Strengthening the Competitiveness, Productivity and Innovation of Cross-border Industrial Corridors

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Abstract   Over the past few decades, globalization has been shifting economic power upward to transnational actors on the one hand, and downward to subnational or regional spaces on the other. This phenomenon has resulted in the centrality of territorially delimited subnational regions acting as critical loci of economic governance within a complex and globally distributed value chain of trade and service flows. Within this broader context of industrial restructuring are economic regions that span national borders in their collective assets. The paper focuses on investigating the economic competitiveness and productivity of cross-border (or binational) economic regions. Using the conceptual framework of economic clusters, an econometric model that measures proxies of geographic proximity of firms in the life sciences cluster, and a new binational economic model, the paper examines the key characteristics, potentials and constraints of economic competitiveness and productivity in a cross-border region comprising counties in Western New York and regional municipalities in Southern Ontario. The findings demonstrate the direct and indirect benefits of closer cross-border economic cooperation. The paper then concludes with some policy observations about leveraging cross-border economic clusters for strategic industrial cooperation.

Keywords   Cross-border economic cooperation, Hamilton-Niagara-Buffalo Region, Binational economic model, Life-science industries, Economic scenario simulation

I. Introduction

One significant aspect of the transformation that is occurring in the global economic system as the twenty-first century unfolds is the exposure of the fragility of national models of economic governance (Porter 1998; Scott 2001; Asheim, Cooke, and Martin 2011; Vincente 2018). Faggian, Partridge & Malecki, 2017). Globalization is shifting economic power upward to transnational forces on the one hand, and downward to subnational or regional spaces on the other (OECD, 2007; Storper, 2013; Webber et al., 2018; Economist Intelligence Unit, 2016). Globalization and technological change seem to be reinforcing, instead of undermining, the importance of "location" in the organization of economic life. What has emerged are new localized production systems of specialized, geographically delineated industrial agglomeration. These point to the general resurgence of geographic clusters of economic regions as the main spaces of contemporary economic development and governance (Scott, 2001; Huggins et al., 2014; Gertler and Wolfe, 2006; Wolf and Gertler, 2016).

Within this broader context of subnational economic regions, recent studies (Snyder et al., 2014; Makkonen and Williams 2016) suggest that cross-border regions are becoming more globally prevalent in firms' growth strategies. The idea of "thinking and acting across borders" to enable innovative, competitive and prosperous communities with a highly skilled workforce and well-paying jobs is not new (Luecke and Katz, 2003; Vincente, 2018). However, cross-border regions are increasingly viewed as critical hubs for leveraging the forces of globalization in facilitating firm-specific and industry-wide innovation, creativity and prosperity. At the same time, however, borders can be challenging for firms because of the differences in legislative approaches, exchange rates, labour markets, wages, social security and political systems (Slusarcius, 2016). Of particular interest to cross-border areas is whether a 'cliff effect' – where price or other differences – has a positive or negative effect on the development of a cross-border cluster.

A small but growing body of literature has shed considerable light on cross-border regions highlighting interconnected research themes of cooperation, development, governance and mobility that shape the contours of these regions (Makkonen and Williams, 2016). The literature spans various methodologies, policy issues and geographies, including the Association of Southeast Asian Nations (ASEAN) and other free-trade areas. Among the pioneering scholarship on cross-border regions, Perkmann (2003) has traced the 1990s surge in the number of cross-border regions across Western and Eastern Europe, providing a conceptual definition and overview of the history of cross-border regions in Europe and their relationship with E.U. policies that support them. Similarly,

Huber (2003) has shed one of the early lights on cross-border cooperation by looking at the determinants of cross-border cooperation between Austrian firms and their Central and Eastern European partners. Some of these earlier studies (Scott 1999) juxtapose European and North American experiences with cross-border regionalism, exploring such trends against the backdrop of the supranational institutional arrangements of the European Union and the North American Free Trade Area. Most of the extant literature, however, has an understandably European focus given the active promotion of cross-border regions within the institutional and policy context of the European Union. Schäffler and colleagues (2017), for instance, have empirically demonstrated the regional determinants of German foreign direct investment (FDI) in the border regions of the Czech Republic. Also, most recently, Capello and others (2018) have looked at the European Union's Cross Border Cooperation Program regions, and examined border effects using a methodology rooted in the standard gravitational approach. Similarly, Oliveira (2015) has investigated the Euroregion of Galicia in north-west Spain and northern Portugal, employing a constructing regional advantage approach to investigate the potential of joint branding strategies for cross-border regions.

A smaller but no less insightful body of work has offered an exclusively North American focus on cross-border regions. For instance, in their study of the automotive industry in the Southern Ontario and U.S. Great Lakes States, Rutherford and Holmes (2013) look at how workplace governance is being shaped by, and in turn shaping the currents of cross-border economic, social and territorial configurations. In a similar vein, Andresen's work (2010) on North America observes that although the Canada–United States border effect is a heavily researched area, yet very few systematic regional analyses have emerged. Nearly ten years after Anderson's (2010) observation, there is still a dearth of theoretical and systematic empirical work on Canada-US cross-border regions within the broader scholarship on subnational economic regions and clusters. This fact is even more concerning given recent political currents and sentiments in the United States opposed to international trade and cross-border economic cooperation. Our paper is a modest effort to address this gap by pursuing two primary objectives; first to advance the empirical literature grounded in a systematic methodology testing the value proposition of cross-border economic regions as competitive economic spaces; and second, to enrich the body of knowledge on Canada-US cross-border regions, which have received far less empirical attention than their European counterparts.

