structural changes have taken place in each of these sectors during the last five decades. Do these changes have any impact on the

international competitiveness of the selected agri-food sectors? This too remains a fruitful area for future research.

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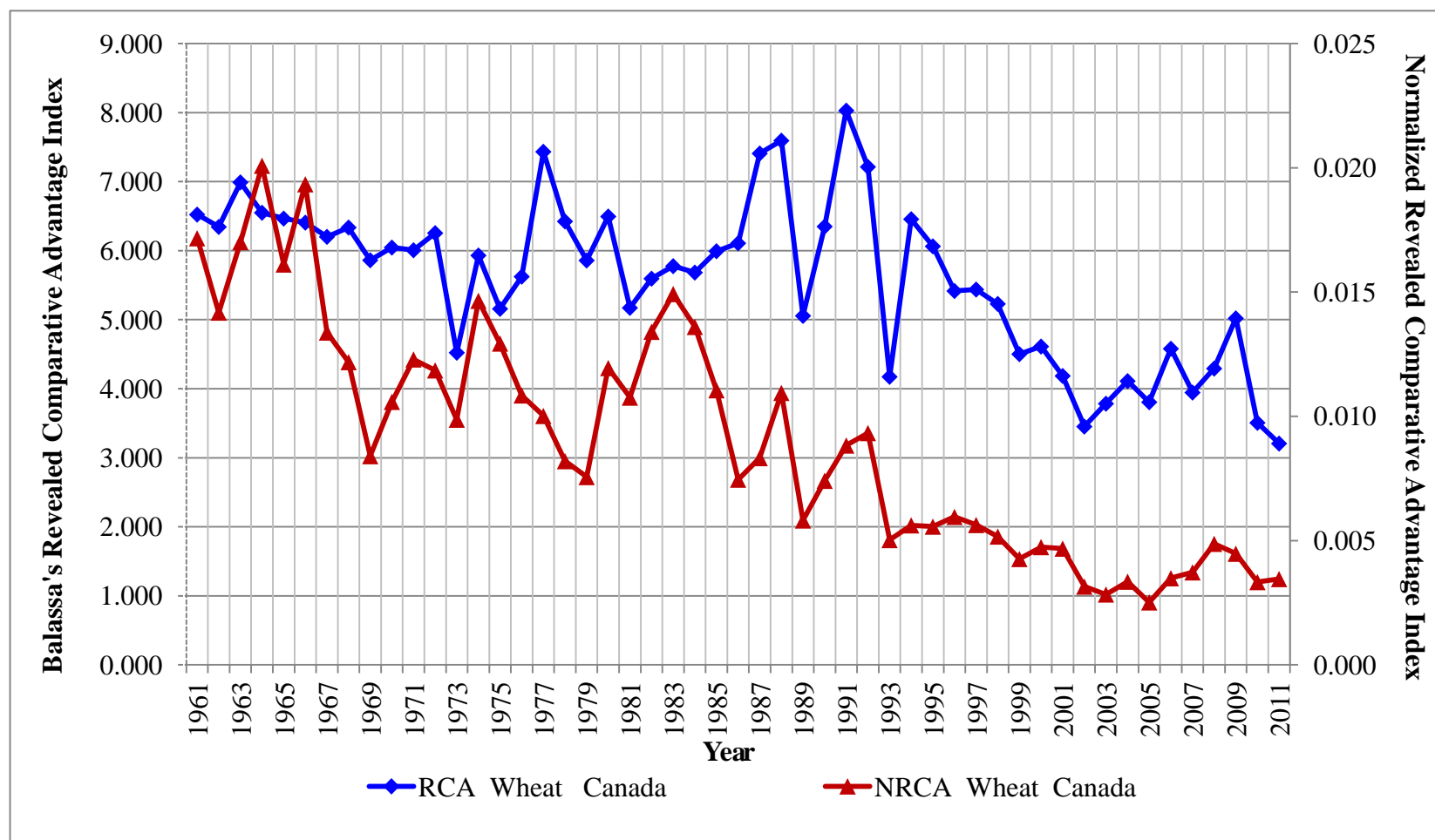


Figure 1. Comparison of Balassa's Revealed Comparative Advantage Index and Normalized Revealed Comparative Advantage Index of wheat exported from Canada, 1961-2011

