TRANSPORT INFRASTRUCTURE AND LOCAL ECONOMIC DEVELOPMENT

A Study of the Relationship between Continental Accessibility and Employment Growth in Canadian Communities

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This study can also be accessed (in English and in French) on the Internet at http://projetic.ucs.inrs.ca.

The website houses an interactive atlas: ***Canadian Interactive Web-Atlas of Transport Infrastructures and Local Economic Development***. The atlas presents the major quantitative findings of the study in a user-friendly series of maps and tables.

“…as always in human experience since the invention of the telephone, the dissemination of electronic media may paradoxically even increase the need and the incentive for face-to-face contact…A key question, therefore, concerns the way people will travel to do business: …It is clear that cities with a high degree of accessibility – for instance, cities accessible within a one-day return trip from a large number of other cities – are at a special advantage”

— (Sir) Peter Hall, *Cities in Civilization*, p. 962-963.

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EXECUTIVE SUMMARY

The purpose of this summary is to present the principal findings of the study in a straightforward manner. Technical aspects and conceptual issues – beyond those briefly covered in points 2 through 6 – are dealt with in the core of the study.

1. The study seeks to measure the impact of transport infrastructures on local employment growth in Canada (1971-2000). Canada is divided into 145 urban and 214 rural places. Only those areas south of the 55th parallel are considered in the growth models because growth dynamics are very different in extreme northern communities and small employment numbers can lead to extreme growth and/or decline rates. The three decades (1971-1981, 1981-1991, and 1991-2001) are examined separately.

2. Explaining local economic development raises numerous conceptual and empirical issues. An impressive literature has accumulated over the years in Canada and elsewhere. Some writings stress "local" – sociological, institutional – factors, while others emphasize geographic and structural factors – city size, location, industry mix, etc. A rich research tradition has also developed dealing with the economic impacts of infrastructure investments. Measuring the impact of transport infrastructure on local employment growth remains a challenge, in part because the impacts are diffused over space and over time.

3. The rise of the knowledge economy has accelerated the interdependency between transport modes, as business travel – in part dependant on air transport – increasingly complements merchandise trade, relying in turn on rail, road, and water transport. At the same time, the progressive integration of the North American economy, notably since NAFTA, has meant that exports to continental – as opposed to local or national – markets account for a growing share of local GDP in Canadian communities. Trade as a share of local GDP is on the rise everywhere. In this evolving context, market access – via various transport modes – should, it is reasonable to expect, be an increasingly important factor driving the growth of local economies.

Methodology: Innovative Features

4. The study examines the impact of transport infrastructures on local employment growth via the access they provide to continental markets. This is an innovative feature, made possible by the application of GIS (Geographical

Information Systems) techniques combined with econometric modelling. Transport networks by mode – air, road, rail, and harbours – were mapped and digitalized for all of North America (Canada and the US). Continental accessibility indicators – by transport mode – were, in turn, calculated for all Canadian communities. Our study is based upon access to people, which is almost perfectly correlated with access to jobs and access to income.

5. A second innovative feature of the study is the integration of the continental accessibility variables – associated with the four transport modes – into a broader econometric model of regional growth, which integrates other variables (city size, location, industrial structure, labour force characteristics…) that can contribute to local employment growth. This allows the study to identify the incremental impact of transport infrastructures, independently of other factors that might influence local economic development. By the same token, this allows the study to flush out impacts – of transport infrastructures – that might otherwise have remained hidden, swamped by other variables.

6. A third feature is the use of multivariate statistical techniques, which ensure not only the statistical significance of the results, but also allows the study to isolate statistically independent transport variables. A factor analysis was applied to the four continental accessibility variables, resulting in the identification of four statistically independent factors, henceforth called modal mixes: (1) Harbours and Roads; (2) Rail; (3) Roads and Air; (4) Air. It is these four modal mixes – specifically, the continental accessibility they provide Canadian communities – that are at the heart of the analysis. It is the impact of these four modal mixes – via the accessibility they provide – on local employment growth in Canada that the study examines.

Initial Findings: Transport Infrastructures and Continental Accessibility

7. Transport modes – in terms of the accessibility they provide to North American markets – do not act in isolation. The results of the factor analysis – referred to in point 6 – confirm that transport modes are, as a rule, present (in any given location) in combination with other transport modes. This comes as no surprise. A harbour or an airport with no road leading to it is of little use. Accessibility is necessarily the result of a bundle of transport infrastructures; all must work together to generate accessibility (recall also point 3).

8. Each modal mix – bundle of transport infrastructures – produces a unique range of accessibilities. Thus, modal mix 1, in which harbours are dominant (followed by roads, and to a lesser extent by rail and air), reflects a different geography of continental market access from that of modal mix 3, in which roads and air are the dominant modes. Again, this comes as no surprise.

Roads do not affect accessibility in the same manner as rail lines, for instance. The fact that each modal mix has a dominant mode means that different infrastructures interact differently and have distinct impacts. A locality with a major port necessarily offers a different range of (continental) market destinations from that of an inland locality with no waterway.

9. Each of these modal mixes is statistically independent from the others: they are not correlated across the 359 geographic units we study. This does not mean that *in certain regions* the modal mixes do not combine. For instance, even though there is no correlation between modal mixes 3 (road and air) and 4 (air) across Canada, they combine in some of Canada's largest cities. However, one also finds high air access in some of Canada's remotest Northern communities – but these have very low access by road. Indeed, the principal exception (but not a major one) to the interdependency of transport modes is air, which sometimes acts in almost total isolation from other transport modes.

10. Looking at the location of employment (in 2001), the study finds that different transports modes are associated with different industries. Modal mix 3 (Roads and Air), strongest in larger cities, shows a significant positive statistical relationship with employment in financial services and producer services, a reflection of the role of air travel (but also urban size) in modern business transactions. Manufacturing employment, on the other hand, is associated, although not strongly, with harbours, roads, and rail. Wholesaling is positively associated with all modal mixes, a reflection of the importance of transport infrastructure for distribution and marketing. Public sector employment, on the contrary, exhibits a negative relationship with all transport modes, indicating that public sector employment (including health and education) is proportionally more concentrated in the least accessible places.

11. The previous point dealt with the relationship between transport infrastructure and the location of employment at a single moment in time (2001). The focus of the study, however, is on the relationship with employment *growth*. That is the subject of the remaining points of this executive summary.

Principal Findings: The Positive Relationship with Growth

12. The study finds a significant positive relationship between transport infrastructures – via the access they provide to continental markets – and local employment growth. For total employment growth, the introduction of the four transport variables raises the predictive power of the model for all three decades between 1971 and 2001. The positive incremental effect (increase in r^2, in statistical terms) of the combined impact of the four modal mixes ranges from 4.6% to 8.0%, depending on the decade. It is useful to

recall (point 5) that this result reflects the independent – incremental – effect of transport infrastructures on employment growth, once other factors contained in the model have been accounted for. In this respect, the results of the study constitute a conservative estimate of the positive relationship between transport infrastructures and local employment growth. In particular, the increased accessibility associated with being located close to a large city or closer to the US border is already integrated in the model.

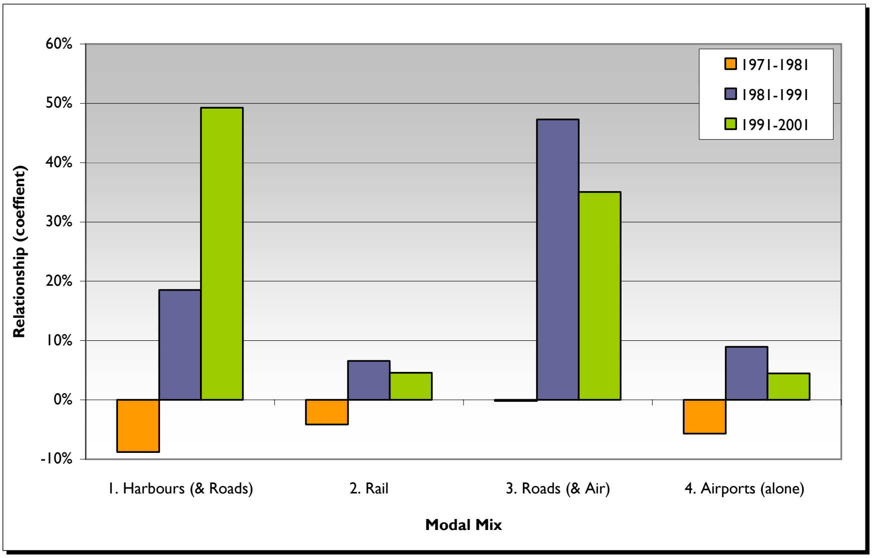
13. Producer services (employment in consultancies, computer services, advertising agencies, etc.) provide a useful illustration of how the study works to isolate the independent effects of transport infrastructure on growth. A simple regression between accessibility (all transport modes) and employment growth in producer services reveals a statistically significant relationship for the two most recent decades. However, once the four transport variables are introduced into the broader econometric model, the relationship disappears. Accessibility, in other words, is associated with other attributes – notably city size and proximity to large cities – which, once included, wipe out (statistically speaking) any positive relationship with employment growth. This does not mean that transport infrastructures have no effect on local employment in producer services, only that growth effects are intermediated by other attributes. Stated differently, the possible growth effects of transport infrastructures on producer service employment are not independent of other factors. While an airport, for instance, might produce a positive effect in a large city, its presence, *by itself*, will have little effect in other locations. This is indicative of processes of agglomeration: airports will tend to locate in larger cities in response to demand, and roads converge on these larger cities. This leads to better market access for producer services and faster growth, which then consolidates the larger city's size and may lead to more investment in infrastructure and a new round of growth. However, an airport located far from a large city will not, *by itself*, generate economic activity.