In pursuit of the above-stated aims, we focus on investigating the case for economic competitiveness, productivity and innovation in the Niagara-Buffalo economic region spanning the border between Canada and the United States. We selected the Counties of Erie, Niagara and Cattaraugus in Western New York and the Regional Municipality of Niagara and the City of Hamilton in

Southern Ontario as our point of entry.[1] Notwithstanding the fact that the cross-border region boasts many cross-border assets (explored below), there remains a sense that it has not lived up to its promise. This research is pursued within the broader context of calls by cross-border stakeholders in both the United States and Canada for a deeper dive to assess the cross-border region's strengths, opportunities, barriers, gaps in understanding, and challenges to collaboration to create a comprehensive understanding and clear-eyed strategy that fully captures cross-border regions' potentials. Our focus is to explore one cross-border spatially configured area to understand the spill-over economic effects. We believe this study will contribute to suggesting how binational cooperation efforts can be effective and have economic effects for various ASEAN and other developing countries because they are geographically closely located with similar cultures and economic backgrounds.

The rest of the discussion is structured as follows: The next (second) section lays out an explication of the conceptual framework of binational industrial corridors that serves as the analytical lens for the rest of the discussion. This section will clarify the key elements of cross-border "industrial corridors." The following section then delves into the case studies, using the conceptual framework, an econometric model and a new binational economic model to examine the key characteristics, potentials and constraints of economic competitiveness and productivity in the cross-border regions of Niagara, Hamilton and Buffalo. The last section concludes with some inferences and policy lessons about the prospects and challenges of fostering binational industrial corridors.

II. Background

1. Conceptual Framework of Cross-border Industrial Corridor

A dominant understanding of cross-border (or binational) economic regions in the academic and policy literature corresponds to geographic spaces functionally linked together via a shared export base, the flows of interfirm

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1 This paper is part of a large study involving research institutes at Brock University and the University at Buffalo, along with the participation of the private sector, public sector, non-profit sector and NGO interests. The short-term objective is to use the life sciences sector as a starting point, to make the economic case and develop a forward-looking approach for cross-border coordination and collaboration - an approach that uses scenarios to examine benefits, constraints and multiple paths forward. The ultimate goal is to expand the study and deepen the research, analysis, understanding and engagement towards an innovation and prosperity agenda for this cross-border region.

relations, or the flows of labour force activities within a particular sector (Testa et al, 2000; OECD, 2013; Campbell et al, 2015; Nadalutti and Kallscheuer, 2018; Capello et al, 2018; Schäffler et al, 2017). For this research, a binational economic region is a cross-border geographic space comprising a cluster of surrounding communities sharing similar economic assets in a particular sector, such as manufacturing, tourism, life sciences and agriculture.

The concept of economic cluster (Vincente, 2018; Porter, 1998) provides a useful framework for understanding economic regions in the Niagara-Buffalo region. Porter defines clusters as "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, associated institutions…in particular fields that compete but also cooperate" (1998, 197). A core element of this definition is that of *geographical proximity*: clusters are spatially localized concentrations of interlinked firms. Co-location is a central determinant of value creation that arises from networks of direct and indirect interactions among private businesses, and between firms, customers, local public agents (such as economic development officials, for example), post-secondary institutions, and related entities with vested interests in the economic well-being of their community (Warrian and Bramwell, 2016).

Cross-border economic clusters can consist of a combination of geographically proximate cities and surrounding peripheries of smaller communities from two or more countries bound together by interlocking economic flows of products and skills that create a self-reinforcing interdependency and synergy. Implicit in this definition is the centrality of clusters of shared assets in a particular sector, which provides the basis for surrounding communities to plan economic development investment priorities in leveraging natural resources, human capital, investment capital, and market access to sustain and enhance the binational region's economic well-being.

A central feature of economic clusters in general is the notion of industrial agglomerations (Camagni et al, 2015). This concept points to the vital role of external economies of scale (Aoyama, Murphy and Hanson, 2011; Wolfe and Gertler, 2016).[2] There are two types of agglomeration. The first derives from urbanization economies, the second from localization economies (Friedman, 2002). Urbanization economies are benefits that accrue to cities by virtue of their population and market density, which make them economically resilient and often self-sustaining. Localization economies, on the other hand, can be seen in agglomerations that typically manifest specialization in a key industrial sector (Brusco, 1982; Russo, 1985; Amin and Thrift, 1992).

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2 External economies of scale are viewed as largely generated by positive externalities. Externalities, by definition, are costs (negative) or benefits (positive) that accrue to a firm or corporation above and beyond its accounting.