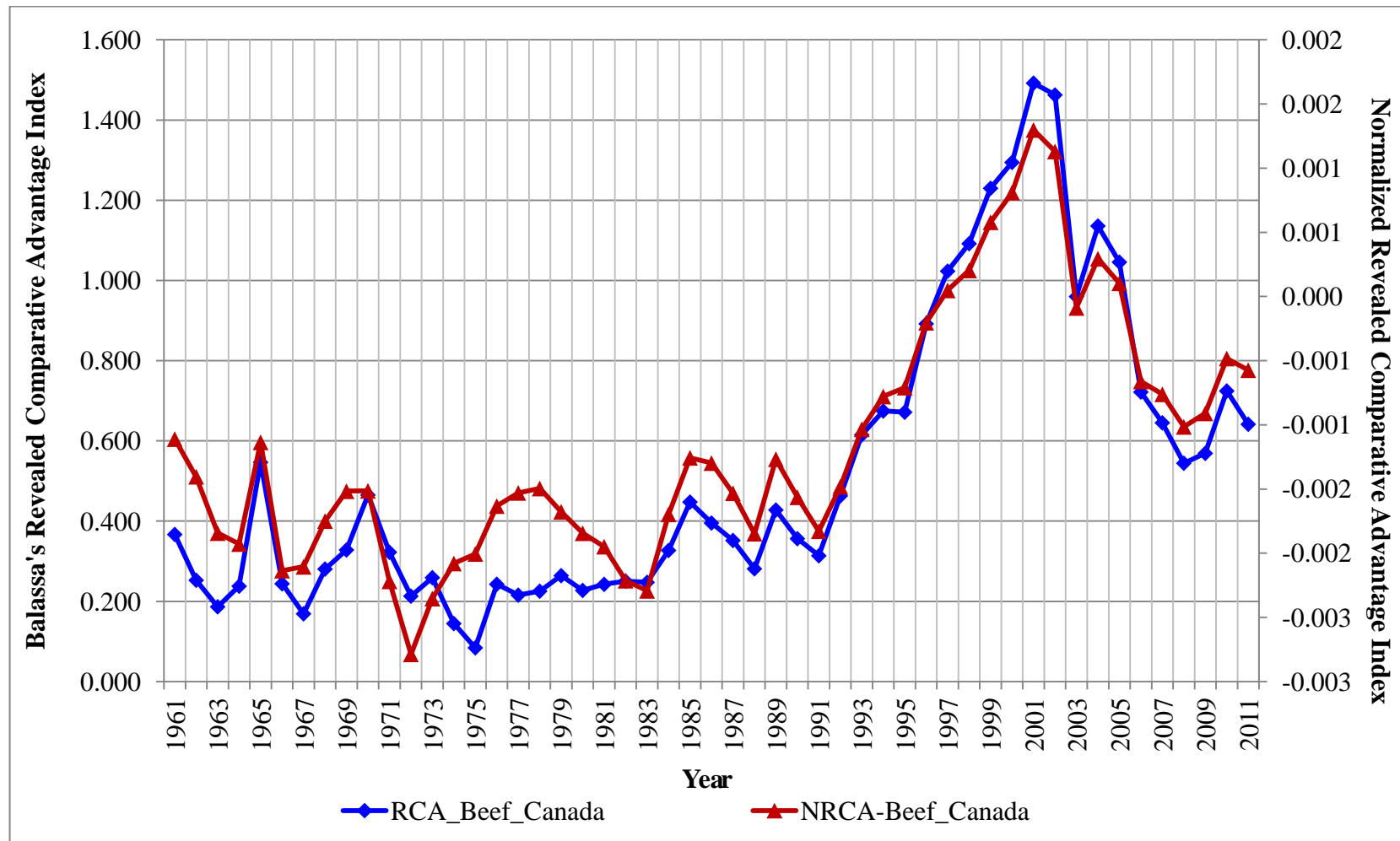


Figure 2. Comparison of Balassa's Revealed Comparative Advantage Index and Normalized Revealed Comparative Advantage Index of beef exported from Canada, 1961-2011

