Tingting Wu, PhD
Assistant Professor
The Department of Finance
John Molson School of business
Concordia University
1455 de Maisonneuve Blvd. W. Montreal
Quebec H3G 1M8
Canada

October 17, 2019

Professor Mark L. Waller
Professor and Acting Department Head
Department of Agricultural Economics
Texas A&M University
2124 TAMU, College Station
Texas 77843-2124

Subject: Application for the Assistant Professor - Agricultural Marketing & Quantitative Analysis

Dear Professor Waller,

I am writing to apply for the Assistant Professor position at the Department of Agricultural Economics. I finished my PhD study in agricultural economics at McGill University in summer 2018, since then I have been working as an assistant professor at the Department of Finance, Concordia University. My strengths are in both research and teaching, my international perspective and experiences, my interpersonal skills, and focus and perseverance. These strengths make me well suited to the position advertised. I will be attending the AEA Annual meeting in January. I would appreciate an opportunity to meet you or other members of your faculty at that time, so that we could have the opportunity to assess the extent that I fit this position.

My research interests include the impact of government policies on economic development, such as agricultural production, and food markets. I am also interested in inter-disciplinary research between agricultural economics and corporate finance. I am familiar with CGE modeling and econometric analysis, and used these methods in my research studies. My job market paper investigated the impact of a carbon tax on food prices and food consumption patterns in Canada. In this study, I developed a multi-regional price model to incorporate spatial dimensions in the analysis so that the impact of a carbon tax can be analyzed at the provincial level rather than just at the national level. Also, I applied the Almost Ideal Demand Systems model to analyze the price elasticities of food in Canada. I showed that the carbon tax has a negative impact on food prices, and would decrease the level of food consumption for households. In addition, households with different levels of income are affected similarly by the carbon tax. Two of my other research papers evaluate the impact of renewable energy sources on economy and environment. In addition, I am also interested in research on international economics. One of my research papers investigates the factor intensities of Canadian international trade, and studies the greenhouse gas emissions intensity associated with Canadian imports and exports. With my solid background in interdisciplinary research, in economics, agriculture, and environment, I want to apply my knowledge to more empirical research projects, to promote the development of agriculture, and sustainability. In addition, I have been involved in other research projects, you will find the descriptions of other research projects in my curriculum vitae.

When I was a student, I started to publish my research work in peer reviewed journals. Currently I have published two research papers. I also have two working papers, which are in preparation, and I will submit them before the end of this year. In addition, I have presented all my research work in highly competitive conferences, including the Annual AAEA (Agricultural&Applied Economics Association) meeting, International Association of Agricultural Economists (IAAE) conference, the CEA (Canadian Economic Association) meeting, etc. For both the IAAE and CEA meetings, I was awarded scholarship for attending the meetings. With these experience, I have learned a lot from colleagues all over the world. In addition, these experience also honed my grant writing, interpersonal, and presentation skills.

Over the past one year, I have learned a lot as a professor. I also find myself really enjoy teaching. As a new professor, I am always looking for ways to improve my teaching and to update my knowledge. My efforts include sufficient preparation before classes, consulting teaching specialists for advices, constantly seeking for student feedbacks, and doing research, etc. Also,I fully understand the challenges and opportunities students with different backgrounds face during their studies. I always keep in mind the diversity of our students while designing the curriculum. My goal is to cultivate an inclusive climate in class, so all of the students, with different backgrounds, could benefit from my lecture. I am also continuously looking for the best methods to deliver my class effectively. I am familiar with up-to-date technologies for lecturing, at the same time I also use standard lecturing methods such as writing on blackboard, especially when I want to demonstrate the drawing of economic graphs to my students. I always keep in mind that my goal is to deliver the class as clear as possible. For instance, when teaching the Analysis of Markets course, I distributed lecture notes to students before the class, so the students could focus more on my lecture, and I could spend more time on topics that are hard to understand and less intuitive. I am open to suggestions, so I could help the students better. Therefore, I constantly seek for students feedback throughout the semester. I also reflect on my teaching after each class, and try to improve the next time. With all these efforts, I find myself to handle big classes well, and can deliver the class effectively. My efforts and improvements are also reflected on the improvement of my course evaluations over one year's time. My course evaluation is better than the departmental average, even though I have one of the biggest class size in JMSB. Last but not the least, education is not only about helping students to learn textbook knowledge, university is also a place for the students to hone their skills, to establish good values and disciplines, and to be ready for their lives after graduation. As a professor, we could influence our students by showing these qualities. Small acts like remembering their names to show respects, and trying to create an inclusive environment in the classroom could all make the difference. Being a professor comes with a lot of responsibilities, and I am trying to do as much as I can to have a positive influence on my students.In sum, I am really passionate about teaching and I will alway try to improve myself. I am confident that with my specialty and devotion, I will do well as a professor and will also contribute to your universityś teaching capacity.

Furthermore, my experience collaborating with scientists from different disciplines internationally has broadened my horizon. For instance, I have worked with animal scientists on a project to promote a local beef brand in China. My role is to provide suggestions on marketing strategies. I have learned a lot about dairy science and beef production system from my colleagues. I also worked with environmental scientists to design suitable farm operations to reduce the environmental impact from overgrazing and to improve herdersĺivelihood in western China. Having worked at JMSB for more than a year, I have collaborate with professors in the business school on projects in corporate finance. With these collaboration works, I witnessed and am convinced that the interdisciplinary research could make a difference in the real world. This is also one of the main reasons that I am passionate about research and want to contribute more to research. I would also like to utilize my connections with other universities, especially in China and Canada, to expand our department's academic collaborations with these universities. My teaching experience at universities in both Canada and China also trained me to adjust my teaching style to suit needs of students with different background.

I am passionate about research and teaching, and want to continue my career as a professor. At the moment, my position at JMSB is 100% teaching. My interest is to do both the teaching and research. More importantly, my long term goal is to bring my global, interdisciplinary, and comprehensive perspective about economics and science in general into my research, so that I could contribute to address critical issues in our society. Therefore, all of the above factors make me eager to apply for the Assistant Professor appointment in the Department of Agricultural Economics, Texas A&M University.

Please find my application package attached, which includes the letter of application, my CV, the evidence of teaching effectiveness (including my course evaluation and the course outline), my transcript, and my research papers. Thank you very much for taking the time to review my application. If I can provide any additional information, please feel free to contact me at 514-816-5857 or tingting.wu@concordia.ca. I look forward to hearing from you.

Sincerely yours,

Tingting Wu

Tingting (Tina) Wu

The Department of Finance
John Molson School of Business
Concordia University
1455 de Maisonneuve Blvd. W. Montreal
Tel: (514)816-5857, Email: tingting.wu@concordia.ca

Employment

- **Assistant Professor**, Department of Finance, John Molson School of Business, Concordia University, Canada. August 2018 - Present

Education

- **Ph.D. in Agricultural Economics**, McGill University, Canada. May 2018
  PhD Dissertation: Essays on the evaluation of the impact of GHG emissions mitigation strategies on environment and economic development in Canada
- **MSc. in Agricultural Economics**, McGill University, Canada. August 2011
  MSc. Thesis: An Investigation of the Leontief Paradox using Canadian Agriculture and Food Trade: An Input-Output Approach
- **B.A. in Economics**, Univ. International Business and Economics, China July 2008

Areas of Interest

- **Research**: Agricultural Economics; International Trade; Environmental Economics; Finance; Policy Analysis.
- **Teaching**: Economics, Quantitative Methods, Market Analysis, Finance, Policy.

Published Papers

- Wu, T., K. Mukhopadhyay, and P. J. Thomassin (2016). "A Life-Cycle Analysis of Wood Pellets for Greenhouse Production at Macdonald Campus of McGill University, A Case Study." *AIMS Energy*, 4(5): 697-722.
- Wu, T., K. Mukhopadhyay, and P. J. Thomassin (2017). "Using H-O-V theorem to predict the factor intensities in Canadian agricultural trade." *The International Journal of Applied Economics*, 14(1), March 2017: 45-64.

Working Papers

- "The Impact of Carbon Taxes on Food Prices and Food Consumption Patterns based on Provincial Plans in Canada -using a multi-regional model"
- "An Analysis of the Impact of the National Carbon Tax Plans on Food Prices and Food Consumption Patterns in Canada"
  Presented at the *30th International Conference of Agricultural Economists & 2018 AAEA Annual Meeting*, 2018
- "An Economic and Environmental Impact Assessment of Wood Pellets for Greenhouse Vegetable Production in Canada."
  Presented at the *48th Annual Conference of the CEA*, 2014

Other Research

- "Agricultural land planning and habitat protection for endangered bobolink in Montreal." (Funded by City of Montreal in 2016, Grant: $20,000)
- "Understanding the food consumption trends and nutrition security from Canadian households." (Funded by Agricultural and Agri-Food Canada in 2015, Grant: $25,000)

Conference Presentations

- 2018 AAEA Annual Meeting. August 5-August 7, 2018, Washington, D.C., USA. (Poster)
- The 30th International Conference of Agricultural Economists. July 28-August 2, 2018, Vancouver, Canada. (Oral presentation)
- The 48th Annual Conference of the CEA. May 29-June 1, 2014, Vancouver, Canada. (Oral presentation)
- The 59th Annual North American Meetings of the Regional Science Association International. Nov. 4th-6th, 2012, Ottawa, Canada. (Oral presentation)
- The 20th International Input-Output Conference. June24-29, 2012. Bratislava, Slovakia. (Oral presentation)

Teaching Experience

- **Assistant Professor**, Concordia University, Canada
  Fall 2019: Analysis of Markets (COMM220), TWO sections; Average Class size: 118;
  Summer 2019: Analysis of Markets (COMM220) TWO sections; Average Class size: 130;
  Winter 2019: Analysis of Markets (COMM220) THREE sections; Average Class size: 118;
  Fall 2018: Analysis of Markets (COMM220) TWO sections; Average Class size: 118.

- **Teaching Assistant**, McGill University, Canada
  AGEC200: Principles of Microeconomics (Fall, 2009,2011, 2012, 2013, 2014, 2015)
  ECON219: Current Economic Problems: Topics (Winter 2015)
  AEMA310: Statistical Methods (Fall 2014)
  ECON313: Economic Development 1 (Winter 2011)
  My responsibility was to lecture review sessions and conference every week (about one hour per session), teach regular classes, and grade assignments and exam papers. (Size of the classes: ranging from 100 to 300 students)

Awards and Recognitions

- International Graduate Fellowship ($15,000/year, selectivity: top 1%) (2008-Present)
- Rossinger Fellowship ($15,000/year, selectivity: top 1%) (2011-Present)
- Graduate Excellence Fellowship ($6,000/year, selectivity: 10%) (2011-Present)
- CEA annual meeting travel award for students (2014)
- Sir Vincent Meredith Fellowship ($15,000/year, selectivity: top 1%) (2008-2010)
- Provost Graduate Scholarship ($5,000, selectivity: top 10%) (2008-2010)
- Principal's Graduate Fellowship ($2,500, selectivity: top 10%) (Sept.2008)
- Outstanding Student Scholarship (selectivity: 5%) (2005-2008)
- Best English Tutor (selectivity: top 1%) (2006-2008)

Fieldwork Experience and Internships

- **Consultant: Business development and farm management** Jan.2013-Present
  Efficient Animal Nutrition and Consulting Company, Lanzhou, China
  - Promoted company products at major agricultural exhibitions internationally, e.g. World Dairy Expo.
- **Researcher: International trade and financial crisis** June-Sept.2010
  United Nations-Headquarters, New York, USA
  - Investigated changes in patterns of international trade during the financial crisis in 2008-2010.
- **Experiment Instructor** Dec.2008-Jan.2009
  Center for Interuniversity Research and Analysis Organizations ((CIRANO), Montreal, Canada
  - Designed economic experiments to understand the willingness to pay by farmers to control non-point source pollution.
- **Financial Analyst** June-Aug.2007
  Gansu Hualong Investment Company, Lanzhou, China

Languages

- English (Fluent)
- Chinese (Native)
- French (Beginner)
- Spanish (Beginner)

References

Dr. Paul J. Thomassin (Chair)
Associate Professor of Agricultural Economics
Department of Agricultural Economics
McGill University
Research Fellow, Center for Interuniversity Research and Analysis of Organizations (CIRANO)
Director, McGill Centre for the Convergence of Health and Economics
Phone: (514) 398 7956
Email: paul.thomassin@mcgill.ca

Dr. Robert D. Cairns
Professor of Economics
Department of Economics
McGill University
Phone: (514) 398 1075
Email: robert.cairns@mcgill.ca

Dr. Rahul Ravi
Associate Professor and Chair
Department of Finance
Director, Goodman Program in Investment Management
John Molson School of Business Concordia University
Phone: (514)848 2424 Ext. 2961, Ext. 2107
Email: rahul.ravi@concordia.ca

Dr. Anwar Naseem
Associate Research Professor of Agricultural Economics
Department of Agricultural, Food, and Resource Economics
Rutgers University
Phone: (848) 932 9125
Email: anwar.naseem@rutgers.edu

Paper Abstracts

- **The Impact of a Carbon Tax on Food Price and Consumption Patterns in Canada** (*Job market paper*)
  This study analyzed the impact of a carbon tax on food prices and consumption patterns in Canada. The findings suggest that a carbon tax has negative impacts on both food prices and food consumption patterns in Canada. The magnitude of the impact depends on whether agriculture sectors are exempt from the carbon tax. When these sectors are exempt, the negative impacts of a carbon tax on food prices and food consumption patterns are small. A multi-regional price model was constructed to analyze the impact of the carbon tax by region. Specifically, this study compared the changes in food prices and food consumption patterns among different provinces in Canada. The results show that food prices in Quebec are the most affected, followed by Alberta. In addition, there is no evidence that the impact of a carbon tax on the food consumption patterns would vary by income group. These results shed light on the impact of carbon taxes on food security and affordability in Canada.

- **A Life Cycle Inventory Analysis of Wood Pellets For Greenhouse Heating: A Case Study at Macdonald Campus of McGill University** (with Mukhopadhyay, and P. J. Thomassin) *AIMS Energy*, 2016.
  Wood pellets are one of the most promising alternatives to fossil fuels in Canada. Using wood pellets for heating allows saving on heating source expenses as compared to fossil fuels. Moreover, direct carbon emissions from wood pellets are regarded as carbon neutral since regrowth of vegetation captures and stores carbon that already exists in the atmosphere. Using wood pellets as a heating fuel for greenhouse vegetable production is expected to result in less greenhouse gas emissions than fossil fuels. Increasing the domestic consumption of wood pellets for greenhouse heating in Canada would reduce the environmental impact of energy consumption. This study investigated the potential of using wood pellets as an alternative fuel for commercial greenhouses in Quebec. This study applied a life-cycle analysis to demonstrate the energy flows and environmental consequences of using wood pellets for greenhouse vegetable production. The results suggest that greenhouse gas emissions from wood pellets are lower than natural gas in greenhouse operations.

- **An Economic and Environmental Impact Assessment of Wood Pellets for Greenhouse Vegetable Production in Canada** Presented at the Annual North American Meetings of the Regional Science Association International
  Climate change impedes country's abilities to achieve sustainable development. With risks resulted from climate change, all countries are expected to enforce measures to reduce greenhouse gas emissions. At the Paris climate conference, Canada has pledged its target to cut the greenhouse gas emissions by 30% from the 2005 level by 2030. One effective way to avoid the volatile fossil fuel market and to meet the environmental target is to adopt renewable energy based technologies. In Canada, wood pellet is one of the most promising alternative energy source, given Canada's comparative advantage in the international wood pellet market and wood pellets' environmental advantages over fossil fuels. This study proposed to implement wood pellets as the heating fuel for greenhouse vegetable production in Canada, where conventionally fossil fuels are used. In Canada, greenhouse accounts for 3% of the total agriculture production in Canada. The value of greenhouse production has been steadily increasing, and reached $1.28 billion in 2014. The high dependence on fossil fuels in status quo not only exposes the greenhouse industry to increased risks due to price volatility, it also results in increased greenhouse gas emissions. This study investigated the changes in the economic and environmental impacts resulted from the adoption of wood pellets technology for greenhouse vegetable productions in Canada. The

Canadian Input-Output model was modified and applied to estimate the changes in industrial output, GDP, employment, and GHG emissions from status quo. Results suggest that wood pellets for greenhouse heating would increase the total industrial output while reducing GHG emissions. These results provide quantifiable scientific basis for Canadian government to implement policies to promote renewable energy in agricultural sectors, which in turn would result in a win-win solution in terms of economic and environmental development.

- **Using H-O-V Theorem to Predict the Factor Intensities in Canadian Agricultural Trade** (with Mukhopadhyay, and P. J. Thomassin) *The International Journal of Applied Economics* , 2017. Presented at The 20th International Input-Output Conference
  Canada is an open economy that relies heavily on international trade, which contributes approximately 30% to GDP. More specifically, Canada is one of the world largest suppliers of agricultural products. The current study investigated factor intensities and greenhouse gas emissions intensity from Canadian agriculture and processed food trade. Capital, labor, and land were included as production factors. Contrary to Leontief's finding for the US trade, it is revealed that Canada's exports were relatively capital-intensive as compared to its imports. GHG emissions from exports were higher than imports, coinciding with previous findings. Moreover, land, representing natural resources, was found to be relatively more intensive in exports as compared to the capital intensity in exports. This finding also reaffirms the assumption of natural resources as being a determinant factor in the structure of Canadian agricultural and processed food trade.

Tingting Wu Application
Assistant Professor, Agriculture Economics Department,
Texas A&M University
Supplementary Addendum

Dr. Wu's application materials present a strong picture of her international involvement and perspective during her formal graduate education. However, she has been involved in international economic endeavors for much of her life that were omitted because the focus of her application was in terms of post-baccalaureate academic credentials. Therefore, the following list of international activities complement those in her application providing a more complete discription of Dr. Wu's considerable lifelong involvement in international economic initiatives.

1. Participation in cultural exchanges between China and European countries including Germany, France, and Norway.

2. Involvement in:

    a. World Bank financed "Rural Development Project" in northwestern China.

    b. Participation in an ACIAR project for "Sustainable Grassland Management" in northwest region's pasture area in 2004 and 2006.

    For both projects, her role was:
    1) Facilitation of household surveys
    2) Aid in identification of variables important ro grassland management in the regions.
    3) Support in model development for feed balance and precision livestock management.

3. Undergraduate program from the premier business school in China emphasized international trade and economics.

4. Participated in tours of agriculture research institutes and food production stations in Australia for three years during her undergraduate training.