The main implication of understanding urban agglomeration is that it directs the construct of cross-border economic clusters to focus on specific assets and their associate economies of scale and market density within a given geographic location. Such a construct allows for an economic cluster made up of communities with demonstrable strengths in certain sectors — say, life sciences, advanced manufacturing or tourism — to leverage their local resources, mobilize non-local public resources, and attract private investment in scaling up their sectoral strengths and potential for greater economic competitiveness (Fritsch and Storey, 2017). The concept of cross-border economic clusters thus draws our attention to the reality of economic development as a highly varied and complex territorial process (Asheim, Cooke, and Martin, 2011; Martin and Sunley, 2008; Miller and Nelles, 2018). The significance of this observation is that different types of clusters will manifest different economic and demographic characteristics, and, therefore, possess different capacities to respond to and cope with both external and internal shocks and changes. The section below presents an econometric model and examines some data exploring the potentials, constraints and challenges of the Hamilton-Niagara-Buffalo region as a binational economic cluster.

2. The Hamilton-Niagara-Buffalo Region

The Buffalo-Niagara-Hamilton region is the largest cross-border region along the Canada-US border, and unique in North America for the depth and breadth of its cross-border assets. Whether part of a broader "Tor-Buff-Chester" megaregion (Florida, 2008), or as part of a Great Lakes cross-border region,3 this cross-border region experiences tremendous flows of technology, people and trade across the international border by sheer virtue of its geography (Snyder et al., 2014). The challenge, however, is that much of the region's planning and public policy ignores its cross-border nature and potential assets.

With four international bridges and two airports, the region reigns as a major port of entry along the Canada-US border, facilitating more than 15 percent of commerce between two of the world's largest trading partners (Regional Municipality of Niagara, 2018). These complementary cross-border economic development efforts, in turn, generate opportunities for integrated supply chains in innovative industry clusters for export to global markets. Augmented by strong cross-border shopping, heritage, and tourism economies, an advanced logistics industry, and sophisticated "soft" infrastructure – customs brokers, 3PLs, warehousing, attorneys, insurance brokers, bankers, and the like – the region has considerable potential for strengthening prosperity by strategically

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3 https://councilgreatlakesregion.org/working-groups/economic-corridors-and-clusters

leveraging cross-border economic ties.

The most basic question raised about economic regions is their population characteristics such as size and age distribution since such data point to the merits of agglomeration advantages and labour market size. As Table 1 indicates, the combined 2016 population total of the Buffalo-Niagara-Hamilton binational region is 2,366,527. The median age of the region is 44 years. Other basic demographic information is provided in Table 1 for both regions.

Table 1. Socio-economic facts of the binational region

Category		Cattaraugus County	Erie County	Niagara County	Hamilton CMA	St. Catharines - Niagara CMA	Total (or Average)
Total population		77,677	922,578	212,652	747,545	406,075	2,366,527
Median age		42	40	43	42	46	44
0 to 19 years		14,526	153,815	34,728	122,540	59,120	384,729
20 to 29 years		14,681	191,578	40,022	139,095	71,915	457,291
30 to 44 years		12,584	161,183	35,575	140,355	66,585	416,282
45 to 59 years		21,983	256,051	63,316	212,065	120,050	673,464
60 years and older		13,982	156,578	38,116	133,495	88,405	430,576
Dependency ratio	2016	58%	51%	52%	52%	57%	53%
	2011	53%	49%	50%	49%	52%	50%
Annual wage per employee	2016	$38,913	$46,169	$39,836	$50,451	$41,764	$46,357
	2012	$36,583	$42,654	$37,192	$43,968	$37,727	$41,768
	Increase ratio	6.37%	8.24%	7.11%	14.7%	10.7%	10.1%
Real GDP per capita (2015)		$44,054[4]			$36,052	$35,292	

Note: The table was reorganized by the authors using the American Community Survey (U.S. Census Bureau 2011; 2016) and Bureau of Economic Analysis (2016) data for the U.S., and the Census Profile data for Canada (Statistics Canada, 2012a; 2012b; 2017a; 2017b).

In addition, economic clusters frequently raise questions about the pressure on working-age residents to support non-working individuals through public assistance programs like social security. This is reflected by the dependency ratio, which measures the ratio of non-working to working people and gives an indication of the pressures faced by the working-age population. As Table 1 indicates, in the binational region, on both sides of the border in all counties (in the case of the U.S.) or census metropolitan areas (CMAs – in Canada), this ratio has increased over the last five years, with the St. Catharines-Niagara CMA and Cattaraugus County experiencing the greatest increase in the ratio.

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4 Note that this value represents real GDP per capita (2015) for Buffalo-Cheektowaga-Niagara Falls, NY (Metropolitan Statistical Area).

The prosperity and potential competitiveness of a binational region can be measured in terms of GDP per capita and the composition of key sectors. The core industry strengths, as indicated in Table 2 of the region are in Health Care; Manufacturing; Education; Tourism and Retail Trade.