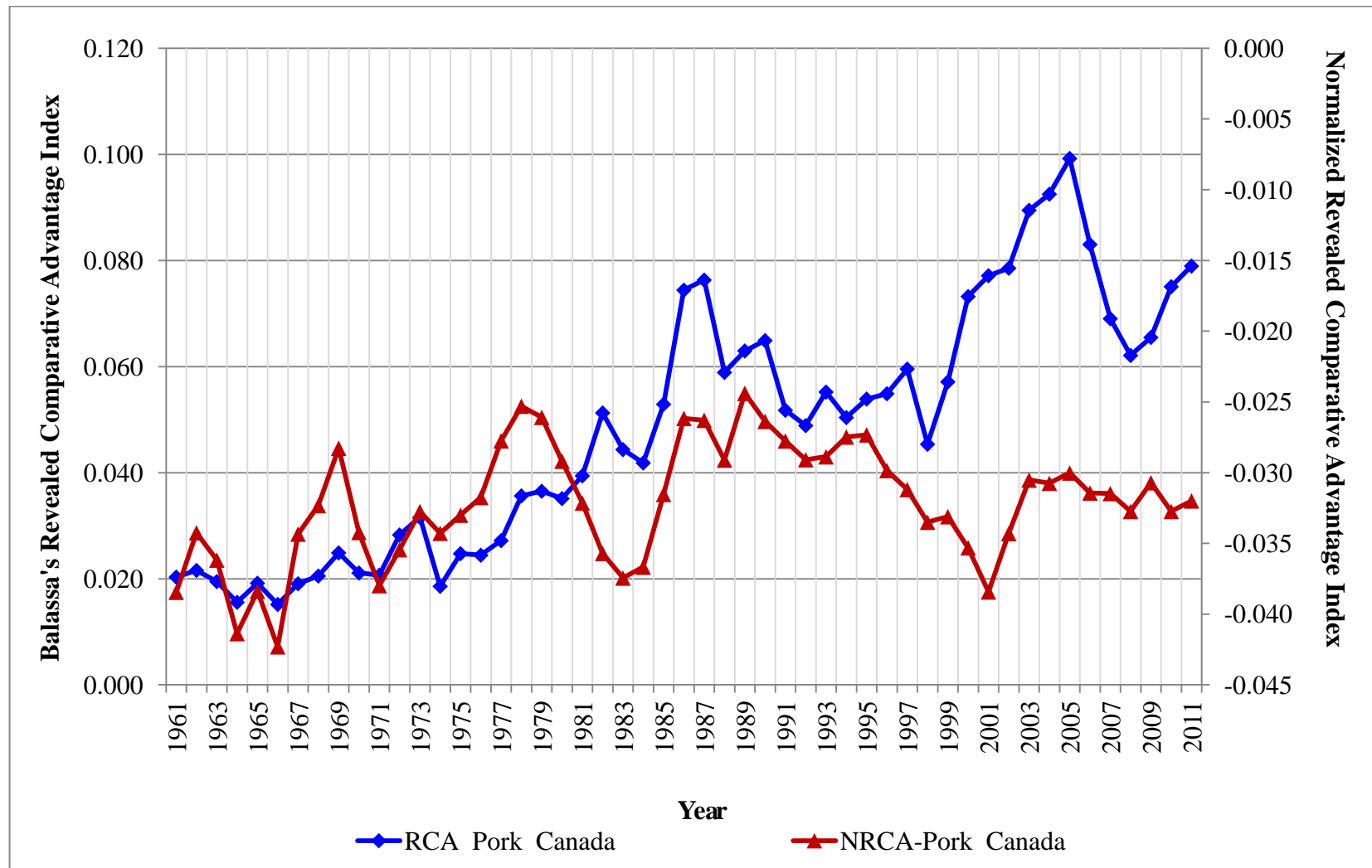


Figure 3. Comparison of Balassa's Revealed Comparative Advantage Index and Normalized Revealed Comparative Advantage Index of pork exported from Canada, 1961-2011

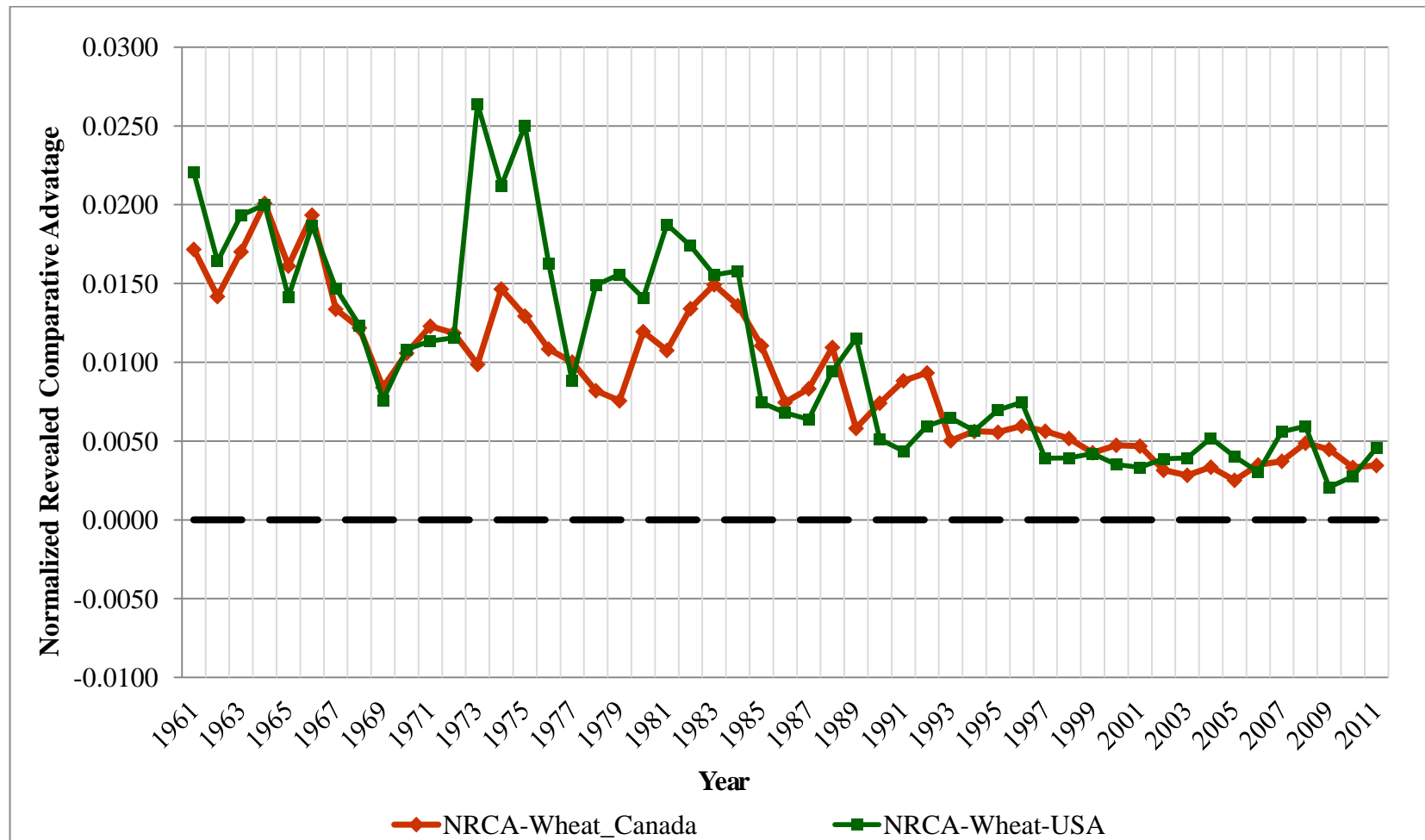


Figure 4. Normalized Revealed Comparative Advantage of wheat exported from Canada and USA, 1961-2011