5. Supported development of presentations introducing China livestock industries and natural resource management to the Australian agricultural community.

6. Business management consultation for dairy farms in Gansu province

7. Education of sales teams for Ralco Nutrition products in China.

8. Assistance in development of business plan for Ruikeyisheng Animal Nutr. LLC in China.

McGill UNIVERSITY

INCLUDING / Y COMPRIS
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MONTRÉAL, CANADA

DATE OF BIRTH / DATE DE NAISSANCE: **Aug 16**

STUDENT No / No MATRICULE: **260313391**

REFERENCE / RÉFÉRENCE:

DATE ISSUED / DATE D'ÉMISSION: **2019/10/11**

STUDENT NAME / NOM DE L'ÉTUDIANT

Wu, Tingting

COURSE NUMBER / NUMÉRO DE COURS		TITLE / TITRE	CR / C.E.U / CR / U.E.C	GRADE / NOTE	REMARKS / REMARQUES	EARNED / OBTENUS	CLASS AVG / MOY. DU GROUPE

PREVIOUS EDUCATION
Univ/Coll outside Canada/US
Quebec Univ (incl. McGill)
McGill University - Master of Science 2012
U Intl Business Econ Beijing - Bachelor of Economics 2008

Sir Vincent Meredith Fellowship in Ag.Econ.
Sir Vincent Meredith Fellowship in Ag.Econ.

Fall 2008
Master of Science
Thesis Full-time
Agricultural Economics (Thesis) - Thesis

AGEC	633	Enviro & Natural Resource Econ	3	A-		3
AGEC	690	Seminar	1	B+		1
AGEC	691	M.Sc. Thesis 1	6	P		6
ECON	610	Microeconomic Theory 1	3	A-		3
ECON	624	International Economics	3	B+		3

Advanced Standing

					Att Cr	Earned Cr	GPA Cr	Points
TERM GPA:	3.54	Transfer Credits:	0.00	TERM TOTALS:	16.00	16.00	10.00	35.40
CUM GPA:	3.54	TOTAL CREDITS:	16.00	CUM TOTALS:	16.00	16.00	10.00	35.40

ESLN	590	Writing for Graduate Students	3	A		3

Standing: Satisfactory

Winter 2009
Master of Science
Thesis Full-time
Agricultural Economics (Thesis) - Thesis

AGEC	692	M.Sc. Thesis 2	3	P		3
AGEC	693	M.Sc. Thesis 3	6	P		6
ECON	510	Experimental Economics	3	A-		3
ECON	665	Quantitative Methods	3	B+		3

Advanced Standing

					Att Cr	Earned Cr	GPA Cr	Points
TERM GPA:	3.50	Transfer Credits:	0.00	TERM TOTALS:	15.00	15.00	6.00	21.00
CUM GPA:	3.52	TOTAL CREDITS:	31.00	CUM TOTALS:	31.00	31.00	16.00	56.40

Standing: Satisfactory

Summer 2009
Master of Science
Thesis Continuing
Agricultural Economics (Thesis) - Thesis

Standing: Satisfactory

Fall 2009
Master of Science
Thesis Full-time

TINGTING WU

Gillian Nycum, Registrar

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Agricultural Economics (Thesis) - Thesis							
AGEC	694	M.Sc. Thesis 4	6	P		6	
AGEC	695	M.Sc. Thesis 5	6	P		6	
ECON	620	Macroeconomic Theory 1	3	B		3	

					Att Cr	Earned Cr	GPA Cr	Points
TERM GPA:	3.00	Advanced Standing Transfer Credits:	0.00	TERM TOTALS:	15.00	15.00	3.00	9.00
CUM GPA:	3.44	TOTAL CREDITS:	46.00	CUM TOTALS:	46.00	46.00	19.00	65.40

Standing: Satisfactory

Winter 2010
Master of Science
Thesis Additional Session
Agricultural Economics (Thesis) - Thesis

Standing: Satisfactory

Summer 2010
Master of Science
Thesis Additional Session
Agricultural Economics (Thesis) - Thesis

Standing: Satisfactory

Fall 2010
Master of Science
Thesis Additional Session
Agricultural Economics (Thesis) - Thesis

Standing: Satisfactory

Winter 2011
Master of Science
Thesis Additional Session
Agricultural Economics (Thesis) - Thesis

Standing: Satisfactory

Summer 2011
Master of Science
Thesis Additional Session
Agricultural Economics (Thesis) - Thesis

Standing: Satisfactory

Fall 2011
Doctor of Philosophy
Thesis Full-time
Renewable Resources (Thesis) - Thesis

ECON	662D1 ✧	Econometrics	3	A-		3		

					Att Cr	Earned Cr	GPA Cr	Points
TERM GPA:	3.70	Advanced Standing Transfer Credits:	0.00	TERM TOTALS:	3.00	3.00	3.00	11.10
CUM GPA:	3.70	TOTAL CREDITS:	3.00	CUM TOTALS:	3.00	3.00	3.00	11.10

Gillian Nycum, Registrar

COURSE NUMBER / NUMÉRO DE COURS		TITLE / TITRE	CR / C.E.U / CR / U.E.C	GRADE / NOTE	REMARKS / REMARQUES	EARNED / OBTENUS	CLASS AVG MOY. DU GROUPE

Standing: Satisfactory

Masters Thesis Title
An investigation of the Leontief Paradox using Canadian agriculture and food trade: an input-output approach

Master of Science Granted: February 2012
Agricultural Economics (Thesis) - Thesis

Winter 2012
Doctor of Philosophy
Thesis Full-time
Renewable Resources (Thesis) - Thesis

ECON	611	Microeconomic Theory 2	3	B		3
ECON	662D2 ✧	Econometrics	3	A-		3

					Att Cr	Earned Cr	GPA Cr	Points
		Advanced Standing						
TERM GPA:	3.35	Transfer Credits:	0.00	TERM TOTALS:	6.00	6.00	6.00	20.10
CUM GPA:	3.46	TOTAL CREDITS:	9.00	CUM TOTALS:	9.00	9.00	9.00	31.20

Standing: Satisfactory

Summer 2012
Doctor of Philosophy
Thesis Continuing
Renewable Resources (Thesis) - Thesis

Standing: Satisfactory

Fall 2012
Doctor of Philosophy
Thesis Full-time
Renewable Resources (Thesis) - Thesis

NRSC	701	Ph.D.Comprehensive Examination	0	P		0
NRSC	751	Graduate Seminar 4	0	A-		0
NRSC	753	Graduate Seminar 6	0	A		0

Standing: Satisfactory

Winter 2013
Doctor of Philosophy
Thesis Full-time
Renewable Resources (Thesis) - Thesis

ECON	621	Macroeconomic Theory 2	3	F		

					Att Cr	Earned Cr	GPA Cr	Points
		Advanced Standing						
TERM GPA:	0.00	Transfer Credits:	0.00	TERM TOTALS:	3.00	0.00	3.00	0.00
CUM GPA:	2.60	TOTAL CREDITS:	9.00	CUM TOTALS:	12.00	9.00	12.00	31.20

Standing: Satisfactory

Winter 2013 - Supplemental
Doctor of Philosophy
Thesis Full-time
Renewable Resources (Thesis) - Thesis

ECON	621	Macroeconomic Theory 2	3	B+		3

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Advanced Standing

					Att Cr	Earned Cr	GPA Cr	Points
TERM GPA:	3.30	Transfer Credits:	0.00	TERM TOTALS:	3.00	3.00	3.00	9.90
CUM GPA:	2.74	TOTAL CREDITS:	12.00	CUM TOTALS:	15.00	12.00	15.00	41.10

Standing: Satisfactory

Summer 2013
Doctor of Philosophy
Thesis Continuing
Renewable Resources (Thesis) - Thesis

Standing: Satisfactory

Fall 2013
Doctor of Philosophy
Thesis Full-time
Renewable Resources (Thesis) - Thesis

Standing: Satisfactory

Winter 2014
Doctor of Philosophy
Thesis Full-time
Renewable Resources (Thesis) - Thesis

AGEC	685	Selected Topics in Agric Econ	3	A		3
NRSC	752	Graduate Seminar 5	0	A		0
NRSC	754	Graduate Seminar 7	0	P		0

Advanced Standing

					Att Cr	Earned Cr	GPA Cr	Points
TERM GPA:	4.00	Transfer Credits:	0.00	TERM TOTALS:	3.00	3.00	3.00	12.00
CUM GPA:	2.95	TOTAL CREDITS:	15.00	CUM TOTALS:	18.00	15.00	18.00	53.10

Standing: Satisfactory

Summer 2014
Doctor of Philosophy
Thesis Continuing
Renewable Resources (Thesis) - Thesis

Standing: Satisfactory

Fall 2014
Doctor of Philosophy
Thesis Additional Session
Renewable Resources (Thesis) - Thesis

Standing: Satisfactory

Winter 2015
Doctor of Philosophy
Thesis Additional Session
Renewable Resources (Thesis) - Thesis

ECON	625	Economics of Natural Resources	3	A-		3
ECON	724	International Economics	3	A		3

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Advanced Standing

				Att Cr	Earned Cr	GPA Cr	Points
TERM GPA: 3.85	Transfer Credits: 0.00		TERM TOTALS:	6.00	6.00	6.00	23.10
CUM GPA: 3.17	TOTAL CREDITS: 21.00		CUM TOTALS:	24.00	21.00	24.00	76.20

Standing: Satisfactory

Summer 2015
Doctor of Philosophy
Thesis Additional Session
Renewable Resources (Thesis) - Thesis

Standing: Satisfactory

Fall 2015
Doctor of Philosophy
Thesis Additional Session
Renewable Resources (Thesis) - Thesis

Standing: Satisfactory

Winter 2016
Doctor of Philosophy
Thesis Additional Session
Renewable Resources (Thesis) - Thesis

Standing: Satisfactory

Summer 2016
Doctor of Philosophy
Thesis Additional Session
Renewable Resources (Thesis) - Thesis

Standing: Satisfactory

Fall 2016
Doctor of Philosophy
Thesis Additional Session
Renewable Resources (Thesis) - Thesis

Standing: Satisfactory

Winter 2017
Doctor of Philosophy
Thesis Additional Session
Renewable Resources (Thesis) - Thesis

Standing: Satisfactory

Summer 2017
Doctor of Philosophy
Thesis Additional Session
Renewable Resources (Thesis) - Thesis

Standing: Satisfactory

Gillian Nycum, Registrar

McGill UNIVERSITY

INCLUDING / Y COMPRIS
MACDONALD CAMPUS
MONTRÉAL, CANADA

DATE OF BIRTH: / DATE DE NAISSANCE: **Aug 16**

STUDENT No: / No MATRICULE: **260313391**

REFERENCE: / RÉFÉRENCE:

DATE ISSUED: / DATE D'ÉMISSION: **2019/10/11**

STUDENT NAME / NOM DE L'ÉTUDIANT

Wu, Tingting

COURSE NUMBER / NUMÉRO DE COURS	TITLE / TITRE	CR / C.E.U / CR / U.E.C	GRADE / NOTE	REMARKS / REMARQUES	EARNED / OBTENUS	CLASS AVG MOY. DU GROUPE

Fall 2017
Doctor of Philosophy
Leave of Absence
Renewable Resources (Thesis) - Thesis

Leave of Absence-Grad Studies

Standing: Satisfactory

Winter 2018
Doctor of Philosophy
Thesis Evaluation
Renewable Resources (Thesis) - Thesis

Standing: Subject toTime Limitation

Summer 2018
Doctor of Philosophy
Thesis Evaluation
Renewable Resources (Thesis) - Thesis

Standing: Satisfactory

Doctoral Thesis Title
The evaluation of GHG emissions mitigation strategies
on environment and economic development in Canada

Doctor of Philosophy Granted: October 2018
Renewable Resources (Thesis) - Thesis

END OF TRANSCRIPT

Please do not remit this record to the student. To be considered official, electronic (PDF) transcripts must be received directly from the National Student Clearinghouse.

Gillian Nycum, Registrar

18 October 2019

To whom it may concern:

I am pleased to provide a reference for Tingting Wu. Tingting was a student in my graduate course, Economics of Natural Resources, ECON 625B, in the winter term of 2015. Tingting did very well in my course, obtaining "A-". Her term paper was on a real-options approach to the decision to harvest a forest in a stochastic setting. She has been able to use what she learned for later work on her dissertation and is thinking about incorporating incentives and responses into future work on forests and climate change.

While her work has been mainly in Agricultural Economics (administratively a division of Natural Resource Sciences), she is well prepared in Economics. For a PhD in Ag Econ at McGill, students must satisfy the course requirements in Economics. Consequently, her record shows a full complement of Economics (ECON) courses. She did a good job in her core courses and her record has improved over time.

Tingting has had a variety of work experience in the past ten or so years, reported on her cv. All of it is on practical economic topics. In combination with her academic skills, she is in a good position to do solid economic research in the future.

I recommend Tingting Wu for your position.

Sincerely,

Robert Cairns

Professor, McGill University

Rahul Ravi , Ph.D.
Associate Professor of Finance
John Molson School of Business
Concordia University
MB 12-321
Phone: (514)848-2424 x 2107
Email: rahul.ravi@concordia.ca

October 30, 2019

To Whom It May Concern:

I am writing this letter in support of Dr. Tingting Wu's application for a Faculty Positions in the Department of Agricultural Economics at Texas A&M.

My association with Tinting dates back to fall 2018 when she joined Concordia as an Assistant Professor on a Limited Term Appointment (LTA). Limited term appointments at Concordia are generally for one year at a time and they are renewable twice if the person is performing satisfactorily. After three consecutive years on an LTA contract, the person is obliged to leave Concordia University. Tingting`s first year as LTA Assistant Professor ended May 2019 and her contract has been renewed for another year (ending May 2020).

Tingting was hired mainly to teach courses at the undergraduate level. She has taught Analysis of Markets (COMM 220). This is a managerial economics course and it is a required course for all students enrolled in the John Molson School of Business. The typical class size ranges between 118 to 150 students. Tingting taught five sections of this course during her first year, and another two sections during the summer of 2019. She is currently teaching three sections of the same course. Her recent teaching evaluations rank her among the best instructors in the course and she has either met or exceeded the Department average for the course.

Tingting is a highly motivated instructor, dedicated to her profession and always willing to take new initiatives. As an example, I would like to mention that while Tingting was hired primarily for teaching Comm 220, the Department of finance has assigned her a section of Comm 308 (Introduction to Finance) for teaching during the Winter 2020 (January 2020 to April 2020) term. This assignment was in response to her request for an opportunity to try out a different course outside her comfort zone. We feel confident that she will do a good job in teaching Comm 308.

In addition to teaching, Tingting has kept herself engaged in research. She has two peer-reviewed publications. She has another three working papers, which show good promise and two works in progress. I am sure she will be successful in publishing her working papers in the near future.

In conclusion, I would like to say that it has been a pleasure knowing and working with Tingting for the past year and a half. She is a very hard working individual and a devoted teacher, well respected by her students and her colleagues. I strongly recommend that Dr. Tingting Wu be favorably considered for the position in your department. Please, do not hesitate to contact me in case of any questions.

Sincerely,

Rahul Ravi

Rahul Ravi

Print | Notes | Back

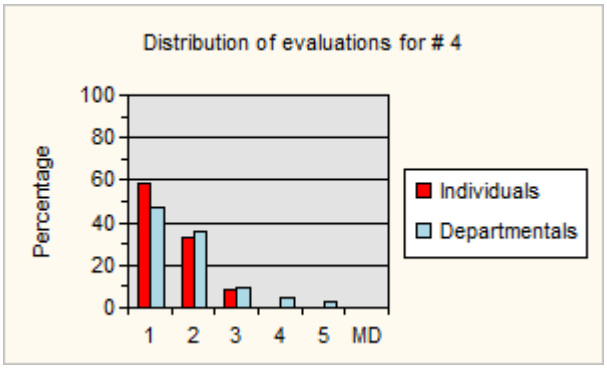
Concordia University Course Evaluation Report

JOHN MOLSON SCHOOL OF BUSINESS

PROF: Tingting Wu **DEPT:** FINANCE **COURSE:** COMM 220 **SECTION:** K **YEAR:** 2018 **TERM:** 4W

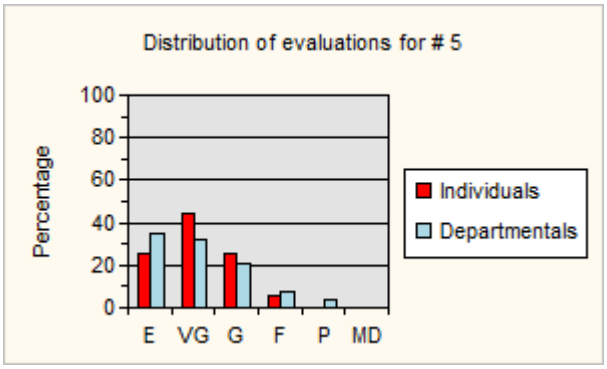
NUMBER OF EVALUATIONS:	1
NUMBER OF STUDENTS:	61
STUDENTS RESPONDING:	36
PERCENTAGE OF STUDENTS RESPONDING:	59.02%

4. Overall, I have learned a great deal in this course.						
Mean for this course:						1.50
Standard Deviation:						0.65
Departmental Mean (current semester):						1.79
Departmental Mean (historical):						1.89
Faculty Mean (current semester):						1.89
Centiles:						
Lowest mean for a course in this department:						1.06
Highest mean for a course in this department:						3.67
Student	**1**	**2**	**3**	**4**	**5**	**MD**
Responses:	21	12	3	0	0	0



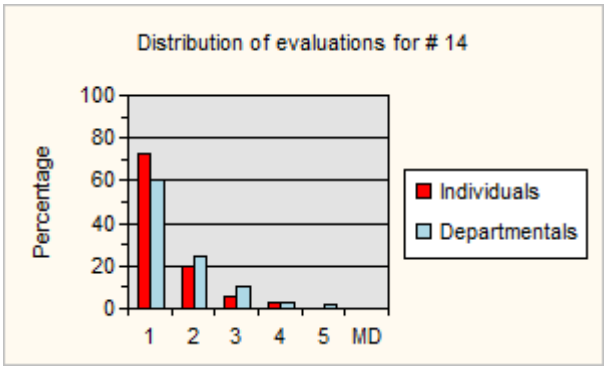
1=Strongly Agree, 2=Agree, 3=Neither agree nor disagree, 4=Disagree, 5=Strongly Disagree, MD=Missing Data