Table 2. Top 10 industry sectors for the number of employees of the binational regions

Industry	Cattaraugus County	Erie County	Niagara County	Hamilton CMA	St. Catharines -Niagara CMA	Total
Wholesale and retail trade	4,551	76,125	13,512	61,200	34,200	189,588
Health care and social assistance	3,436	74,219	11,184	53,300	28,000	170,139
Manufacturing	3,943	43,609	8,619	44,300	19,100	119,571
Accommodation and food services	3,933	45,000	9,169	21,400	24,600	104,102
Business, building and other support services	1,263	37,056	3,518	20,200	10,700	72,737
Finance, insurance, real estate, rental and leasing	873	35,020	2,003	24,900	8,600	71,396
Construction	635	16,913	2,881	29,400	17,100	66,929
Professional, scientific, and technical services	708	29,322	1,498	25,900	8,000	65,428
Educational services	1,750	13,307	1,866	33,400	12,200	62,523
Information, culture and recreation	758	13,864	1,439	18,500	10,900	45,461
Total for all sectors	22,925	417,701	60,907	385,800	203,100	1,090,433

Note: The table was reorganized by the authors using the U.S. Census Bureau (2015) data for the U.S. and the Statistics Canada (2018a; 2018b) data for Canada.

III. Methodology

1. Binational life science economic cluster

Three economic indicators for both regions were compared: wage, unemployment rate and education. First, the average weekly wage on both sides of the border has grown over the past 5 years (2010-2015) by 11.37 percent in Ontario and 7.65 percent in New York. On the U.S. side, this is greater than the U.S. wage growth between 2010-2015 (7.51) but on the Canadian side, less than the Canadian average of 12.94 percent.

Second, the rate of unemployment in the binational region is 7.2 percent, and the rate of poverty is 13.8 percent – this is lower than the U.S. poverty rate but slightly higher than the Canadian poverty rate; and lower than both the New York and Ontario poverty rates. With respect to levels of education, which can serve as a proxy for a region's innovation environment, 90.5 percent have a high school degree or more. 26.75 percent have completed a bachelor's degree or more. In a knowledge-driven economy, one would hope for higher figures of post-secondary graduates, but at a minimum, a high degree of high school completion rate above seventy-five percent is considered healthy.

The focus of the rest of the discussion is to investigate the case for economic competitiveness, productivity and innovation in the region. For the discussion in this paper, we focus on the life sciences sector, one of the four leading sectors of the cross-border region. The next set of figures presents some data that provide a basis for appreciating the potentials and constraints of economic competitiveness resulting from greater economic integration between the regions on both sides of the border. To set the context for this discussion, Table 3 provides an overview of the key characteristics of the life sciences sector in the binational region, while Figure 1 provides a GIS portrait of their geographical spread and density across the binational region.

Table 3. Number of companies in major industry sectors of the binational regions

| NAISC Code	Collected Codes	Buffalo-Niagara	Hamilton-Niagara	Total
31-33 Manufacturing	325412 Pharmaceutical Preparation Manufacturing	11	3	14
	325413 In-Vitro Diagnostic Substance Manufacturing	2	0	2
	325414 Biological product manufacturing	3	1	4
42 Wholesale Trade	423450 Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers	151	50	201
	423460 Ophthalmic Goods Merchant Wholesalers	8	0	8
54 Professional, Scientific, and Technical Services	541380 Testing Laboratories	50	33	83
	541711 Research and Development in Biotechnology	193	71	264
	541940 Veterinary Services	189	122	311
61 Educational Services	611310 Colleges, Universities and Professional Schools	172	27	199
62 Health care and Social Assistance	621511 Medical Laboratories	134	24	158
	621512 Diagnostic Imaging Centers	62	34	96
	622110 General Medical and Surgical Hospitals	73	20	93
	622310 Specialty (except Psychiatric and Substance Abuse) Hospitals	13	0	13
Total		1,061	385	1,446
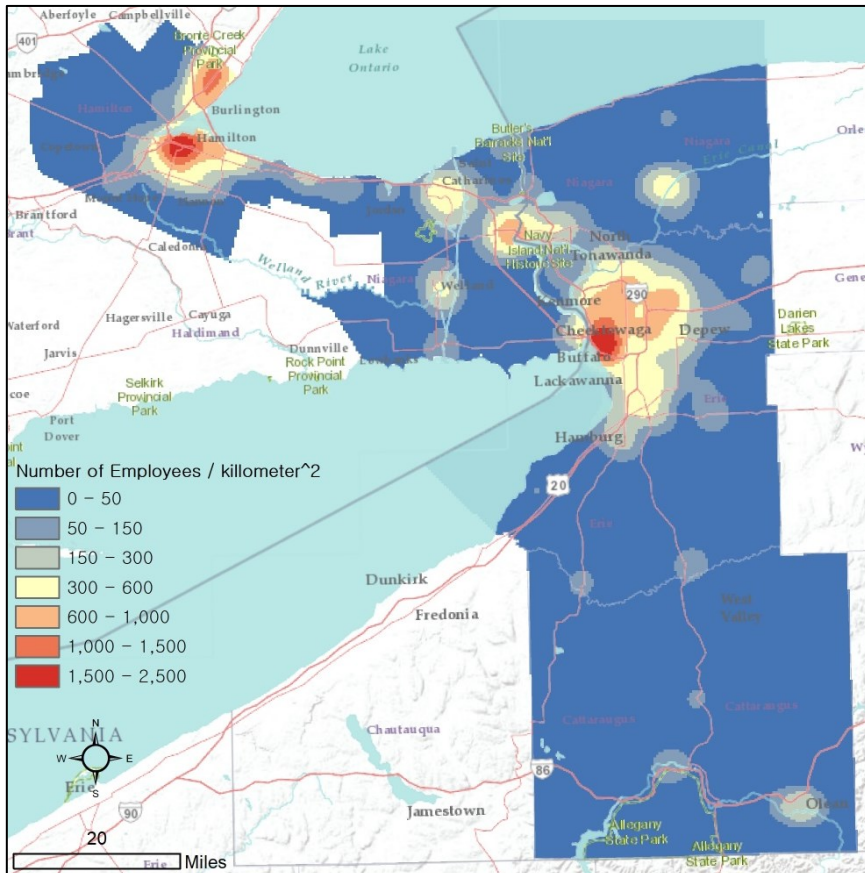
Figure 1. Employment heat map for life science-related industries of the binational region