Table 1. Alternative Approaches to Measure the Revealed Comparative Advantage

Measure of Comparative Advantage	Formula	Strengths	Weaknesses
Balassa's Index of Revealed Comparative Advantage (BRCA):	$RCA_j^A = (X_j^A / X^A) / (X_j^{REF} / X^{REF})$ <p>Where,  <math>X_j^A</math> = the export of sector j in country A  <math>X^A</math> = the total export of country A  <math>X_j^{REF}</math> = the total export of sector j of the reference countries  <math>X^{REF}</math> = the total export of the reference countries</p>	<ul style="list-style-type: none"> <li>• RCA only signifies whether or not a country has comparative advantage in a commodity (Hillman, 1980; Yeats, 1985)</li> <li>• Preferred by policymakers who want to identify comparative advantage sectors without considering their economic impacts</li> </ul>	<ul style="list-style-type: none"> <li>• The magnitude of the RCA has neither the ordinal property nor the cardinal property (Yeats 1985). It can generate inconsistent and misleading results.</li> <li>• The distribution of the RCAs around the mean is asymmetric.</li> <li>• Deriving the distribution of the standard RCA is further complicated by its dependence on the number of countries in the analysis.</li> <li>• The mean of RCA is unstable and larger than the theoretically expected value of 1. Therefore, economic interpretation of its mean problematic.</li> </ul>
Logarithm of Balassa's RCA (Vollrath, 1991)		Make Balassa's RCA symmetrical	A commodity with zero export would be undefined
Symmetrical RCA Index (SRCA) (Laursen, 1998)	$SRCA_j^i = (RCA_j^i - 1) / (RCA_j^i + 1)$	The distribution of SRCA scores symmetrically ranges from -1 to +1 with 0 being the comparative-advantage-neutral point.	However this symmetry comes at a cost as the transformation makes the economic interpretation of the SRCA index not as clear as the RCA index (Benedictis and Tamberi 2001)

Weighted RCA (WRCA)  Proudman and Redding (1998)	$WRCA_j^i = \frac{RCA_j^i}{(1/N \sum_{j=1}^N RCA_j^i)}$ <p>Where N is the number of commodities</p>	<p>The transformation results in a time-invariant mean of N for an individual country and helps to establish the WRCA index's comparability within an individual country.</p>	<p>Does not correct the asymmetric problem of the RCA index.</p> <p>The transformation makes the comparative advantage neutral point sensitive to the classification of commodities (Benedictis and Tamberi, 2001).</p>
Additive RCA (ARCA)-(Hoen and Oosterhaven, 2006)	$ARCA_j^A = \left( \frac{X_j^A}{\bar{X}^A} \right) - \left( \frac{X_j^{REF}}{\bar{X}^{REF}} \right)$ <p>Interpretation:</p> <p>ARCA= 0 if the export share of sector j in country A is equal to that of the reference countries.</p> <p>ARCA &gt;0 if country A has a 'revealed comparative advantage' in sector j and vice versa</p> <p>The ARCA for an individual sector, with country A excluded from the group of reference countries, ranges from exactly -1 to exactly +1.</p>	<ul style="list-style-type: none"> <li>The mean of the ARCAs has a value of 0, independent of the number of and classification of the sectors or countries.</li> <li>The economic interpretation is clear: the average sector does not have a comparative (dis)advantage and it is identical across time and space (stable mean).</li> </ul> <p>The distribution of the ARCAs is centered symmetrically around its stable mean.</p> <ul style="list-style-type: none"> <li>The sum of a country's ARCA scores is constant and equals to zero, which makes the comparison of a country's comparative advantage in different commodities feasible.</li> </ul>	<p>Does not reveal whether or not a country 'as a whole' has a relatively specialized export package.</p> <p>However the sum of all countries' ARCA scores for an individual commodity generally is not a constant.</p> <p>Finally, ARCA's comparability across country is not as well established as its comparability across commodities.</p>
Normalized RCA (NRCA Index)	Measures the degree of deviation of a country's actual export from	<ul style="list-style-type: none"> <li>Reveals the extent of comparative advantage that a country has in a</li> </ul>	

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its comparative-advantage-neutral level in terms of its relative scale with respect to the world export market.

$$NRCA_j^i = \left( \frac{E_j^i}{E} \right) - \left( \frac{E_j E^i}{EE} \right)$$

$E_j^i$  = Country i's actual export of commodity j in the real world

$E$  = Export of all commodities by all countries

$E_j$  = Export of commodity j by all countries

$E^i$  = Country i's export of all commodities

Interpretation:

$NRCA_j^i > 0$  indicates that country i's actual export of j is higher than its comparative-advantage neutral level. Thus it indicates that country i has comparative advantage in commodity j.

$NRCA_j^i < 0$  indicates that country i's actual export of j is lower than its comparative-advantage neutral level. Thus it indicates that country i has comparative disadvantage in commodity j.

commodity more precisely and consistently than other RCA indices. Therefore it gives a proper indication of the underlying comparative advantage.

