International trade and the convergence in youth technological awareness and expectations within NAFTA: The case of GMOs and nuclear power technologies

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Abstract

Relying on the USA, Canada and Mexico extract from the cross-national data sample on the environmental affection and cognition of adolescent students (Niankara, 2019), along with seemingly unrelated bivariate weighted ordered probit regression modeling (Niankara and Zoungrana, 2018), this study reports on the convergence of technological awareness and expectations within the context of international trade. We achieve this by adopting a regional perspective in investigating the effects of affective, cognitive and situational factors on youth's awareness and expectations about genetically modified organisms (GMOs) and nuclear power technology (NPT) within the North American free trade block. Identification of model parameters is achieved using maximum simulated likelihood methods. The findings show that although it has been over 20 years as of 2015 that USA, Canada, and Mexico ratified the north American free trade agreement (NAFTA), the diffusion of technology and information within the trade block has not succeeded in homogenizing awareness and expectations about GMOs and Nuclear power technology, as observed in the youth population across the three countries. Indeed, with regards to technological awareness, compared to youth from the USA, those from Canada show 15% (GMOs) and 7.1% (NPT) more awareness respectively; while those in Mexico are respectively 34.4% and 19.5% less aware about GMOs and NPT. With respect to technological expectations, compared to youth from the USA, those from Canada and Mexico are respectively 34.4% and 39.9% more optimistic about GMOs, while 15% and 49.7% more optimistic about NPT. Overall, youth within NAFTA country members are respectively 2.5% and 6.7% more optimistic about GMOs and NPT for every level increase in their awareness about the two technologies.

Keywords: Expectations convergence, NAFTA, Sustainable development, Technological transfer, Youth awareness
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1. Introduction

Free Trade Areas (FTAs) characterized by trade liberalization with national trade policy autonomy are processes through which nations enter into agreements to share a common trade zone, allowing all trading partners to benefit from a larger market with lower trade barriers. By allowing member countries to trade with less frictions, FTAs contribute theoretcally overtime to within block convergences in economic, social and environmental factors. In applying the theory of information integration to attitudes and social judgments, based on the principle of information integration, Anderson (1971) concluded that

"*Integration theory has had reasonable success in the areas of learning, perception, judgment, decision making, and personality impressions, as well as attitude change*".

Within the context of international trade, "*Integration theory identifies the economic effects – both short-term static and long-term dynamic – of particular stages of integration processes which should be expected within integrating economies such as free trade areas (FTA)*" (Witkowska, 2016).

As of 2015, the trilateral North American Free Trade Agreement (NAFTA), which was signed between two developed economies (USA, Canada) and one developing economy (Mexico) in 1994, had been in implementation for over 20 years (Zlatev et al., 2018). The adolescents population in US, Canada, and Mexico as of 2015 had been born roughly after NAFTA ratification, and therefore have been directly and indirectly influenced since birth by the trade relationships under its implementation over time (Villareal and Fergusson, 2017). This raises therefore the question as to "*Whether there might be a cross-sectional evidence of convergence in youth technological awareness and expectations in relation to genetically modified organisms (or biotechnology) and Nuclear Power technology between NAFTA country members as of 2015*".

Although much has been written about the extent of economic integration and convergence, or lack of it, among countries (Bélanger and Mace, 2017; Blecker et al., 2017; Franks et al., 2018). Exclusively all of the literature on trade convergence has focused on factors such price (Chatterjee and Das, 2018; Ogrokhina, 2015), income (Kant, 2018; Zhou et al., 2018), real exchange rate (Engel, 2018), economic freedom (Naghshpour and Nissan, 2018) and other macro-economic indicators (Kogan et al., 2017; Ritzberger-Grünwald et al., 2018). Very little is known about the convergence of consumers' awareness and expectations about the traded goods, services, and technology across the integrated economies.

Since economic convergence relies heavily on the diffusion of technology (Park, 2011; Kogan et al., 2017; Wan et al., 2015), knowledge (Grossman and Helpman, 2015), and increased volume of trade (Van den Berg and Lewer, 2015), convergence in technological awareness and expectations should be an important precondition, for an effective economic convergence. Therefore, the impact of increased awareness and positive expectations on resource allocation, research and technological development cannot be exemplified enough. To the best of our knowledge, none of the mainstream convergence literature above mentioned has addressed this issue before. The current analysis

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therefore aims to fill this important void in the literature using the North American extract of the unique data source published in Niankara (2019).

Our major contention in this study is that: "*All things being equal, in the long run, international trade and technological diffusion should lead to a convergence in technological awareness and expectations among trading partners within trading blocks*".

This convergence if successful should be observable in the youth population (Anderson, 1971). Furthermore, with the world population growing at an unprecedented rate, the need for technological innovation to increase productivity in the energy and food sectors are being felt by governments, policy makers, and populations worldwide (Arkolakis et al., 2018). Since Energy as a factor is a proactive agent in facilitating increases in other sectors including food production(Canadian Nuclear Association, 2017), Energy security can be regarded as an important step for food security.

While In the energy sector nuclear power technology (NPT) has been proposed as a cleaner alternative for achieving energy security [1], in the food sector, genetically modified organisms (GMOs) have been proposed as a sustainable solution for global food security [2]. For many aspects of a technology such as its efficacy or safety there are not only "hard" aspects implied, but also they are subject to the perspective of diverse social actors regarding what is considered functional or safe. Such societal determination of "what is" and "how good is" a technology constitutes an important part of not only its "construction" process, but also its "diffusion". Indeed, technologies are bound by the so-called concept of "socio-technical systems" (Smith et al., 2014; Fuenfschilling and Truffer, 2016), whereby technologies are influenced by alliances from heterogeneous factors that impact in their functionality, and in turn technologies can impact on the viability of socio-economic models (Smith and Stirling, 2018).

GMOs and NPT altogether can be seen as two inter-dependents technological artifacts. The interplay of society and technological artifacts can be studied using different approaches including Actor-Network Theory (Bencze et al., 2018; Latour et al., 2005), Social Construction of Technology (Pinch and Bijker, 1984; Bijker, 2009; Rip, 2018), or Socio-technical analysis (Arranz, 2017; Jano-Ito and Crawford-Brown, 2016; Navarro-Pineda et al., 2017). It is important to take into account that, while safety or efficacy of a new technology necessarily needs to be assessed case by case, policies are necessarily made for general application, and thus it is convenient to count with

[1] The International Energy Agency (Ang et al., 2015) defines energy security as "the uninterrupted availability of energy sources at an affordable price". Energy security is essential to support basic human needs and economic necessities (Kruyt et al., 2009) and represents a critical feature regarding systems planning in the environmental, technical, political and social realm (Augutis et al., 2017).

[2] The 1996 World Food Summit declared that "food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996)

analytical tools that address GMOs and NPT as two inter-dependents artifacts.

To this end, we adopt an integration theory approach (Anderson, 1971) , while relying on bivariate weighted ordered probit regression modeling (Niankara, Forthcoming; Niankara and Zoungrana, 2018), to represent our qualitative ordinal measures of youth awareness and expectations about GMOs and NPT in the United states, Canada, and Mexico. This representation allows us to test for the convergence in youth technological awareness and expectations within the North American free trade block, in addition to identifying the determinants factors of youth technological awareness and expectations within the block. The rest of the paper is therefore organized as follows: Section 2 provides a background discussion on GMOs and NPT in the North American Free Trade block; section 3 presents the adopted methodology, by first describing the data, followed by the variables used in the analysis, and ending with the econometric model. Section 4 presents and discusses the findings, while section 5 concludes the analysis and provides policy recommendations.

2. Background

2.1. The North American Free Trade Block

The North American free trade block was formed in January 1st 1994 by the signature of a trilateral trade agreement between the United States of America, CANADA, and Mexico (Nti, 2016). With its environmental cooperation and labor cooperation supplements, NAFTA is credited to have benefited its country members over the years (Zlatev et al., 2018). One of the major expectations of the three countries for such multilateral cooperation was to create a single regionally integrated market which will drastically reduce the cost of imports and inflation to spur trade and investment among the NAFTA partners (Nti, 2016).

Although views are shared in this regards, a recent congressional research report concluded that "NAFTA did not cause the huge job losses feared by the critics or the large economic gains predicted by supporters. The net overall effect of NAFTA on the U.S. economy appears to have been relatively modest, primarily because trade with Canada and Mexico accounts for a small percentage of U.S. GDP. However, there were worker and firm adjustment costs as the three countries adjusted to more open trade and investment among their economies" (Villareal and Fergusson, 2017).

Furthermore, with respect to cross-border technological diffusion, Park (2011) reports that NAFTA played an important role in stimulating technology trade among member countries relative to their trade with the rest of the world. The extent however and scope of technology trade varied by member countries. Mexico for example received a large technology inflow (post-NAFTA) but did not contribute much to technology outflows. Canada on the other hand observed significant inflows and outflows of technology with NAFTA. In the case of the USA, the difference in level of technology trade with NAFTA members, compared to non-NAFTA members was insignificant. Recently, NAFTA country members had come to an agreement to replace its current version with the United States-Mexico-Canada Agreement (USMCA) (Executive Office of the US President, 2018), however NAFTA will remain in vigor till ratification of this new agreement. Nuclear power technology (NPT) and GMOs (biotechnology) play important roles in energy security and food security within NAFTA.

2.2. Nuclear Power Technology (NPT)

NPT is an integral part of most advanced economies. In Canada, Nuclear science & technology contributes over $6 billion annually to the national economy, and supports many sectors including medicine, food safety and energy production (Canadian Nuclear Association, 2017). One of the most familiar applications of this technology in medicine is its use for diagnosis and treatment of various diseases including cancer(Greenwood et al., 2018).

In the agriculture, food and health sectors, radiation from nuclear sources is widely used to sterilize much of the food and products consumed today (Goresline, 2018). Gamma rays are used to kill bacteria and other pathogens while leaving products unchanged and safe for consumption(Vaclavik and Christian, 2014). Cobalt-60 is also a primary source for sterilization, and used for radiation therapy treatments, although this use is being gradually replaced by alternative procedures (Martin, 2018).

In the energy sector nuclear power is the largest non–hydro source of low–carbon, clean energy worldwide (Pioro and Duffey, 2019). It currently provides 11.5% of global electricity supply, with 446 operable nuclear reactors worldwide, and a net generating capacity of approximately 391 GWe (Canadian Nuclear Association, 2017). NAFTA country members account for 115104 MWe, with respectively 100, 19 and 2 power reactors currently operating at nuclear generating stations in USA, Canada, and Mexico, for a total net capacity of 100,013 MWe; 13,491 MWe and 1,600 MWe (World Nuclear Association, 2018*b*,*a*, 2017). These capacities represent 19.5% , 16.6%, and 6.8% of the respective shares of electricity production in the USA, Canada and Mexico.