5. Overall, this course is...						
Mean for this course:						2.11
Standard Deviation:						0.85
Departmental Mean (current semester):						2.10
Departmental Mean (historical):						2.20
Faculty Mean (current semester):						2.23
Centiles:						
Lowest mean for a course in this department:						1.23
Highest mean for a course in this department:						4.33
Student	**E**	**VG**	**G**	**F**	**P**	**MD**
Responses:	9	16	9	2	0	0



E=Excellent, VG=Very Good, G=Good, F=Fair, P=Poor, MD=Missing Data

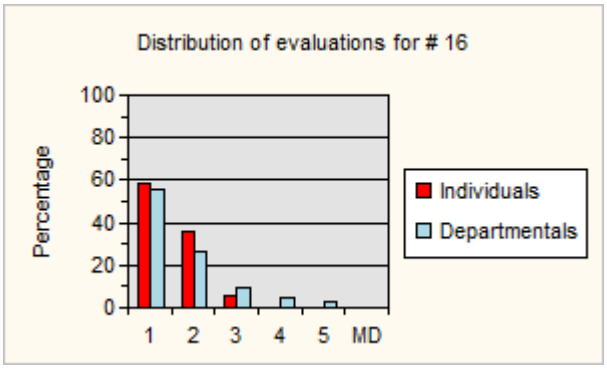
14. The instructor is accessible to students (office hours, after class, voice/e-mail).						
Mean for this course:						1.39
Standard Deviation:						0.73
Departmental Mean (current semester):						1.59
Departmental Mean (historical):						1.78
Faculty Mean (current semester):						1.66
Centiles:						
Lowest mean for a course in this department:						1.00
Highest mean for a course in this department:						3.00
Student	**1**	**2**	**3**	**4**	**5**	**MD**
Responses:	26	7	2	1	0	0



1=Strongly Agree, 2=Agree, 3=Neither agree nor disagree, 4=Disagree, 5=Strongly Disagree, MD=Missing Data

16. Overall, the instructor performed effectively.	
Mean for this course:	1.47

Standard Deviation:						0.61
Departmental Mean (current semester):						1.72
Departmental Mean (historical):						1.84
Faculty Mean (current semester):						1.78
Centiles:						
Lowest mean for a course in this department:						1.00
Highest mean for a course in this department:						3.67
Student	**1**	**2**	**3**	**4**	**5**	**MD**
Responses:	21	13	2	0	0	0



1=Strongly Agree, 2=Agree, 3=Neither agree nor disagree, 4=Disagree, 5=Strongly Disagree, MD=Missing Data

		1	2	3	4	5	MD	Class Mean	Class Std.Dev.	Dept. Semester	Dept. History	Faculty Mean	Centiles	Low Mean	High Mean
1	The course outline/syllabus is clear and complete (e.g., learning objectives, course topics, evaluation method).	25	9	1	1	0	0	1.39	0.69	1.60	1.69	1.71		1.00	3.67
2	The methods used for evaluating student work are fair and appropriate.	21	12	1	2	0	0	1.56	0.81	1.72	1.89	1.88		1.07	2.73
3	The subject matter of this course is something that I consider useful.	21	11	3	1	0	0	1.56	0.77	1.58	1.70	1.72		1.00	2.67
6	The instructor makes the student feel welcome in seeking help in or outside the classroom.	28	7	1	0	0	0	1.25	0.50	1.60	1.77	1.67	<	1.00	3.33
7	The instructor is enthusiastic about teaching the course.	27	8	1	0	0	0	1.28	0.51	1.53	1.68	1.60		1.00	2.69
8	The Instructor covers the scheduled material and/or activities within the allotted time.	20	11	4	1	0	0	1.61	0.80	1.69	1.78	1.69		1.00	3.18
9	The instructor is well prepared for classes.	27	7	2	0	0	0	1.31	0.58	1.57	1.66	1.60		1.00	3.00
10	The instructor demonstrates a thorough knowledge of the subject matter.	27	7	2	0	0	0	1.31	0.58	1.45	1.55	1.52		1.00	2.33
11	The instructor clearly explains the course concepts.	23	8	4	1	0	0	1.53	0.81	1.82	1.97	1.88		1.00	4.00
12	The instructor provides useful feedback on assigned work.	24	8	4	0	0	0	1.44	0.69	1.91	2.13	1.99	<	1.17	3.00
13	The instructor uses instructional methods (lecture, case-based, media, etc.) that are effective.	19	11	5	1	0	0	1.67	0.83	1.81	1.95	1.84		1.00	3.33
15	The instructor creates a learning environment that encourages student participation.	25	10	1	0	0	0	1.33	0.53	1.65	1.81	1.69		1.00	3.67

1=Strongly Agree, 2=Agree, 3=Neither agree nor disagree, 4=Disagree, 5=Strongly Disagree, MD=Missing Data

LEGEND:

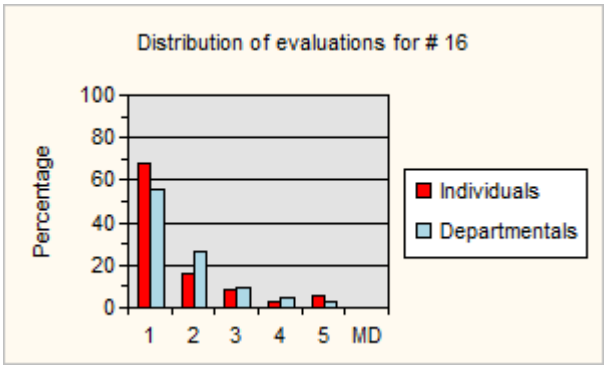
The term 'N/A' stands for 'Not Applicable'
The term 'MD' stands for 'Missing Data'

STATISTICS:

The total number students participating in the evaluations and the total number of classes used in the comparisons for this particular report are listed in the following table:

TOTALS	**DEPARTMENT**		**FACULTY**	
	Current Semester	**All**	**Current Semester**	**All**
# of Classes	44	1709	254	10968
# of Participants	874	43301	4876	283657

Standard Deviation:						1.11
Departmental Mean (current semester):						1.72
Departmental Mean (historical):						1.84
Faculty Mean (current semester):						1.78
Centiles:						
Lowest mean for a course in this department:						1.00
Highest mean for a course in this department:						3.67
Student	**1**	**2**	**3**	**4**	**5**	**MD**
Responses:	25	6	3	1	2	0



1=Strongly Agree, 2=Agree, 3=Neither agree nor disagree, 4=Disagree, 5=Strongly Disagree, MD=Missing Data

		1	2	3	4	5	MD	Class Mean	Class Std.Dev.	Dept. Semester	Dept. History	Faculty Mean	Centiles	Low Mean	High Mean
1	The course outline/syllabus is clear and complete (e.g., learning objectives, course topics, evaluation method).	27	8	0	0	2	0	1.43	0.96	1.60	1.69	1.71		1.00	3.67
2	The methods used for evaluating student work are fair and appropriate.	25	6	1	2	2	1	1.61	1.15	1.72	1.89	1.88		1.07	2.73
3	The subject matter of this course is something that I consider useful.	22	9	3	1	2	0	1.70	1.10	1.58	1.70	1.72		1.00	2.67
6	The instructor makes the student feel welcome in seeking help in or outside the classroom.	28	5	3	0	1	0	1.41	0.86	1.60	1.77	1.67		1.00	3.33
7	The instructor is enthusiastic about teaching the course.	27	5	4	0	1	0	1.46	0.90	1.53	1.68	1.60		1.00	2.69
8	The Instructor covers the scheduled material and/or activities within the allotted time.	19	10	4	1	3	0	1.89	1.22	1.69	1.78	1.69	>	1.00	3.18
9	The instructor is well prepared for classes.	25	7	2	1	2	0	1.59	1.09	1.57	1.66	1.60		1.00	3.00
10	The instructor demonstrates a thorough knowledge of the subject matter.	26	8	2	0	1	0	1.43	0.83	1.45	1.55	1.52		1.00	2.33
11	The instructor clearly explains the course concepts.	22	8	2	3	2	0	1.78	1.21	1.82	1.97	1.88		1.00	4.00
12	The instructor provides useful feedback on assigned work.	25	6	3	1	1	1	1.53	0.97	1.91	2.13	1.99	<	1.17	3.00
13	The instructor uses instructional methods (lecture, case-based, media, etc.) that are effective.	23	8	1	3	2	0	1.73	1.19	1.81	1.95	1.84		1.00	3.33
15	The instructor creates a learning environment that encourages student participation.	26	6	4	0	1	0	1.49	0.90	1.65	1.81	1.69		1.00	3.67

1=Strongly Agree, 2=Agree, 3=Neither agree nor disagree, 4=Disagree, 5=Strongly Disagree, MD=Missing Data

LEGEND:

The term 'N/A' stands for 'Not Applicable'
The term 'MD' stands for 'Missing Data'

STATISTICS:

The total number students participating in the evaluations and the total number of classes used in the comparisons for this particular report are listed in the following table:

TOTALS	**DEPARTMENT**		**FACULTY**	
	Current Semester	**All**	**Current Semester**	**All**
# of Classes	44	1709	254	10968
# of Participants	874	43301	4876	283657

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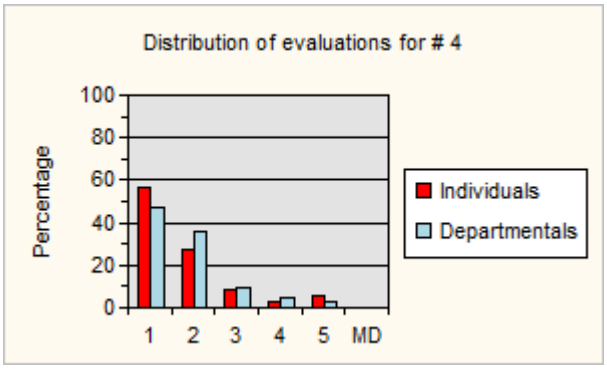
Concordia University Course Evaluation Report

JOHN MOLSON SCHOOL OF BUSINESS

PROF: Tingting Wu **DEPT:** FINANCE **COURSE:** COMM 220 **SECTION:** EE **YEAR:** 2018 **TERM:** 4W

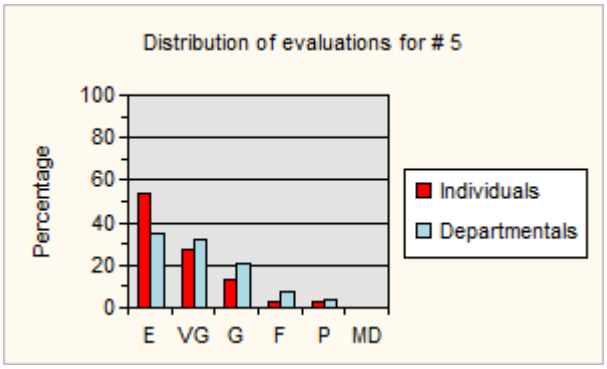
NUMBER OF EVALUATIONS:	1
NUMBER OF STUDENTS:	90
STUDENTS RESPONDING:	37
PERCENTAGE OF STUDENTS RESPONDING:	41.11%

4. Overall, I have learned a great deal in this course.						
Mean for this course:						1.73
Standard Deviation:						1.10
Departmental Mean (current semester):						1.79
Departmental Mean (historical):						1.89
Faculty Mean (current semester):						1.89
Centiles:						
Lowest mean for a course in this department:						1.06
Highest mean for a course in this department:						3.67
Student	**1**	**2**	**3**	**4**	**5**	**MD**
Responses:	21	10	3	1	2	0



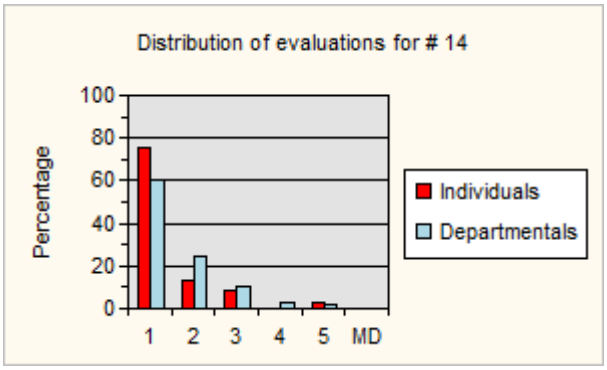
1=Strongly Agree, 2=Agree, 3=Neither agree nor disagree, 4=Disagree, 5=Strongly Disagree, MD=Missing Data

5. Overall, this course is...						
Mean for this course:						1.73
Standard Deviation:						0.99
Departmental Mean (current semester):						2.10
Departmental Mean (historical):						2.20
Faculty Mean (current semester):						2.23
Centiles:						
Lowest mean for a course in this department:						1.23
Highest mean for a course in this department:						4.33
Student	**E**	**VG**	**G**	**F**	**P**	**MD**
Responses:	20	10	5	1	1	0



E=Excellent, VG=Very Good, G=Good, F=Fair, P=Poor, MD=Missing Data

14. The instructor is accessible to students (office hours, after class, voice/e-mail).						
Mean for this course:						1.41
Standard Deviation:						0.86
Departmental Mean (current semester):						1.59
Departmental Mean (historical):						1.78
Faculty Mean (current semester):						1.66
Centiles:						
Lowest mean for a course in this department:						1.00
Highest mean for a course in this department:						3.00
Student	**1**	**2**	**3**	**4**	**5**	**MD**
Responses:	28	5	3	0	1	0



1=Strongly Agree, 2=Agree, 3=Neither agree nor disagree, 4=Disagree, 5=Strongly Disagree, MD=Missing Data

16. Overall, the instructor performed effectively.	
Mean for this course:	1.62

NOTES:

1. Departmental means and percentages have been calculated as the average of all the individual course means and percentages (rather than from the individual responses for the department which would result in large classes unduly influencing the results).
2. The numbers quoted are actual numbers of respondents.
3. Standard Deviation is a measure of the degree to which the responses varied for each question. A smaller value suggests a higher level of agreement among the respondents.
4. The graphical symbols represented as Centiles are decoded as: << (0-10) < (10-30) > (70-90) >> (90-100) in which the number designates the percentile of the class mean in relation to the department.
5. The lowest and highest mean for a course in this department is for the current semester.

- For more detailed information please click on this link: Centre for Teaching & Learning Services (CTLS).
- Scanned version of the Questionnaire Forms are also available at the CTLS website.
- To print this page click here

  Note: *Please use the **"Print Preview"** function in your browser to ensure the full contents will be printed. You may need to change the page setup (in your browser options) or even change the default values for the **margins** in order for the contents to fit within the page. Also, in order to print the charts properly, you need to activate the **"Print background colors and images"** option. The option is accessible via the Advanced tab from the Internet Options in Microsoft Internet Explorer.*

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Send comments and questions to Concordia Help Desk

John Molson School of Business

Department of Finance

COMM 220 - Analysis of Markets

Fall 2019 Section AA

General Information

Class time and location: Wednesday 17:45 – 20:15 in MB 2.270

Course instructor: Tingting Wu

Office location: MB-12.236

Email: tingting.wu@concordia.ca (please write COMM220 at the start of subject line)

Office hours: Wednesday 11:00 –13:00 or by appointment

UNIVERSITÉ Concordia UNIVERSITY

Concordia University John Molson School of Business

Course Description

This course provides a general perspective on the history, operation and relationships between Canadian and international product, labour and financial markets. Specifically, students will be introduced to issues of fundamental importance to today's managers and entrepreneurs such as changes in structure and competitiveness in these markets in response to government policies, the determination and behaviour of interest rates, inflation, market integration, and the role and function of financial intermediation. It further provides students with the knowledge of the role and impact of regulation and other government interventions in these markets.

Prerequisite: COMM 210, 215; ECON 201 or equivalent; ECON 203 or equivalent previously or concurrently.

Learning Objectives

COMM 220 builds upon the pre-requisite micro- and macro-economic courses students have previously taken and develops an integrated conceptual framework for the economic analysis of the relationships between firms, consumers, and the economic environment in which they operate. This course provides the necessary foundations for courses in areas of Finance, Management, Accounting, Marketing, and Entrepreneurship. The course objective is to provide students with an understanding of the key economic concepts used in the analysis of markets as well as the ability to draw upon these in application.

After studying this course students should be able to explain and illustrate

- How a competitive market works and how supply and demand determine the prices and quantities of goods and services.
- The effect of government policies and the resulting impact on consumers and producers.
- What the labour market does and how it works.
- The firm's profit-maximization and cost-minimization processes.
- People's preferences toward risk and the ways that people can compare and choose among risky alternatives.
- The basic function and effects of financial markets and financial intermediaries on the economy.
- How asymmetric information problems interfere with the efficient functioning of financial markets and how government regulation and financial intermediaries can lessen asymmetric information problems.
- The factors that cause interest rates to change.
- The movement of short-term interest rates in the future using the yield curve.
- The elements of international economic integration.
- The gains from trade and the concepts of absolute advantage, comparative advantage, and competitiveness.
- The factors that cause exchange rates to change and the interest rate parity condition.

Required Textbook

COMM 220 Analysis of Markets for Concordia University
Edition: 4
ISBN: 9780136505587
Publisher: Pearson

Course Evaluation

The final grade for the course will be based on the following components:

Two In-Class Tests @10% each		20%
Midterm Exam		30%
Final Exam		50%
	Total	100%

No make-up test or midterm will be allowed. If you are unable to write a test or the midterm for a **valid and documented** reason, you must notify me **before** the test/midterm and provide the documentation (i.e., the **original** of your doctor's note) **within seven days** of the test/midterm and the test/midterm weight will be added to the final exam. **Otherwise, you will receive a zero for the test/midterm.**

The tests/exams are **closed book.** Only **non-programmable calculators** are permitted. All electronic devices (e.g., cell phones, laptops, etc.) must be **turned off** and deposited at the front or rear of the classroom during the test/exam. **A student will need a minimum of 40% in the final exam and an overall minimum of 50% to pass the course. Students cannot write a 100% final.**

Exam	Date	Chapters
In-Class Test 1	Oct 2 (Wednesday)	*1, 2, 3*
Midterm	Oct 20 (Sunday 18:00–20:30)	*1, 2, 3, 4, 5*
In-Class Test 2	Nov 13 (Wednesday)	*6, 7, 8, 9, 10, 11*
Final	To be announced (Dec 5–19)	Cumulative

I collect and keep all the tests/exams. Please email me for an appointment to review your test/exam. If you have questions about the grades, please convey them to me in writing.