In addition to the previous overview, we have further broken down the life sciences sector of the binational region into the number of employees in each region, using the North American Industrial Classification Systems (NAICS) coding, as seen in Table 4. The investment figures in each sector are proportional to the number of employees in each region.

Table 4. Proportion of Number of Employees in Life Science-Related Businesses

NAICS code	Code description	Buffalo-Niagara		Southern-Ontario		Total	
31	Manufacturing	58,102	25.52%	50,131	25.66%	108,233	25.58%
42	Wholesale trade	25,735	11.30%	22,674	11.60%	48,409	11.44%
54	Professional, scientific and technical services	41,058	18.03%	19,440	9.95%	60,498	14.30%
61	Educational services	19,302	8.48%	42,906	21.96%	62,208	14.70%
62	Health care and social assistance	83,516	36.68%	60,247	30.83%	143,763	33.98%
Total		227,713	100.00%	195,398	100.00%	423,111	100.00%

Notes: 1. Unit: number of employees
2. Sources: a. Bureau of Economic Analysis (CA25N Total Full-Time and Part-Time Employment by NAICS Industry 1/)
b. EMSI Analyst, St. Catharines-Niagara CMA and Hamilton CMA

2. Binational network-combined economic model

Against the backdrop of the above context of the life sciences in the binational region, we developed a binational economic model that combines a binational road network simulation model at the business level and a binational input-output approach. The network-combined economic model simulates scenarios of $100 million investment into an integrated industry relationship in the binational region. The Buffalo region in the U.S. is coded as BN and the Hamilton-Niagara region in Southern Ontario is coded as HN. It is worth noting that while there may be several factors determining the outcome of this relationship, for the purpose of this paper, "travel time" is used as a proxy for greater integration between businesses in different industry sectors across the border. The simplicity and focus allow for a clearer demonstration of the competitiveness of economically integrated binational regions. The 2-digit NAICS code system was used to measure the strength of the industrial relationship. The key hypothesis of the model is that the industrial relationship between the two regions will be stronger if the average travel time between businesses in different industries within the binational region is smaller. A simulation-based network model of which a key variable is the average travel time has been developed for a trade flow matrix needed in the binational economic model development.

A Multi-Regional Input-Output Model (MRIO) for the binational regions of BN and HN is generated by the formula suggested in equation (1) (Park et al., 2007; Park, 2008; Miller and Blair, 2009).

$$x = (I - C \cdot A)^{-1} \cdot f \tag{1}$$

where, x = total output;

f = final output;

I = identity matrix;

A = technical coefficient matrix that describes the inter-industrial relationship in each region;

C = trade coefficient matrix that indicates the magnitude of the trade relationship between and within regions.

For the A matrix of Buffalo-Niagara and Hamilton-Niagara regions, Input-Output (IO) models for Buffalo-Niagara and Hamilton-Niagara regions are needed, whereas only state and provincial levels of IO models are available up to date. To tackle this limitation, the FlexNIEMO approach was applied (Gordon et al., 2009; Park and Richardson, 2014; Park et al., 2017). Assuming the final demand between both the provincial level and Hamilton-Niagara region is same, the sectoral proportions of both areas' GDP values have been applied for the FlexNIEMO approach.

For the C matrix of Buffalo-Niagara and Hamilton-Niagara regions, a Transportation Combined Business Model that covers the two regions was generated. After combining spatial data for individual businesses and highway networks of the two regions, the magnitude of the trade relationship between and within the two regions is defined by the average travel time between businesses in different industry sectors with the formula suggested in equation (2). The fundamental assumption in this approach is that inter-business relationship between the two regions will be inversely proportional to the travel time between businesses. Changes in travel time due to border security level was used to simulate the economic effect change in the binational economic cluster.

$$c_{ij} = exp(-\alpha \cdot t_{ij}) \tag{2}$$

where, $c_{ij} \in C$;

α = unit adjustment coefficient;

t_{ij} = travel time between business i and business j.