14. The positive relationship between growth and continental accessibility varies between industries. The relationship with employment growth in the primary sector is weak, for instance, as one might expect. Resources are not necessarily found in the most accessible places. The strongest positive relationship, leaving the public sector aside, is with growth in manufacturing employment, a reflection of the weight of merchandise exports in interregional and in cross-border trade. One would expect the relationship to be strongest for industries – outside the primary sector – whose products are widely traded.

15. The combined positive impact of the four modal mixes on growth in manufacturing employment rises systematically over time, with r^2 increases (attributable to accessibility) of – 0.5%, 4.8%, and 9.1% for the three decades between 1971 and 2001. In sum, growth in manufacturing employment in

Canada is increasingly linked to considerations of transport access to continental markets. Location – at least as it affects the transport of goods to markets – is increasing in importance. This is one of the ironies of continental economic integration: as barriers to trade are lifted and as transport costs fall, location has taking on a new meaning. This is not really surprising when one considers the growing importance of external markets for local communities (recall point 3). Most provinces have seen the share of their GDP going to the rest of Canada decline, compared to the share exported to the US.

Figure 1
Relationship between Continental Market Access – via Four Modal Mixes – and Local Employment Growth in Manufacturing

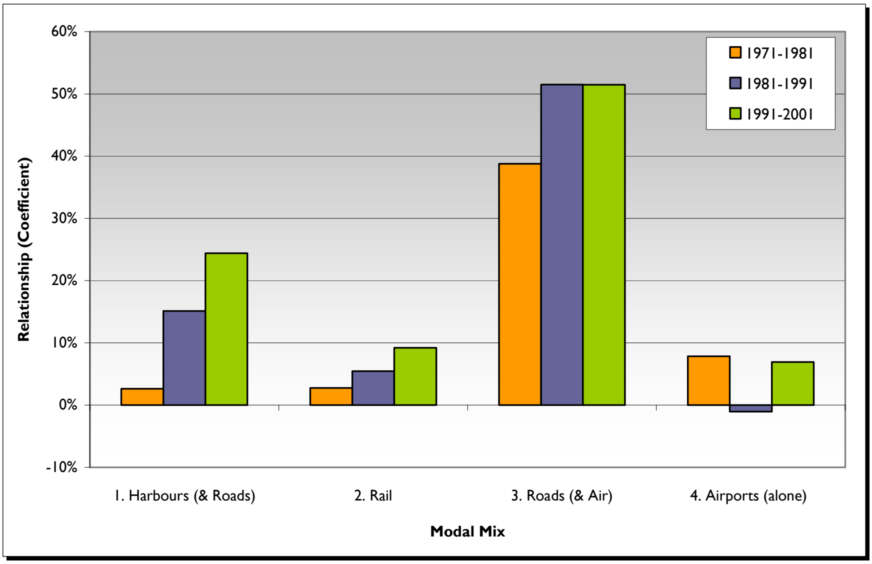


Note: This table shows the standardised regression coefficients of each of the four modal mixes when they are added to the CPS growth model.

16. For manufacturing employment, the strongest – and growing – relationship is with modal mix 1, which captures the effects of harbours and road networks (figure 1). For the most recent period, the strength of the relationship is impressive. Places well served by harbours *and* well connected to the North American road and highway systems are clearly at an advantage for generating manufacturing jobs. The role of harbours (well connected to road systems) is growing, it would seem, which is consistent not only with the over-all globalization of the Canadian economy but also with the findings of US studies that observe a long-term shift in employment to coastal regions and places well served by waterways.

17. Modal mix 3, which mainly captures the impacts of combined road and air links, also exerts a strong positive influence on manufacturing employment growth, notably since 1981. The importance of road networks – which are also a significant component of modal mix 1 – suggests that much manufacturing trade takes place between regions that are fairly close to each other. Trucking is the optimal transport mode for shorter hauls. This suggests that the most rapid expansion in merchandise trade – with concomitant growth effects – has often occurred between neighbouring provinces and states (say, between B.C. and Washington or between Québec and Vermont) as tariff barriers are eliminated, which is consistent with what economic theory would predict. By the same token, the relationship with modal mix 2, which mainly captures the effects of rail, is weak although positive; this suggests that overland long haul trade – often in bulk goods – is not a major driver of manufacturing employment growth, at least not in the majority of Canadian communities.

Figure 2
Relationship between Continental Market Access – via Four Modal Mixes – and Total Local Employment Growth



Note: This table shows the standardised regression coefficients of each of the four modal mixes when they are added to the CPS growth model.

18. For total employment (all industries), modal mix 3 – which chiefly captures the effects of roads and air – exerts the strongest positive influence on growth (figure 2). The positive relationship is very strong, and has grown since 1971. This modal mix, let us recall, is generally associated with large cities; the relationship with growth thus comes as no surprise. However, the positive relationship with modal mix 3 suggests that good road and air links give such

locations an additional – incremental – boost, above and beyond the usual advantages of city size and proximity. Or, stated otherwise, the probable incremental growth impact of transport infrastructures is likely to be greatest in such locations.

19. The positive relationship since 1971 with total employment has grown most rapidly for modal mix 1 (harbours and roads), reinforcing the findings for manufacturing employment (point 16). Proximity to a well-connected harbour is increasingly an asset. The strength of the positive relationship with rail access has also grown over time, but remains weaker than for modal mixes 1 and 3, which are the dominant modal mixes driving local employment growth (figure 2).

20. Three conclusions flow from the findings of the study:

- *First*: The gap between communities that are “well-connected” and those that are not is likely to widen in the future. This is good news for communities – small cities as well as large – in Southern Ontario, in south-western Quebec, and in parts of the Maritimes and in the B.C. Lower Mainland; but bad news for communities in Canada’s peripheral regions, less well-connected to continental markets.

- *Second*: Growth, most noticeably in manufacturing employment and in related industries, will tend to coalesce along trade and transport corridors. The prime example in Canada has always been, and remains, the Windsor-Québec City corridor. Other examples are the Edmonton-Calgary-Lethbridge corridor in Alberta and the Halifax-Moncton-Fredericton corridor, around which growth in the Maritimes is increasingly coalescing.

- *Third*: Investments in transport infrastructures that *significantly* improve the combined road, water, rail, and air accessibility of communities to continental markets should stimulate local employment growth, notably in manufacturing. However, the optimism implicit in the preceding sentence needs to be tempered by the word *significantly*; accessibility to continental markets is not only determined by local – or proximate – infrastructures, but by the entire continental network.

Finally, the findings of the study suggest that investments in infrastructures that improve the continental accessibility of Canadian communities have an overall positive effect on the Canadian economy, but whose scope is difficult to measure.

PART I
CONCEPTUAL ISSUES. ACCESSIBILITY, CONTINENTAL INTEGRATION, THE KNOWLEDGE ECONOMY, AND LOCAL DEVELOPMENT

The purpose of this study is to further our understanding of the forces driving the growth (or decline) of communities across Canada. Specifically, this study focuses on the impact of transportation infrastructures – via the access they provide to other destinations – on local and regional development in Canada,[1] as measured by indicators such as employment, population and income. In this study, the focus is on employment.

1.1 The Changing Face of Regional Development in Canada

Regional development has been a recurring theme in Canadian history. Development has never been evenly distributed – insofar as such a notion even makes sense – across Canada, if only because of its immense size and peculiar geography. From the beginning, economic development was highly concentrated in few pockets of settlement, only very loosely tied together by prevailing transport links – road, rail, or water – over vast distances. Regional disparities are part of the Canadian landscape. Since regional income and employment data began to be regularly collected – in 1926 (by the then Dominion Bureau of Statistics, now Statistics Canada) – the three Maritime Provinces, for example, have systematically lagged behind the rest of the nation on various indicators of economic welfare and performance, as has Newfoundland and Labrador since it joined Confederation in 1949. The two “eastern” Prairie Provinces of Manitoba and Saskatchewan have also systematically fared less well than the rest of the nation since the Great Depression of the 1930’s.