Letter Grades and Numerical Scores

Letter	Score	Letter	Score	Letter	Score	Letter	Score
A+	90 – 100	B+	77 – 79	C+	67 – 69	D+	57 – 59
A	85 – 89	B	73 – 76	C	63 – 66	D	53 – 56
A-	80 – 84	B-	70 – 72	C-	60 – 62	D-	50 – 52
FNS	< 50						

* D- is the minimum requirement to pass the course.

Class Schedule

The schedule may change depending on class progress; any changes will be announced in class. You are expected to read the assigned chapter(s) before coming to class.

# of Lectures and Date(s)	Textbook	Topic(s)
0.5 Sep 4	Chapter 1[1]	**Preliminaries** 1.1 The Themes of Microeconomics 1.2 What is a Market? 1.3 Real versus Nominal Prices 1.4 Why Study Microeconomics?
1.5 Sep 4,11	Chapter 2	**The Basics of Supply and Demand** 2.1 Supply and Demand 2.2 The Market Mechanism 2.3 Changes in Market Equilibrium 2.4 Elasticities of Supply and Demand 2.6 Understanding and Predicting the Effects of Changing Market Conditions 2.7 Effects of Government Intervention – Price Controls
1.5 Sep 18,25	Chapter 3	**The Analysis of Competitive Markets** 3.1 Evaluating the Gains and Losses from Government Policies – Consumer and Producer Surplus 3.2 The Efficiency of a Competitive Market 3.3 Minimum Prices 3.4 Price Supports and Production Quotas 3.5 Import Quotas and Tariffs 3.6 The Impact of a Tax or Subsidy
0.5 Sep 25	Chapter 4	**Overview of the Labor Market** • The Labor Market: Definitions, Facts, and Trends • How the Labor Market Works • Applications of the Theory
Oct 2	**Class Test 1**	

[1] Only section 1.3 will be covered in class. However, you are expected to read the entire chapter so that you are familiar with the concepts used in the analysis of markets. If you have trouble with any of the concepts, please feel free to meet me during office hours.

# of Lectures and Date(s)	Textbook	Topic(s)
1.5 Oct 2,9	Chapter 5 Appendix 5A	**The Demand for Labor** • Profit Maximization • The Short-Run Demand for Labor When Both Product and Labor Markets Are Competitive • The Demand for Labor in Competitive Markets When Other Inputs Can be Varied • Policy Application: The Labor Market Effects of Employer Payroll Taxes and Wage Subsidies **Graphical Derivation of a Firm's Labor Demand Curve** • The Production Function • Demand for Labor in the Short Run • Demand for Labor in the Long Run
1 Oct 16	Chapter 6	**Supply of Labor to the Economy: The Decision to Work** • Trends in Labor Force Participation and Hours of Work • A Theory of the Decision to Work • Policy Applications
Oct 20 (Sun)	**Midterm Exam Time: 18:00–20:30 Venue: MB2.270**	
1 Oct 23	Chapter 7	**Uncertainty and Consumer Behavior** 7.1 Describing Risk 7.2 Preferences Toward Risk 7.3 Reducing Risk 7.4 The Demand for Risky Assets
0.5 Oct 30	Chapter 8	**An Overview of the Financial System** • Function of Financial Markets • Structure of Financial Markets • Financial Market Instruments • Internationalization of Financial Markets • Function of Financial Intermediaries: Indirect Finance • Types of Financial Intermediaries • Regulation of the Financial System

# of Lectures and Date(s)	Textbook	Topic(s)
0.5 Oct 30	Chapter 9	**An Economic Analysis of Financial Structure** • Basic Facts about Financial Structure Throughout the World • Transaction Costs • Asymmetric Information: Adverse Selection and Moral Hazard • The Lemons Problem: How Adverse Selection Influences Financial Structure • How Moral Hazard Affects the Choice Between Debt and Equity Contracts • How Moral Hazard Influences Financial Structure in Debt Markets
0.5 Nov 6	Chapter 10	**The Meaning of Interest Rates** • Measuring Interest Rates • The Distinction between Interest Rates and Returns • The Distinction between Real and Nominal Interest Rates
0.5 Nov 6	Chapter 11	**The Behaviour of Interest Rates** • Determinants of Asset Demand • Supply and Demand in the Bond Market • Changes in Equilibrium Interest Rates • Supply and Demand in the Market for Money: The Liquidity Preference Framework • Changes in Equilibrium Interest Rates in the Liquidity Preference Framework • Money and Interest Rates
0.5 Nov 13	Chapter 12	**The Risk and Term Structure of Interest Rates** • Risk Structure of Interest Rates • Term Structure of Interest Rates
Nov 13	**Class Test 2**	
1 Nov 20	Chapter 13 Chapter 14	**An Introduction to the World Economy** • Introduction: International Economic Integration • Elements of International Economic Integration **Comparative Advantage and the Gains from Trade** • Introduction: The Gains from Trade • Comparative Productivity Advantage and the Gains from Trade • Absolute and Comparative Productivity Advantage Contrasted • Gains from Trade with No Absolute Advantage • Comparative Advantage and “Competitiveness” • Economic Restructuring

# of Lectures and Date(s)	Textbook	Topic(s)
1 Nov 27	Chapter 15 Appendix	**Exchange Rates and Exchange Rate Systems** • Introduction: Fixed, Flexible, or In-Between? • Exchange Rates and Currency Trading • The Supply and Demand for Foreign Exchange • The Real Exchange Rate • Alternatives to Flexible Exchange Rates • Choosing the Right Exchange Rate System **The Interest Rate Parity Condition**
Final Exam (Dec 5 – 19)		

Important Dates

Sep 16 (Monday): Deadline for withdrawal from the course with tuition refund (DNE)
Nov 4 (Monday): Last day for academic withdrawal from the course without tuition refund (DISC)

Tutorials

There will be three tutorials each week starting Sep 6, 2019. Any change to the schedule will be posted in the "COMM 220 All Sections" course on Moodle.

Day	Time	Location	1st Tutorial	Last Tutorial
Fridays	12:00–14:00	MB 1.210	Sep 6	Nov 29
Saturdays	12:00–14:00	MB S2.210	Sep 7	Nov 30
Sundays	12:00–14:00	MB S2.210	Sep 8	Dec 1

The tutorials will use material that is not available in the textbook and give review prior to test/exam. Attending tutorials is not mandatory. However, you are strongly encouraged to attend at least one tutorial per week.

Please note that private tutorial companies, some of whom aggressively promote their services on and off campus, are not authorized by Concordia University to distribute flyers on University premises and may not use Concordia University facilities to promote or provide their services.

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Assessment of Learning Objectives

The learning objectives are assessed through class tests, midterm and final examinations.

<table>
<tr><th>Learning Activity / Learning Objective</th><th>Class Tests</th><th>Midterm Exam</th><th>Final Exam</th></tr>
<tr><td>Explain and illustrate how a competitive market works and how supply and demand determine the prices and quantities of goods and services</td><td rowspan="10">Theory and algorithmic-type multiple-choice questions</td><td rowspan="3">Theory and algorithmic-type multiple-choice and exam questions</td><td rowspan="12">Theory and algorithmic-type multiple-choice and exam questions</td></tr>
<tr><td>Explain and illustrate the effect of government policies and the resulting impact on consumers and producers</td></tr>
<tr><td>Explain and illustrate what the labour market does and how it works</td></tr>
<tr><td>Explain and illustrate the firm’s profit-maximization and cost-minimization processes</td><td></td></tr>
<tr><td>Explain and illustrate people’s preferences toward risk and the ways that people can compare and choose among risky alternatives</td><td></td></tr>
<tr><td>Explain the basic function and effects of financial markets and financial intermediaries on the economy</td><td></td></tr>
<tr><td>Explain how asymmetric information problems interfere with the efficient functioning of financial markets and how government regulation and financial intermediaries can lessen asymmetric information problems</td><td></td></tr>
<tr><td>Explain and illustrate the factors that cause interest rates to change</td><td></td></tr>
<tr><td>Explain and illustrate the movement of short-term interest rates in the future using the yield curve</td><td></td><td></td></tr>
<tr><td>Explain the elements of international economic integration</td><td></td><td></td></tr>
<tr><td>Explain and illustrate the gains from trade and the concepts of absolute advantage, comparative advantage, and competitiveness</td><td></td><td></td></tr>
<tr><td>Explain and illustrate the factors that cause exchange rates to change and the interest rate parity condition</td><td></td><td></td></tr>
</table>

Moodle

We will use Moodle to facilitate interaction. To access our Moodle course, open your browser and log in to the MyConcordia Portal using your Concordia netname and password. You will find our Moodle course appear in the My Moodle Courses section. Problems should be directed to help@concordia.ca.

Student Responsibilities

You are strongly advised to attend all the classes. Read the assigned material before coming to class and be prepared to participate in class discussions. Please understand that the class time is very limited and the material to be covered is very extensive; it is impossible to go over or even mention everything in class. Therefore, it is crucial that you read the assigned chapters and do the end-of-chapter problems on your own. If you have any questions, you can come and discuss them with me during office hours. **You are responsible for what is covered in class and any absence on your part leaves you responsible for finding out what was presented in class**.

Classroom Discipline

It is important to observe silence and respect your classmates' right to hear and benefit from what is being said during class. Please turn your cell phones to silent mode and do not use them in class. Laptops are allowed in the classroom provided they are being used to take notes or for other class-related activities. A student who distracts attention of other students by consistently talking in classes will be asked to leave the room. For a second offence, **the penalty will be 15% off her/his final grade for the course**.

Academic Integrity

The Academic Code of Conduct states that "The integrity of University academic life and of the degrees, diplomas and certificates the University confers is dependent upon the honesty and soundness of the instructor-student learning relationship and, in particular, that of the evaluation process. Therefore, for their part, all students are expected to be honest in all of their academic endeavours and relationships with the University." (Academic Code of Conduct, Article 1)

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Students shall not make any recording (audio or video) of a classroom lecture without having obtained the prior written permission from the instructor. Permission to record may be granted to a student at the discretion of the instructor and normally for the sole purpose of accommodating a student's particular needs and only for the purpose of private study. Students who have obtained permission to record a lecture must do so in a manner which ensures the privacy of other students present. Students who have obtained permission to record a lecture shall respect all related intellectual property rights in accordance with applicable laws and the University's *Policy on Copyright Compliance*.

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Support Services

Concordia University offers many on-campus support services that are available to help students achieve academic and personal success.

LIST OF STUDENT SERVICES

1. Undergraduate Academic Advising: JMSB Undergraduate Academic Advising
2. Counselling and Psychological Services: concordia.ca/students/counselling-life-skills
3. Concordia Library Citation and Style Guides: library.concordia.ca/help/howto/citations.html
4. Student Success Centre: concordia.ca/students/success
5. Health Services: concordia.ca/students/health
6. Financial Aid and Awards: concordia.ca/offices/faao
7. HOJO (Off Campus Housing and Job Bank): concordia.ca/students/international/hojo
8. Academic Integrity: concordia.ca/students/academic-integrity

9. Access Centre for Students with Disabilities: concordia.ca/offices/acsd

10. Student Advocacy Office: concordia.ca/offices/advocacy

11. Dean of Students Office: concordia.ca/offices/dean-students

12. International Students Office: concordia.ca/students/international

13. Student Hub: concordia.ca/students

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The Impact of Carbon Tax on Food Prices and Consumption in Canada

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Abstract

This study analyzed the impact of a carbon tax on food prices and consumption patterns in Canada. The findings suggest that a carbon tax has negative impacts on both food prices and food consumption patterns in Canada. The magnitude of the impact depends on whether agriculture sectors are exempt from the carbon tax. When these sectors are exempt, the negative impacts of a carbon tax on food prices and food consumption patterns are small. A multi-regional price model was constructed to analyze the impact of the carbon tax by region. Specifically, this study compared the changes in food prices and food consumption patterns among different provinces in Canada. The results showed that food prices in Quebec are the most affected, followed by Alberta. In addition, there was no evidence that the impact of a carbon tax on the food consumption patterns would vary by income group. These results shed light on the impact of carbon taxes on food security and affordability in Canada.

1. Introduction

Climate change is an example of an externality that results from a market failure. As more concerns are raised about the environment and climate change, GHG emissions mitigation has become one of the focuses for government policy. Setting a price for carbon is believed to be the most cost-effective way to reduce emissions, since it increases the cost of production and therefore changes behavior and drives innovation by encouraging individuals and businesses to switch from fossil fuels and become more energy efficient. Recently the federal government of Canada imposed a carbon tax of $10 per tonne on CO_2e emissions for 2018 and the price will increase to $50 per tonne by 2022. This federal carbon tax will be applied to provinces who do not have a provincial carbon reduction system. In the short term, the government expects that a carbon tax discourages the use of energy sources that emit GHG by increasing the cost of production for sectors that use fossil fuels intensively. In the long run, a carbon tax may promote the development of technologies which reduce GHG emissions.

Agriculture has been classified as a sector that could be exempt from the carbon tax because the goods it produces are essential for life, even though agricultural production is associated with ¼ of global carbon emissions. It is recognized that food security is another major problem, in particular in the developing countries, which may also justify an exemption from the carbon tax. In addition, agriculture is highly subsidized in many countries to maintain the affordability of food. Even though the agriculture sector is exempt from the carbon tax, it may affect the agriculture sector indirectly by adding the social cost of GHG emissions to production. For example, a carbon tax restrains processed industries, such as oil and gas, transportation, manufacturing, etc., which indirectly affect food prices through the supply chain of agricultural products.

In Canada, farmers in Alberta and British Columbia have argued that the carbon tax will impact their production costs and fear that these cost increases will continue as the carbon tax increases. The domestic price of food may also increase, passing the price of carbon from producer to consumers, so that food becomes more expensive and less accessible to lower income families. Maintaining accessibility of nutritious and high quality food to all populations is a task governments strive to accomplish. On one hand, a carbon tax is designed to reduce the carbon footprint generated by human activity in order to avoid catastrophic consequences of climate change. On the other hand, a carbon tax may hinder the ability of the agriculture sector to feed the population through two channels, i.e. less agriculture production due to farmers' exiting the agricultural sector and more expensive food prices that reduce the purchasing power of the Canadian population.

In this study, a price model will be used to estimate the impact of carbon taxes on food prices. Changes in food prices are investigated under both the federal and provincial carbon tax schedules in Canada. For the analysis of the federal carbon tax system, two scenarios are studied, i.e. a carbon tax imposed on all economic sectors and a carbon tax imposed on all but the agriculture and government services sectors. The results indicate that the impact of carbon taxes on food prices is stronger when the tax is executed on all sectors. This is because the carbon tax can directly affect the cost of production of the agriculture sector. While in the scenario where agriculture and government services sectors are exempt from the carbon tax, these sectors can only be affected indirectly by the carbon tax effects on other sectors.

When carbon taxes are applied at the provincial level, their impact on food prices is relatively larger than that of the federal tax plan. This is because the federal carbon tax starts at $10 per tonne of CO_2e emissions, which is lower than all provincial carbon prices. In addition, the inter-

provincial price model adds the spatial dimension to the analysis, allowing us to compare the impact of carbon taxes among provinces. For instance, food prices in Quebec are the most affected, with an increase of 0.62%, followed by Alberta.

To better understand whether carbon taxes affect food consumption patterns in Canada, food price elasticities of demand in Canada were estimated using the almost ideal demand system (AIDS) model. The food price elasticity reflects the change in quantity demanded due to a change in food price. This study found that both the federal and provincial carbon taxes have limited impact on food consumption in Canada. Also, there is no clear evidence that carbon taxes have distributional effects on food consumption patterns for different income groups.

In sum, this study contributes to the literature theoretically and empirically. This study developed a multi-regional price model endogenizing import prices between regions, which provides a more comprehensive result as compared to the original price model. Empirically, by studying the impact of carbon taxes on food prices and food consumption patterns in Canada, this study provides evidence on the effect of carbon taxes on social development. The empirical results will help policy making to design a carbon pricing system that mitigates GHG emissions and minimizes its negative impacts on social development.

The rest of the paper is organized as follows. A literature review in section 2 explains how this paper contributes to the existing literature. Methodology and data sources are elaborated in section 3. Section 4 presents the results and discusses their implications. Section 5 concludes the paper.

2. Literature review

GHG emissions are an example of a negative externality whose social cost is not considered in the private cost of emitters. When there is a negative externality, competitive markets do not lead to the socially optimal level of emissions in the absence of government intervention. Without any controls on GHG emissions, firms continue their production till the point where their private marginal cost equals the marginal benefit. In this case, the costs of GHG emissions is not accounted for. This is an example of a market failure, which can be solved by policy intervention, such as taxes or command and control.

In Canada, carbon taxes are proposed by the federal government to curb GHG emissions, and provinces such as Alberta, British Columbia started their own carbon tax systems even before the federal proposal. The effectiveness of a carbon tax on GHG emissions mitigation is evident empirically. British Columbia introduced North America's first carbon tax in 2008, aiming at reducing its GHG emissions by 33% below 2007 levels by 2020. Since the implementation of the carbon tax, BC's use of petroleum fuels has dropped by more than 15%, and its GHG emissions have shown a similarly substantial decline (Prosperity 2012).

Many studies have shown that carbon taxes are effective in GHG emissions mitigation. For instance, Weitzman (1974) suggested that if the marginal cost of reducing emissions increases quickly and the damages from climate change are relatively insensitive over a short period, then setting a price on GHG emissions becomes an appropriate policy instrument. Several researchers (Hoel and Karp 2002; Newell and Pizer 2003; Karp and Zhang 2005; Quirion 2004) expanded Weitzman's work and consistently found that carbon taxes outperformed the quantity-control policy instruments in terms of efficiency to reduce GHG emissions. There are other theoretical

frameworks that also prove that a carbon tax is the most cost-effective instrument for reducing CO_2 emissions ((Farzin and Tahvonen 1996; Nordhaus 2005; Tol and Yohe 2007).

A carbon tax inevitably has an impact on other aspects of social development, while it is utilized to mitigate GHG emissions. Some studies explore the welfare changes due to carbon taxes. For instance, Wesseh et al. (2017) showed that introducing carbon taxes leads to both welfare and environmental gains in all regions except for low-income countries. Farzin and Tahvonen (1996), and Lu (2010) showed that revenue neutral and distributionally neutral carbon taxes have the potential to reduce negative impacts of a carbon tax on social welfare.