- The sum (and the mean value) of a country or a commodity's NRCA scores is constant and equals to zero. This implies that if a country gains comparative advantage in a commodity, some other countries must lose comparative advantage in this commodity. Similarly, if a country gains comparative advantage in some commodities, it must lose comparative advantage in some other commodities.
  - NRCA index is independent of the classification of the commodities and countries.
  - The distribution of NRCA scores is symmetrical ranging from -1/4 to +1/4 with 0 being the comparative advantage neutral point.
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Table 2. Descriptive statistics of Balassa's Revealed Comparative Advantage Index and the Normalized Revealed Comparative Advantage Index

Measure	Sector	Mean	Standard Deviation	Minimum	Maximum	Skewness
Balassa's Revealed Comparative Advantage Index	Wheat	5.593	1.164	3.207	8.031	-0.208
	Beef	0.526	0.365	0.084	1.492	1.178
	Pork	0.048	0.023	0.015	0.099	0.261
Normalized Revealed Comparative Advantage Index	Wheat	0.009	0.005	0.003	0.020	0.486
	Beef	-0.001	0.001	-0.003	0.001	0.866
	Pork	-0.032	0.004	-0.042	-0.024	-0.319

Table 3. Changes in international competitiveness of wheat, beef and pork Sectors in Canada during different policy regimes

Competitiveness of		Safety Net Payments		WTO Agreement on Agriculture		NAFTA	
		Pre-decoupled Payment Era	Post-decoupled Payment Era	Pre-WTO Agreement on Agric.	Post WTO Agreement on Agric.	Pre-NAFTA Period	Post-NAFTA Period
		1961-1990	1991-2011	1961-1995	1996-2011	1961-1993	1994-2011
Mean	WHEAT	0.01208	0.00476	0.01133	0.00410	0.01168	0.00427
	BEEF	-0.00177	-0.00029	-0.00168	-0.00001	-0.00174	-0.00010
	PORK	-0.03264	-0.03136	-0.03200	-0.03238	-0.03227	-0.03182
Variance	WHEAT	0.00001	0.00000	0.00001	0.00000	0.00001	0.00000
	BEEF	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	PORK	0.00002	0.00001	0.00002	0.00001	0.00002	0.00001

Table 4. Differences in international competitiveness of wheat, beef and pork sectors in Canada and in the United States

Competitiveness of		WTO Agreement on Agriculture		NAFTA	
		Pre-WTO Agreement on Agriculture	Post WTO Agreement on Agriculture	Pre- NAFTA Period	Post- NAFTA Period
		1961-1995	1996-2011	1961-1993	1994-2011
Mean	WHEAT_CANADA	0.0113	0.0041	0.0117	0.0043
	BEEF_CANADA	-0.0017	-0.00001	-0.0017	-0.0001
	PORK_CANADA	-0.0320	-0.0324	-0.0323	-0.0318
	WHEAT_USA	0.0133	0.0042	0.0137	0.0044
	BEEF_USA	-0.0092	-0.0028	-0.0095	-0.0030
	PORK_USA	-0.1563	-0.1156	-0.1575	-0.1179
Difference (Canada-USA)	WHEAT	-0.0019	-0.0001	-0.0020	-0.0002
	BEEF	0.0076	0.0028	0.0078	0.0029
	PORK	0.1243	0.0833	0.1253	0.0860

Table 5. Summary statistics of the variables used in the Normalized Revealed Comparative Advantage of wheat, beef and pork in Canada models

Variables	Units of Measurement	Wheat				Beef				Pork			
		Mean	St Dev	Min	Max	Mean	St Dev	Min	Max	Mean	St Dev	Min	Max
Cost of Fertilizer-Canada	US \$/Ac	48.08	13.15	26.51	103.77								
Cost of Seeds-Canada	US \$/Ac	22.55	11.63	11.29	58.34								
Cost of Energy-Canada	US \$/Ac	42.51	5.84	32.24	59.50								
Cost of Fertilizer-USA	US \$/Ac	18.12	3.53	11.98	30.05								
Cost of Seeds-USA	US \$/Ac	7.45	2.43	3.88	19.35								
Cost of Energy-USA	US \$/Ac	9.75	2.62	5.24	14.62								
Cost of Feed-Canada	US \$/Head					17.01	4.71	3.41	23.79				
	US \$/Kg Wt Gain									0.85	0.35	0.37	1.69
Cost of Energy-Canada	US \$/Head					4.29	1.28	2.65	7.29				
	US \$/Kg Wt Gain									0.03	0.01	0.01	0.06
Cost of Hired Labour-Canada	US \$/Head					9.97	3.01	5.17	15.20				
	US \$/Kg Wt Gain									0.04	0.02	0.02	0.08
Cost of Meat Processing Labour-Canada	US\$/hr					15.41	2.09	11.19	19.81	15.41	2.09	11.19	19.8
Cost of Feed-USA	US \$/Head					32.87	8.71	16.92	45.62				
	US \$/Kg Wt Gain									0.55	0.16	0.30	0.90
Cost of Energy-USA	US \$/Head					21.56	6.86	13.89	42.63				
	US \$/Kg Wt Gain									0.03	0.01	0.02	0.06