The overall procedure for constructing the binational economic model is described in Figure 2.
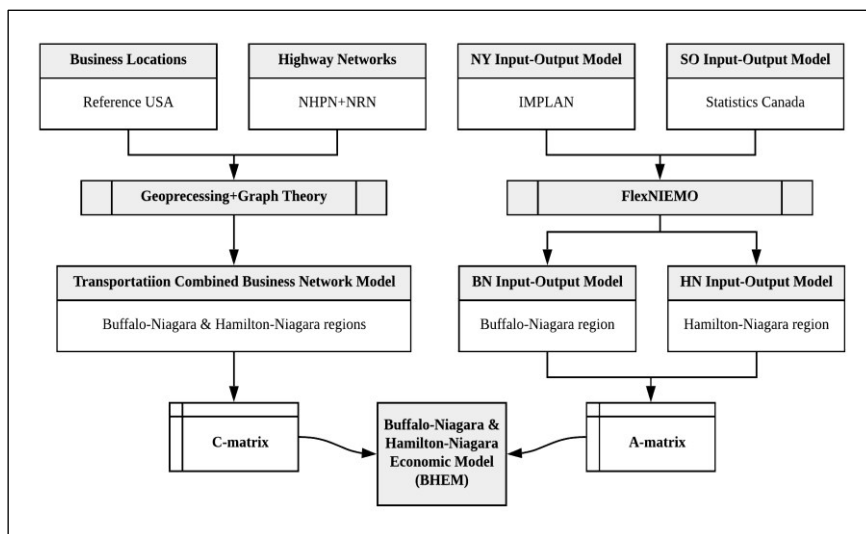
Figure 2. Constructing a Binational Economic Model for the Buffalo-Niagara and Hamilton-Niagara region

Notes: 1. NHPN: National Highway Planning Network, US
2. NRN: National Road Network, Canada
3. IMPLAN: Economic Impact Analysis for Planning
4. NY: New York State, US
5. SO: Southern Ontario region, Canada
6. BN: Buffalo-Niagara region, U.S.
7. HN: Hamilton-Niagara region, Canada

3. Simulation Scenarios

With the aforementioned formula based on the binational economic model (BSEM), we plot several simulation scenarios consisting of an investment of $100 M to life-science-related industries. Below is a list of four scenarios, plotted and illustrated in Table 5.

Single Region Investment Scenarios ($100 Million for one region):
- Scenario 1. Buffalo-Niagara region (no trade effects considered)
- Scenario 2. Hamilton Niagara region (no trade effects considered)

Coordinated Regional Investment Scenarios ($50 Million for each region):
- Scenario 3. Binational Investment to BN & HN region (trade effects considered)
- Scenario 4. Investment to BN and HN, respectively (no trade effects considered)

Table 5. Overall Effects by Scenario

Scenarios			Number of jobs	GDP ($Million)	Total output ($Million)
Scenario1	Buffalo-Niagara		1,174	80.35	118.31
	Southern-Ontario		-	-	-
	Total		1,174	80.35	118.31
Scenario2	Buffalo-Niagara		-	-	-
	Southern-Ontario		1,252	59.82	106.42
	Total		1,252	59.82	106.42
Scenario3	Buffalo-Niagara		615	37.87	61.88
	Southern-Ontario		694	33.51	60.27
	Total		1,309	71.38	122.15
Scenario4	Buffalo-Niagara		587	40.18	58.89
	Southern-Ontario		626	29.91	53.17
	Total		1,213	70.09	112.06

Scenario 3 created the highest number of jobs (in considering trade effects). This shows binational investment strategy is superior to a single region investment strategy in creating more jobs. Scenario 1 shows the highest value in GDP. This may be due to a higher tax rate and lower salary of the HN region compared to the BN region. The total output shows Scenario 3 is superior to the other scenarios.

IV. Results

1. Direct Effects

Scenario 2 shows the sizable number of created jobs in industry sectors 61 and 62, as illustrated in Table 5. These sectors include a relatively lower salary level, and hence, create more jobs flexibly responding to the economic influx. Recall that NAICS coded 61 is Educational services and 62 Health care and social assistance. Scenarios 3 and 4 create more jobs than other scenarios in general. Scenario 1 shows the sizable increase in GDP in general. Table 6 illustrates the direct effects of GDP yields.