2.3. Genetically Modified Organisms (GMOs)

According to the Cartagena Protocol on Biosafety, a GMO is defined as "any living organism that possesses a novel combination of genetic material obtained using modern biotechnology"(Hagen and Weiner, 1999). There are two types of GMOs, transgenics and non-transgenics based on the transformation process (Sprink et al., 2016). Transgenic GMOs are altered by the addition of genetic material from a different species, while non-transgenic GMOs are genetically modified without the addition of genetic material from any other or the same species (Bleotu et al., 2018).

While some countries, like the United States and Canada, grow and consume genetically modified (GM) crops and meat openly, others have banned the production and reject their consumption (Brookes and Barfoot, 2016). The worldwide top producing countries of GMOs (crops and meat) are the United States, Brazil, Argentina, Canada and India; while Mexico ranks seventeen, based on the extend of the area used to grow GM crops (Aldemita and Hautea, 2018).

The most commonly produced GM crops are soybean (Glycine max L.), maize (Zea mays subesp. mays L.), cotton (Gossypium hirsutum L.), and canola (Brassica rapa subsp. oleifera) (Aldemita et al., 2015), with the most frequent traits introduced into the GM species being herbicide tolerance (53%), insect resistance (14%), and a combination of both (33%) (James, 2015).

The reported benefits of using GMOs for food or fiber include improvement in yield and reliability of the food supply under harsh climate and limited farmland conditions (Brookes and Barfoot, 2016; Goron and Raizada, 2015; Raman, 2017). These benefits are achieved because of enhanced nutrient utilization and tolerance to drought, high salt content in soil (Jez et al., 2016; Ma et al., 2018).

2.4. Technological Controversies

Both GMOs and NPT use in North America is not without controversy. There is plenty of literature covering non-adoption/rejection of technological artifacts or systems, the Luddite movement at the beginning of the industrial age in the UK is one of the most prominent examples(O'Rourke et al., 2013). Usually referred to as "Resistance", this phenomenon is usually more than just rejection of a certain technological artifact (Clancy, 2017). It involves ideological opposition to the "otherness" among socio-technical alliances of actors with differing interests; and is often channeled through constructing a "non-functional" interpretation of the technological artifact (Thomas et al., 2017).

The use of GMOs as a solution for food security has been very controversial with opposing views among scientists, consumers, and the public (Frewer et al., 2013; Ribeiro et al., 2016; Valente and Chaves, 2018). Some of the concerns expressed by opponents include the potential harm to the environment, biodiversity, human health in combination with socioeconomic, political, and ethical consequences (Raman, 2017; Bonny, 2017; Grumezescu and Holban, 2017).

Nuclear power technology has also been viewed as a controversial energy option for reducing carbon emissions, alleviating global warming and transitioning to low-carbon societies (Jacobson, 2009; Ahearne, 2011); partly because of the 1979 three mile Island nuclear incident in Pennsylvania, the 1986 Chernobyl nuclear disaster in Ukraine, and the more recent 2011 Fukushima-Daichii nuclear accident in Japan (Fan, 2018). The general public often associates nuclear energy with risks that include nuclear accidents, nuclear waste contamination, and nuclear weapons proliferation among others (Yoshida, 2015).

The creation of "The North American Young Generation in Nuclear (NA-YGN)[3]" with chapters across NAFTA country members, is a testament of the important role that young people play in the

[3] "with the vision of developing leaders to energize the future of nuclear, NAYGN was created with the mission of providing opportunities for a young generation of nuclear enthusiasts to develop leadership and professional

sustainable development of nuclear power technology in North America. As such understanding youth's awareness and expectations about nuclear power technology is of the utmost interest to all stakeholders of the North American nuclear industry(Peters and Slovic, 1996).

Beyond all controversies however, three important questions that spring from the above background discussion are:

- (i) what is the consensus about the use of GMOs and NPTs among youth in the North American Free Trade Block?
- (ii) Are there apparent signs of significant convergence in youth awareness and expectations about the two technologies within the block ?
- (iii) What are the determinants of youth awareness and expectations about the two technologies within the block ?

To provide answers to the above raised questions, we follow the methodology presented next.

3. Methods

3.1. Data and Variables Description

The data used in this paper comes from the "Cross-national Data Sample on the Environmental Affection and Cognition of Adolescent Students of Varying Interests in Ecosystem Services and Sustainability" (Niankara, 2019). This data contains information on 187821 students from 50 countries worldwide. After downloading the published data-set from "Data in Brief", we queried the North American (USA, Canada and Mexico) subset for the current analysis. Additional description of its sampling design is found in the OECD report(OECD, 2017, 67-91). The extracted North American subset contains information on 17981 youth respondents, distributed as 3197(USA), 4308(Mexico), 10476(Canada), and is presented in table (1). The exposition in this section closely follow the methodology presented in Niankara and Zoungrana (2018).

3.1.1. Dependents Variables

In this analysis the dependent variables are adolescent students' levels of awareness and expectations about the use of GMOs and NPT in North America:

- TA: Self-Expressed-Technological Awareness : ordinal variable taking the values (1-Never heard, 2-Heard but can't explain, 3-Know and can provide general explanation 4-Familiar and can provide detail explanation) for each of the two technologies:

skills, create life-long connections, engage and inform the public, and inspire today's nuclear power technology professionals to meet the challenges of the 21st century" (NAYGN, 2018).

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1. GMOs: TAgmo; with mean value = 2.55 , and standard deviation = 0.95
2. NPT: TAnpt; with mean value = 2.61 , and standard deviation = 0.83

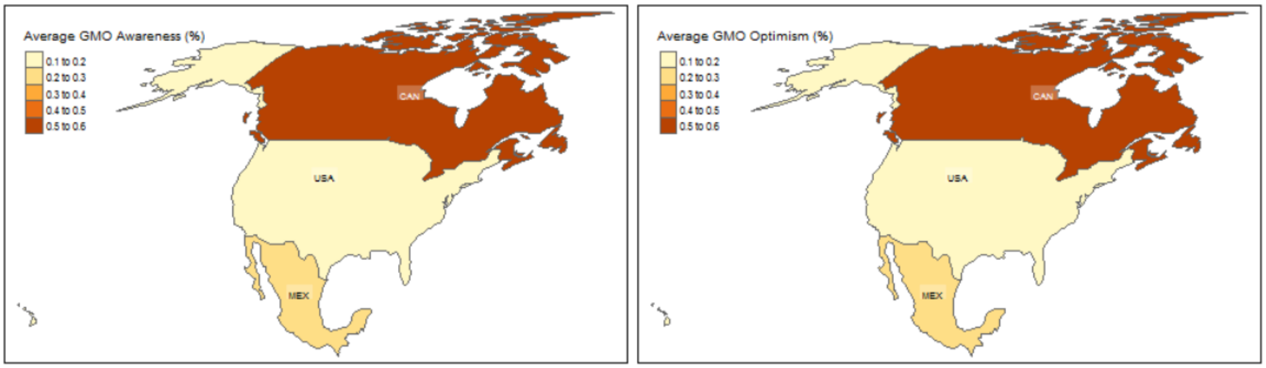

Figure 1: Spatial distribution of youth GMOs awareness and expectations within NAFTA

- TE: Self-Expressed- Technological Expectation: also an ordinal variable taking the values (1-worse, 2-same, 3-Improve) for each of the two technologies:
  1. GMOs: TEgmo; with mean value = 2.28 , and standard deviation = 0.75
  2. NPT: TEnpt; with mean value = 2.41 , and standard deviation = 0.71

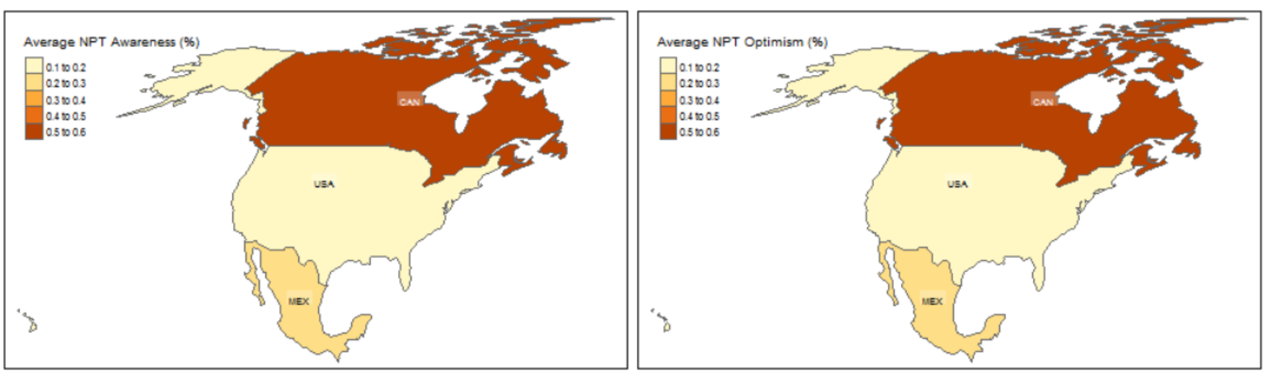

Figure 2: Spatial distribution of youth NPTs awareness and expectations within NAFTA

3.2. Econometric Model Specification

Following the seemingly unrelated bivariate weighted ordered probit model of awareness and expectation presented in Niankara (Forthcoming) and subsequently expended in Niankara and

Zoungrana (2018), which is derived from the latent variable framework described in (Sajaia, 2008), we assume that the awareness (A^*) and Expectation (E^*) for adolescent student i in country j about the technology k are determined by the following two equations:

$$\begin{aligned} A^*_{ijk} &= \alpha_{1jk} + \mathbf{x'}_{1i}\beta_{1k} + \epsilon_{1ijk} \\ E^*_{jik} &= \alpha_{2jk} + \mathbf{x'}_{2i}\beta_{2k} + \gamma_k A^*_{ijk} + \epsilon_{2ijk} \end{aligned} \tag{1}$$

Where β_{1k} and β_{2k} are vectors of unknown parameters to be estimated for each technology k, γ_k is an unknown scalar capturing the effect of youth's awareness on their expectations, and is estimated for each technology k, ϵ_{1ijk} and ϵ_{2ijk} are the error terms of the awareness and expectation equations respectively. α_{1jk} and α_{2jk} denote the country specific effects in the awareness and expectation equations respectively. The explanatory variables in the model are assumed exogenous such that $E(\mathbf{x'}_{1i}\epsilon_{1ijk}) = E(\mathbf{x'}_{2i}\epsilon_{2ijk}) = 0$.