Variables	Units of Measurement	Wheat				Beef				Pork			
		Mean	St Dev	Min	Max	Mean	St Dev	Min	Max	Mean	St Dev	Min	Max
Cost of Hired Labour-USA	US \$/Head US \$/Kg Wt Gain					19.19	3.98	13.33	27.53	0.07	0.04	0.02	0.14
Cost of Meat Processing Labour-USA	US\$/hr					8.00	2.72	2.65	11.53	8.00	2.72	2.65	11.53
Exchange Rate:													
Canada-France	\$CDN/Euro	1.46	0.21	1.07	1.89								
Canada-Australia	\$CDN/\$AUS												
Canada-USA	\$CDN/\$US	0.90	0.08	0.73	1.09	0.90	0.08	0.73	1.09	0.90	0.08	0.73	1.09
Canada-EU	\$CDN/Euro					1.61	0.27	1.16	2.29	1.61	0.27	1.16	2.29
Canada-China	\$CDN/Yuan									0.24	0.11	0.13	0.60
Dummy Variable- Implementation of:													
Western Grain Stabilization Act	1= 1976-1990 & 0=otherwise	0.37	0.49	0.00	1.00								
Western Grain Transportation Act	1= 1971-1996 & 0=otherwise	0.63	0.49	0.00	1.00	0.63	0.49	0.00	1.00	0.63	0.49	0.00	1.00
Decoupled Policy	1=from 1991-2011& 0=otherwise	0.51	0.51	0.00	1.00	0.51	0.51	0.00	1.00	0.51	0.51	0.00	1.00
National Tri-Partite Stabilization Act	1=1981-1994 & 0=Otherwise									0.34	0.48	0.00	1.00
BSE	1=2002,2003 &2004 & 0=Otherwise					0.07	0.04	0.00	1.00				
NAFTA	1=1994-2011 & 0=Otherwise									0.44	0.50	0.00	1.00

Note: BSE denotes Bovine Spongiform Encephalopathy, or Mad Cow Disease.

Table 6. Drivers of Normalized Revealed Comparative Advantage of Wheat in Canada	
Factor	Estimated Coefficient
Relative Cost of Fertilizer	-0.00425 ( 0.00284)
Relative Cost of Seeds	-0.00195** (0.00083)
Relative Cost of Energy	0.00019 (0.00099)
Exchange Rate-Canada-USA	-0.00418 (0.00555)
Exchange Rate-Canada-France	-0.00323 (0.0035)
Dummy_ Western Grain Stabilization Act	-0.00471** (0.00143)
Dummy_ Western Grain Transportation Act	0.00344** (0.00168)
Dummy_ Decoupled Agricultural Policy	-0.00306 (0.00193)
Constant	0.00191 (0.00184)
Box-Cox Parameter ( $\hat{\lambda}$ )	1.550
R <sup>2</sup> -Adjusted	0.687
F -Value	11.964**
Number of Observations	41
Durbin-Watson Statistic	2.022
Autocorrelation: R <sup>2</sup>	0.0032
F-Statistics	0.008
Jarque-Bera Normality Test –Chi-Squared (2df)	2.217
P-Value:	(0.330)

Note: The figures in the parentheses are standard errors. The symbol \*\* indicates statistical significance at 5 percent level of error probability.

Table 7. Drivers of Normalized Revealed Comparative Advantage of Beef in Canada

Factor	Estimated Coefficient
Relative Cost of Feed	-0.0000608 (0.0000885)
Relative Cost of Energy	0.000107 ( 0.000179)
Relative Labour Cost of Meat Processing	-0.0000091* ( 0.0000052)
Exchange Rate-Canada-USA	0.00278** ( 0.000568)
Exchange Rate-Canada-France	-0.000673 (0.000641)
Dummy_ Western Grain Transportation Act	-0.000276 (0.000405)
Dummy_ Decoupled Agricultural Policy	0.000881** (0.00040)
Dummy_ National Tri-Partite Stabilization Program	0.000492** (0.000248)
Dummy_BSE	0.00022 (0.000323)
Constant	-0.000333 (0.000423)
Box-Cox Parameter ( $\hat{\lambda}$ )	5.000
R <sup>2</sup> -Adjusted	0.778
F -Value	16.538**
Number of Observations	41
Durbin-Watson Statistic	1.8890
Autocorrelation: R <sup>2</sup>	0.1483
F-Statistics	0.406
Jarque-Bera Normality Test –Chi-Squared (2df)	1.500
P-Value:	(0.472)

Note: The figures in the parentheses are standard errors. The symbols \*\*, \* indicate statistical significance at 5 percent and 10 percent levels respectively.

Table 8. Drivers of Normalized Revealed Comparative Advantage of Pork in Canada	
Factor	Estimated Coefficient
Relative Cost of Feed	-0.000395 (0.00291)
Relative Cost of Energy	0.00261 (0.00157)
Relative Cost of Hired Labour	-0.00223 (0.00138)
Relative Labour Cost of Meat Processing	-0.00429** (0.00129)
Exchange Rate-Canada-USA	-0.02484** (0.0083)
Exchange Rate-Canada-EU	0.0126** (0.00504)
Exchange Rate-Canada-China	-0.002309 (0.001587)
Dummy_ Western Grain Transportation Act	0.000591 ( 0.00269)
Dummy_ Decoupled Agricultural Policy	-0.000322 (0.001956)
Dummy_ National Tri-Partite Stabilization Program	0.000793 (0.002745)
Dummy_ NAFTA	0.001977 (0.002891)
Constant	-0.000174 (0.00256)
Box-Cox Parameter ( $\hat{\lambda}$ )	1.17
R <sup>2</sup> -Adjusted	0.475
F-Value	4.291**
Number of Observations	41
Durbin-Watson Statistic	1.121
Autocorrelation: R <sup>2</sup>	0.033
F-Statistics	0.930
Jarque-Bera Normality Test –Chi-Squared (2df)	0.019
P-Value	0.991

Note: The figures in the parentheses are standard errors. The symbol \*\* indicates statistical significance at 5 percent level of error probability.