Table 6. Direct effects: number of employees and GDP by scenario for each NAICS code

NAICS	Number of Employees				GDP ($Million)			
	S1	S2	S3	S4	S1	S2	S3	S4
31	50	57	54	54	6.75	6.60	6.68	6.68
42	71	65	68	68	8.93	6.63	7.63	7.63
54	150	87	119	119	11.71	5.98	8.84	8.84
61	217	563	390	390	6.34	16.08	11.21	11.21
62	500	921	710	710	22.70	21.56	24.38	24.38

Notes: a. S: Scenario
   b. NAICS codes 31= Manufacturing; 42= Wholesale trade; 54= Professional, scientific and technical services; 61=Educational services; 62= Health care and social assistance
   c. Scenarios: S1: $100 M to BN (no trade effects); S2: $100 M to HN (no trade effects); S3: $50 M to BN and $50 M to HN (trade effects); and S4: $50 M to BN and $50 M to HN (no trade effects)

2. Indirect Effects

There are also indirect effects (throughout the whole economy) from the $100 million investment. Table 7 shows in terms of the number of jobs, GDP and total output. Notice the stark difference between Scenario 1 and 2, meaning that the BN region generates more indirect effects throughout the regional economy when invested. However, the indirect effects of HN dramatically increase when trade effects are considered. The indirect effects of HN in Scenario 4 increase more than three times in Scenario 3. Trade effects provide positive effects to the BN region as well. The indirect effects of BN in Scenario 4 increase about 1.2 to 1.5 times in Scenario 3.

Table 7. Indirect effects by scenario

		Number of jobs	GDP ($Million)	Total output ($Million)
Scenario1	Buffalo-Niagara	186	11.47	18.42
	Southern-Ontario	-	-	-
	Total	186	11.47	18.42
Scenario2	Buffalo-Niagara	-	-	-
	Southern-Ontario	61	3.28	5.98
	Total	61	3.28	5.98
Scenario3	Buffalo-Niagara	120	7.43	11.94
	Southern-Ontario	97	5.23	9.52
	Total	217	12.66	21.46
Scenario4	Buffalo-Niagara	93	5.73	9.21
	Southern-Ontario	31	1.64	2.99
	Total	124	7.37	

Note: Scenarios: S1: $100 M to BN (no trade effects); S2: $100 M to HN (no trade effects); S3: $50 M to BN and $50 M to HN (trade effects); and S4: $50 M to BN and $50 M to HN (no trade effects)

The indirect effects of $100 million investment in terms of the number of employees and size of GDP created, respectively, as suggested in Table 8. Scenario 3 shows the highest indirect effects on job creation throughout overall industry sectors. Scenarios 3 and 4 show significant differences in indirect effects, whereas direct effects were similar (this may be caused by trade effects).

Table 8. Indirect effects on employees and GDP by NAICS code by scenario

NAICS	Number of Employees				GDP ($Million)			
	S_1	S_2	S_3	S_4	S_1	S_2	S_3	S_4
11	10	1	8	6	0.26	0.10	0.34	0.18
21	3	1	4	2	0.59	0.22	0.73	0.40
22	1	1	2	1	0.36	0.18	0.53	0.27
23	6	1	6	4	0.40	0.14	0.49	0.27
31	2	1	2	1	0.23	0.08	0.28	0.16
42	6	2	6	4	0.70	0.17	0.72	0.43
44	16	5	18	10	0.68	0.19	0.74	0.43
48	7	2	8	5	0.39	0.14	0.47	0.26
51	3	1	4	2	0.47	0.16	0.56	0.31

52	9	1	7	5	1.27	0.18	1.11	0.72
54	15	3	14	9	1.16	0.19	1.05	0.67
56	13	5	16	9	0.56	0.21	0.70	0.39
61	23	8	27	15	0.66	0.23	0.79	0.45
62	21	9	23	11	0.66	0.22	0.78	0.44
71	16	4	16	10	0.80	0.15	0.77	0.48
72	19	7	23	13	0.54	0.15	0.59	0.34
81	11	6	17	8	0.34	0.20	0.53	0.27
92	15	1	11	8	1.29	0.17	1.11	0.73
93	0	2	3	1	0.11	0.18	0.37	0.15

Notes: a. S: Scenario

　　　b. The definition of NAICS code is presented in Appendix 1.

　　　c. Scenarios: S1: $100 M to BN (no trade effects); S2: $100 M to HN (no trade effects); S3: $50 M to BN and $50 M to HN (trade effects); and S4: $50 M to BN and $50 M to HN (no trade effects).

Scenario 3 shows the highest indirect effects on GDP increase in many industry sectors, while Scenario 1 outpaces Scenario 3 in several industry sectors. This is the constant result in overall effects and direct effects as well. This may be caused by the higher tax rate and lower salary level of HN than the BN region. However, as shown before, Scenario 3 is superior to other scenarios overall.

To conclude, based on a new network-based binational economic model, $100M investment with trade effect generates 1,309 jobs in total. Among them, 1,092 jobs could be created from direct effect and additional 217 jobs from indirect effect via industrial relationships. Associated with indirect effects, the difference of 93 new jobs between S3 and S4 can be credited to the effect of the binational cluster. This indicates that the trade effect may increase 75% of the indirect effect calculated as 100x93/(217-93) and 7.65% of the total effect 100x93/(1,309-93). This rate of job creation within the life sciences sector appears quite high, and part of the jobs are typically very highly paid. More importantly, the spillover generated throughout the whole economy (other sectors outside life sciences) from indirect trade effects of the investment into the binational region is considerably large. The general picture points to positive gains in job creation and overall economic competitiveness and growth measured in GPD for the binational region.