The model system as presented in equation (1) assumes that there are unobserved heterogeneity in adolescents' awareness (A^*_{ijk}) and expectations (E^*_{ijk}) across countries j for each technology k, which are captured by the non-constant model intercepts α_{ijk}. These country-specific effects are the leftover sources of variation in youth's environmental awareness and expectation that cannot be explained by the included predictors in the models. Since free trade areas (FTAs) are characterized by trade liberalization and national trade policy autonomy, the country specific effects control for factors such as the unique local culture, property rights and regulatory practices in each country, which might help explain observed variations in youth's technological awareness and expectations within NAFTA. Given the potential correlation between these country-specific effects and the included predictors, the fixed effect estimator as implemented here using the Rchoice package(Sarrias, 2016) would be more appropriate for the identification of the model system.

Since the sample space covers youth respondents from all 3 country members of NAFTA, the above described approach implies that we would have 3-1 = 2 country specific effects, representing the average differences in youth's technological awareness and expectations with regards to GMOs and NPT between youth in the USA (the reference country), and those in the two other NAFTA country members (Canada and Mexico). These country specific effects are recovered after estimation using the following equations:

$$\begin{aligned} \hat{\alpha}_{1j} &= \bar{A}^*_{ijk} - \bar{\mathbf{x}}'_i\hat{\beta}_{1k} \\ \hat{\alpha}_{2j} &= \bar{E}^*_{ijk} - \bar{\mathbf{x}}'_i\hat{\beta}_{2k} - \bar{A}^*_{ijk}\hat{\gamma}_k \end{aligned} \tag{2}$$

3.3. Test of convergence in youth technological awareness and expectations within NAFTA

We rely on the estimated values of the country specific effects $\hat{\alpha}_{1j}$ and $\hat{\alpha}_{2j}$ to test for the convergence in youth awareness and expectations about GMOs and NPT technologies within the

North American Free Trade block. These are composite statistical tests with the following nulls and alternative hypotheses:

3.3.1. Test of convergence in youth technological Awareness

For this composite test, the null hypothesis assumes cross-sectional convergence in youth's GMOs and NPT Awareness within the north American free trade block as of 2015, that is over 20 years after ratification by the three country members. On the other hand, the alternative hypothesis assumes no cross-sectional convergence in youth's GMOs and NPT Awareness within the north American free trade block as of 2015. Algebraically, this is equivalent to the following notation:

- $H_0 : \alpha_{1jk} = 0$
- $H_1 : \alpha_{1jk} \neq 0$

For more notational clarity, these composite null and alternative hypotheses can be formulated more explicitly for each of the two technologies as follows:

a) For GMOs Awareness.

- $H_0 : \alpha_{1,can,GMO} = \alpha_{1,Mex,GMO} = 0$
- $H_1 : \alpha_{1,can,GMO} \neq \alpha_{1,Mex,GMO} \neq 0$

Where the null explicitly suggests "Homogeneity" in youth GMOs Awareness across the three countries, hence cross-sectional convergence in GMOs awareness; while the alternative suggests "heterogeneity" in youth GMOs Awareness, and hence no cross-sectional convergence. Similarly for NPT Awareness as shown next.

b) For NPT Awareness.

- $H_0 : \alpha_{1,can,NPT} = \alpha_{1,Mex,NPT} = 0$
- $H_1 : \alpha_{1,can,NPT} \neq \alpha_{1,Mex,NPT} \neq 0$

3.3.2. Test of convergence in youth technological Expectations

For this composite test, the null hypothesis assumes cross-sectional convergence in youth's GMOs and NPT Expectations within the north American free trade block as of 2015. On the other hand, the alternative hypothesis assumes no cross-sectional convergence in youth's GMOs and NPT Expectations within the north American free trade block as of 2015. Algebraically, this is equivalent to the following notation:

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- $H_0 : \alpha_{2jk} = 0$
- $H_1 : \alpha_{2jk} \neq 0$

For more notational clarity as well, these composite null and alternative hypotheses of youth expectations can be formulated more explicitly for each of the two technologies as follows:

a) For GMOs Expectations.

- $H_0 : \alpha_{2,can,GMO} = \alpha_{2,Mex,GMO} = 0$
- $H_1 : \alpha_{2,can,GMO} \neq \alpha_{2,Mex,GMO} \neq 0$

Where the null explicitly suggests "Homogeneity" in youth GMOs expectations across the three countries, hence cross-sectional convergence in GMOs expectations; while the alternative suggests "heterogeneity" in youth GMOs Expectations, and hence no cross-sectional convergence. Similarly for NPT Expectations as shown next.

b) For NPT Expectations.

- $H_0 : \alpha_{2,can,NPT} = \alpha_{2,Mex,NPT} = 0$
- $H_1 : \alpha_{2,can,NPT} \neq \alpha_{2,Mex,NPT} \neq 0$

Using the identification method described next, we estimate the effects described in the system of equations (2), and test the above declined hypotheses.

3.4. Identification of Model Parameters

From the latent variables' model specification in equation (1), abstracting from the subscripts for country j and technology k, the observed variables for youth's self-expressed technological awareness (TA) and technological expectation (TE) for each technology (GMOs , NPT) are related to their corresponding latent variables in equation (1) as:

$$TA_i = \begin{cases} 1 - Never\ Heard & \text{if } A_i^* \leq \mu_1 \\ 2 - Heard,\ but\ Unable\ to\ Explain & \text{if } \mu_1 \leq A_i^* \leq \mu_2 \\ 3 - Know,\ can\ provide\ General\ Explanation & \text{if } \mu_2 \leq A_i^* \leq \mu_3 \\ 4 - Familiar,\ can\ provide\ Detailed\ Explanation & \text{if } \mu_3 < A_i^* \end{cases} \tag{3}$$

$$TE_i = \begin{cases} 1 - Worse & \text{if } E_i^* \leq \delta_1 \\ 2 - Same & \text{if } \delta_1 \leq E_i^* \leq \delta_2 \\ 3 - Improve & \text{if } \delta_2 < E_i^* \end{cases} \tag{4}$$

Where $\mu_1 < \mu_2 < \mu_3$ and $\delta_1 < \delta_2$ are unknown cutoffs points. For identification purposes, following Jackman (2000); McKelvey and Zavoina (1975) we define $\mu_1 = \delta_1 = 0$, while $\mu_0 = \delta_0 = -\infty$ and $\mu_4 = \delta_3 = +\infty$ in order to avoid handling the boundary cases separately. For any two index j and k on the two latent scales, the probability that $TA_i = j$ and $TE_i = k$ is given by:

$$\begin{aligned} Pr(TA_i = j\ ,\ TE_i = k) &= Pr(\mu_{j-1} < A_i^* \leq \mu_j\ ,\ \delta_{k-1} < E_i^* \leq \delta_k) \\ &= Pr(A_i^* \leq \mu_j\ ,\ E_i^* \leq \delta_k) \\ &- Pr(A_i^* \leq \mu_{j-1}\ ,\ E_i^* \leq \delta_k) \\ &- Pr(A_i^* \leq \mu_j\ ,\ E_i^* \leq \delta_{k-1}) \\ &+ Pr(A_i^* \leq \mu_{j-1}\ ,\ E_i^* \leq \delta_{k-1}) \end{aligned} \tag{5}$$

Assuming the joint distribution of ϵ_{1i} and ϵ_{2i} is bivariate standard normal, with correlation ρ each youth's contribution to the likelihood function is expressed as:

$$\begin{aligned} Pr(TA_i = j\ ,\ TE_i = k) &= \Phi_2(\mu_j - \alpha_j - \mathbf{x}'_{1i}\beta_1\ ,\ (\delta_k - \alpha_k - \gamma\mathbf{x}'_{1i}\beta_1 - \mathbf{x}'_{2i}\beta_2)\zeta, \tilde{\rho}) \\ &- \Phi_2(\mu_{j-1} - \alpha_{j-1} - \mathbf{x}'_{1i}\beta_1\ ,\ (\delta_k - \alpha_k - \gamma\mathbf{x}'_{1i}\beta_1 - \mathbf{x}'_{2i}\beta_2)\zeta, \tilde{\rho}) \\ &- \Phi_2(\mu_j - \alpha_j - \mathbf{x}'_{1i}\beta_1\ ,\ (\delta_{k-1} - \alpha_{k-1} - \gamma\mathbf{x}'_{1i}\beta_1 - \mathbf{x}'_{2i}\beta_2)\zeta, \tilde{\rho}) \\ &+ \Phi_2(\mu_{j-1} - \alpha_{j-1} - \mathbf{x}'_{1i}\beta_1\ ,\ (\delta_{k-1} - \alpha_{k-1} - \gamma\mathbf{x}'_{1i}\beta_1 - \mathbf{x}'_{2i}\beta_2)\zeta, \tilde{\rho}) \end{aligned} \tag{6}$$

where $\zeta = \frac{1}{\sqrt{1+2\gamma\rho+\gamma^2}}$ and $\tilde{\rho} = \zeta(\gamma + \rho)$. Φ_2 is the cumulative distribution function of the bivariate standard normal. This model specification is referred to as simultaneous bivariate ordered probit. When $\rho = 0$ it simplifies to a seemingly unrelated specification with $\zeta = 1$ and $\tilde{\rho} = \gamma$. As in Niankara (Forthcoming); Niankara and Zoungrana (2018) the model is estimated here under the weighted seemingly unrelated specification, using the package(Sarrias, 2016) from the R statistical software(R Core Team, 2015).

4. Results

4.1. Descriptive Summary Statistics of the Explanatory Variables

The means and standard deviations of the quantitative variables at the top of table (1) show that the average youth respondent is somewhat interested (3.50) in ecosystem services and sustainability, but interested (4.02) in how science can help prevent diseases. The standardized measure of youth enjoyment of science suggests that the average adolescent in the North American free trade block is 0.44 standard deviation above the mean value of youth's science enjoyment across all respondents in the 2015 Programme for International Students Assessment (PISA)(OECD, 2016).