## DATA APPENDIX

The purpose of this appendix is to provide additional details on data used in the computation of the Normalized Revealed Comparative Advantage for the selected sectors. It also describes how we constructed the explanatory variables used in our regression analysis to determine the drivers of competitiveness and the sources of these data.

To compute the BRCA and the NRCA indices for beef, pork and wheat sectors in Canada, annual data on exports of wheat, pork and beef and on total agricultural exports from Canada, United States and the whole world from 1961 to 2009 were obtained from FAOSTAT database. Data were obtained in the form of both quantity (in tonnes) and value (in 1000 US \$) of exports. Annual data on exports of wheat, pork, beef and on total agricultural exports from Canada, United States and the world from 2000 to 2011 were obtained from Global Trade Atlas database. The data sets collected from the two sources were then compared for reliability and similarity. Since the average difference between the data from the two sources were about 5 percent, the export data for 2010 and 2011 from Global Trade Atlas were used to complete the data set used in this study.

### **Canadian Data: Wheat Input Prices**

Since provinces in Western Canada (Manitoba, Saskatchewan, Alberta and British Columbia) accounted for more than 80% of total wheat production in Canada during the study period, we employed average input prices for wheat production in Western Canada in this study (CANSIM- Wheat Production data).

Major wheat input costs were identified as cost of fertilizer, seed, energy and hired farm labour (Ali and Vocke, 2009) and the annual data for the respective input costs and the total acreage for the period 1971-2011 (except for fertilizer cost: 1971-1985) were obtained from the CANSIM database.

Annual Western Canada input price indices for fertilizer, seeds, energy and hired labour from 1971-2007 and quarterly data on Western Canada Farm Input Price Index (FIPI) related to crop production for the period from 1971 to 2011 were obtained from CANSIM data base. The quarterly FIPI data were converted to yearly data. The input costs per acre were converted to real dollars by using the FIPI. Missing fertilizer cost data for the period 1996-2011 were obtained as follows: fertilizer cost per acre data (1971-1995) were regressed on fertilizer price index for the same period through the origin and the resulting coefficient was used to generate the missing fertilizer costs per acre.

#### **Canadian Data: Beef Input Prices:**

The annual data for total operating expenses of beef, cattle ranching, including feedlots were obtained from CANSIM for Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia for the period from 1993-2011.

The annual data on total feed cost, hired labour cost and energy cost were obtained from CANSIM for the period 1971-2011. The total operating expenses for beef, cattle ranching, including feedlots from 1993-2011 were used to obtain the feed cost, hired labour cost and energy cost for beef operations. The following method has been used to generate a complete data set of beef input costs:

- 1) The annual data on total farm expenses were obtained from the CANSIM for the period from 1971-2011. The yearly data (1993-2010) on total operating expenses were divided by the respective year's total farm expenses to compute total operating expenses as a share of total farm expenses. The average of these operating expenses share values was obtained to generate the missing values of total operating expenses from 1971 to 1992 using total farm expenses.
- 2) The yearly data (1993-2010) on total operating expenses of beef, cattle ranching, including feedlots were divided by the respective years detailed operating expenses value to compute total operating expenses of Beef, Cattle ranching, including feedlots as a share of detailed operating expenses. The average of these operating expenses share values was obtained to generate the missing values of total operating expenses of beef, cattle ranching, including feedlots from 1971 to 1992 using total detailed farm operating expenses. Then the yearly data (1971-2011) on beef farm operating expenses were divided by the total detailed farm operating expenses (1971-2011) to obtain the share of beef farm operating expenses.
- 3) The yearly data on total feed expenses (1971-2011) and the yearly values of share of beef farm operating expenses computed in step (2) were used to generate the total feed expenses for beef.
- 4) Above procedure was used to obtain the complete data set of total energy cost and total hired labour cost for beef.

Total number of beef cattle in Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia during the period from 1971-2011 were obtained from CANSIM to compute input cost per beef cattle. All cost data were then converted to their real values using the Farm Input Price Index. Then we used the US-Canada exchange rate to convert the costs in Canadian dollars to US dollars.

### **Canadian Data: Pork Input Prices:**

The total operating expenses of hog and pig farming were obtained from CANSIM for Quebec, Ontario, Prairie Provinces, British Columbia for the period from 1993 to 2010.