Income disparities between provinces have lessened considerably in recent decades, in part a result of the various interregional transfer mechanisms built into the Canadian fiscal system: equalization payments; other intergovernmental transfers, progressive taxation, direct federal wage and infrastructure expenditures, etc.

However, the issue has taken on a new dimension in recent years as a result of changes in demography, technology, global economic conditions, and resource availability – of which more will be said later on. Barring the very special case of Alberta – which is putting considerable strain on the Canadian fiscal system – the starkest social and economic differences between communities are now often found *within* provinces; that is, between the large urban and surrounding parts of a province and the more peripheral and rural parts. The difference between rapidly growing southern Ontario – centered on greater Toronto – and “declining”

[1] All throughout this study, the adjectives “regional” and “local” are used interchangeably. The terms “growth” and “development” are also often used as synonyms. Thus, references to regional (or local) economic development and to regional growth all denote the same general process in which a region, locality or community moves from a lower to a higher level – depending on the variable considered (employment, income, population…).

northern Ontario is striking. Every census agglomeration in Northern Ontario has seen its population decline since the 1996 census, a matter of growing concern both to the Federal and Provincial governments.[2] A no less striking dichotomy is observable within Newfoundland between the Avalon Peninsula –centered on St. John's – and the rest of the Island, where almost every community has seen its population decline in recent years. Indeed, the majority of Canada's peripheral urban areas with populations below 250,000 declined between the 1996 and 2001 censuses (Bourne and Simmons 2004). In Quebec, the gap between the comparatively prosperous southwest – basically the area southwest of the city of Rimouski – and *Les Régions ressource*s has been widening, compounded most recently by the acute crisis in the forestry and logging industries.[3]

Canada has a rich research tradition on the challenges facing resource-dependent and peripherally located regions (Innes 1933, Barnes and Hayter 1994, Lucas 1971, Randall and Ironside 1996, Slack *et al.* 2003). To describe the Canadian economic landscape, economists, geographers, and regional scientists have evoked dichotomies such as "heartland-hinterland," "core-periphery," and "centre-periphery" (Anderson 1988, Kerr 1968, McCann 1982, 1998, McCann and Simmons 2000). Large parts of Canada are sparsely settled and far from major markets. The widening gap between the urban, cosmopolitan, and growing parts of the nation and the rest of Canada is now well documented (Bourne 2000, 2002, Bourne and Rose 2001, Bourne and Simmons 2003, 2004). Bourne and Simmons (2003) speak of "new fault lines". Peripheral communities in Canada witnessed periods of population decline before, but most continued to grow until the late 1980s. Absolute population decline was the exception. This period is coming to an end, as the regional implications of the demographic transition – from high to low birth rates – are starting to sink in.

It is important to note that Canada is not unique in this respect. Analogous trends have emerged in other large industrialized nations that have completed their demographic transition – meaning natural growth rates close to zero[4] – and are characterized by historical core-periphery relationships. Slack *et al* (2003) mention Australia, Russia, and Scandinavia. The last Australian census documents the decline of numerous small peripheral communities (Ausstats 2000), an increasing cause of concern in that nation (Collits 2000, Forth 2000). Hanell *et al.* (2002) observe that some 90% of Finland's inhabited land area underwent population decline during the 1990s. Almost all municipalities in

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2 See, for example, Slack *et al.* (2003).

3 For a more detailed analysis of the challenges facing Quebec and Atlantic peripheral communities see Polèse and Shearmur (2002, 2006).

4 As in most other Western societies, birth rates have declined sharply in Canada, with a major drop in the early 1960's. The effects of that drop on population growth became visible during the 1990s, as women born during the baby boom years passed childbearing age. The number of deaths will soon equal (and then surpass) births.

central and northern Sweden witnessed decline. Even in Japan, despite its different geography and higher population densities, the projected population decline of its southern and northern peripheries (Kyushu and Hokkaido) has become a cause for concern (Portnov and Permutter 1999).

In a nutshell, stabilizing national populations mean a zero-sum demographic game for communities. In a zero-sum demographic environment, population decline is the inevitable result of net out-migration. In this emerging context, regional employment growth and job opportunities take on a new importance. Population movements largely follow the spatial distribution of economic opportunities – in this, Canadians are no different from others. As Bryant and Joseph (2001) note, over time it is people who respond to economic activity; this is a common assumption in economic geography (Courchene 1970). The key factor becomes the spatial distribution and growth of employment, which is the principal focus of this study.

However, demography is not the only thing that has changed. The 1990's saw the rise of new information technologies, impacting productivity, the demand for new services, and the role of location in economic decisions. The IT revolution – the Internet and all that – is supposed to have heralded the death of distance (Cairncross 2001). However, one of the paradoxes of the IT revolution is that it may in fact have increased the importance of location and accelerated the concentration of economic activity (and population) in and around large metropolitan areas; about more will be said later. The rise, in general, of the knowledge economy, has tended to favour urban concentration, in large part because of the importance of personal contact – necessary correlate of creativity and imagination – for most knowledge-rich activities (about which more will also be said later). Continental economic integration accelerated during this period as the FTA and then NAFTA came into full force. Although this study will look at trends over a thirty year period (1971–2001), the focus is on the most recent – post 1990 – period. During 1990's and since, provincial trade (as a share of total trade) has steadily declined compared to trade with American states (Statistics Canada 1998, 2000, 2004). Correspondingly, we would expect access to U.S. markets to be an increasingly powerful determinant of the growth of Canadian communities.

Explaining why employment – globally, or in particular industries – locates and grows in particular places and not in others is, arguably, the most important research question in economic geography, and also the most difficult to answer. Describing the location patterns of particular industries – at given moments in time – is not all that difficult.[5] It is, for example, fairly well established that high-order services – professional, technical, and scientific services – tend to concentrate in the largest cities. This is as true in Canada as elsewhere. However, explaining why an industry will locate in a particular city – say, in Montreal

[5] See, for example, our own writings on the subject for Canada (Polèse and Shearmur 2004; 2006a).

rather than Toronto – is far more difficult. We can, for example, predict with some assurance that a large state-of-the-art software firm, specializing in computer graphics, will most likely locate its main operation in one of Canada's large metropolitan areas; but, predicting in which one exactly is another matter.

Explaining regional *growth* (or decline) is even more difficult, primarily because no unique explanation – valid for all communities and all time periods – exists or can exist. Different places can grow (or decline) for different reasons. The current growth of greater Calgary is built on very different foundations from that of the growth of greater Toronto. By the same token, the decline of many small towns in Saskatchewan is not occurring for the same reasons as the decline of Newfoundland outposts. Common explanatory factors do exist – otherwise all attempts at statistical modelling would be fruitless – but attempts to explain regional growth will never attain a 100% success rate (an r^2 of 1.00, in econometric parlance). Some things will always be left out of the equation.

1.2 The (Difficult to Measure) Impact of Transport Infrastructures

In this study, we focus on a specific variable in the regional growth equation: transportation infrastructure. An abundant literature exists documenting the positive impact of investments in infrastructures – in transportation infrastructures in particular – on economic growth (Aschauer 1993, Bidder and Smith 1996, Crichfield and McGuire 1997, Freire and Polèse 2003, Kessides 1992, Lobo and Rantisi 1999, Prud'homme 1997, TD 2004). We shall address the impact of transportation infrastructure from a different perspective, more closely related to the research tradition of economic geography and regional economics. We suggest that it is not the infrastructure *per se*, but rather the *accessibility* that it provides to other locations across the whole network that affects the location and the growth of economic activity.

In this study, we shall consider accessibility with respect to all of North America. Building on a previously developed econometric model of regional growth for Canada – which is described in greater detail further on – we introduce a new set of variables into the equation that consider a community's accessibility to markets and other destinations.

Accessibility is not an easy concept to operationalize, if only because accessibility can take different forms: accessibility in terms of time, cost, reliability of service, etc. We focus on four transport modes: the road and highway network, the railway network, the airline network and ports. A community may have various accessibilities, so to speak. Thus, a community may be highly "accessible" by road – with a high market potential for goods transported by truck – but with low accessibility for goods transported by water. One would expect such a community to have a different industrial structure – and thus also growth rate – from communities with important maritime and/or fluvial infrastructures. The manner in which the accessibility variables are estimated and specified is explained below.

The basic postulate, in short, underlying this study is that accessibility – by road, rail, water or air – is a significant determinant of employment growth (or decline) for the periods studied, in turn impacting population and income. A transport infrastructure as such – its mere presence – may not trigger growth: an airport or highway will not, by itself, generate growth. The important variable, we suggest, is the increased access they provide to potential customers, suppliers, and – as we shall explain in greater detail shortly – to information, relationships, and ideas that are dependant on face-to-face contacts. In this respect, different transport modes – and the different accessibilities they provide – are often complements rather than substitutes. Selling a good – shipping it by truck or rail – may necessitate several parallel meetings between suppliers and customers, in turn dependant on air travel. By the same token, some "accessibilities" will matter more over shorter distances, while others will matter more over longer distances. Road and air infrastructures do not – for obvious reasons – address the same markets.