With regards to youth's information diet, which may help shape their awareness and expectations about GMOs and NPT within NAFTA, it can be noted that the average adolescent reports to regularly visit ecological websites (3.41), follow news blogs (3.27), read books on broad science (3.37), visit websites on broad science (3.06), read science articles in magazines and newspapers, and also attend science clubs (3.70). Of all the sources of information considered, television programs on broad science, which respondents report to watching sometimes (2.95), seem to attract the least youth interests.

The descriptive results from the socio-economic and demographic factors suggest that the average youth respondent is 15.84 years of age, and lives in a family with wealth that is 0.14 standard deviation above the mean value of wealth across all respondents; and socio-economic status that is 0.13 standard deviation above the mean economic, social and cultural status across all respondents. Furthermore, the mean parental education level shows that both parents have a least a post-secondary non-tertiary education, mother (4.50) and father (4.38), based on the UNESCO international standard classification of education.

The descriptive results of the qualitative variables at the bottom of table (1) suggest that the majority of the youth respondents in our sample live in Canada (58.26%), followed by Mexico (23.96%), and finally USA (17.78%). Most respondents (83.27%) are natives of their country of reporting, with only 7.70% first generation immigrants, and 9.03% second generation. With respect to gender, we note that 52.38% of the respondents are females, against 47.62% males. In terms of their grade in school, we note that most youth (83.3%) are in 10th grade, followed by 12.02% in 9th grade, then 3.65% in 11th grade, 0.67% in 8th grade, 0.27% in 7th grade, and finally 0.08% in 12th grade. This latter result suggests that 98.97% of all youth respondents in the data are between 9th and 11th grade.

4.2. Unconditional frequency distributions of youth technological awareness and expectations

The unconditional percent relative frequency distributions of youth awareness and expectations about GMOs and NPT within the North American free trade block are presented in table (2), and also graphically summarized in figure (3).

With regards to GMOs awareness (TAgmo), we note that the majority of youth (34.78%) report to having heard about GMOs but are unable to explain, followed by 32.66% that report knowing about it and able to provide general explanations, then 18.31% that report being familiar with GMOs and able to provide detailed explanations, and finally 14.25% that report having never heard about GMOs. Concerning youth GMOs expectations for the next 20 years (TEgmo), we note that the majority of youth respondents are optimistic (46.38%), and believe it will improve overtime; followed by 35.6% that trust it will stay the same, and finally 18.02% that feel pessimistic, trusting it will get worse over the next 20 years.

We also observe a similar pattern with regards to youth NPT awareness and expectations. Indeed, from the distribution of youth NPT awareness (TAnpt) we note that the majority of north

American youth adolescents (38.86%) report to having heard about NPT, but are unable to explain, followed by 38.32% that report knowing about it and able to provide general explanations, then 15.33% that report being familiar with it and able to provide detailed explanations, and finally 7.49% that report having never heard about it. In relation to their expectations about NPT for the next 20 years (TEnpt), we note that the majority of youth respondents are optimistic (54.28%), and believe it will improve overtime; followed by 32.24% that trust it will stay the same, and finally 13.48% that feel pessimistic, trusting it will get worse over the next 20 years.

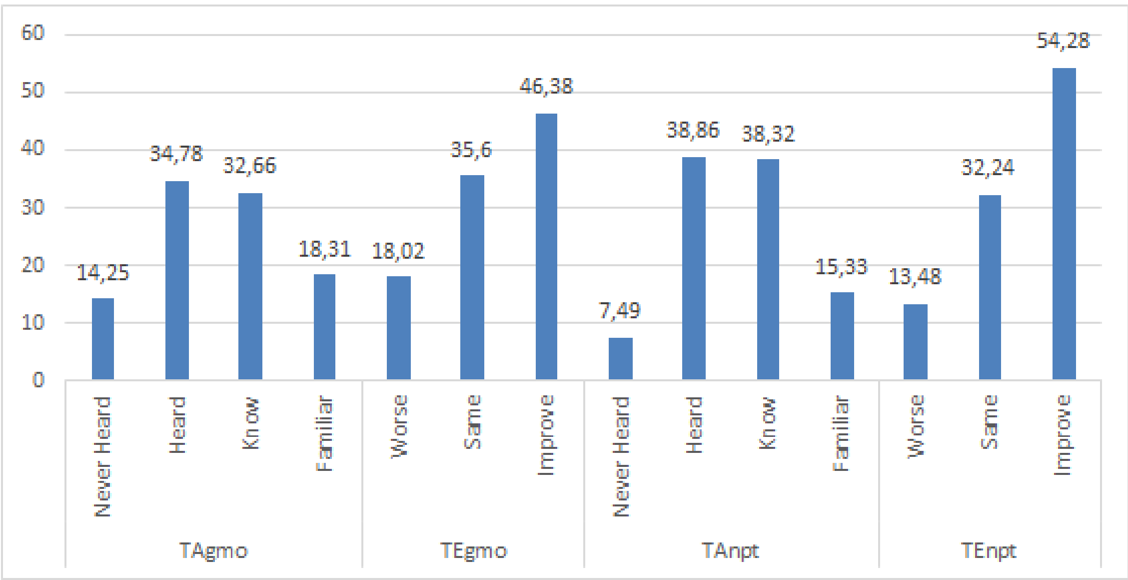

Figure 3: Unconditional percent relative frequencies of youth technological awareness and expectations

4.3. Conditional frequency distributions of youth technological awareness and expectations

Breaking down the above described unconditional percent relative frequency distributions by youth country of residency (CNT) within NAFTA, we can observe the variations in youth's awareness and expectations about GMOs and NPT, across the North American Free Trade block. This conditional percent relative frequency distribution is presented in table (2), and further summarized in figure (4).

Focusing on GMOs awareness (TAgmo), we note that except among the youth that report to being familiar with GMOs and able to provide detailed explanations, where the relative frequency of youth from USA (17.89%) is higher than that of Mexico (8.72%) and both lower than that of Canada (74.06%), across all levels of GMOs awareness, the relative frequency of youth is the highest in Canada, followed by Mexico, and finally the USA. With regards to GMOs expectations (TEgmo), we note that overall, across all levels of expectations, the relative frequency of youth is the highest in Canada, followed by Mexico, then the USA.

Turning our attention now to youth awareness about NPT (TAnpt), we observe an identical pattern to that previously described for the case of GMOs awareness (TAgmo). The same observation is made of youth expectations about NPT (TEgmo) also in figure (4).

In sum, the results indicate significant variations in youth's GMOs and NPT awareness and expectations between USA, Canada, and Mexico. These results are further confirmed by the chi-square test results shown in the last column of table (2). Indeed the p-values of the chi-square tests suggest highly significant ($\alpha = 0.1\%$) relationships between youth's country of residence (CNT) within the north American free trade block, and their reported technological awareness (TAgmo, TAnpt) and expectations (TEgmo, TEnpt) within NAFTA.

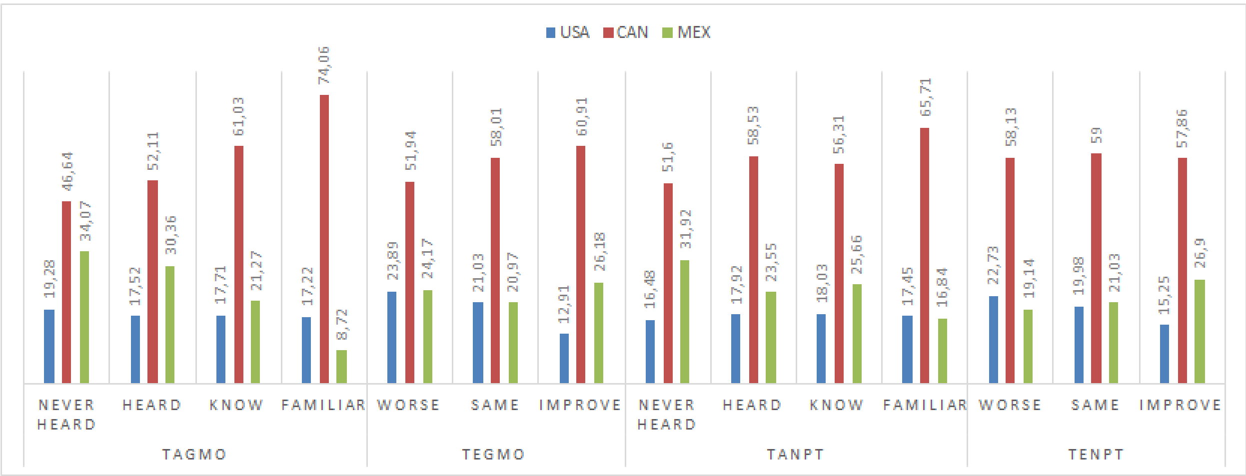

Figure 4: Conditional percent relative frequencies of youth technological awareness and expectations by country

4.4. Econometric Results

The determinants factors of youth's GMOs and NPT awareness and expectations are grouped into four broad categories including: Affective factors, knowledge control factors, demographic & economic factors, and country specific factors. These are summarized in tables (3) and (4) respectively for GMOs and NPT.

4.4.1. Determinants of youth's GMOs awareness within NAFTA

Maximum likelihood estimation (MLE) results for the determinants of youth's GMOs awareness are summarized in the first column of table (3). Starting with the affective factors, we note that all three have positive and significant effects on youth awareness about GMOs in the north American free trade area. Indeed, each level increase in youth's interests in ecosystem services and sustainability (IntBiosph) raises their level of awareness about GMOs by 16.6%. Similarly, each level increase in youth's interests in science as a means for disease prevention (IntScPrevDis),

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raises their awareness about GMOs by 3.9%. Moreover, a standard deviation increase in youth's normalized index of science enjoyment also increases their awareness about GMOs by 17.3%.

Conversely, the knowledge control factors are all negative and significant, suggesting that each level increase in youth's frequency of ecological website visits (EcoWebVisit), blogs visits (BlogsVisit), broad science television program watching (BroadScTVprog), broad science books reading (BroadScBooks), broad science web browsing (BroadScWeb), science article reading in newspapers and magazines (MagScArtNewsp), and science club attendance (ScClubAttend) reduce respectively by 0.5%, 6%, 3.2%, 2.4%, 5%, 2.5%, and 2.1% youth's awareness about GMOs.

From the demographic and economic factors, we note that each year increase in age raises youth's awareness by 6.7%, while each unit increase in family wealth raises their GMOs awareness by 0.6%. Furthermore, each standard deviation increase in youth's standardized index of economic, social, and cultural status (ESCS), leads to 16% higher awareness about GMOs. Similarly each level increase in father's education raises by 2.1% youth's GMOs awareness, while each level increase in mother's education reduces youth's GMOs awareness by 6.7%.