Many researchers evaluate distributional effects of pollution taxes (Poterba 1991; Safirova et al. 2004; Pearson and Smith 1991; Barker and Köhler 1998; Verde and Tol 2009; Hamilton and Cameron 1994; Cornwell and Creedy 1996; Oladosu and Rose 2007; Yusuf and Resosudarmo 2007; Van Heerden et al. 2006; Brännlund and Nordström 2004). For instance, Poterba (1991) was among the earliest to study the distribution effects brought about by a gasoline tax in the US. He concluded that the tax is slightly regressive. In contrast, Safirova et al. (2004) found that road pricing or fuel taxation is strongly regressive in Washington, DC, USA. In both Pearson and Smith (1991) and Barker and Köhler (1998) studies, they found that environment taxes in France, Germany, Italy, Netherlands, and Spain were weakly regressive, while the tax in UK and Ireland were significantly regressive. Hamilton and Cameron (1994) studied the distribution consequences of a carbon tax in Canada using an Input-Output simulation. Their study discovered that the distributional consequences of the carbon tax was moderately regressive. Other researchers found that a revenue-recycling carbon tax system reduces the adverse effect of carbon tax on GDP, and the gap between rich and poor (Oladosu and Rose 2007; Yusuf and Resosudarmo 2007; Van Heerden et al. 2006).

Topics on the impact of carbon taxes on social development also cover households' spending and energy price levels. Labandeira and Labeaga (1999) combined the Input-Output analysis and the micro-simulation to assess the effect of a carbon tax on Spanish households. Their study suggested a limited short-run reaction to a carbon tax, with a significant tax burden. Cansino et al. (2018) looked at the impact of a carbon tax on energy prices, specifically on electricity. They found that a carbon tax rate between 6.25% and 5.52% on electricity would help Spain to reach its total target of GHG emissions reduction in 2020.

The impact of a carbon tax is a well-researched topic internationally. Many of these contributions have focused on evaluating carbon taxes and testing their effects on various aspects including, welfare, economic growth, energy consumption, environment, and renewable energy development. Notable research includes Beauséjour et al. (1992), Hamilton and Cameron (1994), Zhang (1998), Labandeira et al. (2004), Wissema and Dellink (2007; 2010), Robinson (1985), Al-Abdullah (1999), Klimenko et al. (1999), Dinan and Rogers (2002), Tezuka et al. (2002), Wier et al. (2005), Van Heerden et al. (2006), Fullerton and Heutel (2007), Liang et al. (2007), Pettersson (2007), Kerkhof et al. (2008), Shammin and Bullard (2009), Zhang and Li (2011), Liang and Wei (2012), Fang et al. (2013), Dissou and Siddiqui (2014), Liu and Lu (2015). In general, there is mixed evidence of the effects of introducing a carbon tax.

To the authors' knowledge, this study is the first to address the carbon tax effect on food prices and food consumption patterns in Canada. This paper employs both the national and the inter-provincial price models to analyze food price changes due to a carbon tax. The resulting price changes are then combined with food consumption elasticities estimated from the AIDS model to further provide insights on how carbon taxes affect food consumption patterns for different income groups.

This paper also contributes to the current literature theoretically. This is the first study that extends the price model to the inter-provincial level, where provinces are linked through trade. The extended model brings the spatial dimension into the analysis which allows different provinces to have different tax schedules so that price changes due to carbon taxes can vary across regions. The extended model also shed lights on the impact of carbon taxes on consumption patterns by province. This gives an opportunity to better evaluate carbon tax policies and to reach a balance between environmental protection and social development at the provincial level.

3. Methodology and data sources

This paper applies the price model that belongs to the family of cost push models to analyze food price changes due to the implementation of a carbon tax in Canada. This study considers both the federal and provincial carbon tax systems, and therefore requires the applications of both the national and inter-provincial price models. This paper borrowed the methodology from the Statistics Canada price model to build the national price model. With further modification, this paper then constructed the provincial price model. Both price models make use of the same accounting identities and structural parameters as the Input-Output model. This section starts with the introduction Input-Output model.

3.1. The Input-Output model

The Canadian Input-Output is different from the original Input-Output model developed by Leontief (1936) in that the accounting tables of the Canadian version share a rectangular framework where the number of commodities and services exceeds the number of industries. Due to this reason, the Canadian Input-Output model consists of three basic matrices (tables), i.e. Use Matrix(U), Make Matrix(V), and Final Demand Matrix(F). The model is based on the following accounting equations:

$$q = Ui + Fi \quad (1)$$

where q is a vector of total demand for commodities, i.e. intermediate inputs plus final demand by commodity; U is the matrix of intermediate inputs by industrial sectors; F is the Final Demand Matrix, allocating the flow of commodities to final demand categories; i is a column vector whose elements are unity with appropriate row dimensions.

Under the industry-based technology assumption, an input coefficient matrix B can be estimated using this assumption as follows:

$$B = U\hat{g}^{-1} \quad (2)$$

where, g is the vector of the total value of industrial output by industrial sector; "^" indicates a diagonal matrix, and superscript "-1" represents a vector or matrix inverse. The input coefficient matrix is a commodity by industry matrix. Each coefficient is the percentage of that input as a function of the total cost for that sector.

Similarly, the industrial sectors share of the total market for commodities can be represented by a matrix of commodity output proportions, also called the market share matrix, "D". This can be expressed as follows,

$$D = V\hat{q}^{-1} \quad (3)$$

where, V is the Make Matrix, documenting the share of each commodity produced by each industrial sector.

The total demand for commodities and industrial output can therefore be expressed as

$$q = B(\hat{g}i) + Fi = Bg + Fi \quad (4)$$

$$g = D\hat{q}i = Dq \quad (5)$$

Rearranging (4) by replacing g according to (5), (4) can be rewritten as:

$$q = (I - BD)^{-1}Fi \qquad (4^*)$$

where, I is an identity matrix with appropriate dimensions; i.e., industry by industry or commodity by commodity.

Equation (4*) is used to estimate the commodity output change due to a change in the final demand for commodities. This model is called the Commodity-Demand Driven Model (Miller and Blair 2009). The industrial output changes to satisfy an exogenous shock by final demand can be written as:

$$g = [(I - DB)^{-1}D]Fi \qquad (6)$$

The bracketed quantity $[(I– DB)^{-1}D]$ is an Industry by commodity total requirement matrix. This matrix is called the impact matrix. The impact matrix is used to estimate the direct plus indirect impacts in industrial output that are required to satisfy a change in final demand. Leakage is defined as imported commodities that are used to satisfy intermediate and final demand, donated as μ, as a vector. Equation (6) should be adjusted as

$$g = [(I - D(I - \hat{\mu})B)^{-1}D]Fi \qquad (7)$$

The inverse matrix $[(I - D(I - \hat{\mu})B)^{-1}]$is used by the price model to compute the industrial output price change and domestically used commodity price change.

3.2. The national price model

The price model assumes cost-push behavior. The model assumes that when an industry is faced with a change in the costs of raw material or primary inputs, it will adjust its output price to offset the increase in input costs. An industry's output is also an intermediate input to the other

industries. As a result, the other industries must adjust their product price. It is assumed that changes in prices do not give rise to substitution among inputs, therefore there is no price induced substitution in the price model. The price model also assumes that each industry will change the prices of all the commodities it produces in the same proportion. In other words, a commodity price is a linear combination of industry output prices, and the weights are the market share of each industry in the production of the commodity, which is the computed matrix "D". The price models can be used to determine the impact on all industry output prices and commodity prices of a change in primary inputs, import prices, commodity prices, and industrial prices.

All of the price variables in the price model are index numbers. Therefore, it is set that the price indices before an external change are 1. The model is expressed as,

$$P_g' = P_{qd}'(I - \hat{\mu})B + P_m'\hat{\mu}B + \sum_{i=1}^{NI} P_{yi}'H_i \quad (8)$$

where, $P_g$is a NI (number of industry) order vector of industry selling price indices. P_{qd} is a NC (number of commodity) order vector of domestically produced commodity price indices. P_m is a NC order vector of import price indices. P_y is a NY (number of primary input) by NI matrix of primary input prices. P_{yi} is the ith column of the matrix P_y . H_i is an NY by NI matrix whose ith column equal to the ith column in H and other elements equal to zero[1]. Equation (8) states that an industry selling price index is a linear combination of input prices for industrial production. The input elements include the intermediate commodities domestically produced and imported, and primary inputs. When all the prices on the RHS equal to 1, then P_g equals to 1. Given this, the

1. The primary factor input share from output is denoted as "H", and can be estimated using $H = YI\hat{g}^{-1}$, where YI is the primary factor input matrix.

domestically produced commodity price can be simply writing as a transferred form of the industry selling price index:

$$P'_{qd} = P'_g D \tag{9}$$

rearranging (8) using (9), one can solve for $P_g$using,

$$P'_g = (P'_m \hat{\mu} B + \sum_{i=1}^{NI} P'_{yi} H_i)[(I - D(I - \hat{\mu})B)^{-1}] \tag{10}$$

When simulating the price model at the national level, equation (10) and (9) are used.

3.3.A multi-regional price model

In the national price model, the price of an imported commodity is treated the same regardless of its countries of origin. This study develops a multi-regional price model, where regions are linked through trades. This model allows the import price of a commodity to be different given its places of origin. To allow the model to accommodate these changes, equations (8) and (9) are modified to:

$$P'_{gn} = P'_{qdn}(I - \hat{\mu}_n)B_n + \sum_{j=1}^{NR} P'_{mnj} \hat{\mu}_{nj} B_n + \sum_{i=1}^{NI} P'_{yin} H_{in} \tag{11}$$

$$P'_{qdn} = P'_{gn} D_n \tag{9*}$$

satisfies $\sum_{j=1}^{NR} \hat{\mu}_{nj} = \hat{\mu}_n$ (12)

Reorganizing equation (11) with the help of (9*), one can solve for P_{gn} using,

$$P'_{gn} = (\sum_{j=1}^{NR} P'_{mnj} \hat{\mu}_{nj} B_n + \sum_{i=1}^{NI} P'_{yin} H_{in})[(I - D_n(I - \hat{\mu}_n)B_n)^{-1}] \tag{13}$$

Subscript "n" denotes region n and other notations are the same as the ones in the national price model. This study defines six regions in the multi-region model, which are British Columbia, Alberta, Manitoba and Saskatchewan, Ontario, Quebec, and the rest of Canada. P_{mnj} is the import

price vector goes into region n from region j, and m denotes commodities. Note that j can be from any region in Canada or the rest of the world, and j does not equal to n in equation (11). P_{qdn} denotes the new domestically produced commodity price vector, or the resulted export price from region n to the other regions. Equation (12) states that the sum of the inter-regional and international import shares are equal to the total share of imported commodities going into region n. This setup allows the model to recognize imported goods by their places of origin, and allows the export prices of a good to be different across provinces.

In equations (11) and (9*), when there is an exogenous price change in the primary input (P_{yin}), the industry selling prices (P_{gn}) and the prices of domestically produced commodities (P_{qdn}) will change accordingly. Since P_{qdn} of region n can also be regarded as its export price vector to the other regions in the model, P_{qdn} feeds back to equation (11) and replaces P_{mjn} which stands for the import price vector from region n to region j. Therefore, the inter-regional trade price vectors P_{mnj} are actually endogenized in this feedback system, and the international trade price vector remains exogenous. One can iterate the feedback model until the resulting changes in domestically produced commodity converge to almost zero. The total change in industry selling and domestically produced commodity prices are the result of an exogenous price change and the endogenous import price changes. The total impact on the industry selling and commodity prices consists of the first- and the secondary- order impacts, which will be defined in detail in section 4.4.2.

This study focuses on the impact of carbon taxes on food prices and food consumption patterns. The resulting commodity food price changes together with the computed price elasticities of food are analyzed in later sections to evaluate the impact of carbon taxes on food consumption patterns in Canada.

3.4.The computation of food price elasticities

Price elasticity measures the impact of price changes on the consumption patterns of a commodity. The product of food price changes and food price elasticities shows how carbon taxes affect the food consumption in Canada. In this paper, the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer 1980) model was applied to compute the own-price elasticities for food and agricultural commodities in Canada. The AIDS model is the model of choice for many applied demand studies because of its theoretical consistency and relative ease of estimation (Wadud 2006). Also, the model can be used to gauge own- and cross- price elasticities, and expenditure elasticities. In this study, we are mostly interested in the own-price elasticities of food.

The AIDS model gives a first-order approximation to any demand system and has many desirable qualities of demand systems. The system of demand equations is derived from the indirect utility function which belongs to a PIGLOG class, where preferences are expressed using the expenditure function:

$$\log c(u,p) = (1-u)\log(a(p)) + ulog(b(p)) \quad (14)$$

This equation describes the minimum expenditure required to achieve a given level of utility "u" with given prices "p". Utility "u" falls within a range between 0 (subsistence) and 1 (bliss) so that the positive linearly homogeneous functions a(p) and b(p) can be regarded as the costs of subsistence and bliss, respectively.

$$\log a(p) = a_0 + \sum_i logp_i + \frac{1}{2}(\sum_i \sum_j \gamma_{ij} log\, p_i logp_j) \quad (15)$$

$$\log b(p) = \log\big(a(p)\big) + \tau \prod_i {p_i}^{\beta_i} \quad (16)$$

Substituting equations (15) and (16) into equation (14), the budget share of good i, i.e. "w_i", can be estimated by differentiating the indirect utility function, log c(u, p), by price "p_i". The basic specification of the AIDS model is obtained and can be expressed as:

$$w_i = \alpha_i + \sum_j \theta_{ij} ln\, P_j + \beta_i ln \frac{X}{P} \quad (17)$$

where P is the price index for the bundle of goods J=1,2, …, i, …, J, and X is the total expenditures on food consumed at home, assuming weak separability between food consumption and the rest of household demand.[2] The conditions of Adding up, Homogeneity, and Slutsky symmetry must hold for equation (17).

In addition, socio-demographic variables were added to the AIDS model, which resulted in the following modification to equation (17):

$$w_i = \alpha_i + \sum_j \theta_{ij} ln\, P_j + (\beta_i + \eta_i' \boldsymbol{z})(ln \frac{X}{P\overline{m}}) \quad (18)$$

where $\mathbf{Z}$ is a vector representing social-demographic characteristics by household. The social-demographic variables included in the model were: age and gender of the reference person who responded the household survey, household type (single, married with children, married without children, single parent), income per capita by household, region, urban or rural. A multiplicative factor, $\overline{m}$, measures the social-demographic variables' impact on expenditures, which generally takes the form: $\overline{m} = 1 + \rho \boldsymbol{Z}$.

The Canadian household survey data did not provide price information by food item or category. To address this issue the price variable was replaced with a unit value (Huang and Lin 2000; Pomboza and Mbaga 2007), and the unit value was estimated by dividing the expenditure

2. The Stone index, LnP, can be sestimated using: $lnP = \alpha_0 + \sum_j \alpha_j ln\, P_j + \frac{1}{2} \sum_j \sum_i \theta_{ij}\, lnP_i lnP_j$.

on food i by the quantity of food i. The unit value is a function of both price and quality and thus the estimation of the expenditure elasticity should be updated to take into account food quality.

The uncompensated price elasticity can be derived using estimated parameters from (18), and is expressed as:

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\theta_{ij}}{w_i} - \frac{\alpha_j \beta_i}{w_i} - \frac{\beta_i}{w_i} \sum_k \theta_{kj} \, lnP_k - \frac{\eta_i' \boldsymbol{z}}{w_i} (\alpha_j + \sum_k \theta_{kj} \, lnP_k) \quad (19)$$

where $-\delta_{ij}$ is the Kronecker delta which equals 1 when i=j, and 0 otherwise.

The Hicksian elasticity, i.e. the compensated price elasticity, can be estimated using the uncompensated price elasticity and the adjusted expenditure elasticity[3]:

$$\varepsilon_{ij}^{C} = \varepsilon_{ij} + \varphi_i w_j \quad (20)$$

3.5.Data source

To estimate the single- and multi-regional price models in this study, the 2013 national and inter-provincial Input-Output tables (Statistics Canada 2016a; b) are used to estimate parameters and coefficients. Information on the carbon tax plans at federal and provincial levels were collected to be used as price shocks in the price models. Data on GHG emissions and energy use per industry was extracted to calculate the carbon tax for each industry. Data from the Food Expenditure Survey in Canada was employed to estimate food price elasticities in Canada.

3. Food quality elasticity λ_i is borrowed to adjust the expenditure elasticities to correct the bias problem. The adjusted expenditure elasticity is then calculated using:

$$\varphi_i = \left(1 + \frac{\beta_i}{w_i}\right) + \frac{1}{w_i} [\sum_j (\delta_{ij} - \beta_i w_j) \lambda_j] - \lambda_i.$$

3.5.1 Data for the simulations of the national and inter-provincial price models

Both the national and inter-provincial price models use the 2013 data, which is the most up-to-date data when this study was undertaken (Statistics Canada, 2016). The detailed national and inter-provincial Input-Output tables are used to calculate the coefficients for the price models. The detailed Input-Output tables include 488 commodities, 8 primary inputs, and 236 industrial sectors. Among all the commodities, there are 48 agricultural and food commodities. And among all the industries, there are 5 agriculture sectors and 9 food manufacturing sectors. These commodities and sectors are kept at the detailed level for both models.

The national price model was aggregated and eventually includes 172 commodities and 98 industries. This aggregation was for computational reason in that the industrial output and total commodity demanded vectors should not have zero elements. This is because elements in these vectors are used as the denominators to calculate the market share coefficients "D" and input coefficients "B". Commodities and industrial sectors that were relevant to agriculture, food, and energy were not aggregated because they were the items of interest in this study.

The original inter-provincial Input-output model divides Canada to 14 provinces and territories. This study merges some of the provinces and territories together, and merging those provinces helps fill the missing observations for industrial sectors and commodities. A province with its own carbon price system is left as a single region, while other provinces and territories are merged based on their economic structures and geographical locations. The inter-provincial price model comprises of six provinces and territories, i.e. British Columbia (BC), Alberta (AB), Saskatchewan and Manitoba (MS), Ontario (ON), Quebec (QC), and the rest of the Canada (RC). The rest of Canada (RC) is constructed by merging the Canadian territorial enclaves abroad, North Brunswick, Newfoundland and Labrador, Nova Scotia, Northwest Territories, Nunavut, Prince

Edward Island, and Yukon together. In addition, there are some adjustments in the aggregation of industrial sectors and commodities as compared to the national model. The inter-provincial price model contains 167 commodities and 90 industries. Most of the sectors and commodities are in line with the national model. The difference was solely for computational reasons that the vector of total industry output and the vector of total demand for commodities do not have zero entries across all provinces.