As the reader will have guessed by now, accessibility is a multidimensional concept, which cannot be reduced to a single measure. The important point to bear in mind all throughout this study is that we shall be examining the impact of transport modes on local economic development *compared* to other determinants of regional growth. Or, stated differently, do transport modes – via the accessibility they provide – have an independent impact on growth, above and beyond other factors? Accessibility is not necessarily the primary determinant of growth. The currently dominant theories in economic geography stress the role of agglomeration, industrial diversity, and proximity to large urban centres (Fujita and Thisse 2002, Henderson 2003, Krugman 1995, Phelps and Ozawa 2003, Quigley, 1998). Others have stressed the importance of industrial specialisation – clusters – as determinants of growth (Porter 1996, 2000). Others again point to the importance of "local" – institutional and social – determinants of local economic development (see section 1.5).

The econometric model used in this study – which is presented in part 2 – incorporates various variables that can influence growth: urban size, initial industrial structure, education, etc. The question then becomes, how important is accessibility relative to other factors, which accessibility, and for which industries? The relative importance of different accessibilities may also be changing over time for different industries. We may, for example, reasonably assume that air travel accessibility will be of greater importance for explaining the location and growth of high-order services – say financial services – than for explaining the location and growth of manufacturing. Financial services – to stay with that example – are also *a priori* more sensitive than most other sectors to the introduction of IT; for most standardized financial transactions, electronic communication is today a practical substitute for face-to-face contacts. For service industries for which the final product (service) can now be delivered at almost zero cost, we would expect the relative weight of different “accessibilities” to have changed over time. If output can be transported without cost, then the primary consideration becomes the cost of transporting inputs.

The rise of the knowledge economy and especially the rise of tradable services – services that can be consumed over large distances – require that we take a closer look at how different transport modes relate to each other.

1.3 The Knowledge Economy, Face-to-Face Linkages, and the Growing Interdependency of Transport Modes[6]

As in other industrialized nations, the most rapid growth in the Canadian economy over the last few decades has been in services, specifically in scientific and technical services, professional services, and entertainment and leisure related services. What do these sectors have in common? They rely heavily on face-to-face contacts and direct human interaction. Why the need for face-to-face meetings? Simply put, because these are often “creative” activities (to use a currently fashionable term) with high knowledge content, where spontaneity, imagination, and informal meetings play a major role in determining productivity. At another level, the need to establish and reinforce trust, especially for the most information sensitive activities (R&D, investment…), also fuels the demand for face-to-face contacts.

The obvious question is: why has IT not reduced the demand for face-to-face meetings? Should not e-mail, cell phones, and other media of electronic communication reduce the need to meet? The impact of IT is often quite the opposite. IT can in fact *increase* the need for face-to-face meetings. Gasper and Glaeser (1998) argue that electronic communication and face-to-face contacts are complements, not substitutes. People who regularly communicate via e-mail will, eventually, have to meet. In other words, IT has fuelled a new demand for face-to-face meetings, and thus – this is the paradox – in fact increased the importance of location and the forces of urban concentration, as various authors have pointed out (Ghemawat 2001, Glaeser 1998, Zook 2001, 2004). The same thing happened, Gasper and Glaeser (1998) recall, a century ago with the introduction of the telephone. The evidence appears to bear them out. Never has the demand for business air travel (9/11 notwithstanding) risen so fast as in the last few decades. This also sheds light on an apparent contradiction. While communication – both electronically and via travel – increasingly occurs over greater distances, suggesting a weakening of distance, the locations via which such contacts occur

6 This section draws in part on a paper prepared for Infrastructure Canada (Polèse 2005).

are increasingly polarized, suggesting a strengthening of distance. IT links have become largely ubiquitous (at least outside the poorest nations and regions) generating electronic exchanges that are *not* sensitive to distance, but which in turn must be complemented by face-to-face contacts, which *are* sensitive to distance and thus to relative accessibility.

The most rapidly growing services are generally producer services; that is, intermediary inputs into the production process, most notably, professional, scientific and technical services. In the knowledge economy, the production of goods – manufacturing – is increasingly linked to a set of services that rely on face-to-face contacts. This change in the production process will continue as long as the knowledge content of manufactured goods continues to grow. The growth in the marketing of goods and of direct investments – in plants, distribution facilities, etc. – over large distances has a similar impact. Managing a plant at a distance is facilitated by IT, but must be backed up by meetings between management, technical and marketing people at both ends.

In short, electronic communication, trade in goods, direct investment linkages, and face-to-face meetings are often interdependent. Growth in one – say in goods shipped by rail – will in turn fuel growth in the demand for other modes of communication and transport. In an economy where the knowledge and the creative content of products – goods and services – is on the rise, we should normally expect demand for face-to-face contacts to grow. This favours, one would predict, those places which are well positioned in terms of multiple accessibilities – air, rail, water, and road. This *a priori* favours the largest cities. However, the role of cities as centres of exchange, communication, and trade is double. Not only are they "natural" hubs where various modes come together, but they are also the points with the highest potential for direct interaction with the greatest number of people.

Cities exist, in large part, to facilitate face-to-face contacts. As the American economist and Nobel prize winner R. Lucas (1988: 39) famously wrote: "What can people be paying Manhattan or downtown Chicago rents for, if it is not for being near other people?". Why indeed would a firm choose to pay the high rents and wages of a location in Toronto, Montreal or Vancouver if it could avoid it? Arguably, the primary advantage of large cities in the knowledge economy is the diversity of potential contacts they offer. The non-standardized nature of modern producer services, with constantly changing demand and input requirements, is a powerful force driving them towards large cities. Where else but in New York (perhaps Toronto or Montreal) is one likely to find a Portuguese-speaking accountant, versant in international trade regulations, qualified to practice in Brazil? For a consultancy wishing to bid on a World Bank contract, rapid access to such a person can be crucial. An advertising agency may need an opera singer one day, a symphony orchestra the next, and a whiz in computer graphics the following day. A research laboratory may need to bring in a variety of scientists on short notice. The entertainment industry relies on a broad range of face-to-face linkages: actors, screenwriters, musicians, technicians, producers, etc. coming together in ever changing combinations.

The preceding paragraph refers to the range of face-to-face contacts between people in the same city. It is easy to see that larger cities hold a clear advantage.[7] This advantage is compounded by the superior accessibility that large cities also provide for distant face-to-face contacts. The polarisation of air travel-dependant face-to-face meeting is largely driven by the economics of air transportation, sensitive to scale economies. Only large markets with high volume can provide frequent cost-efficient service. Flights between Montreal and New York are far more frequent (and generally less costly) than between Montreal and, say, Rimouski. At the other end, the businessperson in Rimouski has no access to a direct – face-to-face – air-link with New York. He or she must spend more time and more money (probably flying via Montreal) to develop an active relationship with associates in New York. Little wonder, given the choice, that a Québécois establishment with close ties to New York will prefer Montreal. For the entrepreneur in Rimouski, if the need for face-to-face meetings with New York associates grows beyond a certain point, the pressure to move to Montreal may become irresistible.

However, the double role of large cities as both points of dense and diverse local interaction and as points of multiple accessibilities (to other points) creates an analytical problem, which is not easy to resolve: the circular relationship between agglomeration economies and accessibility, notably for transport modes sensitive to scale economies and the (mainly) service industries that rely on them. The concentration of financial services – to take that example again – in large cities is undoubtedly driven both by the local density of potential contacts and by the wider accessibility which the infrastructures in large urban places provide. It might even be argued that accessibility, certainly multi-mode accessibility, is simply a subset of the broader concept of agglomeration economies. The challenge is separating out the “pure” effects of accessibility on growth.

The interdependency between different accessibilities – driven by the growing interrelationship between the production of goods and the need for services – also operates at a second level. The concentration of producer services in large cities affects the location of other industries, precisely because the consumption of theses services depends on face-to-face contacts. Our findings for Canada (Polèse and Shearmur 2004, 2006a) as well as evidence for France (Gaigné *et al.* 2005)

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7 On this, a quote from a recent survey of New York in *The Economist* (2005: 6, 10), which needs no further comment: “Discourse and intercourse – in the broad sense of that word – are the essence and the comparative advantage of New York” and (four pages later): “…a design or a report can be e-mailed from anywhere; but a handshake, a lunch and look in the eye remain popular as foreplay”.

and the U. S. (Desmet, K. and M. Fafchamps 2005) suggest very similar patterns for most manufacturing, specifically medium value-added manufacturing: electronics, machines, furniture, motor vehicles and parts, etc. Such industries tend – in relative terms – to concentrate in small and medium-sized cities.