The positive coefficient value on the gender variable suggests that compared to female respondents, males are 8.9% more aware about GMOs. The estimated effects of immigration status suggest that compared to youth that are natives of their country of reporting, first generation immigrants youth do not show a significant difference in GMOs awareness, while second generation youth immigrants do show 6.7% less awareness about GMOs. Finally, the grade level effects show that compared to youth in 7th grade, those in 8th and 11th grade are respectively 4.6% and 3.8% more aware about GMOs, while those in grades 9, 10, and 12 are respectively 17.3%, 8.8% and 64.8% less awareness about GMOs.

4.4.2. Determinants of youth's GMOs expectations within NAFTA

Maximum likelihood estimation (MLE) results for the determinants of youth's GMOs expectations are summarized in the second column of table (3). All three affective factors are found to positively and significantly affect youth expectations about GMOs in the north American free trade area. Indeed, we note that each level increase in youth's interests in ecosystem services and sustainability (IntBiosph) raises their level of optimism about GMOs by 2.2%. Similarly for each level increase in youth's interests in science as a means for disease prevention (IntScPrevDis), which is found to raise by 1.9% youth optimism about GMOs. Finally, each standard deviation increase in youth normalized index of science enjoyment positively influence (0.5%) their expectations about the evolution of GMOs for the next 20 years in the north American free trade area.

Turning our attention to the knowledge control factors, we note that all sources of information positively affect youth's GMOs expectations except for broad science television program viewing, which seems to negatively influence youth's expectations. Indeed, the results show that each level increase in youth's frequency of ecological website visits raises their optimism about GMOs by 3.7%, this figure is however 1.5% for youth increased frequency of blogs visits, 0.4% for their increased frequency of broad science books reading, 0.5% for their increased frequency of broad science web browsing, 1.7% for their increased frequency of science article reading in newspapers and magazines, and finally 2.9% for youth's increased frequency of science club attendance. On the opposite, each level increase in youth frequency of broad science television program viewing reduces by 0.8% their level of optimism about GMOs in the north American free trade area.

From the demographic and economic factors, we note that each year increase in age raises youth's optimism about GMOs by 0.7%, while each unit increase in family wealth reduces their optimism about GMOs by 4.3%. Furthermore, each standard deviation increase in youth's standardized index of economic, social, and cultural status (ESCS), raises by 8.8% their optimism about GMOs. Conversely however, each level increase in parental education reduces youth optimism about GMOs by respectively 0.6% for mother's education, and 1.6% for father's education.

The negative coefficient value on the gender variable suggests that compared to female youth respondents, males are 17.1% less optimistic about GMOs. The estimated effects of immigration status suggest that compared to youth that are natives of their country of reporting, first and second generations immigrants youth are respectively 12% and 9.2% less optimistic about GMOs in the north American free trade area.

The estimated grade level effects show that compared to their 7th grade counterparts, youth in 8th, 9th, 10th, 11th, and 12th grades are respectively 10.9% , 19%, 27.4%, 39.5%, and 70% more optimistic about the evolution of GMOs for the next 20 years in the north American free trade area. Finally, the positive coefficient value ($\hat{\gamma} = 0.025$) on the awareness variable at the bottom of table (3) indicates that youth in the north American free trade area are 2.5% more optimistic about GMOs, for every level increase their awareness about genetically modified organisms.

4.4.3. Determinants of youth's NPT awareness within NAFTA

MLE results for the determinants of youth's NPT awareness are summarized in the first column of table (4). Starting with the affective factors, all three have positive and significant effects on youth awareness about NPT in the north American free trade area. Indeed, it can be noted that each level increase in youth's interests in ecosystem services and sustainability (IntBiosph) raises their level of awareness about NPT by 14.6%. Similarly for every level increase in youth's interests in science as a means for disease prevention (IntScPrevDis), which is found to raise youth's NPT awareness by 4.8%. Finally, each standard deviation increase in youth normalized index of science enjoyment also raises their awareness about NPT by 13.8%.

Conversely, the knowledge control factors are all negative and significant, except for "ScClubAttend", suggesting that each level increase in youth's frequency of ecological website visits (EcoWebVisit), blogs visits (BlogsVisit), broad science television program watching (BroadScTVprog), broad science books reading (BroadScBooks), broad science web browsing (BroadScWeb), science article reading in newspapers and magazines (MagScArtNewsp) reduce respectively by 4.2%, 7.1%, 3.2%, 3.3%, 3.8%, and 3.9%, their awareness about NPT. Conversely, each level increase in science club attendance (ScClubAttend) raises by 3.5% youth's awareness about NPT in the north American free trade area.

From the demographic and economic factors, we note that each year increase in age raises youth's awareness about NPT by 3.2%, while each unit increase in family wealth raises youth's awareness about NPT by 2.1%. Furthermore, each standard deviation increase in youth's standardized index of economic, social, and cultural status (ESCS), leads to 5.8% higher awareness about NPT. Similarly, for each level increase in father's education level, which raises by 2.3% youth's NPT awareness. Conversely, each level increase in mother's education level is found to reduce by 1.9% youth's NPT awareness.

The positive coefficient value on the gender variable suggests that compared to female respondents, males are 15% more aware about NPT. The estimated coefficient values on immigration status suggest that compared to youth that are natives of their country of reporting, first generation immigrants youth are 5.4% more aware about NPT, while second generation youth immigrants show 12.9% less awareness about NPT in the north American free trade area.

Finally, the effects of grade levels suggest that compared to youth in 7th grade, only those in 8th, 11th, and 12th grades show significantly different levels of awareness about NPT. However, although 8th graders show relatively 8.4% less awareness, 11th and 12th graders show respectively 11.5% and 61.5% more awareness about NPT in the north American free trade area.

4.4.4. Determinants of youth's NPT expectations within NAFTA

MLE results for the determinants of youth's NPT expectations are summarized in the second column of table (4). Focusing first on the affective factors, we note that each level increase in youth's interests in ecosystem services and sustainability (IntBiosph) raises their level of optimism about NPT by 1%. A similar observation is made for each level increase in youth's interests in science as a means for disease prevention (IntScPrevDis), which is found to raise by 2.8% their optimism about NPT. Conversely, each standard deviation increase in youth's normalized index of science enjoyment reduces by 1.5% their expectations about the evolution of NPT in the next 20 years.

Turning our attention now to the knowledge control factors, we note that all sources of information positively affect youth NPT expectations, except for blogs visits (BlogsVisit) and broad science web browsing (BroadScWeb), which seem to negatively influence youth expectations. Indeed, the results show that each level increase in youth's frequency of ecological website visits raises their optimism about NPT by 6.4%; This figure is however 2.7% for youth increased frequency of broad science television program viewing, 0.45% for their increased frequency of broad science books reading, 1% for their increased frequency of science article reading in newspapers and magazines, and finally 6.4% for youth's increased frequency of science club attendance. On the opposite, north American youth are 1.3% less optimistic about NPT, for each level increase in their frequency of news blogs visits (BlogsVisit), while 2.1% less optimistic about the technology, for each level increase in their frequency of broad science web browsing (BroadScWeb).

From the demographic and economic factors, we note that each year increase in age raises youth's optimism by 4.5%, while each unit increase in family wealth reduces youth optimism about NPT by 1.4%. Furthermore, each standard deviation increase in the standardized index of economic, social, and cultural status (ESCS), raises by 6.2% youth's optimism about NPT. Conversely however, each level increase in parental education reduces youth optimism about NPT by respectively 0.4% for mother's education, and 1% for father's education. The estimated effects of immigration status suggest that compared to youth that are natives of their country of reporting, first generation immigrants youth are 3.4% more optimistic, while second generation youth immigrants are 2.7% less optimistic about NPT.

The estimated grade level effects show that compared to their 7th grade counterparts, youth in 8th, 9th, 10th, and 11th grades are respectively 3.4% , 23.8%, 46.3%, 63.1%, and 68.8% more optimistic about NPT. Finally, the positive coefficient value ($\hat{\gamma} = 0.067$) for awareness at the bottom of table (4) indicates that youth in the north American free trade area are 6.7% more optimistic about NPT, for each level increase in their awareness of the technology.

4.5. Convergence tests results

The results of the tests of convergence in youth technological awareness and expectations within the north American free trade block are captured by the estimated country specific effects reported at the bottom of tables (3) and (4) for GMOs and NPT respectively.

4.5.1. Convergence in youth GMOs and NPT Awareness within NAFTA

For the test of convergence in youth's GMOs awareness as stated in section (3.3.1.a) since the country specific effects at the bottom of the first column in table (3) are all statistically significant, we reject the null hypothesis, and conclude that the evidence is enough to suggest the existence of significant heterogeneity in youth's awareness about GMOs between USA, Canada, and Mexico. More specifically, compared to youth from the USA, those from Canada show 15.2% more awareness about GMOs, while youth from Mexico are 34.4% less aware about GMOs than their USA counterparts. Together these results indicate the absence of convergence in youth's GMOs awareness within the north American Free trade block.

A similar observation is made about the test of convergence in youth's NPT awareness as stated in section (3.3.1.b). Indeed, since the country specific effects at the bottom of the first column in table (4) are all statistically significant, we reject the null hypothesis and conclude that the evidence is enough to suggest the existence of significant heterogeneity in youth's awareness about NPT between USA, Canada, and Mexico. More specifically, compared to youth from the USA, those from Canada are 7.1% more awareness about NPT, while youth from Mexico are 19.5% less aware about NPT than their USA counterparts. Together these results suggest the absence of convergence in youth's awareness about NPT within the north American Free trade block.

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4.5.2. Convergence in youth GMOs and NPT Expectations within NAFTA

With regards to the test of convergence in youth's expectations about GMOs as stated in section (3.3.2.a), since the country specific effects at the bottom of the second column in table (3) are all positive and statistically significant, we reject the null hypothesis, and conclude that the evidence is enough to suggest the existence of significant heterogeneity in youth's expectations about GMOs between USA, Canada, and Mexico. More specifically, compared to youth from the USA, those from both Canada and Mexico are respectively 34.4% and 39.9% more optimistic about the evolution of GMOs in the next 20 years. Together these results indicate the absence of convergence in youth's expectations about GMOs within the north American Free trade block.