While the Canadian federal government has imposed a binding carbon tax target at the federal level, it also allows provinces to have their own carbon tax schedules to combat climate change. The inter-provincial model provides the opportunity to study the carbon tax policies at the provincial level.

3.5.2 The carbon tax plan in Canada

The Pan-Canada Framework on Clean Growth and Climate Change (Goverment of Canada 2016) states Canada's plan on GHG emissions mitigation and building resilience to adapt to a changing climate. According to the federal plan, a carbon tax of $10 per tonne of CO_2e emissions should be applied across Canada in 2018, and should be increased to $50 per tonne CO_2e emissions by 2022, with an increase of $10 per tonne per year. The impact of the federal carbon tax plan is estimated using the national price model. Specifically, after the implementation of the federal carbon tax, food price changes are estimated using equation (9) and (10).

Alberta and British Columbia have their own carbon tax plans (Alberta Government 2016; Government of British Columbia 2016), and Quebec and Ontario participate in a North American cap-and-trade system (Government of Quebec 2016; Government of Ontario 2016). The rest of provinces have not adopted their own carbon pricing models. The requirement of the federal government is that each province must set an emission cap which corresponds to how much a

specific carbon price is expected to reduce emissions. The emission reductions must stay in line with Canada's commitment of 30% reduction by 2030.

In Albert, the carbon tax is $20 a tonne in January 2017, and the rate will increase to $30 a tonne in 2018. The tax applies to gasoline, diesel, natural gas and propane. The fuels for on-farm use are exempt from the carbon tax. Since 2008, British Columbia has established its own carbon tax system which sets a price of $30/tonne in 2017. This equals to adding an extra 6.67 cents to each litre of gasoline and 7.67 cents to each litre of diesel. BC and Alberta have several exemptions to the tax, such as those that apply to the agricultural sector and some air travel. Ontario has entered the cap-and–trade system. Like Ontario, Quebec established a carbon price of $17 per tonne of CO_2e emissions. Saskatchewan and Manitoba don't have their own provincial plan yet. Manitoba plans to release their carbon tax proposal by the end of 2017. Nova Scotia, Newfoundland and Labrador, New Brunswick, Prince Edward Island don't have their own carbon schedules.

The impact of provincial taxes is estimated using the inter-provincial price model, in which BC and Alberta have a carbon tax of $30 per tonne, Ontario and Quebec have a carbon tax of $18 and $17 respectively, and the rest of provinces follow the federal carbon tax schedule.

3.5.3 Data for AIDS estimation

The AIDS model is applied to estimate food price elasticities. Expenditure and quantity data were extracted from the 2001 Food Expenditure Survey (Statistics Canada 2003). This study cannot use the 2010 Food Expenditure Survey because it does not include the food purchase quantity information at the household level. In total 4,695 observations were used to estimate the AIDS model.

In this study, the food consumption data was categorized into sixteen food categories: (1) fresh fruits and nuts, (2) fresh vegetables, (3) processed fruits and nuts, (4) processed vegetables, (5) poultry, (6) pork, (7) beef, (8) processed meat, (9) fish, (10) dairy products, (11) eggs, (12) grains, (13) processed food, (14) sweets, (15) sweetened drinks, and (16) fats. The first two food categories included all unprocessed fruits, vegetables and nuts. The processed fruits and nuts group and processed vegetables included all processed fruits, vegetables and nuts such as juices, canned and frozen fruits and vegetables. Processed meats included cured meats, bacon, ham, meat preparations and cooked meat such as bologna, uncooked meats such as sausages, wieners, and canned meats. The fish and seafood category included fresh and frozen fish, pre-cooked fish portions, canned fish and other marine products. Whole milk, low fat milk, fluid skim milk as well as dairy substitutes, yogurts, cream, cheese and butter were included in the dairy products category. The grains category included bread products as well as other grain products such as rolls, dry or fresh pasta, rice, flour, breakfast cereals and other cereal products. Processed foods included chips and crackers, pre-packaged frozen dinners and other processed foods such as canned pasta, pasta mixes, dried soups and sauces and sauce mixes. The sweets category includes cookies and biscuits, muffin, doughnuts; yeast raised sweet goods and desserts such as ice cream, pudding and custards as well as syrups, sugar, gum, chocolate bars, sugar candy and other sugar preparations. Drink powders, fruit drinks and carbonated beverages are included in the sweeten drinks category. The fats category includes fats and oils such as margarine, shortening, lard, cooking salads and oils and processed cheeses.

This study estimates the food price elasticities for three income groups to examine whether a carbon tax would have a distributional effect on food consumption patterns. These income groups are categorized as, lower (0-$29,000), medium ($30,000-$59,000) and higher ($60,000 and above).

By calculating the food price elasticities by income group and food price changes due to carbon taxes, one can estimate the impact of carbon tax on food consumption patterns.

4. Results

There are concerns that the implementation of a carbon tax would lead to a hike in food prices, which could in turn impede the ability of the Canadian population to access affordable food. To have a better understanding of the impact of the carbon tax policies in Canada, this paper investigated the impact of carbon taxes on food prices and food consumption patterns in Canada.

4.1.National price changes resulted from the federal carbon tax

According to the Pan-Canadian Framework on Clean Growth and Climate Change (Goverment of Canada 2016), the federal government sets the carbon tax target at $10 per tonne of CO_2e emissions in 2018, and this tax will increase to $50 per tonne by 2022. Therefore, in the national price model simulation, the federal carbon tax starts at $10 per tonne of CO_2e emissions, with an increase of $10 per year till 2022.

A carbon tax can directly affect food prices when the carbon tax applies to the agriculture sector. Carbon taxes on other sectors can also indirectly affect food prices because of price changes in inputs that are used for food production. Two scenarios are considered in the federal carbon simulation using the national price model. The first scenario allows the carbon tax to be implemented on all production sectors. In this case, the impact of carbon tax is the combination of the direct and indirect effects. The second scenario excludes the agriculture and the government service sectors from the carbon tax plan since GHG emissions from these two sectors are not regulated in Canada. This setup provides the opportunity to focus on the indirect impact of a carbon tax on food prices.

4.1.1 Scenario 1

In this scenario, the federal carbon tax is applied to all the economic sectors presented in the Input-Output table.[4] The commodity price changes due to the implementation of the federal carbon tax were estimated. The resulted total price changes in food and agricultural goods are presented in Table 1. Overall, the implementation of the federal carbon tax would lead to an increase in commodity prices. A carbon tax of $10 per tonne of CO_2e emissions would lead to an average increase of 0.64% in commodity prices in Canada. When the carbon tax increases by $10 per year till year 2022, the commodity price would also increase by around 0.61% to 0.63% per year.

(Table 1 here)

This study focuses the impact of carbon taxes on food prices. The average food product price would increase by 0.95% if the carbon tax is at $10. By 2022, the food product prices would increase by 4.69% as compared to the pre- carbon tax time. It is also observed that the impact of the carbon tax on commodity prices decelerate over the years. This is simply because the percentage change of carbon tax over the years decreases. For instance, the carbon tax increases 100% from 2018 ($10 per tonne) to 2019 ($20 per tonne), while increases 50% from 2019 ($20 per tonne) to 2020 ($30 per tonne).

There is a large variation among food price increases due to the federal carbon tax, with the range being from 0.34% to 3.6%. The most affected food commodities are fishery products, with an increase in price of 3.60%, followed by unprocessed fluid milk and eggs, with an increase of 2.24%. The prices of sugar, chocolate, and confectionery products are the least affected, with an increase by 0.34%. There would be an increase of 1.64% for packaged seafood products. In

4. Note that the agriculture and government services sectors are also accounted for their carbon emissions.

addition, the prices of meat products and dairy products would also increase by more than 1% (Table 1).

In sum, a carbon tax of $10 per tonne of CO_2e. emissions has negative impacts on food prices. The impacts vary by food commodity, among which fishery products, prepared and packaged seafood products, meat and dairy products, are the most affected. In order to understand the indirect impact of carbon taxes on prices in the agriculture sector, scenario 2 was undertaken, where the agriculture sectors were exempted from the federal carbon tax plan.

4.1.2 Scenario 2

In this scenario, the agriculture and government services sectors were exempt from the carbon tax schedule, meaning that these two sectors do not need to pay for their CO_2e emissions. For example, in British Columbia and Alberta, on-farm fuel use for agriculture production is exempt from the carbon tax systems. In Ontario and Quebec, the agriculture sectors are not regulated in the cap-and-trade system. Therefore, this scenario is in line with many provincial government policies. At the same time, exempting the agriculture sector from the carbon tax would allow one to compare the result of scenario 2 (indirect impact) with those of scenario 1 (direct impact). The results of scenario 2 were regarded as the indirect impact of the carbon tax on agricultural and food prices.

The average food price would increase by 0.23% if the $10 per tonne of CO_2e emissions were implemented on all but the agriculture and government services sectors. By 2022, the average food price would increase by 1.17%. The price increases do not vary much by food commodity, ranging from 0.17% to 0.27%. The highest increase was found in bread, baked goods, flour mixes, dough and dry pasta, and snack food products. The price of oilseeds, grains, fresh fruits and nuts, and fresh vegetables were the least affected. Compared to scenario 1, the impact of carbon tax on food

prices reduces substantially (by approximately 5 times) when the agriculture sector is exempt from carbon taxes. Therefore, exempting the agriculture sectors from the carbon tax system is effective in reducing the impact of carbon taxes on food and agricultural product prices.

(Table 2 here)

The results of scenario 2 imply that the indirect impact of the carbon tax on food prices is limited. This is good news for policy makers that the negative impact of the carbon tax on food prices is limited as long as the agriculture sector is exempt from carbon taxes.

4.2. Food price changes due to the carbon taxes at the provincial level

The provincial carbon tax plans are described as follows. British Columbia and Alberta have their own carbon tax systems, while Ontario and Quebec follow the cap-and-trade system. The other provinces, Manitoba and Saskatchewan, and the Rest of Canada, follow the federal tax plan, i.e. $10 per tonne of CO_2e emissions, since they do not yet have their own carbon tax systems. Therefore, according to the provincial schedules, British Columbia and Alberta implements a carbon tax of $30 per tonne of CO_2e emissions in 2018. The cap-and-trade system set the carbon tax of $18 and $17 for Ontario and Quebec respectively.

The inter-provincial model in this study analyzes the direct and indirect impacts of carbon taxes on food prices, as well as the first-order and the secondary-order impacts. These impacts are defined as follows.

The direct and the indirect impacts are commonly used in the Input-Output model exercises. In this paper, a carbon tax imposed on agricultural sectors would increase the cost of agricultural production, and this is the direct impact. The tax on other sectors, such as pesticides and

agricultural chemical production, energy, and fertilizers, would also affect the price of the inputs for agricultural sectors through backward linkages. This is an example of the indirect impact.

The first-order and the secondary-order impacts differ from the direct and the indirect impacts. The inter-provincial price model endogenize the inter-provincial commodity trading prices. In other words, the carbon tax for each province affects the commodity prices for that province, which turns to affect other provinces' commodity prices through inter-provincial trading. In this study, the first-order impact is referred to the first-round direct impact of a carbon tax on provincial commodity prices, without considering the changes in commodity prices due to trading between provinces. The secondary-order impact of a carbon tax refers to the price changes caused by the changes in endogenized inter-provincial trading commodity prices. The sum of the first-order and the secondary-order impacts gives the total impact of carbon taxes. This study iterates the estimation of the secondary-order impacts till the change in inter-provincial import prices converges to less than 0.01% for all provinces. The results from this inter-provincial model tests are elaborated below.

In general, the implementation of carbon taxes would increase commodity prices. The results indicate that the federal carbon taxes have a negative impact on food prices for all regions. When the provincial carbon taxes are implemented, the average commodity price increases between 0.36% to 0.92% for the six regions (Table 3). Furthermore, the total impact of the provincial carbon tax on food prices were more moderate than their impact on the average commodity prices. For instance, the food price in Quebec would increase by 0.63%, followed by Alberta with an increase of 0.56%, Rest of Canada by 0.45%, and Manitoba and Saskatchewan by 0.42%. The average increase in food prices in British Columbia and Ontario are among the lowest, just 0.27% and 0.39% respectively. More detailed discussion for the each province follows.

(Table 3 here)

In Alberta, the price of meat products, such as beef and veal, pork, poultry, and other meat products, had the largest increase, by 0.68%. The price of unprocessed fluid milk, eggs, and preserved fruit and vegetables and frozen food, would increase by 0.63%, the second highest increase. The increase in the average food price due to the first-order impact of the carbon tax was 0.46%, and their secondary-order impact would result in an increase of 0.1%. The sum of the two impacts results in a total impact of 0.56%. Table 4 and Appendix I provide the detailed first-order and secondary-order impacts per food and agricultural commodity.

(Table 4 here)

In Quebec, the price of fresh, frozen and canned vegetable and vegetable juices would increase the most, by 0.85%, and this was followed by the preserved fruit and vegetables and frozen food with an increase of 0.84%. Prepared and packaged seafood products were the least affected food, with an increase in price of 0.46%. The first-order impact of the provincial carbon tax would result in an increase of 0.46% in the average food price, and the average secondary-order impact on food price was an increase of 0.17%.

It is worth mentioning that Quebec has a largest average increase in food prices than Alberta mainly due to the secondary-order impact, given that Quebec ’s food price increase due to the first-order impact was smaller than that of Alberta. By definition, the secondary-order impact is caused by the endogenous changes in the inter-provincial trade prices. Therefore, Quebec depends more on inter-provincial trade, and the price changes in import goods would affect its domestic price level more.

Another interesting finding is that even though the carbon tax is priced at $30 per tonne CO_2e emissions in Alberta, which is much higher than $17 per tonne in Quebec, the first-order impact of the carbon tax on food price increases in Alberta, 0.45%, is still less than that of Quebec, 0.46%. This result occurs because food manufacturing sectors in Quebec are more affected by the carbon price than in Alberta, indicating that Quebec has more food manufacturing facilities, and its food manufacturing facilities are relatively more energy intensive.

The changes in food prices also vary among other provinces. In Ontario, the most affected commodities were preserved fruit and vegetable food, which saw an increase in price by 0.33%. The prices of bread, rolls, and flatbreads, baked sweet goods, flower mixes, confectionery products, and seasoning and dressings increased by 0.32%. In British Columbia, the most affected food price was for preserved fruit and vegetables and frozen foods, with an increase of 0.46%, followed by flour mixes, cereal products, and snack food products. Manitoba and Saskatchewan were similar to Quebec, in that they are highly dependent on inter-provincial trade. As a result, their estimated secondary-order impact was relatively high. For the rest of Canada, the most affected food commodity was confectionery products, with an increase of 0.78% in the price. The second most affected food prices were fresh, frozen, canned vegetable and fruits juices, and preserved fruits and vegetables and frozen food, which saw an increase of 0.63%.

Overall, the distribution of food price changes due to the provincial carbon taxes varied across provinces. For all provinces, the average increase in food price was lower than the average increase in the price of other commodities. This indicates two things. First, an exclusion of the agriculture sectors from being taxed on the carbon emissions would reduce the impact a carbon tax on food prices. This is consistent with the findings in the national price model. Second, the proposed carbon

tax plans by the federal and provincial governments do not have a detrimental impact on food prices and the competitiveness of Canadian farm products.

4.3. The carbon tax impact on food consumption patterns

4.3.1. The own-price elasticities of food in Canada

The AIDS model was applied to estimate food price elasticities in Canada. The price elasticity of food measures the changes in the demand quantity of food with respect to a 1% change in food price. The uncompensated own-price elasticity is derived from the Marshallian demand function, while the compensated own-price elasticity is derived from the Hicksian demand function. The uncompensated and compensated own-price elasticities are reported in Appendix II and Table 5. The estimated own price elasticities of food are all negative values, meaning that the food categories considered in this study are normal goods. As a result, an increase in the price of one type of food would lead to a decrease in the consumption of that food. In general, the own-price elasticities of food in Canada are relatively inelastic. As shown in Table 5, a 1% increase in food prices would lead to a less than 1% decrease in food consumption.

(Table 5 here)

The analysis of the impact of carbon taxes on food consumption patterns is based on the compensated food price elasticities, assuming that the demand function aims at minimizing costs while maintaining the same level of utility. The following sub-sections discuss the impacts at both federal and provincial levels.

4.3.2. The impact of the federal carbon tax on the food consumption patterns

4.3.2.1 The federal carbon tax excluding the agriculture and government service sectors

The impact of the federal carbon tax on the food consumption patterns were first analyzed. There is no obvious evidence that the impact of the federal carbon tax on food consumption patterns is different across the income levels. The 2018 federal carbon tax plan that excludes agriculture and government services sector is used to illustrate the relationship between carbon tax and food consumption patterns (Table 6). The results show that the average food consumption would decrease by around 0.15%-0.16% for all income groups. Among the consumption of all food items, the most affected are cereal products, and cooking oil, whose consumption would decrease by 0.31%-0.33% for all three income groups. Consumption of grain and oilseed products, milk, and fish were the least affected, with a less than 0.1% reduction in consumption. The federal carbon tax affects the consumption patterns of the three income levels similarly, suggesting that it would not aggravate the inequality in terms of food expenditures. Overall, one can conclude that the federal carbon tax plan excluding the agriculture and government services sectors has little negative impact on the food consumption patterns in Canada.

(Table 6 here)

4.3.2.2 The federal carbon tax including the agriculture and government service sectors

The same exercise was conducted for the federal carbon tax plan that included all economic sectors. The resulting reduction in food consumption was higher than the case that excludes the agriculture and government services sectors. The average consumption of food commodities would decrease by 0.48%, 0.5%, and 0.49% respectively for the lower-income, medium-income, and higher-income groups (Table 7). These impacts were three times the impact of a carbon tax

that excludes the agriculture and government services sectors. The mostly affected commodities were the consumptions of processed meat products, fresh and frozen pork and poultry.

(Table 7 here)

4.3.3. The impact of provincial carbon taxes on food consumption patterns

This section compares the changes in food consumption patterns due to the provincial carbon taxes by provinces (Table 8). The provincial carbon taxes have negative impacts on food consumption patterns for all provinces in Canada, and the impacts vary by provinces. Food consumption patterns in Quebec would decrease the most, by 0.44%, among all provinces. It is followed by Alberta, with a reduction of 0.39%, Rest of Canada with a 0.32% reduction, Manitoba and Saskatchewan with a 0.3% reduction, British Columbia with a reduction of 0.27%, and Ontario with a reduction of 0.19% in the average food consumed.