The process at the root of this location behaviour is commonly called "crowding-out"; that is, the expulsion from metropolitan areas of medium-tech, space-extensive activities, due to high land, labour, and other congestion costs in large metropolitan areas brought on, precisely, by the growing concentration of high-order services and knowledge-intensive activities in large cities (Carlino and Chatterjee 2002, Graham and Spencer 1997, Ingram 1998). For manufacturing, Henderson (1997) nicely explains the process in terms of economic theory, explaining why all manufacturing does not concentrate in the biggest cities. Simply put, since such industries are important consumers of space and do not generally require a highly skilled labour force, they will seek out locations with lower land costs and lower wages. The decision to locate or not in the biggest cities will in part be determined by the trade-off between the gains from agglomeration economies (of locating *in* a large city) and the cost-savings of locating in a smaller city. If smaller urban areas are distinct labour sheds with lower wages and lower land costs, then those industries most sensitive to wage and land costs will locate there. For French manufacturing, Gaigné *et al.* (2005) note the relationship between wages and land (housing) costs, the latter being in part driven by the former. If distance (from a metro area) drives down land prices, labour costs in turn will follow. This feedback between land (housing) costs and wages, in sum, serves to push space-extensive, low-wage industries ever further from metro areas, and ultimately into the periphery, Henderson *et al.* (2001) observe this "dispersal" process for manufacturing for various nations.

The evidence for Canada and other industrialized nations also shows us that most such industries, given the choice, prefer to locate close to (but not in) a metropolitan area, generally within a radius of an hour's drive or so. The reason, in large part, is the need for frequent face-to-face meetings. Plants need to be in frequent contact with providers of producer services, generating a constant flow of travel back and forth between the plant and the nearby metropolis for technical, financial, marketing or other services. By locating within an hour's drive (more or less), face-to-face contacts can still be maintained with the neighbouring metropolis, but without incurring the costs of an intra-metropolitan location; the plant is, so to speak, "borrowing" the agglomeration advantages of the large city, but without actually locating in it. Compared to the entrepreneur in Rimouski, this provides a considerable advantage. Not only does the plant manager close to, say, Montreal have the option of driving there when he or she pleases – at fairly low cost and time lost – but he or she also, indirectly, has the use of the infrastructures that define Montreal's multiple accessibility – port; rail, airport. The economies of scale – hub and spoke configuration – of the airline industry do not penalize him (or her).

Thus, we would expect most manufacturing activities – unless directly tied to resources (i.e. pulp and paper plants) – to be influenced by two distinct accessibility criteria: accessibility to markets, often continental in scope; accessibility to a large metropolis. The introduction of the second accessibility criteria suggests that there are limits to the dispersal process of manufacturing to more outlying locations. It also follows that communities of similar size – but below a certain threshold – can have very different accessibilities and thus, in principle, different growth potentials. Communities close to a metropolis will have a different matrix of accessibilities – for different modes – than those far away. St-Hyacinthe (about 45 minutes from Montreal) may be about the same size as Rimouski, but its accessibility both to large metropolis and to U.S. markets is not the same.

The interdependency of transport modes and the importance of accessibility to multiple locations have at least two implications for regional growth. First, this suggests that in many cases the salient territory will be the broader city-region, encompassing a large metropolis as well as the smaller cities linked to it (but, beyond its commuting shed). Second, it suggests that growth will often concentrate along trade corridors, traversed by various transport modes, combining the advantages – so to speak – of accessibility to distant markets and to cities located on the corridor. The Economist (2006), in a recent article, notes that of the fifteen new car and truck plants that were opened in the U.S. between 1980 and 1990, all but two were built along Interstates 65 and 75, which form a narrow corridor running from Michigan down the Ohio Valley; since then, three more have been built further south on I-65. Lang and Dhavale (2005) note a similar phenomenon – for population growth in general – for other “corridors” in the U.S.; for example, along I-35, which cuts across the United Sates from the Mexican border to Kansas City, crossing San Antonio, Austin, Dallas, and Wichita.

1.4 The Competition Effects of IT and Lower Transport Costs

A basic tenet of regional economics holds that a fall in communications or transport costs (linkage costs, in other words) will generate competition between the locations connected, and will in turn foster the concentration of production (in one of the locations) if: a) production is subject to scale and/or agglomeration economies; b) one of the two locations holds an initial advantage. This economic “law”, when combined with the rise of face-to-face linkages as a production input, largely explains the trend to spatial concentration.

Geographic concentration is facilitated when transport costs are nil or negligible and when the product in question (good or service) is very sensitive to scale and/or agglomeration economies. The entertainment industry is a prime example. It is very sensitive to agglomeration economies, largely defined by its reliance on a diverse web of face-to-face linkages. But, this was also largely true in the past.

What has changed is the cost of transporting the final product (sound, images…), which can now literally be transported free of charge over the air waves or by other electronic media. Video clips or CDs can be mailed at little expense. The result has been the decline of entertainment-related employment in small and middle-sized communities. One simply needs to turn on a Radio, TV or computer, where before one might have gone to a local cinema, show, or concert. The national news we watch on TV is produced in Toronto (if English) or Montreal (if French), where the jobs are located.

There are countervailing forces working against spatial concentration. Congestion costs, as we saw, act as barriers to concentration – traffic, housing costs, pollution, higher wages – pushing manufacturing towards smaller places. Resources still need to be exploited where they are found. Information (verbal, written…) is sensitive to cultural and linguistic differences, which has prevented the (total) concentration of entertainment and broadcasting-related jobs, as well as other language-sensitive services,[8] in Toronto (Polèse and Shearmur 2004a). However, in the Canadian case, we should not be too optimistic about the decentralising impact of congestion costs. Our largest metropolis – Toronto – is fairly unremarkable by world standards, barely a sixth the size of greater Tokyo and barely fourth that of greater New York. In other words, if communications costs continue to fall in the future, we should expect continued concentration in and around large urban centres.

In sum, falling communication costs produce conflicting results. They reduce distance costs, but they also increase competition. The rise of the automobile and of paved roads – greater accessibility, in sum – was largely responsible for the demise of small towns in rural Saskatchewan. Where before, residents shopped locally, they now prefer the nearest larger town, accessible by car. In more recent times, IT and other innovations (i.e. bar codes, ATMs…) have facilitated the spatial concentration of jobs in finance, distribution, and marketing. Warehouses, outlets, and plants can now be more easily managed from the centre. The information highway goes both ways. It opens up big city markets to small distant producers, but it also allows big city producers to penetrate distant markets. E-commerce has had a devastating effect on many small town wholesalers.

That falling transport or communications costs foster centralization runs counter to much popular perception, especially since the arrival of the Internet. As noted earlier, the Internet was supposed have sealed the death of distance. The conclusion seems logical at first sight. Does not modern information technology (IT) free firms from the tyranny of distance, so to speak, from the need to locate in big cities? Witness, for example, the outsourcing of computer programming services to Bangalore (India) and of call centers to smaller-sized cities across North America

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8 Other examples are marketing, publicity, and consulting, as well as some financial services.

and elsewhere. To understand what is actually happening, it is useful to think of communications or transport costs as if they were tariffs or other barriers to trade. When such barriers fall, say between two nations, competition increases. If one of the two nations is more efficient in the production of good x, it will increase its share of the market perhaps totally eliminating producers in the other nation. Production of good x is now “centralized” in one nation. The outsourcing of certain services to new (more distant) places does not mean that distance no longer matters. Rather, it means that the new location can produce the service (being outsourced) at lower cost. The fall in communications costs brought on by IT allows production to be increasingly centralized in the new location.

In Canada, the largest metropolitan areas – with population over 500,000 – have grown more rapidly than smaller cities since 1991, a sign that on balance IT has not fostered decentralization. This is consistent with historical experience. The arrival of the steam engine (railways), of the telegraph and of the telephone, and of the internal combustion engine (automobiles, trucks) have all been accompanied by periods of rapid urban growth. The introduction of the telegraph more than a century ago (as revolutionary then as the Internet today) did not slow down the growth of New York or London. Quite the contrary, it allowed the financial institutions and corporate offices in those cities to expand their reach around the planet. The arrival of radio in the 1920’s and television thirty years later provide vivid examples of the centralizing impact of communications technologies. Before that, much entertainment was produced locally. Almost every town had its own theatre. Few remain today. Today, for entertainment or news, one turns on the TV, radio, or Internet. For American or British audiences, the person on the other side (actor, singer, newscaster…) will most likely be in New York, Los Angeles or London.

An obvious implication of the above is that any infrastructure that facilitates trade will also foster agglomeration – in those places best able to dominate the market. Our reference to tariffs and trade barriers was not accidental. Economic integration – NAFTA, globalisation – facilitates agglomeration. At the risk of repetition: low transport and communication costs and falling barriers to trade allow industries to centralize operations. This, in the end, brings us back to the fundamental question in economic geography: why do firms or other institutions choose to “centralize” their operations in one place rather than another? Which is simply another way of restating our central question: why do some communities grow while others lag behind? Numerous other factors, we have suggested, influence regional growth (or decline). An abundant literature has accumulated over the years – in economics, geography, and regional science – on the issue of regional growth; to which we now turn.