A similar observation is made about the test of convergence in youth's expectations about NPT as stated in section (3.3.2.b). Indeed, since the country specific effects at the bottom of the second column in table (4) are all positive and statistically significant, we reject the null hypothesis, and conclude that the evidence is enough to suggest the existence of significant heterogeneity in youth's expectations about NPT between USA, Canada, and Mexico. More specifically, compared to youth from the USA, those from both Canada and Mexico are respectively 15% and 49.7% more optimistic about the evolution of NPT in the next 20 years. Together these results suggest also the absence of convergence in youth's expectations about NPT within the north American Free trade block.

5. Discussions

Though the literature on economic convergence is vast (Bélanger and Mace, 2017; Zlatev et al., 2018), to the best of our knowledge this is the first study to look at awareness and expectation convergence within the context of international trade and technological diffusion. Our findings corroborate however with the past literature including Witkowska (2016), which looked at the state of the integration processes in the global economy, focusing on three regional integration groupings namely the European Union, the ASEAN Economic Community, and NAFTA. In the case of NAFTA, the study reported that member states do not seem to have an intention to deepen integration in the like of the European patterns and are not pushing NAFTA toward more advanced integration stages. The referendum decision by the British people to leave the European Union through Brexit, along with the recent and still ongoing debate over raising a physical wall between USA and Mexico, by the current US administration are both testaments to the general nature of integration challenges facing these regional blocks since the global financial crisis of 2008. They further contribute to explaining the lack of convergence in youth's technological awareness and expectations observed in the present study.

Although significant heterogeneity still exist across countries, our results indicate greater relative frequencies of awareness and optimism about GMOs and NPT in the north American youth population. In democratic countries such as NAFTA members, the development and diffusion

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of technology is highly incumbent on public acceptance of such technology, therefore the level of awareness and optimism observed in this study suggest the likely continued investment and growth in the biotechnology/GMOs and NPT sectors within NAFTA. Such continued expansion in those two sectors will have important implications for respectively food security, and energy security, in the north American region and beyond, given its weight in the global economy (Dithmer and Abdulai, 2017).

As the country of reference in our study, the position of early U.S. nuclear power policy makers as envisioned in the U.S. Atomic Energy Act of 1954, was that U.S. national interests were best served if the anticipated global flow of nuclear power technology, materials and services was subjected to a disciplined, rules-based order of control led by the U.S., which would be embedded in the global cycle of nuclear power technology, nuclear fuels, nuclear materials and nuclear knowledge in order to minimize the unknowns of the global nuclear supply chain (Gattie et al., 2018). The lack of convergence in nuclear awareness and expectations observed in the present study between U.S. youth and their counterparts in Canada and Mexico as of 2015, reflects therefore a minor set back in the original vision of the1954 Atomic Energy Act.

Interestingly however, our findings show that youth involvement in science clubs (ScClubAttend) as a source of information/knowledge, successfully achieves both, raising their awareness by 3.5%, while keeping them 6.4% more optimistic about nuclear power technology. This result highlights the significance of organizations such as "the North American Young Generation in Nuclear (NA-YGN)(NAYGN, 2018), which provide opportunities for the young generation of nuclear enthusiasts to develop the leadership and professional skills, required to move the north American nuclear power industry forward. This observation further corroborates with the literature drawing on the Theory of Planned Behavior (TPB) and community resilience Craig and Sayers (2019), which shows that awareness of local clean energy initiatives, risk perceptions, environmental messaging, and environmental orientation influence young millennial support for federal clean energy policy and taxes in the united States. Similarly, in the like of the "Foundation for biotechnology Awareness and Education", a regional youth club/association might be useful to consider in the biotechnology sector (North American Young Generation in Biotechnology (NA-YGB)) as a way of bringing young people to the table for the future of the north American biotechnology sector.

6. Conclusion and Policy Recommendations

Modern biotechnology (GMOs) (Raman, 2017; Ma et al., 2018) and nuclear power technology (Ahearne, 2011; Greenwood et al., 2018) are two of the most transformative technologies of the 21st century where many exciting and innovative researches are taking place at a rapid pace, and are already revolutionizing the way we all live (Rip, 2018). They remain however unfamiliar to some sections of society that have certain doubts, apprehensions, anxieties, issues and concerns

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about their utility, durability and impacts (Thomas et al., 2017; Fan, 2018; Valente and Chaves, 2018).

This study therefore relied on the North American extract from the cross-sectional data sample on the environmental affection and cognition of adolescent students (Niankara, 2019), along with seemingly unrelated bi-variate weighted ordered probit modeling (Niankara and Zoungrana, 2018) to look at how affective, cognitive, situational, socio-economic and demographic factors influence north American youth's awareness and expectations about GMOs and Nuclear power technologies. It was carried out with the aim of checking whether a cross-sectional evidence of convergence in youth technological awareness and expectations exists between NAFTA country members, as of 2015; namely over 20 years after its ratification by all three members.

We found no evidence of such convergence, instead the results suggested significant heterogeneity in youth awareness and expectations about GMOs and NPT between USA, Canada and Mexico. Overall however, there are relatively more awareness and optimism about the two technologies among the youth in the north American free trade area. If economic integration, technological diffusion for food (FAO, 1996) and energy (Ang et al., 2015) security is to be achieved for the greater good, then the critical need of the hour is for the global scientific community to become more active and reach out to the general public, including the youth population to educate them about these technologies, and also create proper awareness about the developments in science and technology in a way that the public can understand. This will lead to better expectations, and thereby ease the development and diffusion of these technologies.

References

Ahearne, John F (2011), 'Prospects for nuclear energy', *Energy Economics* **33**(4), 572–580.

Aldemita, Rhodora R, Ian Mari E Reaño, Renando O Solis and Randy A Hautea (2015), 'Trends in global approvals of biotech crops (1992–2014)', *GM crops & food* **6**(3), 150–166.

Aldemita, Rhodora R and Randy A Hautea (2018), 'Biotech crop planting resumes high adoption in 2016', *GM crops & food* **9**(1), 1–12.

Anderson, Norman H (1971), 'Integration theory and attitude change.', *Psychological review* **78**(3), 171.

Ang, Beng Wah, Wei Lim Choong and Tsan Sheng Ng (2015), 'Energy security: Definitions, dimensions and indexes', *Renewable and sustainable energy reviews* **42**, 1077–1093.

Arkolakis, Costas, Natalia Ramondo, Andrés Rodríguez-Clare and Stephen Yeaple (2018), 'Innovation and production in the global economy', *American Economic Review* **108**(8), 2128–73.

Arranz, Alfonso Martínez (2017), 'Lessons from the past for sustainability transitions? a meta-analysis of socio-technical studies', *Global environmental change* **44**, 125–143.

Augutis, Juozas, Ričardas Krikštolaitis, Linas Martišauskas, Sigita Pečiulytė and Inga Žutautaitė (2017), 'Integrated energy security assessment', *Energy* **138**, 890–901.

Bélanger, Louis and Gordon Mace (2017), Convergence or divergence effects? nafta and state preferences towards the ftaa, *in* 'Regionalism and the State', Routledge, pp. 25–44.

Bencze, Larry, Lyn Carter and Mirjan Krstovic (2018), Youth uses of actor-network theory for undermining societal consumerism, *in* 'Sociocultural perspectives on youth ethical consumerism', Springer, pp. 71–99.

Bijker, Wiebe E (2009), 'Social construction of technology', *A Companion to the Philosophy of Technology* pp. 88–94.

Blecker, Robert A, Juan Carlos Moreno-Brid and Isabel Salat (2017), 'Trumping the nafta renegotiation: an alternative policy framework for mexican-us cooperation and economic convergence', *real-world economics review* p. 94.

Bleotu, Coralia, Lilia Matei, Laura D Dragu, Liana Grigorescu, Carmen C Diaconu and Gabriela Anton (2018), Methods for plant genetic modification, *in* 'Genetically Engineered Foods', Elsevier, pp. 385–401.

Bonny, Sylvie (2017), 'Corporate concentration and technological change in the global seed industry', *Sustainability* **9**(9), 1632.

Brookes, Graham and Peter Barfoot (2016), 'Global income and production impacts of using gm crop technology 1996–2014', *GM crops & food* **7**(1), 38–77.

Canadian Nuclear Association (2017), *The Canadian Nuclear Factbook-2017*, Canadian Nuclear Association, Retrieved on 4 January 2019.
URL: *https://cna.ca/wp-content/uploads/2017/01/2017-Factbook-EN-WEB-FINAL.pdf*

Chatterjee, Kalyan and Kaustav Das (2018), 'Bilateral trading with incomplete information and price convergence in a small market: The continuous support case', *Economics Letters* **163**, 118–120.

Clancy, Brett (2017), 'Rebel or rioter? luddites then and now', *Society* **54**(5), 392–398.

Craig, Christopher A and Elizabeth L Petrun Sayers (2019), 'Building clean energy support with young millennials in the united states', *The Electricity Journal* **32**(1), 18–24.

Dithmer, Jan and Awudu Abdulai (2017), 'Does trade openness contribute to food security? a dynamic panel analysis', *Food Policy* **69**, 218–230.

Engel, Charles (2018), 'Real exchange rate convergence: The roles of price stickiness and monetary policy', *Journal of Monetary Economics* p. (in press). https://doi.org/10.1016/j.jmoneco.2018.08.007.

Executive Office of the US President (2018), *United States-Mexico-Canada Agreement (USMCA)*, Office of the United States Trade Representative, Retrieved on 5 January 2019.
URL: *https://ustr.gov/trade-agreements/free-trade-agreements/united-states-mexico-canada-agreement/agreement-between*

Fan, Mei-Fang (2018), 'Risk discourses and governance of high-level radioactive waste storage in taiwan', *Journal of Environmental Planning and Management* pp. 1–15.

FAO (1996), *Rome Declaration on World Food Security*, The Food and Agriculture Organization (FAO) of the United Nations (UN), Retrieved on 18 January 2019.
URL: *http://www.fao.org/WFS/*

Franks, Mr Jeffrey R, Ms Bergljot B Barkbu, Mr Rodolphe Blavy, William Oman and Hanni Schoelermann (2018), *Economic Convergence in the Euro Area: Coming Together or Drifting Apart?*, International Monetary Fund.

Frewer, Lynn J, Ivo A van der Lans, Arnout RH Fischer, Machiel J Reinders, Davide Menozzi, Xiaoyong Zhang, Isabelle van den Berg and Karin L Zimmermann (2013), 'Public perceptions of agri-food applications of genetic modification–a systematic review and meta-analysis', *Trends in Food Science & Technology* **30**(2), 142–152.

Fuenfschilling, Lea and Bernhard Truffer (2016), 'The interplay of institutions, actors and technologies in socio-technical systems—an analysis of transformations in the australian urban water sector', *Technological Forecasting and Social Change* **103**, 298–312.