(Table 8 here)

The average food consumption reductions in all regions were higher than the average food consumption reductions when the federal tax (excluding the agriculture and the government services sectors) was applied. The existing provincial carbon taxes in each province would have higher levels of negative impact on food consumption patterns than the federal carbon tax would. This is because the federal carbon tax starts with a much lower price level, i.e. $10 per tonne of emissions, than the provincial carbon taxes. For instance, the carbon taxes for BC and Alberta are $ 30 per tonne. Moreover, the reduction in food consumption due to the impact of provincial carbon taxes varies by province. This is because the production structures are different in each province. Like results discovered for the federal carbon tax situation, there is no evidence that the provincial

carbon taxes would affect different income groups differently in terms of the food consumption patterns.

In sum, carbon taxes have a negative impact on food prices and food consumption patterns in Canada. Their impacts, however, are relatively small, especially when the agriculture sector is exempt from the carbon tax.

5. Conclusion

This study analyzes the impact of carbon taxes on food prices and food consumption patterns in Canada. Carbon taxes on GHG emissions reductions are well studied and have been recognized theoretically and empirically as being effectual. The social impact of a carbon tax should also be assessed before a carbon tax is implemented.

To have a complete understanding of the impact of carbon taxes on food prices on the agriculture sectors, both the federal and the provincial carbon taxes were considered in this study. Under the federal tax framework, two scenarios were examined. In the first scenario, agriculture sectors were taxed on carbon emissions, the results show that price of food would increase by 0.95% to 0.9% from 2018 to 2022 on a yearly basis. The most affected food commodities include dairy products, beef and veal, pork, poultry, processed meat, and prepared seafood products. The second scenario assumes agriculture and government services sectors are exempt from carbon taxes. The increase in food prices was estimated to be 0.24% per year on average, which is significantly smaller than in the first scenario.

In order to analyze the impact of provincial carbon taxes on food prices, a multi-regional price model was constructed. The results show that food prices in Quebec were the most affected among all provinces, with an increase of 0.62%. On average, the price increases under the provincial tax

systems were greater than the price increases under the federal system. This occurs because the carbon taxes at the provincial level start at a higher rate than the federal tax.

In the analysis of the impact of carbon taxes on food consumption patterns, the study finds that there is a reduction in consumption of food due to the carbon tax, though the reduction is small at both the federal and provincial levels. Under the federal carbon tax plan, there is an average 0.16% reduction in food consumption in Canada. Under the provincial carbon tax plan, the food consumption reductions ranged between 0.19% to 0.44%, and Quebec shows the highest reduction in food consumption. In sum, the current federal and provincial levels of carbon taxes have a relatively small impact on food prices and food consumption in Canada. However, if the agriculture sectors are taxed on carbon emissions, this impact becomes larger.

Table 1. The price changes of food and agricultural products after the implementation of the federal carbon tax including all economic sectors

Year	2018	2019	2020	2021	2022
Food commodities					
Canola (including rapeseed)	0.88%	0.87%	0.87%	0.86%	0.85%
Oilseeds (except canola)	0.87%	0.86%	0.86%	0.85%	0.84%
Wheat	0.87%	0.86%	0.86%	0.85%	0.84%
Grains (except wheat)	0.87%	0.86%	0.86%	0.85%	0.84%
Fresh potatoes	0.87%	0.86%	0.86%	0.85%	0.84%
Fresh fruits and nuts	0.87%	0.86%	0.86%	0.85%	0.84%
Other miscellaneous crop products	0.85%	0.84%	0.84%	0.83%	0.82%
Fresh vegetables (except potatoes)	0.73%	0.73%	0.72%	0.72%	0.71%
Unprocessed fluid milk	2.24%	2.19%	2.14%	2.10%	2.06%
Eggs in shell	2.24%	2.19%	2.14%	2.10%	2.06%
Fish, crustaceans, shellfish and other fishery products	3.69%	3.56%	3.44%	3.32%	3.22%
Flour and other grain mill products	0.58%	0.57%	0.57%	0.57%	0.56%
Margarine and cooking oils	0.60%	0.60%	0.59%	0.59%	0.59%
Breakfast cereal and other cereal products	0.58%	0.58%	0.57%	0.57%	0.57%
Grain and oilseed products	0.59%	0.59%	0.59%	0.58%	0.58%
Sugar and sugar mill by-products	0.34%	0.34%	0.34%	0.34%	0.34%
Chocolate (except confectionery)	0.34%	0.34%	0.33%	0.33%	0.33%
Confectionery products	0.34%	0.34%	0.34%	0.34%	0.33%
Fresh, frozen and canned fruit and vegetable juices	0.37%	0.36%	0.36%	0.36%	0.36%
Preserved fruit and vegetables and frozen foods	0.41%	0.41%	0.41%	0.41%	0.40%
Processed fluid milk and milk products	1.19%	1.18%	1.16%	1.15%	1.14%
Cheese and cheese products	1.20%	1.18%	1.17%	1.16%	1.14%
Butter and dry and canned dairy products	1.16%	1.15%	1.14%	1.12%	1.11%
Ice cream, sherbet and similar frozen desserts	1.20%	1.19%	1.17%	1.16%	1.15%
Fresh and frozen beef and veal	1.30%	1.28%	1.26%	1.25%	1.23%
Fresh and frozen pork	1.30%	1.28%	1.26%	1.25%	1.23%
Fresh and frozen poultry of all types	1.30%	1.28%	1.26%	1.25%	1.23%
Processed meat products, other miscellaneous meats & animal by-products	1.27%	1.26%	1.24%	1.23%	1.21%
Prepared and packaged seafood products	1.64%	1.61%	1.59%	1.56%	1.54%
Bread, rolls and flatbreads	0.36%	0.36%	0.36%	0.36%	0.36%
Cookies, crackers and baked sweet goods	0.36%	0.36%	0.36%	0.36%	0.36%
Flour mixes, dough and dry pasta	0.42%	0.42%	0.42%	0.42%	0.41%
Snack food products	0.40%	0.40%	0.40%	0.40%	0.40%
Flavouring syrups, seasonings and dressings	0.40%	0.40%	0.40%	0.39%	0.39%
Other food products	0.49%	0.49%	0.49%	0.49%	0.48%
All food products	**0.95%**	**0.93%**	**0.92%**	**0.91%**	**0.90%**
Other agricultural commodities					
Imputed feed	0.87%	0.86%	0.86%	0.85%	0.84%
Nursery and floriculture products	0.50%	0.50%	0.49%	0.49%	0.49%
Cattle and calves	2.24%	2.19%	2.14%	2.10%	2.06%
Hogs	2.24%	2.19%	2.14%	2.10%	2.06%
Poultry	2.24%	2.19%	2.14%	2.10%	2.05%
Other live animals	2.24%	2.19%	2.14%	2.10%	2.06%
Raw fur skins, and animal products	2.04%	2.00%	1.96%	1.92%	1.88%
Imputed fertilizer	2.24%	2.19%	2.14%	2.10%	2.06%
Support services for crop production	0.78%	0.77%	0.76%	0.76%	0.75%
Support services for animal production, hunting and fishing	1.65%	1.63%	1.60%	1.57%	1.55%
All commodities	**0.64%**	**0.63%**	**0.62%**	**0.62%**	**0.61%**

Table 2. The price change of food and agricultural products after the implementation of the federal carbon tax including all but agriculture and government services sectors

Year	2018	2019	2020	2021	2022
Food commodities					
Canola (including rapeseed)	0.19%	0.19%	0.19%	0.19%	0.19%
Oilseeds (except canola)	0.17%	0.17%	0.17%	0.17%	0.17%
Wheat	0.17%	0.17%	0.17%	0.17%	0.17%
Grains (except wheat)	0.17%	0.17%	0.17%	0.17%	0.17%
Fresh potatoes	0.17%	0.17%	0.17%	0.17%	0.17%
Fresh fruits and nuts	0.17%	0.17%	0.17%	0.17%	0.17%
Other miscellaneous crop products	0.17%	0.17%	0.17%	0.17%	0.17%
Fresh vegetables (except potatoes)	0.19%	0.19%	0.19%	0.19%	0.19%
Unprocessed fluid milk	0.21%	0.21%	0.21%	0.21%	0.21%
Eggs in shell	0.21%	0.21%	0.21%	0.21%	0.21%
Fish, crustaceans, shellfish and other fishery products	0.29%	0.29%	0.29%	0.29%	0.29%
Flour and other grain mill products	0.23%	0.23%	0.23%	0.23%	0.23%
Margarine and cooking oils	0.22%	0.22%	0.22%	0.22%	0.22%
Breakfast cereal and other cereal products	0.22%	0.22%	0.22%	0.22%	0.22%
Grain and oilseed products	0.22%	0.22%	0.22%	0.22%	0.22%
Sugar and sugar mill by-products	0.27%	0.27%	0.27%	0.27%	0.27%
Chocolate (except confectionery)	0.27%	0.27%	0.27%	0.27%	0.27%
Confectionery products	0.27%	0.27%	0.27%	0.27%	0.27%
Fresh, frozen and canned fruit and vegetable juices	0.27%	0.27%	0.27%	0.27%	0.27%
Preserved fruit and vegetables and frozen foods	0.28%	0.28%	0.28%	0.28%	0.28%
Processed fluid milk and milk products	0.25%	0.25%	0.25%	0.25%	0.25%
Cheese and cheese products	0.25%	0.25%	0.25%	0.25%	0.25%
Butter and dry and canned dairy products	0.25%	0.25%	0.25%	0.25%	0.25%
Ice cream, sherbet and similar frozen desserts	0.25%	0.25%	0.25%	0.25%	0.25%
Fresh and frozen beef and veal	0.24%	0.24%	0.24%	0.24%	0.24%
Fresh and frozen pork	0.24%	0.24%	0.24%	0.24%	0.24%
Fresh and frozen poultry of all types	0.24%	0.24%	0.24%	0.24%	0.24%
Processed meat products, other miscellaneous meats & animal by-products	0.24%	0.24%	0.24%	0.24%	0.24%
Prepared and packaged seafood products	0.24%	0.24%	0.24%	0.24%	0.24%
Bread, rolls and flatbreads	0.27%	0.27%	0.27%	0.27%	0.27%
Cookies, crackers and baked sweet goods	0.27%	0.27%	0.27%	0.27%	0.27%
Flour mixes, dough and dry pasta	0.27%	0.27%	0.27%	0.27%	0.27%
Snack food products	0.27%	0.27%	0.26%	0.26%	0.26%
Flavouring syrups, seasonings and dressings	0.26%	0.26%	0.26%	0.26%	0.26%
Other food products	0.26%	0.26%	0.26%	0.26%	0.26%
All food products	**0.23%**	**0.23%**	**0.23%**	**0.23%**	**0.23%**
Other agricultural commodities					
Imputed feed	0.17%	0.17%	0.17%	0.17%	0.17%
Nursery and floriculture products	0.28%	0.28%	0.28%	0.28%	0.28%
Cattle and calves	0.21%	0.21%	0.21%	0.21%	0.21%
Hogs	0.21%	0.21%	0.21%	0.21%	0.21%
Poultry	0.21%	0.21%	0.21%	0.21%	0.21%
Other live animals	0.21%	0.21%	0.21%	0.21%	0.21%
Raw fur skins, and animal products	0.23%	0.23%	0.23%	0.23%	0.23%
Imputed fertilizer	0.21%	0.21%	0.21%	0.21%	0.21%
Support services for crop production	0.24%	0.24%	0.23%	0.23%	0.23%
Support services for animal production, hunting and fishing	0.27%	0.27%	0.27%	0.27%	0.27%
All commodities	**0.39%**	**0.39%**	**0.39%**	**0.39%**	**0.38%**

Table 3. The total impact of the provincial carbon taxes on food prices in 2018

	AB	BC	RC	MS	ON	QC
Food Commodities						
Oilseeds	0.50%	0.34%	0.36%	0.38%	0.21%	0.58%
Wheat	0.50%	0.34%	0.36%	0.35%	0.21%	0.58%
Grains (except wheat)	0.50%	0.34%	0.36%	0.35%	0.21%	0.58%
Fresh potatoes	0.50%	0.34%	0.36%	0.35%	0.21%	0.58%
Fresh fruits and nuts	0.50%	0.34%	0.36%	0.35%	0.21%	0.58%
Other miscellaneous crop products	0.50%	0.41%	0.36%	0.35%	0.21%	0.58%
Fresh vegetables (except potatoes)	0.51%	0.33%	0.39%	0.35%	0.26%	0.66%
Unprocessed fluid milk	0.63%	0.38%	0.35%	0.51%	0.26%	0.53%
Eggs in shell	0.63%	0.38%	0.35%	0.51%	0.26%	0.53%
Fish, crustaceans, shellfish & other fishery products	0.39%	0.24%	0.28%	0.41%	0.18%	0.52%
Flour and other grain mill products	0.57%	0.37%	0.48%	0.42%	0.26%	0.64%
Cereal products, margarine and cooking oils	0.57%	0.45%	0.45%	0.41%	0.25%	0.62%
Grain and oilseed products	0.57%	0.38%	0.48%	0.41%	0.26%	0.64%
Confectionery products	0.52%	0.34%	0.78%	0.43%	0.32%	0.65%
Fresh, frozen &canned fruit and vegetable juices	0.57%	0.42%	0.63%	0.41%	0.29%	0.85%
Preserved fruit and vegetables and frozen foods	0.63%	0.46%	0.63%	0.52%	0.33%	0.84%
Processed fluid milk and milk products	0.60%	0.40%	0.43%	0.48%	0.30%	0.62%
Cheese and cheese products	0.60%	0.40%	0.43%	0.48%	0.30%	0.62%
Butter and dry and canned dairy products	0.60%	0.40%	0.43%	0.48%	0.30%	0.63%
Ice cream, sherbet and similar frozen desserts	0.60%	0.40%	0.43%	0.48%	0.30%	0.63%
Fresh and frozen beef and veal	0.68%	0.41%	0.50%	0.44%	0.29%	0.63%
Fresh and frozen pork	0.68%	0.41%	0.50%	0.44%	0.29%	0.63%
Fresh and frozen poultry of all types	0.68%	0.41%	0.50%	0.44%	0.29%	0.63%
Processed meat products, other miscellaneous meats	0.68%	0.40%	0.46%	0.44%	0.29%	0.63%
Prepared and packaged seafood products	0.52%	0.29%	0.38%	0.39%	0.26%	0.46%
Bread, rolls and flatbreads	0.50%	0.45%	0.54%	0.43%	0.32%	0.71%
Cookies, crackers and baked sweet goods	0.51%	0.44%	0.57%	0.47%	0.32%	0.71%
Flour mixes, dough and dry pasta	0.52%	0.45%	0.55%	0.42%	0.32%	0.70%
Snack food products	0.50%	0.45%	0.55%	0.43%	0.30%	0.71%
Flavouring syrups, seasonings and dressings	0.45%	0.42%	0.38%	0.33%	0.32%	0.71%
Other food products	0.55%	0.43%	0.46%	0.43%	0.31%	0.69%
Total food	**0.56%**	**0.39%**	**0.45%**	**0.42%**	**0.27%**	**0.63%**
Other agricultural products						
Imputed feed	0.50%	0.34%	0.36%	0.35%	0.21%	0.58%
Nursery and floriculture products	0.59%	0.32%	0.49%	0.50%	0.28%	0.89%
Cattle and calves	0.63%	0.38%	0.35%	0.51%	0.26%	0.53%
Hogs	0.63%	0.38%	0.35%	0.51%	0.26%	0.53%
Poultry	0.63%	0.38%	0.35%	0.50%	0.26%	0.53%
Other live animals	0.63%	0.38%	0.35%	0.51%	0.26%	0.53%
Raw furskins, and animal products	0.60%	0.35%	0.34%	0.50%	0.23%	0.55%
Imputed fertilizer	0.63%	0.38%	0.35%	0.51%	0.26%	0.53%
Support services for crop production	0.51%	0.26%	0.34%	0.34%	0.20%	0.59%
Support services for animal production, hunting, fishing	0.58%	0.31%	0.32%	0.44%	0.18%	0.58%
Total commodity	**0.82%**	**0.53%**	**0.66%**	**0.68%**	**0.36%**	**0.92%**

Table 4. The first-order impact on food prices due to the provincial carbon taxes in 2018

Commodity	AB	BC	RC	MS	ON	QC
Food Commodities						
Oilseeds	0.43%	0.22%	0.28%	0.27%	0.13%	0.36%
Wheat	0.43%	0.22%	0.28%	0.24%	0.13%	0.36%
Grains (except wheat)	0.43%	0.22%	0.28%	0.24%	0.13%	0.36%
Fresh potatoes	0.43%	0.22%	0.28%	0.24%	0.13%	0.36%
Fresh fruits and nuts	0.43%	0.22%	0.28%	0.24%	0.13%	0.36%
Other miscellaneous crop products	0.43%	0.32%	0.28%	0.24%	0.13%	0.36%
Fresh vegetables (except potatoes)	0.44%	0.25%	0.30%	0.24%	0.17%	0.44%
Unprocessed fluid milk	0.50%	0.26%	0.25%	0.33%	0.17%	0.36%
Eggs in shell	0.50%	0.26%	0.25%	0.33%	0.17%	0.36%
Fish, crustaceans, shellfish and other fishery products	0.30%	0.15%	0.21%	0.23%	0.08%	0.32%
Flour and other grain mill products	0.49%	0.21%	0.24%	0.30%	0.17%	0.41%
Cereal products, margarine and cooking oils	0.49%	0.38%	0.31%	0.30%	0.17%	0.38%
Grain and oilseed products	0.49%	0.22%	0.24%	0.30%	0.17%	0.41%
Confectionery products	0.44%	0.28%	0.68%	0.33%	0.25%	0.51%
Fresh, frozen and canned fruit and vegetable juices	0.48%	0.34%	0.53%	0.30%	0.22%	0.72%
Preserved fruit and vegetables and frozen foods	0.54%	0.38%	0.54%	0.41%	0.25%	0.71%
Processed fluid milk and milk products	0.49%	0.29%	0.33%	0.32%	0.20%	0.46%
Cheese and cheese products	0.49%	0.30%	0.33%	0.32%	0.20%	0.46%
Butter and dry and canned dairy products	0.49%	0.30%	0.33%	0.32%	0.20%	0.46%
Ice cream, sherbet and similar frozen desserts	0.49%	0.29%	0.33%	0.32%	0.20%	0.46%
Fresh and frozen beef and veal	0.49%	0.30%	0.33%	0.32%	0.18%	0.49%
Fresh and frozen pork	0.49%	0.30%	0.33%	0.32%	0.18%	0.49%
Fresh and frozen poultry of all types	0.49%	0.30%	0.33%	0.32%	0.18%	0.49%
Processed meat products, other miscellaneous meats	0.49%	0.29%	0.31%	0.32%	0.18%	0.50%
Prepared and packaged seafood products	0.34%	0.24%	0.31%	0.22%	0.15%	0.34%
Bread, rolls and flatbreads	0.43%	0.37%	0.45%	0.33%	0.26%	0.59%
Cookies, crackers and baked sweet goods	0.44%	0.37%	0.48%	0.37%	0.26%	0.59%
Flour mixes, dough and dry pasta	0.45%	0.36%	0.45%	0.31%	0.26%	0.57%
Snack food products	0.43%	0.38%	0.45%	0.33%	0.23%	0.59%
Flavouring syrups, seasonings and dressings	0.38%	0.34%	0.28%	0.22%	0.25%	0.58%
Other food products	0.46%	0.36%	0.39%	0.33%	0.24%	0.56%
Total food	**0.45%**	**0.29%**	**0.34%**	**0.30%**	**0.19%**	**0.46%**
Other agricultural products						
Imputed feed	0.43%	0.22%	0.28%	0.24%	0.13%	0.36%
Nursery and floriculture products	0.52%	0.25%	0.40%	0.38%	0.19%	0.68%
Cattle and calves	0.50%	0.26%	0.25%	0.33%	0.17%	0.36%
Hogs	0.50%	0.26%	0.25%	0.33%	0.17%	0.36%
Poultry	0.50%	0.26%	0.25%	0.33%	0.17%	0.36%
Other live animals	0.50%	0.26%	0.25%	0.33%	0.17%	0.36%
Raw furskins, and animal products	0.48%	0.24%	0.24%	0.32%	0.15%	0.34%
Imputed fertilizer	0.50%	0.26%	0.25%	0.33%	0.17%	0.36%
Support services for crop production	0.44%	0.14%	0.25%	0.23%	0.12%	0.36%
Support services for animal production, hunting, fishing	0.46%	0.19%	0.22%	0.29%	0.11%	0.35%
Total commodity	**0.75%**	**0.45%**	**0.58%**	**0.56%**	**0.28%**	**0.68%**