1.5 Unravelling the Myriad Components of Regional Growth: What Is Local and What Is Not?

In this section, we briefly outline two complementary approaches to understanding regional growth. We specifically distinguish between endogenous place-based factors, which focus upon local milieus and local innovation systems, and approaches – closer to the research traditions of regional economics and economic geography – that focus upon broader geo-structural factors. As will become clearer as we proceed, the introduction – into our model – of explicit accessibility variables is in part an attempt to operationalize and to better measure those geo-structural factors.

Much has been written on what makes a region grow, and often it is growth in per capita incomes or GDP, rather than employment, that is analysed (Barro and Sala-I-Martin 1991, 1995; Coulombe 2000; Kangasharju 1998; Kangasharju and Pekala 2000). However, as Martin and Tyler (2000) point out, local employment growth is not necessarily connected to local per capita income or GDP. It is quite conceivable for local wages and per capita GDP to rise (because of rising productivity) at the same time as local employment falls. Of course, productivity and employment are not unrelated: if a *region* provides conditions that are conducive to productivity growth, then economic activity will flow towards it in order to benefit from these conditions. But this link, which is often taken for granted in larger and more diversified regions, is not so evident in smaller and more specialized ones: in such regions there may indeed exist a high-productivity environment but only for a few industries. If employment declines in these industries, few if any alternatives exist.

The two approaches – "local" and geo-structural – are complementary. Both approaches to understanding regional growth take *regions* – communities, localities – as their unit of analysis, and try to understand growth by looking at what is happening *within* regions (local intra-regional analysis – a micro approach) or *between* regions (geo-structural approach – a macro approach). A critical factor is the scale at which regions are defined: at a very large scale (the world), all factors are local. As the scale of analysis becomes smaller – and in Canada we shall often be working with very small units[9] – a key question is whether factors that are endogenous at one scale (e.g. education levels at the scale of nations) are exogenous at another (e.g. education levels in small resource based towns).

In this study, we can only provide a broad outline of the two approaches. The aim is to highlight some of the growth factors that each approach identifies, and to specify the general framework within which our model – presented below – is situated.

[9] 75% of our spatial units have fewer than 50,000 residents in 2001, and 50% have fewer than 25,000. Two hundred and fifteen of the spatial units (those considered rural) do not include any urban area of over 10,000 people.

1.5.1 The "local" approach to regional growth

Work on community development, on the clustering of economic activity, on local milieus, and on regional innovation systems has in common the fact that certain local factors or processes are studied in order to obtain a better understanding of a region's economic performance. The focus and the methodology of this work vary greatly. Some researchers examine the institutional framework within regions (Maillat 1990, Maillat and Kébir 2001; Cooke *et al*. 2004); others study individual and collective actors involved in development processes (Galaway and Hudson 1994); others still explore inter-firm dynamics and the way in which knowledge spillovers, competition and cooperation can lead to innovation and growth (Jacobs 1984; Piore and Sabel 1984; Porter 1990, 2000; Malecki and Oinas, 1999). Related work explores endogenous growth (Romer 1989; Martin and Sunley 1998), human capital (Romer 1989, Florida 2002), social capital (OECD 2001, Putnam 2001), and knowledge spillovers (Audretsch and Feldman 1996). Finally, others have looked at local development more from a policy perspective, emphasising the power of local government action and community organization (Bennington and Geddes 1992, Blackey 1994, EEC 1990, Perry 1987, Wievel and Hall 1992).

A number of local or endogenous factors that appear to be conducive to productivity growth and innovation[10] have been uncovered. On the whole they fall into three groups, which we will briefly describe. First, institutional factors are often presented as key to understanding the local development process (Maillat and Kébir 2001; Cooke *et al*. 2004): the way in which local governments, chambers of commerce, universities and so on interact amongst themselves and with the local and non-local business community can have an impact (positive or negative) on growth. Second, local business practices and industrial structure (Birch 1987; Giaoutzi *et al*. 1988; Piore and SabeL 1984; Porter 1996, 1998) are seen as contributing to local economic success: a stimulating combination of competition and cooperation, which both encourages productivity and innovation whilst ensuring that information and know-how are shared, can lead to growth. By contrast, an industrial structure dominated by a few large firms, or by passive sub-contractors, can slow local development. Third, and somewhat more vaguely, local culture – attitudes towards new ideas, entrepreneurship, innovation, wage expectations, trade-unionism (Pecqueur 1989; Florida 2002) – can be an important factor in determining growth prospects in a region.

[10] Innovation is not distinguished here from productivity: firms can compete on a cost basis (traditional productivity) or on a quality basis (new or improved products). The recent focus on innovation can be partly explained by the recognition that many industries can no longer compete with developing countries on a pure cost basis (Krugman 1991). Productivity and innovation are directly linked if process innovations are considered.

The quality of the local labour force, and in particular the knowledge that it embodies, has been linked with growth at the national and metropolitan scale (Florida 1995; Lever 2002; Romer 1989; Simon 1998). However, the extent to which it is a "local" factor at smaller scales – such as those often encountered in Canada – is debatable because qualified labour is mobile, and can itself be attracted to regions that display conditions conducive to productivity and innovation.

A more "classic" factor that is associated with local development is industrial structure: the mix of economic sectors in a locality can determine growth in a variety of ways, some of which are recognised and investigated in the literature on milieus. Randall and Ironside (1996) and Cuadrado-Roura and Rubalcaba-Bermejo (1998) show how specialisation in particular sectors can lead to volatility, but also, if output from the sectors is in demand, to strong growth. Porter (1998) describes how specialisation in certain types of industry is associated with development, and the work by Henderson (Beardsell and Henderson 1999) and others on agglomeration economies emphasises the importance of the concentration of certain sectors. From another perspective, the tradition of shift-share analysis in regional science rests upon the assumption that local employment growth is partly attributable to industrial structure (Lamarche 2003).

Finally, although not often treated in the literature on local innovation systems and milieus, costs are an important factor that may determine levels of employment growth. To the extent that costs are determined locally – wages, taxes, land costs – they are place-based: but to the extent that they are a reflection of transport costs and distance from markets, they are geo-structural in nature. Notwithstanding the problems associated with categorizing costs as endogenous or exogenous, cost minimization is the straightforward attempt by each firm to identify the location that will enable it to produce a given item at the lowest cost – including transport – given the structure of its inputs and outputs.

It is important to note that there is nothing in these "local" place-based factors that necessarily ties them to any particular type of region or community. Indeed, development policies have attempted to nurture productive milieus, competitive industrial structures or business-friendly environments in a variety of regions decline (OECD 2002; Pezzini 2000). Thus, in Canada, the local economic development initiatives sponsored by ACOA – Atlantic Canada Opportunities Agency – are not limited to the poorest communities of the region, but also involve urban centres such as Moncton, St John's, and Halifax.

However, as Hall (1999), Simmie (2001), Jacobs (1984), Malecki *et al.* (2004) and Crevoisier and Camagni (2000) emphasize, it is most often in large cities that the cultural, institutional and business practice elements conducive to growth are combined. In the same way, the link between labour force qualification and employment growth (Gertler *et al.* 2002) is closely related to urban size: there is a strong tendency for larger cities to have proportionally more qualified inhabitants than smaller cities or remote rural areas (Shearmur 1998). Cost-minimisation can also be linked to urban size: for many firms today, the principal costs, besides labour, are those required to access markets and know-how. The link with transport infrastructure is obvious, and brings home, yet again, the difficulty of separating out the effects of size and of accessibility. To complicate matters more, geo-structural variables – of which accessibility is a subset – may in part be manifestations of "local" level factors and processes. From the perspective of the econometric model applied in this study (see part 2), this is an important consideration. If place-based attributes – say, the level of airline services – are closely linked to larger scale geo-structural variables – the community's population and location on the continent, for example – then it will be difficult to disentangle the effect on growth of these two types of factors. From a policy perspective this would – alas – suggest that intervention on local factors has limited impact, since they are closely associated with broader structures upon which policies can have little influence.

1.5.2 Geo-structural factors

The "geo-structural" approach to regional growth looks at the distribution of growth between regions, and attempts to understand growth patterns by appealing to wider supra-regional factors: urban size, location, distance. Such factors are familiar to most economic geographers: the centre-periphery dichotomy has been discussed for decades (Wallerstein, 1979; Bradfield 1988), and the effects of agglomeration economies have been analysed at least since Marshall first described them in 1890 (Phelps and Ozzawa 2003). Empirical analysis repeatedly shows that employment growth tends to be distributed regularly across these structural dimensions. This is no less true for Canada, as our own work has continually shown (Coffey and Shearmur 1996, Coffey and Polèse 1988 and Polèse and Shearmur 2004). At the risk of repetition, the results show a strong tendency for employment growth – in particular growth in knowledge-rich economic sectors such as high-order services – to concentrate in and around cities, and more specifically larger metropolitan areas. Exceptions to these patterns can occur, particularly during periods of fast growth in resource – or resource dependent – industries and during periods of social and economic upheaval. The current resource boom in Alberta and parts of Atlantic Canada is an obvious example of the former. Only time will tell whether such growth is sustainable, or whether it is simply fuelled by international demand for resources.