Gattie, David K, Joshua L Darnell and Joshua NK Massey (2018), 'The role of us nuclear power in the 21st century', *The Electricity Journal* **31**(10), 1–5.

Goresline, Harry E (2018), Historical aspects of the radiation preservation of food, *in* 'Preservation of Food by Ionizing Radiation', CRC Press, pp. 1–46.

Goron, Travis L and Manish N Raizada (2015), 'Genetic diversity and genomic resources available for the small millet crops to accelerate a new green revolution', *Frontiers in plant science* **6**, 157.

Greenwood, Heather I, Katerina Dodelzon and Janine T Katzen (2018), 'Impact of advancing technology on diagnosis and treatment of breast cancer', *Surgical Clinics of North America* .

Grossman, Gene M and Elhanan Helpman (2015), 'Globalization and growth', *American Economic Review* **105**(5), 100–104.

Grumezescu, Alexandru Mihai and Alina Maria Holban (2017), *Genetically Engineered Foods*, Vol. 6, Academic Press.

Hagen, Paul E and John Barlow Weiner (1999), 'The cartagena protocol on biosafety: New rules for international trade in living modified organisms', *Geo. Int'l Envtl. L. Rev.* **12**, 697.

Jackman, S (2000), 'Models for ordered outcomes [pdf document]', *Retrieved on 25 March 2018 from Lecture notes Online Web site: http://www. stanford. edu/class/polisci203/ordered. pdf* .

Jacobson, Mark Z (2009), 'Review of solutions to global warming, air pollution, and energy security', *Energy & Environmental Science* **2**(2), 148–173.

James, Clive (2015), '20th anniversary (1996 to 2015) of the global commercialization of biotech crops and biotech crop highlights in 2015', *ISAAA brief* **51**.

Jano-Ito, Marco A and Douglas Crawford-Brown (2016), 'Socio-technical analysis of the electricity sector of mexico: Its historical evolution and implications for a transition towards low-carbon development', *Renewable and Sustainable Energy Reviews* **55**, 567–590.

Jez, Joseph M, Soon Goo Lee and Ashley M Sherp (2016), 'The next green movement: plant biology for the environment and sustainability', *Science* **353**(6305), 1241–1244.

Kant, Chander (2018), 'Income convergence and the catch-up index', *The North American Journal of Economics and Finance* p. (in press). https://doi.org/10.1016/j.najef.2018.07.017.

Kogan, Leonid, Dimitris Papanikolaou, Amit Seru and Noah Stoffman (2017), 'Technological innovation, resource allocation, and growth', *The Quarterly Journal of Economics* **132**(2), 665–712.

Kruyt, Bert, Detlef P van Vuuren, Han JM de Vries and Heleen Groenenberg (2009), 'Indicators for energy security', *Energy policy* **37**(6), 2166–2181.

Latour, Bruno et al. (2005), *Reassembling the social: An introduction to actor-network-theory*, Oxford university press.

Ma, Xingliang, Martin Mau and Timothy F Sharbel (2018), 'Genome editing for global food security', *Trends in biotechnology* **36**(2), 123–127.

Martin, Thomas G (2018), Radiation protection and health physics in food irradiation facilities, *in* 'Preservation Of Food By Ionizing Radiation', CRC Press, pp. 247–277.

McKelvey, Richard D and William Zavoina (1975), 'A statistical model for the analysis of ordinal level dependent variables', *Journal of mathematical sociology* **4**(1), 103–120.

Naghshpour, Shahdad and Edward Nissan (2018), 'State and regional convergence in economic freedom of north america', *Journal of Regional Analysis & Policy* **48**(2), 3776.

Navarro-Pineda, Freddy S, R Handler and Julio C Sacramento-Rivero (2017), 'Potential effects of the mexican energy reform on life cycle impacts of electricity generation in mexico and the yucatan region', *Journal of cleaner production* **164**, 1016–1025.

NAYGN (2018), *NA-YGN Strategic Plan - Ongoing and Current Year*, North American Young Generation in Nuclear (NA-YGN), Retrieved on 5 January 2019.
URL: *http://naygn.org*

Niankara, Ibrahim (2019), 'Cross-national data sample on the environmental affection and cognition of adolescent students of varying interests in ecosystem services and sustainability', *Data in Brief* **22**(February), 312–318.

Niankara, Ibrahim (Forthcoming), *Scientific media dieting and youth awareness and expectations about the environmental issues of deforestation and species extinction in the Middle East and North America*, World Review of Science, Technology and Sustainable Development, Availble at: https://www.inderscience.com/info/ingeneral/forthcoming.php?jcode=wrstsd.

Niankara, Ibrahim and Didier T Zoungrana (2018), 'Interest in the biosphere and students environmental awareness and optimism: A global perspective', *Global Ecology and Conservation* **16**, e00489, https://doi.org/10.1016/j.gecco.2018.e00489.

Nti, Frank Kyekyeku (2016), 'Nafta at 21: structural change in mexican's demand for us meat and meat products', *International Journal of Food and Agricultural Economics* **4**(4), 1.

OECD (2016), *Programme for International Student Assessment (PISA) 2015 Database: Stduent Questionnaire data file*, Organization for Economic Co-operation and Development, Paris, France. Retrieved on 30 March 2018 from.
URL: *http://www.oecd.org/pisa/data/2015database/*

OECD (2017), *PISA 2015 Technical Report: Chapter 04 - Sample design*, Organization for Economic Co-operation and Development, Paris, France. Retrieved on 30 March 2018 from.
URL: *http://www.oecd.org/pisa/sitedocument/PISA-2015-technical-report-final.pdf*

Ogrokhina, Olena (2015), 'Market integration and price convergence in the european union', *Journal of International Money and Finance* **56**, 55–74.

O'Rourke, Kevin Hjortshøj, Ahmed S Rahman and Alan M Taylor (2013), 'Luddites, the industrial revolution, and the demographic transition', *Journal of Economic Growth* **18**(4), 373–409.

Park, Walter G (2011), 'Technology trade and nafta', *Progress in economics research* **25**, 51–90.

Peters, Ellen and Paul Slovic (1996), 'The role of affect and worldviews as orienting dispositions in the perception and acceptance of nuclear power 1', *Journal of applied social psychology* **26**(16), 1427–1453.

Pinch, Trevor J and Wiebe E Bijker (1984), 'The social construction of facts and artefacts: Or how the sociology of science and the sociology of technology might benefit each other', *Social studies of science* **14**(3), 399–441.

Pioro, I and R Duffey (2019), Current status of electricity generation in the world and future of nuclear power industry, *in* 'Managing Global Warming', Elsevier, pp. 67–114.

R Core Team (2015), *R: A Language and Environment for Statistical Computing*, R Foundation for Statistical Computing, Vienna, Austria.
URL: *https://www.R-project.org/*

Raman, Ruchir (2017), 'The impact of genetically modified (gm) crops in modern agriculture: A review', *GM crops & food* **8**(4), 195–208.

Ribeiro, Tatiane G, Bruna Barone and Jorge H Behrens (2016), 'Genetically modified foods and their social representation', *Food Research International* **84**, 120–127.

Rip, Arie (2018), Constructive technology assessment, *in* 'Futures of Science and Technology in Society', Springer, pp. 97–114.

Ritzberger-Grünwald, Doris, Josef Schreiner et al. (2018), 'Restarting real economic convergence in', *Focus on European Economic Integration* (Q3-18), 10–23.

Sajaia, Zurab (2008), 'Maximum likelihood estimation of a bivariate ordered probit model: implementation and monte carlo simulations', *The Stata Journal* **4**(2), 1–18.

Sarrias, Mauricio (2016), 'Discrete choice models with random parameters in R: The Rchoice package', *Journal of Statistical Software* **74**(10), 1–31.

Smith, Adrian and Andrew Stirling (2018), 'Innovation, sustainability and democracy: an analysis of grassroots contributions', *Journal of Self-Governance and Management Economics* **6**(1), 64–97.

Smith, Adrian, Mariano Fressoli and Hernan Thomas (2014), 'Grassroots innovation movements: challenges and contributions', *Journal of Cleaner Production* **63**, 114–124.

Sprink, Thorben, Dennis Eriksson, Joachim Schiemann and Frank Hartung (2016), 'Regulatory hurdles for genome editing: process-vs. product-based approaches in different regulatory contexts', *Plant cell reports* **35**(7), 1493–1506.

Thomas, Hernan, Lucas Becerra and Santiago Garrido (2017), Socio-technical dynamics of counter-hegemony and resistance, *in* 'Critical Studies of Innovation', Edward Elgar Publishing.

Vaclavik, Vickie A and Elizabeth W Christian (2014), Food preservation, *in* 'Essentials of food science', Springer, pp. 323–342.

Valente, Marieta and Cristina Chaves (2018), 'Perceptions and valuation of gm food: A study on the impact and importance of information provision', *Journal of Cleaner Production* **172**, 4110–4118.

Van den Berg, Hendrik and Joshua J Lewer (2015), *International trade and economic growth*, Routledge.

Villareal, M and Ian F Fergusson (2017), *The North American Free Trade Agreement (NAFTA)*, (CRS Report R42965). Washington, D.C.: Congressional Research Service., Retrieved on 4 January 2019.
URL: *https://fas.org/sgp/crs/row/R42965.pdf*

Wan, Jun, Kathy Baylis and Peter Mulder (2015), 'Trade-facilitated technology spillovers in energy productivity convergence processes across eu countries', *Energy Economics* **48**, 253–264.

Witkowska, Janina (2016), 'Integration processes in the global economy: Current state and prospects. the cases of the european union, asean economic community, and nafta', *Comparative Economic Research* **19**(4), 47–65.

World Nuclear Association (2017), 'Nuclear power in mexico', Country Profiles, Retrieved on January 2019, from. http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/mexico.aspx.

World Nuclear Association (2018*a*), 'Nuclear power in canada', Country Profiles, Retrieved on January 2019, from. http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/canada-nuclear-power.aspx.

World Nuclear Association (2018*b*), 'Nuclear power in the usa', Country Profiles, Retrieved on January 2019, from. http://www.world-nuclear.org/information-library/country-profiles/countries-t-z/usa-nuclear-power.aspx.

Yoshida, Akemi (2015), Considering the geological disposal program of high-level radioactive waste through classroom debate, *in* 'Nuclear Back-end and Transmutation Technology for Waste Disposal', Springer, Tokyo, pp. 289–299.