The annual feed cost data were obtained from CANSIM (Feed, supplement, straw and bedding expenses on hog and pig farming) for the period 2001-2011. The hired labour cost data were obtained from CANSIM (expenses on salaries on hog and pig farming) for the period 2001-2011. The total operating expenses of hog and pig farming (from 1993 to 2011) were used to generate the missing data for feed cost and hired labour cost for the period 1993-2000. The following method has been used to compute the missing values of input cost data for the hog sector:

- 1) The cost shares for relevant cost items were computed for each year and the average cost share for each cost item was used along with the total operating expenses data from 1993-2000 to generate the missing cost data for the hog sector.
- 2) The annual total farm cash receipts data for the hog sector were obtained from CANSIM for the period from 1971-2011. The yearly data (1993-2010) on total operating cost of hog and pig farming were divided by the respective years total

farm cash receipt's value to compute total operating cost as a share of total farm cash receipts. The average of these cost share values was obtained to generate the missing values of total operating costs from 1971 to 2000 using total farm cash receipts.

- 3) The average cost share values computed in step (1) and the total operating cost data computed in step (2) were used to generate the missing values of feed and hired labour costs from 1971 to 2000.

The energy cost data for the period from 1971-2011 were obtained by taking 2.7% of Total operating Expenses (Coulibaly, 2009). Total number of hogs in hog operations in Western Canada from 1971 to 2011 were obtained from CANSIM to compute the yearly input cost per hog. Then cost/hog were converted to cost per kg wt gain following Caoulibaly (2009). All cost data were converted to real values using the FIPI. Finally, all cost data were converted to US \$ using the exchange rate between Canada and US obtained from the USDA.

#### **Canada-Meat processing labour cost:**

The yearly indices of average hourly earnings for meat product manufacturing from 1983 to 2011 were obtained from CANSIM. Also the data on average hourly earnings on slaughtering and meat processing (1970-1983) and the data for average hourly earnings in meat product manufacturing (1991-2011) were obtained from CANSIM. The two data sets were merged together after verifying the trends and reliability to generate this variable. Missing data for the period 1984-1990 were obtained as follows: average hourly earnings

in slaughtering and meat processing (1991-2012) were regressed on the indices of average hourly earnings for the meat product manufacturing sector for the same period and the estimated coefficients were used to generate the missing values of average hourly earnings in slaughtering and meat processing.

### **Exchange Rates:**

USA, Argentina, France and Australia were identified as the major exporters of wheat to be included in the RCA-Wheat-Canada Model, (Global Trade Atlas data 2000-2011).

For the RCA-Beef-Canada Model, USA, Brazil, France and Australia were identified as the major exporters of Beef (Global Trade Atlas data 2000-2011).

For RCA-Pork-Canada Model USA, Brazil, European Union (EU) and China were identified as the major exporters of Pork (Global Trade Atlas data 2000-2011).

The real annual country exchange rates for Canada, Brazil, Argentina, Australia, China, France and EU (local currency per \$US) for the period 1971-2011 were obtained from USDA.

### **USA Data: Wheat Input Prices**

Major wheat input costs were identified as cost on fertilizer, seed, energy and hired farm labour (Ali and Vocke, 2009).

Yearly data on wheat input costs for years 1975-2010 were obtained from USDA Economic Research Service Commodity Costs and Returns database for the USA Great

Plains Region. These input costs were measured in terms of dollars per planted acre. The missing data for 1971-1974 and 2011 were obtained as follows:

1. The data on index for price paid for the farm sector was used to convert the above nominal cost data to real. Also index of price paid for fertilizer, seed, energy and hired farm labour were obtained from NASS-USDA data on Agricultural Prices.
2. Then the missing data for the period 1971-1974 for above input costs were obtained by regressing each input cost data series with the respective index of price paid and by obtaining the relationship between each input cost item and the respective index of price paid.

#### **USA Data: Beef Input Prices:**

Annual data on U.S. cow-calf production cash costs and returns ( for the Great Plain region) for the period 1982-2010 were obtained from USDA Economic Research Service Commodity Costs and Returns database. The input costs were comprised of cost of purchased feed, cost of fuel, lube and electricity, cost of hired labour and cost of fed cattle. The input costs of purchased feed, cost of fuel, lube and electricity, cost of hired labour were measured in terms of dollars per bred cow and the cost of fed cattle was measured in terms of dollars per cwt. The missing values for 1971-1981 were obtained through interpolation.

#### **Pork Input Prices:**

Annual data on U.S. hog production cash costs and returns for the period from 1992-2010 were obtained from USDA Economic Research Service Commodity Costs and Returns

database. The input costs were comprised of cost of purchased feed, cost of fuel, lube and electricity and cost of hired labour. These input costs were measured in terms of dollars per cwt weight gain and were converted to dollars per kg weight gain. The missing values for 1971-1991 were obtained through interpolation.

### **USA-Meat Processing Labour Cost:**

The unit labour cost index (1987-2012) and the data (1971-2002) on unit labour cost for nondurable goods manufacturing were obtained from Occupational Employment Statistics (OES) Survey of US Bureau of Labor Statistics. The relationship between above two variables were obtained by performing a regression using the data from 1987-2002. The missing values of unit labour cost index (for 1971-1986) were obtained using the above relationship.

The data on slaughters and meat packers mean hourly wage data from 1997-2011 were obtained from the same data source as above. Missing data for the period 1971-1996 were obtained as follows: Slaughters and meat packers mean hourly wage (1997-2011) were regressed on unit labour cost index for the same period and the resulting relationship was used to generate missing values of slaughters and meat packers mean hourly wage.