V. Policy Implications and Conclusion

The regions that successfully combat the threats and exploit the opportunities of the disruptive forces of industrial restructuring are those that can leverage their tangible and intangible economic and social assets to reinvent themselves (Baycan, Nijkamp & Stough, 2017; (Eraydin and Taşan-Kok, 2013; Storper, 2013; Conteh, 2013; Kakderi and Tasopoulou, 2017). The cross-border region encompassing western New York and southern Ontario is in transition. The widening diversity of problems among its constituent communities provides evidence that spatial policies, planning, and practices aimed at addressing the specific economic challenges of communities are more viable alternatives to the one-size-fits-all, top-down programs of conventional national policy interventions (Ahlqvist, 2014; Capello, 2017). The economic structure of the Buffalo-Hamilton-Niagara region has changed over the past 20 years as the area has lost manufacturing jobs and replaced them increasingly with jobs in the service sector, ranging from health care and social assistance to tourism and construction. As a result, the ratio of full-time to part-time jobs has been decreasing. Rather than maintaining a status quo outlook forged from decades of decline in population, employment and GDP, leaders on each side of the border are paying greater attention to the prospects of leveraging assets to strengthen human capital and create purposeful transformation to foster sustainable communities, creativity and innovation. Communities in the region currently are targeting investment in cultural/heritage tourism and health sciences innovation; advanced manufacturing; and stewardship of their natural assets.

This context serves as the background for the focus of our study. We seek to examine whether it makes sense to collaborate with cross-border neighbors to enhance economic competitiveness. Our project aims to contribute to the discussion about catalyzing economic well-being in the Buffalo-Niagara-Hamilton region as a cross-border region by presenting an empirical case for strengthening cross-border partnerships. Recent reports suggest that cross-border regions are becoming more globally competitive for firms and talent. Our key objective, therefore, is to demonstrate through a relatively simplified econometric-combined economic model that a binational, coordinated approach to community economic development will create jobs and well-being in the regions on both sides of the border, as opposed to a "go-it-alone" community development approach.

The policy implication of this project is that sustainable cross-border regional coordination and collaboration require objective information to build understanding. The questions then become: What is the "economic case" for coordination and collaboration? What are the opportunities, and what are the challenges? Conversations over the past five years in the Buffalo-Hamilton-

Niagara cross-border region demonstrate that leadership on both sides of the border are seeking a process that builds understanding, relationships, capacity, and ultimately an agenda to thrive as a binational region in an increasingly competitive and globalized world. As the largest cross-border region along the Canada-US border, it is unique in North America for the depth and breadth of its cross-border assets.

On a final note, integrated cross-border communities are at a strategic advantage in the current age of globalization by virtue of their organically international economic structure relative to other economic regions. Too often, however, local communities have felt as though they are on their own amid the impersonal forces of change. Smaller economic regions are often ill-equipped to take on the forces of globalization. Moreover, municipal and national boundaries that serve political and administrative purposes do not correspond with economic geography, which often involves a constellation of municipalities within a certain industrial corridor or economic cluster. The tendency then is to foster fragmentation and parochialism among residents where a more holistic approach is needed. This clearly points to the need to rethink and restructure current modes of intervention towards more integrated approaches whereby local communities combine their critical assets to combat the threats and exploit the opportunities of global industrial restructuring and economic change.

The literature and empirical evidence on economic clusters place considerable emphasis on their socio-economic characteristics: a community of people and a population of firms in one naturally and historically bounded area. Economic clusters provide the most tangible expression of the fusion of economy and society. This socio-economic understanding of economic clusters has brought to the fore the policy salience of non-economic, socio-territorial dimensions of the concept. It also raises implications for the imperative of creating the institutions and processes that will facilitate interaction, trust, and cooperation among constellations of local actors within a shared geographic space.

This study conceives cross-border economic clusters for public policy purposes as geographically delineated spaces for strategic industrial cooperation across borders towards greater competitiveness and innovation. They provide a platform for asset mapping, problem identification, investment planning, knowledge sharing, organizational learning, and management of new market opportunities. In short, thinking in terms of binational economic clusters can help design platforms of local economic development governance that are critical pieces of regional economic reinvention in an age of tectonic global industrial restructuring, especially for ASEAN and EU countries. In addition, if the methodology presented in this study is applied to the ASEAN region, it will be possible to analyze the effects of border policies, economic cooperation, and the establishment of interconnected infrastructure among ASEAN countries.

Acknowledgment

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Appendix 1. 2-digit North American Industry Classification System (NAICS)

Sector	Name
11	Agriculture, Forestry, Fishing and Hunting
21	Mining, Quarrying, and Oil and Gas Extraction
22	Utilities
23	Construction
31-33	Manufacturing
42	Wholesale Trade
44-45	Retail Trade
48-49	Transportation and Warehousing
51	Information
52	Finance and Insurance
53	Real Estate and Rental and Leasing
54	Professional, Scientific, and Technical Services
55	Management of Companies and Enterprises
56	Administrative and Support and Waste Management and Remediation Services
61	Educational Services
62	Health Care and Social Assistance
71	Arts, Entertainment, and Recreation
72	Accommodation and Food Services
81	Other Services (except Public Administration)
92	Public Administration