Zhou, Lei, Basudeb Biswas, Chris Fawson and Peter J Saunders (2018), 'Empirical investigation of the impact of multilateral trade on income convergence across countries', *The Journal of Business Inquiry* p. (in press).

Zlatev, Vladimir et al. (2018), Market integration in nafta region, *in* 'Business Dynamics in North America', Springer, pp. 55–82.

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Table 1: Summary Description of the Variables used in the Econometric Modeling. (N = 17981)

Quantitative Variables	**(means and standard deviations)**	**Mean**	**s.d.**
IntBiosph	Level of interest in Ecosystem services and Sustainability 1- Don't know what it is, 2- not interested, 3-Hardly interested, 4-Interested, 5-highly interested.	3.50	0.98
IntScPrevDis	Level of Interest in how science can help prevent disease; 1- Don't know what it is, 2- not interested, 3-Hardly interested, 4-Interested, 5-highly interested;	4.02	1.03
JOYSCIE	PISA index of student's Enjoyment of science	0.44	1.07
	How often student do the following:		
	1- never or Hardly, 2- sometimes, 3-regularly, 4-very often.		
EcoWebVisit	↪ Visit Ecological Websites:	3.41	0.82
BlogsVisit	↪ Follow news via blogs:	3.27	0.91
BroadScTVprog	↪ Watch TV programs on broad science:	2.95	0.88
BroadScBooks	↪ Read books on broad science:	3.37	0.80
BroadScWeb	↪ Visit websites on broad science:	3.06	0.91
MagScArtNewsp	↪ Read science article in magazine and newspaper:	3.24	0.86
ScClubAttend	↪ Attend science club:	3.70	0.66
AGE	Student's age	15.84	0.29
WEALTH	Student's family wealth index value	0.14	1.34
ESCS	Standardized Index of economic, social and cultural status	0.13	1.14
MISCED	Student's Mother Education level	4.50	1.66
FISCED	Student's Father Education level	4.38	1.65
WFSTUWT	Student final weight in the Data	161.61	240.95
Qualitative Variables	**(absolute and percent relative frequencies)**	**Abs. Freq.**	**Rel. Freq.**
Gender	Gender:		
	1-Female	9419	52.38
	2-Male	8562	47.62
IMMIG	Student Immigration status:		
	1-Native	14973	83.27
	2-Second-generation	1623	9.03
	3- First-generation	1385	7.70
GradeLev	Student grade level in school:		
	7th grade	49	0.27
	8th grade	121	0.67
	9th grade	2161	12.02
	10th grade	14979	83.30
	11th grade	657	3.65
	12th grade	14	0.08
CNT	Unique Identifier for each NAFTA country member		
	1- USA	3197	17.78
	2- CANADA	10476	58.26
	3- MEXICO	4308	23.96

Source: Authors' construction using the NAFTA extract of the published data (Niankara, 2019).

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Table 2: Conditional and Relative Frequencies of Youth Technological Awareness and Expectation

		CNT			Rel. Freq.	Chi^2 Test
		USA	CAN	MEX	(%)	
TAgmo	1	19.28	46.64	34.07	14.25	X-squared = 806.2***
	2	17.52	52.11	30.36	34.78	df = 6, p-value < 2.2e-16
	3	17.71	61.03	21.27	32.66	
	4	17.22	74.06	8.72	18.31	- - - - - - - - - - - - - - - - - - -
TEgmo	1	23.89	51.94	24.17	18.02	X-squared = 290.47***
	2	21.03	58.01	20.97	35.60	df = 4, p-value < 2.2e-16
	3	12.91	60.91	26.18	46.38	- - - - - - - - - - - - - - - - - - -
TAnpt	1	16.48	51.60	31.92	7.49	X-squared = 145.67***
	2	17.92	58.53	23.55	38.86	df = 6, p-value < 2.2e-16
	3	18.03	56.31	25.66	38.32	
	4	17.45	65.71	16.84	15.33	- - - - - - - - - - - - - - - - - - -
TEnpt	1	22.73	58.13	19.14	13.48	X-squared = 164.6***
	2	19.98	59.00	21.03	32.24	df = 4, p-value < 2.2e-16
	3	15.25	57.86	26.90	54.28	
Rel. Freq.	(%)	17.78	58.26	23.96		

Source: Author's construction using the NAFTA extract of the published data (Niankara, 2019); $^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

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Table 3: MLE Results for Youth's GMOs Awareness and Expectations within NAFTA

N	Awareness		Expectations	
17981	Coef.	(s.e.)	Coef.	(s.e.)
Cutoff 2	$\hat{\mu}_2 = 1.157^{***}$	(0.001)	$\hat{\delta}_2 = 1.057^{***}$	(0.001)
Cutoff 3	$\hat{\mu}_3 = 2.227^{***}$	(0.001)		
(Intercept)	0.145^{***}	(0.042)	-0.075	(0.044)
Affective factors				
IntBiosph	0.166^{***}	(0.001)	0.022^{***}	(0.001)
IntScPrevDis	0.039^{***}	(0.001)	0.019^{***}	(0.001)
JOYSCIE	0.173^{***}	(0.001)	0.005^{***}	(0.001)
Knowledge controls				
EcoWebVisit	-0.005^{***}	(0.001)	0.037^{***}	(0.001)
BlogsVisit	-0.060^{***}	(0.001)	0.015	(0.001)
BroadScTVprog	-0.032^{***}	(0.001)	-0.008^{***}	(0.001)
BroadScBooks	-0.024^{***}	(0.001)	0.004^{**}	(0.001)
BroadScWeb	-0.050^{***}	(0.001)	0.005^{***}	(0.001)
MagScArtNewsp	-0.025^{***}	(0.001)	0.017^{***}	(0.001)
ScClubAttend	-0.021^{***}	(0.001)	0.029^{***}	(0.001)
Demographic & economic factors				
AGE	0.067^{***}	(0.003)	0.007^{**}	(0.003)
WEALTH	0.006^{***}	(0.001)	-0.043^{***}	(0.001)
ESCS	0.160^{***}	(0.001)	0.088^{***}	(0.002)
MISCED	-0.036^{***}	(0.001)	-0.006^{***}	(0.001)
FISCED	0.021^{***}	(0.001)	-0.016^{***}	(0.001)
(Gender)M/F	0.089^{***}	(0.001)	-0.171^{***}	(0.001)
(IMMIG)2/1	-0.067^{***}	(0.002)	-0.120^{***}	(0.002)
(IMMIG)3/1	-0.004	(0.003)	-0.092^{***}	(0.003)
(GradeLev)8/7	0.046^{***}	(0.012)	0.109^{***}	(0.013)
(GradeLev)9/7	-0.173^{***}	(0.010)	0.190^{***}	(0.011)
(GradeLev)10/7	-0.088^{***}	(0.010)	0.274^{***}	(0.011)
(GradeLev)11/7	0.038^{***}	(0.010)	0.395^{***}	(0.011)
(GradeLev)12/7	-0.648^{***}	(0.022)	0.700^{***}	(0.023)
country specific Effects				
(CNT)CAN/USA	0.152^{***}	(0.003)	0.344^{***}	(0.003)
(CNT)MEX/USA	-0.344^{***}	(0.002)	0.399^{***}	(0.002)
Awareness (TAgmo)			$\hat{\gamma} = 0.025^{***}$	(0.001)
Log-likelihood	-3558168.2		-3049266.9	
BIC	7116610.6		6098808.1	
AIC	7116392.3		6098589.8	

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

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Table 4: MLE Results for Youth's NPT Awareness and Expectations within NAFTA

N	Awareness		Expectations	
17981	Coef.	(s.e.)	Coef.	(s.e.)
Cutoff 2	$\hat{\mu}_2 = 1.428^{***}$	(0.001)	$\hat{\delta}_2 = 1.023^{***}$	(0.001)
Cutoff 3	$\hat{\mu}_3 = 2.693^{***}$	(0.001)		
(Intercept)	0.945^{***}	(0.042)	-1.220^{***}	(0.045)
Affective factors				
IntBiosph	0.146^{***}	(0.001)	0.010^{***}	(0.001)
IntScPrevDis	0.048^{***}	(0.001)	0.028^{***}	(0.001)
JOYSCIE	0.138^{***}	(0.001)	-0.015^{***}	(0.001)
Knowledge controls				
EcoWebVisit	-0.042^{***}	(0.001)	0.064^{***}	(0.001)
BlogsVisit	-0.071^{***}	(0.001)	-0.013^{***}	(0.001)
BroadScTVprog	-0.032^{***}	(0.001)	0.027^{***}	(0.001)
BroadScBooks	-0.033^{***}	(0.001)	0.045^{***}	(0.001)
BroadScWeb	-0.038^{***}	(0.001)	-0.021^{***}	(0.001)
MagScArtNewsp	-0.039^{***}	(0.001)	0.010^{***}	(0.001)
ScClubAttend	0.035^{***}	(0.001)	0.064^{***}	(0.001)
Demographic & economic factors				
AGE	0.032^{***}	(0.003)	0.045^{***}	(0.003)
WEALTH	0.021^{***}	(0.001)	-0.014^{***}	(0.001)
ESCS	0.058^{***}	(0.001)	0.062^{***}	(0.002)
MISCED	-0.019^{***}	(0.001)	-0.004^{***}	(0.001)
FISCED	0.023^{***}	(0.001)	-0.010^{***}	(0.001)
(Gender)M/F	0.150^{***}	(0.001)	-0.138^{***}	(0.001)
(IMMIG)2/1	-0.129^{***}	(0.002)	-0.027^{***}	(0.002)
(IMMIG)3/1	0.054^{***}	(0.003)	0.034^{***}	(0.003)
(GradeLev)8/7	-0.084^{***}	(0.012)	0.238^{***}	(0.013)
(GradeLev)9/7	0.007	(0.010)	0.463^{***}	(0.011)
(GradeLev)10/7	-0.010	(0.010)	0.631^{***}	(0.011)
(GradeLev)11/7	0.115^{***}	(0.010)	0.688^{***}	(0.011)
(GradeLev)12/7	0.615^{***}	(0.022)	0.007	(0.022)
country specific Effects				
(CNT)CAN/USA	0.071^{***}	(0.003)	0.150^{***}	(0.003)
(CNT)MEX/USA	-0.195^{***}	(0.002)	0.497^{***}	(0.002)
Awareness (TAnpt)			$\hat{\gamma} = 0.067^{***}$	(0.001)
Log-likelihood	-3321837.3		-2847252.3	
BIC	6643948.8		5694779.0	
AIC	6643730.5		5694560.7	

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$