Table 5. The compensated food price elasticities

Commodity	Aggregate	Lower income	Medium income	Higher income
Fresh fruits and nuts	-0.5205	-0.5553	-0.4975	-0.5233
Fresh vegetables	-0.7105	-0.7057	-0.7053	-0.7375
Processed fruits and nuts	-0.7376	-0.7173	-0.7536	-0.7500
Processed vegetables	-0.7142	-0.7100	-0.7024	-0.7486
Poultry	-0.8144	-0.7378	-0.8349	-0.8895
Pork	-0.8359	-0.8338	-0.7712	-0.9500
Beef	-0.4557	-0.5276	-0.4831	-0.3452
Processed meat	-0.7848	-0.7334	-0.7982	-0.8257
Fish	-0.4363	-0.4501	-0.4716	-0.3752
Dairy products	-0.6149	-0.5993	-0.6311	-0.6054
Egg	-0.4665	-0.5021	-0.4476	-0.4306
Grains	-0.5875	-0.5785	-0.5999	-0.5748
Processed food	-0.7749	-0.7589	-0.7770	-0.7873
Sweets	-0.6956	-0.6962	-0.6874	-0.7179
Sweetened drinks	-0.8493	-0.8729	-0.8223	-0.8553
Fats	-0.6560	-0.6329	-0.6568	-0.7192

Table 6. The changes in food consumption patterns due to the federal carbon tax in 2018 (excluding the agriculture and the government services sectors)

Food commodity	Lower Income	Medium Income	Higher Income
Oilseeds	-0.10%	-0.11%	-0.10%
Wheat	-0.10%	-0.10%	-0.10%
Grains (except wheat)	-0.10%	-0.10%	-0.10%
Fresh potatoes	-0.12%	-0.12%	-0.12%
Fresh fruits and nuts	-0.12%	-0.13%	-0.13%
Other miscellaneous crop products	-0.10%	-0.10%	-0.10%
Fresh vegetables (except potatoes)	-0.12%	-0.12%	-0.13%
Unprocessed fluid milk	-0.10%	-0.11%	-0.10%
Eggs in shell	-0.09%	-0.08%	-0.07%
Poultry	-0.13%	-0.14%	-0.15%
Fish, crustaceans, shellfish and other fishery products	-0.08%	-0.08%	-0.06%
Flour and other grain mill products	-0.13%	-0.14%	-0.13%
Cereal products, Margarine and cooking oils	-0.31%	-0.32%	-0.33%
Grain and oilseed products	-0.13%	-0.13%	-0.13%
Confectionery products	-0.19%	-0.19%	-0.20%
Fresh, frozen and canned fruit and vegetable juices	-0.19%	-0.20%	-0.20%
Preserved fruit and vegetables and frozen foods	-0.20%	-0.21%	-0.21%
Processed fluid milk and milk products	-0.15%	-0.16%	-0.15%
Cheese and cheese products	-0.15%	-0.16%	-0.15%
Butter and dry and canned dairy products	-0.15%	-0.16%	-0.15%
Ice cream, sherbet and similar frozen desserts	-0.19%	-0.20%	-0.20%
Fresh and frozen beef and veal	-0.13%	-0.12%	-0.08%
Fresh and frozen pork	-0.20%	-0.19%	-0.23%
Fresh and frozen poultry of all types	-0.18%	-0.20%	-0.21%
Processed meat products, other meats and animal by-products	-0.18%	-0.19%	-0.20%
Prepared and packaged seafood products	-0.11%	-0.11%	-0.09%
Bread, rolls and flatbreads	-0.21%	-0.21%	-0.21%
Cookies, crackers and baked sweet goods	-0.21%	-0.21%	-0.21%
Flour mixes, dough and dry pasta	-0.20%	-0.21%	-0.21%
Snack food products	-0.20%	-0.21%	-0.21%
Other food products	-0.20%	-0.20%	-0.21%
Total food products	-0.15%	-0.16%	-0.16%

Table 7. The changes in the food consumption patterns due to the 2018 federal carbon tax (including all economic sectors)

Food commodity	Lower Income	Medium Income	Higher Income
Oilseeds	-0.50%	-0.52%	-0.50%
Wheat	-0.50%	-0.52%	-0.50%
Grains (except wheat)	-0.50%	-0.52%	-0.50%
Fresh potatoes	-0.61%	-0.61%	-0.64%
Fresh fruits and nuts	-0.62%	-0.65%	-0.65%
Other miscellaneous crop products	-0.49%	-0.51%	-0.48%
Fresh vegetables (except potatoes)	-0.12%	-0.12%	-0.13%
Unprocessed fluid milk	-0.10%	-0.11%	-0.10%
Eggs in shell	-0.09%	-0.08%	-0.07%
Poultry	-0.13%	-0.14%	-0.15%
Fish, crustaceans, shellfish and other fishery products	-0.08%	-0.08%	-0.06%
Flour and other grain mill products	-0.33%	-0.34%	-0.33%
Cereal products, Margarine and cooking oils	-0.82%	-0.84%	-0.89%
Grain and oilseed products	-0.34%	-0.35%	-0.34%
Confectionery products	-0.24%	-0.23%	-0.24%
Fresh, frozen and canned fruit and vegetable juices	-0.26%	-0.27%	-0.27%
Preserved fruit and vegetables and frozen foods	-0.29%	-0.30%	-0.31%
Processed fluid milk and milk products	-0.71%	-0.74%	-0.71%
Cheese and cheese products	-0.71%	-0.75%	-0.72%
Butter and dry and canned dairy products	-0.69%	-0.73%	-0.70%
Ice cream, sherbet and similar frozen desserts	-0.90%	-0.92%	-0.93%
Fresh and frozen beef and veal	-0.67%	-0.62%	-0.44%
Fresh and frozen pork	-1.07%	-0.99%	-1.22%
Fresh and frozen poultry of all types	-0.94%	-1.07%	-1.14%
Processed meat products, other miscellaneous meats	-0.92%	-1.00%	-1.04%
Prepared and packaged seafood products	-0.73%	-0.76%	-0.60%
Bread, rolls and flatbreads	-0.27%	-0.28%	-0.28%
Cookies, crackers and baked sweet goods	-0.27%	-0.28%	-0.28%
Flour mixes, dough and dry pasta	-0.32%	-0.33%	-0.33%
Snack food products	-0.30%	-0.31%	-0.32%
Other food products	-0.37%	-0.38%	-0.39%
All food products	-0.48%	-0.50%	-0.49%

Table 8. The change in food consumption patterns due to the provincial carbon tax plans in 2018

Commodity	AB	BC	RC	MS	ON	QC	CANADA
Oilseeds	-0.29%	-0.20%	-0.21%	-0.22%	-0.12%	-0.34%	-0.10%
Wheat	-0.29%	-0.20%	-0.21%	-0.21%	-0.12%	-0.34%	-0.10%
Grains (except wheat)	-0.29%	-0.20%	-0.21%	-0.21%	-0.12%	-0.34%	-0.10%
Fresh potatoes	-0.35%	-0.24%	-0.26%	-0.25%	-0.15%	-0.41%	-0.12%
Fresh fruits and nuts	-0.37%	-0.25%	-0.27%	-0.26%	-0.15%	-0.43%	-0.12%
Other miscellaneous crop products	-0.29%	-0.24%	-0.21%	-0.21%	-0.12%	-0.34%	-0.10%
Fresh vegetables (except potatoes)	-0.36%	-0.23%	-0.28%	-0.25%	-0.19%	-0.47%	-0.12%
Unprocessed fluid milk	-0.38%	-0.23%	-0.22%	-0.31%	-0.16%	-0.32%	-0.10%
Eggs in shell	-0.29%	-0.18%	-0.16%	-0.24%	-0.12%	-0.25%	-0.08%
Poultry	-0.51%	-0.31%	-0.29%	-0.41%	-0.21%	-0.43%	-0.14%
Fish and other fishery products	-0.17%	-0.10%	-0.12%	-0.18%	-0.08%	-0.23%	-0.07%
Flour and other grain mill products	-0.34%	-0.22%	-0.28%	-0.24%	-0.15%	-0.37%	-0.13%
Cereal products and cooking oils	-0.82%	-0.65%	-0.64%	-0.59%	-0.36%	-0.89%	-0.32%
Grain and oilseed products	-0.34%	-0.22%	-0.28%	-0.24%	-0.15%	-0.37%	-0.13%
Confectionery products	-0.36%	-0.24%	-0.54%	-0.30%	-0.22%	-0.45%	-0.19%
Fruit and vegetable juices	-0.42%	-0.31%	-0.47%	-0.30%	-0.22%	-0.63%	-0.20%
Preserved fruit and vegetables	-0.46%	-0.33%	-0.46%	-0.38%	-0.24%	-0.61%	-0.21%
Processed milk products	-0.37%	-0.24%	-0.27%	-0.29%	-0.18%	-0.38%	-0.16%
Cheese and cheese products	-0.37%	-0.24%	-0.27%	-0.29%	-0.18%	-0.38%	-0.16%
Butter and dry dairy products	-0.37%	-0.25%	-0.27%	-0.29%	-0.19%	-0.38%	-0.16%
Ice cream, similar frozen desserts	-0.46%	-0.31%	-0.34%	-0.37%	-0.23%	-0.48%	-0.20%
Fresh and frozen beef and veal	-0.31%	-0.18%	-0.23%	-0.20%	-0.13%	-0.29%	-0.11%
Fresh and frozen pork	-0.57%	-0.34%	-0.42%	-0.37%	-0.24%	-0.53%	-0.20%
Fresh and frozen poultry	-0.56%	-0.33%	-0.41%	-0.36%	-0.24%	-0.51%	-0.20%
Processed and miscellaneous meats	-0.53%	-0.32%	-0.36%	-0.34%	-0.23%	-0.50%	-0.19%
Prepared and packaged seafood	-0.23%	-0.13%	-0.17%	-0.17%	-0.11%	-0.20%	-0.10%
Bread, rolls and flatbreads	-0.39%	-0.35%	-0.42%	-0.33%	-0.25%	-0.55%	-0.21%
Cookies and baked sweet goods	-0.40%	-0.34%	-0.44%	-0.37%	-0.25%	-0.55%	-0.21%
Flour mixes, dough and dry pasta	-0.41%	-0.35%	-0.42%	-0.32%	-0.25%	-0.54%	-0.21%
Snack food products	-0.39%	-0.35%	-0.42%	-0.34%	-0.24%	-0.55%	-0.21%
Other food products	-0.43%	-0.33%	-0.36%	-0.34%	-0.24%	-0.53%	-0.20%

Appendix I. The changes in food prices due to the endogenous import price changes

Commodity	AB	BC	RC	MS	ON	QC
Food Commodities						
Oilseeds	0.07%	0.12%	0.09%	0.11%	0.08%	0.22%
Wheat	0.07%	0.12%	0.09%	0.11%	0.08%	0.22%
Grains (except wheat)	0.07%	0.12%	0.09%	0.11%	0.08%	0.22%
Fresh potatoes	0.07%	0.12%	0.09%	0.11%	0.08%	0.22%
Fresh fruits and nuts	0.07%	0.12%	0.09%	0.11%	0.08%	0.22%
Other miscellaneous crop products	0.07%	0.09%	0.09%	0.11%	0.08%	0.22%
Fresh vegetables (except potatoes)	0.07%	0.07%	0.09%	0.11%	0.09%	0.21%
Unprocessed fluid milk	0.13%	0.12%	0.11%	0.18%	0.09%	0.16%
Eggs in shell	0.13%	0.12%	0.11%	0.18%	0.09%	0.16%
Fish, crustaceans, shellfish and other fishery products	0.08%	0.08%	0.07%	0.17%	0.09%	0.19%
Flour and other grain mill products	0.09%	0.16%	0.24%	0.12%	0.09%	0.23%
Cereal products, Margarine and cooking oils	0.08%	0.07%	0.14%	0.11%	0.09%	0.24%
Grain and oilseed products	0.08%	0.16%	0.24%	0.11%	0.09%	0.22%
Confectionery products	0.08%	0.06%	0.11%	0.10%	0.07%	0.13%
Fresh, frozen, canned fruit and vegetable juices	0.09%	0.08%	0.10%	0.11%	0.08%	0.13%
Preserved fruit and vegetables and frozen foods	0.09%	0.07%	0.10%	0.11%	0.08%	0.13%
Processed fluid milk and milk products	0.11%	0.10%	0.10%	0.15%	0.10%	0.16%
Cheese and cheese products	0.11%	0.10%	0.10%	0.15%	0.10%	0.16%
Butter and dry and canned dairy products	0.11%	0.10%	0.10%	0.15%	0.10%	0.16%
Ice cream, sherbet and similar frozen desserts	0.11%	0.10%	0.10%	0.15%	0.10%	0.16%
Fresh and frozen beef and veal	0.19%	0.11%	0.17%	0.12%	0.11%	0.14%
Fresh and frozen pork	0.19%	0.11%	0.17%	0.12%	0.11%	0.14%
Fresh and frozen poultry of all types	0.19%	0.11%	0.17%	0.12%	0.11%	0.14%
Processed meat products, other miscellaneous meats	0.19%	0.11%	0.15%	0.12%	0.11%	0.14%
Prepared and packaged seafood products	0.17%	0.06%	0.07%	0.17%	0.11%	0.13%
Bread, rolls and flatbreads	0.07%	0.07%	0.09%	0.10%	0.07%	0.12%
Cookies, crackers and baked sweet goods	0.07%	0.07%	0.09%	0.10%	0.07%	0.12%
Flour mixes, dough and dry pasta	0.07%	0.08%	0.09%	0.11%	0.07%	0.13%
Snack food products	0.07%	0.07%	0.09%	0.11%	0.07%	0.12%
Flavouring syrups, seasonings and dressings	0.07%	0.08%	0.10%	0.11%	0.07%	0.13%
Other food products	0.09%	0.07%	0.07%	0.11%	0.07%	0.13%
Total food	**0.10%**	**0.10%**	**0.11%**	**0.12%**	**0.09%**	**0.17%**
Other agricultural products						
Imputed feed	0.07%	0.12%	0.09%	0.11%	0.08%	0.22%
Nursery and floriculture products	0.07%	0.07%	0.10%	0.12%	0.10%	0.21%
Cattle and calves	0.13%	0.12%	0.11%	0.18%	0.09%	0.16%
Hogs	0.13%	0.12%	0.11%	0.18%	0.09%	0.16%
Poultry	0.13%	0.12%	0.11%	0.17%	0.09%	0.16%
Other live animals	0.13%	0.12%	0.11%	0.18%	0.09%	0.16%
Raw furskins, and animal products	0.12%	0.11%	0.10%	0.18%	0.08%	0.21%
Imputed fertilizer	0.13%	0.12%	0.11%	0.18%	0.09%	0.16%
Support services for crop production	0.07%	0.12%	0.09%	0.11%	0.08%	0.23%
Support services for animal production, hunting,fishing	0.11%	0.12%	0.10%	0.15%	0.07%	0.23%
All commodity	**0.07%**	**0.08%**	**0.08%**	**0.13%**	**0.08%**	**0.23%**

Appendix II. The uncompensated own-price elasticities of food

Food Category	Aggregate	Lower income	Medium income	Higher income
Fresh fruits and nuts	-0.5821	-0.6137	-0.5617	-0.5828
Fresh vegetables	-0.7837	-0.7796	-0.7751	-0.8154
Processed fruits and nuts	-0.7794	-0.7602	-0.7950	-0.7899
Processed vegetables	-0.7456	-0.7439	-0.7325	-0.7782
Poultry	-0.8751	-0.8026	-0.8928	-0.9480
Pork	-0.8817	-0.8887	-0.8091	-0.9972
Beef	-0.5364	-0.6096	-0.5597	-0.4302
Processed meat	-0.8594	-0.8114	-0.8750	-0.8923
Fish	-0.4843	-0.4990	-0.5189	-0.4201
Dairy products	-0.6995	-0.6816	-0.7167	-0.6938
Egg	-0.4769	-0.5155	-0.4569	-0.4377
Grains	-0.6658	-0.6536	-0.6804	-0.6562
Processed food	-0.9129	-0.8843	-0.9216	-0.9371
Sweets	-0.7999	-0.7937	-0.7976	-0.8249
Sweetened drinks	-0.8889	-0.9102	-0.8645	-0.8910
Fats	-0.6832	-0.6645	-0.6825	-0.7406

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