Our emphasis on accessibility is not accidental. Access, proximity, and other concepts that convey the same idea are the cornerstones of economic geography. Access to markets is a key factor in classical location theory. The Christallerian model of service location emphasizes cumulative distance minimization to customers in the context of the service sector. Lösch’s extension to the Weberian model introduces complex access requirements to customers, workforce and a variety of inputs for manufacturing firms (Dicken and Lloyd 1990). As the requirement to be close to physical resources diminishes for most manufacturing firms, the attraction of the market place increases, and correspondingly the importance of “accessibility” to markets. By the same token, as North American integration proceeds, we should expect the importance of accessibility to continental markets to increase. It follows that regions with better access to continental markets will tend to grow faster than those that do not. In a globalizing world, there are two types of regions that should benefit from increased access to markets: well connected metropolitan areas that provide connection with international transport routes and information networks (Britton 2004; Castells 1996) – as noted earlier – and border regions (Esquival *et al.* 2003, Helliwell 1998).

Agglomeration economies – another cornerstone or regional economics – are the economies directly related to scale, industry or city size. They are usually divided into two sorts, though this classification is constantly being refined (Phelps and Ozawa 2003; Shearmur and Polèse 2005). First, there are economies linked to the co-location of many firms within the same industry. These economies can be linked to a shared labour force, knowledge spillovers, rapid diffusion of innovations, and to stimulation due to competition between firms (Rosenthal and Strange 2001; Porter 1990; Beardsell and Henderson 1999). Second, there are economies linked to the co-location of many diverse activities. Infrastructure such as international airports and highways depend upon a large local market, as do schools, universities and cultural activities. In addition, the presence of a diversity of economic sectors may stimulate the cross-over of ideas, leading to innovations, or even to new economic activities (Jacobs, 1984; Quigley, 1998). This does not mean – as noted earlier – that larger cities alone will benefit from agglomeration economies: rather – and in keeping with Phelps *et al*’s (2001) idea of borrowed size – it is regions within *and close to* larger cities that will benefit from urban size.

Thus, we have come back full circle to the multidimensional nature of accessibility. There is a connection between access to markets, access to scarce inputs – in particular knowledge and skilled labour – and agglomeration economies, although the three do not necessarily overlap. Furthermore, although agglomeration economies are introduced here as a geo-structural factor, we saw that many local or endogenous growth factors cannot easily be separated from city size. In many respects the “local” place-based approaches to employment growth have contributed to a better understanding of what lies behind agglomeration economies. Place-based research has often served to isolate and specify some of the institutional, cultural and firm-level processes that, repeated in various regions, lead to wider scale patterns. However, all regions cannot necessarily sustain the wished-for local processes to the same extent: these processes may, in the end, be specific to certain types of regions – large urban areas and regions with good access to markets – and to certain scales – large, diversified and relatively self-contained regions. In short, in the ongoing debate on endogenous "local" factors vs. exogenous broader factors of regional growth, it is difficult to escape from problems of circular causation and recurrent feedback effects; which does make research on the subject any easier, as various authors keep reminding us: Markusen 1999, Martin and Sunley 1998, Moulaert and Seika 2003, Parr 2001.

1.5.3 Other factors of regional growth

Factors more difficult to situate on the endogenous-exogenous continuum can also affect regional employment growth. For example, development across North America is still conditioned by the westward settlement that occurred over the last 400 years. It is often forgotten that the opening up of the west by railroad only happened – in Canada – in 1881, and the western provinces have only developed an urban system and fixed pattern of settlement over the last 100 years (Pomfret 1981). The underlying mechanism here – it could be argued – is one of path-dependency (Scott 1999).

Another important factor influencing regions' growth is external markets for their exportable goods and services. Irrespective of physical access to markets, if markets for a region's principal goods or services decline or disappear, then the region will suffer employment loss (Manzagol *et al*. 1998). This can occur, for instance, when technological changes render obsolete the product in which a region specializes. It can also occur if exports are destined to a particular country or region which itself is suffering from a recession or an economic crisis, or if there is a sizeable exchange rate fluctuation that increases the price of regional exports to a market on which the region depends (Hervey and Strauss 1997).

A final example of other factors that can influence employment growth, especially in smaller regions, is direct government intervention. Either by way of subsidies to particular industries or by way of public service employment, government spending can alter local employment growth rates (Markusen 1994; Markusen *et al*. 1996). But these, again, are all factors we cannot systematically measure, and cannot thus be introduced into the model. However, our interpretation of the results will be informed by our knowledge of the regions and policy programs, where appropriate.

PART 2
METHODOLOGY: THE AUGMENTED COFFEY-POLÈSE-SHEARMUR MODEL – DATA AND MEASUREMENT ISSUES

In this report we seek to investigate possible statistical links between accessibility and employment growth. The approach that we use is straightforward in its general outline, though certain variables, the accessibility variables in particular, are extremely complex to produce.

Our starting point is a local employment growth model developed over the 1990's and 2000's by Coffey, Shearmur and Polèse (Shearmur and Polèse 2005, 2005a, 2007 – the CPS model). Its latest version, that incorporates geo-structural and local factors, and that has been tested for spatial auto-correlation of residuals, is the base model to which we add accessibility variables. These variables are designed so that they are independent of one another, and each captures a certain type of accessibility. For total employment, and for each specific economic sector that we study, we observe the *increase* in explanatory power of the model once the accessibility variables are added. We also examine whether existing variables (particularly the geo-structural ones) lose their explanatory power once accessibility variables are introduced.

An *increase* in explanatory power of the model after including the accessibility variables tells us that, over and above the growth factors identified by CPS, accessibility improves our understanding of employment growth. Given the underlying theory, it would be plausible to state that accessibility is a causal factor, and that better accessibility explains growth. If the explanatory power of the model remains unchanged, but certain geo-structural variables lose their significance to the benefit of accessibility variables, this would indicate that our geo-structural variables act as (imperfect) proxies for accessibility: once accessibility is explicitly introduced, these variables no longer enter the model significantly.

2.1 Data and Methodology

Except for the purely geographic data derived from digitized maps of Canada, data used for empirically testing the model are derived from the censuses of 1971, 1981, 1991 and 2001. These data cover 290 census divisions (CDs) and 152 urban agglomerations[11] (UAs) which had over 10,000 people in 1991.

Since the 290 CDs cover the entire Canadian territory, it has been necessary to manipulate the data in order not to double-count UAs. To do this, data for UAs contained within a CD are subtracted from the CD data, giving data for the UA, and data for the surrounding non-urban area. If a UA overlaps a number of CDs, the CDs are aggregated until there is no overlap.

[11] In fact, the database includes the 142 CMAs (Census metropolitan areas) and CAs (Census agglomerations) which had over 10,000 people in 1991, to which were added 10 CSDs (Census sub-divisions) which also had over 10,000 people but were not part of an agglomeration.

In this way the database used in the following analysis contains 382 distinct regions, 152 urban agglomerations, and 290 rural areas. Because of small employment numbers in far northern regions and of growth dynamics that are specific to northern communities, we have only used 358 regions in the following analysis (145 urban and 213 rural), having excluded all those north of the 55^{th} parallel. In these northern regions we do not expect our growth model to work: low numbers of jobs can lead to erratic growth rates, and the cultural, economic political structures differ greatly from those that can be found in more southern areas of Canada.

2.2 The Model

The following regression model is applied in order to explore the link between the variables described above and employment growth rates across the 359 regions studied:

$$G = A + aX + bY + c\,P + e(UC) + fS + gE + hD + iW + j(I) + \varepsilon$$

where A = the intercept.

G = growth over the period analysed.[12] The first year of this period is the base year. Growth is for total employment or for total employment or by industry, depending on the data used.

X = east-west co-ordinate in degrees. A negative parameter on X indicates that growth is higher to the west. The east-west co-ordinate of a region is introduced in the model to account for the clear tendency of growth to be faster in the west than in the east (Coffey and Shearmur 1996). As already mentioned, we believe that this variable will pick up a longer term and more general trend of development and settlement in the west.

Y = north-south co-ordinate in degrees. A negative parameter on Y indicates that growth is higher to the south. If this variable enters the model significantly, we expect that over the 1980's and 1990's regions closer to the border grow faster than those further away.

It should be noted that the XY coordinates (particularly the Y coordinate) is interpreted as a proxy for accessibility to the US border in the CPS model. Our new accessibility variables (those that will be added to the CPS model) may be measuring the same thing. However, since there are no multicollinearity problems, and since we are interested in measuring *improvements* in explanatory power of an existing model, we have left these variables in the regression.

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[12] Growth between t_1 and t_2 is measured as $(V_{t2}-V_{t1}) / V_{t1}$ where V_t is employment at time t.

P = Prairie dummy variable, set to 1 if the region is in Saskatchewan or Manitoba, set to 0 otherwise. This corresponds to Canada's equivalent of the US 'empty quarter', located directly to the south (Garreau 1981).

UC = categorical variable that classifies regions into four groups:

central urban (agglomeration of over 10,000 people within one hour of an agglomeration of at least 500,000 people),

peripheral urban (agglomeration of over 10,000 people over one hour from an agglomeration of at least 500,000),

central rural (agglomeration of over 10,000 people further than an hour from an agglomeration of at least 500,000 people) and

peripheral rural (remaining regions. Set to 0 in models).

Metropolitan areas of over 500,000 are classified as central urban. Dummy variables are included for all classes except peripheral rural.

S = logarithm of population size in the base year.

E = percentage of university graduates in the 15 years and over population in the base year.

D = diversity index in the base year (see Shearmur and Polèse 2005). A low diversity index indicates high diversity.

W =average wage in the base year.

I = categorical variable that classifies regions into eight industrial profiles (see Shearmur and Polèse 2005 and table 1). The manufacturing and services profile is set to 0 in the models.

2.3 Accessibility Measures

This entire analysis rests upon the measure of accessibility. Two questions need to be answered: accessibility to what? and accessibility along which routes?

2.3.1 Accessibility to what?

Accessibility is measured to the entire North-American market. In other words, accessibility to employment, income and population across North-America is measured. Due to data limitations, we only have North-American wide information (at the county level) for 1990 and 2000. Thus, our accessibility measures are calculated for 1990 and 2000, and for each of the three measures of market. Correlation levels between these three types of accessibility and between

1990 and 2000 are above 0.99. In other words, despite the population growth and shifts between 1990 and 2000, and despite the fact that the spatial distributions of income, employment and population are not identical, there is almost no shift in relative accessibility between 1990 and 2000.

This should come as no surprise. Despite marginal changes in the spatial distribution of human activity over space, even in the very long term there is tremendous inertia in settlement patterns (Davis & Weinstein 2002). In North America since the 1970's, although changes have occurred, these have not fundamentally altered the pattern of settlement in North America. We have thus used the 2000/2001 accessibility measures for the entire three decades of study. This is necessary due to data constraints, but we have verified that the 1990 and 2000 accessibility measures are virtually identical.

2.3.2 Accessibility along which transport networks?

Accessibility to markets is measured for four types of transport infrastructure: roads, railways, air travel and ports. The logic behind the construction of each accessibility measure will briefly be explained. The technical information and data sources relating to the construction of the digitised distance/time networks are presented in appendix 2. It should be noted that, except for ports, the three distance matrices indicate the *time* it takes to travel between two points along the particular transport network.

Road networks: Accessibility along the road network is not constrained by transhipment costs or subject to economies over longer distances. We have therefore assumed that, by road, a given local area has access to *its own* market as well as to all other markets in North America.

Thus, for a given local area j, say Montreal for example, accessibility to North American markets is calculated as follows:

$$M_j = \sum_{i=1}^{3300} \frac{p_i}{t_{ij}^{\,b}} \quad \text{if } i \neq j,\ t_{ij} \text{ min} = 10 \text{ minutes.} \tag{1}$$

$$a_j = \frac{p_j}{0.5\sqrt{A_j/\pi}^{\,b}} \quad ;\ A_j \text{ min} = 1256 \text{ km}^2;\ A_j \text{ max} = 11\,304 \text{ km}^2 \tag{2}$$

$$X_j = M_j + a_j \tag{3}$$

where

M_j = market potential of *j*, excluding *j*; p_i = population of *i*; t_{ij} = time between *i* and *j* (a minimum time of 10 minutes is imposed); b = exponent of distance, or distance decay (values used 1 and 2).

a_j = auto-potential of *j*; p_j = population of *j*; A_j = area of *j* (constrained in order to keep the denominator between 10 and 30km, i.e. 10 and 30 minutes at 60km an hour).

X_j = market potential of *j*

In order to avoid extreme values (due to oddly shaped regions for which the centre of gravity may be outside its boundaries and to some very small regions) a minimum time of 10 minutes has been imposed. For auto-potential (the distance a region is from itself) a maximum time of 30 minutes has also been imposed on the assumption that even within vast sparsely populated regions human activity tends to agglomerate.

Two different values of market accessibility are calculated.

1. The first has a shallow distance decay function (the value of b is 1). With such a value a more weight is given to distant markets: it is thus a measure of accessibility that can be considered regional or national.

2. The second has a steep distance decay function (the value of b is 2). With such a value less weight is given to distant markets: it is thus a more local measure of accessibility.

Rail networks: Rail networks are not as all-pervasive as road networks. Railways only go through certain areas, and some areas are completely inaccessible by railway. We therefore assume that all areas within 200 km of a railway are accessible to it (at a speed of 60 km an hour). The time taken to access the railway, and the time taken at the other end to reach the final destination, is added to the rail time: furthermore, the time is raised to the power 1.25 in order to take into account the fact that the choice to use a railroad will be more likely the closer one is located to it. Thus, for a region 10 minutes from a railroad, 17.9 minutes are added ($10^{1.25}$). For an area one hour away, 168 minutes are added ($60^{1.25}$). All areas beyond 200km have no rail access. In Canada, this means that 35 spatial units are deemed to have no rail access. However, given the difficulty in treating these 35 spatial units separately, they are assigned a non-zero accessibility value that is below that of the least accessible spatial unit *with* rail access. In other words, we treat them as having very low, but non-zero, accessibility to a railway.

Of more importance is the fact that we assume railways are not used to cover distances of less than 200km. Thus, there is no rail access between areas *i* and *j* if the distance of the rail segment between *i* and *j* is less than 200 km. Our assumption is that for short distances road transport would be used.

$$M_j = \sum_{i=1}^{n} \frac{p_i}{t_{ij}^{\,b}} \text{ if rail segment of } t_{ij} >= 200\text{km} \quad (4)$$

n is the number of regions connected to the rail network for which the rail segment of t_{ij} is greater than 200km.

If *j* is not connected to the rail network (i.e. is over 200km from the closest railway), then M_j = k. k is a constant inferior to the minimum value of *Mj* calculated using formula (4).

Air network: Air transport has been modelled by digitizing all airports in North America. Airports are categorised, from largest to smallest, into classes 1 to 8. Each type of airport is assigned a transhipment time that takes into account the time necessary to get through security and board, and the time necessary to disembark. It also penalises smaller airports for their lack of connections and smaller aeroplanes.

Flight time *between* airports is estimated by converting distances at the rate of 600 kms/hour. These flight times are integrated into an “air and road” matrix; to calculate total time between areas *i* and *j*, the following times are summed:

- road time between *i* and the closest airport
- transhipment time at departure airport
- flight time
- transhipment time at arrival airport (airport closest to *j*)
- road time between arrival airport and *j*.

The penalties are such that it is not worthwhile to fly over distances that would take less than about 2½ hours by road.

Given the travel times that are in the “air and road” matrix, accessibility to markets by “air and road” is calculated in exactly the same way as accessibility by road (see formulas (1), (2) and (3)).

However, because there is overlap between these road and “air and road” accessibility, we have chosen only to analyse the accessibility that air connections *add* to road accessibility.

Thus air accessibility is defined as the residual, r_j, of the following regression:

$$M_j^a = aM_j^r + b + r_j \quad (5)$$

where:

M_j^a = accessibility by “air and road” calculated applying formulas (1), (2) and (3) using the “air and road matrix”

M_j^r= accessibility by road calculated applying formulas (1), (2) and (3) using the “road matrix”

a and *b* are regression coefficients

r_j = residual air accessibility not accounted for by road accessibility.

Ports: Our information on ports was not complete at the time the analysis was undertaken. In any case, the only information that we have since obtained for all ports is an indication of total tonnage: breakdown by bulk / non bulk is available for some ports; it is not available for all of them.

Therefore, we have chosen a simple measure of accessibility for ports. For a region *j*, accessibility for ports is simply measured as the region's average distance to all 200 ports.

$$\overline{d_j} = \sum_{i=1}^{200} d_{ij}{}^b \text{ , with b set at 1 and 2.}$$

This measure is different in nature from the other three because it does not take into account the spatial distribution of the North-American population. Our assumption is that once goods are loaded onto a ship, distance is largely irrelevant. It is therefore access to ports themselves, and not to markets via ports, that is measured.

This measure would be improved if we could weight the average by container tonnage, and if we could estimate separate mean distances to container and to bulk ports. However, this information is difficult to gather and we were not able to obtain it within the time constraints of this work.

It should also be noted that this variable is the only one that *increases* as accessibility *decreases*. For ease of interpretation we have reversed the sign on this variable in the rest of the report.

PART 3
RESULTS: THE IMPACT OF CONTINENTAL ACCESSIBILTY ON LOCAL EMPLOYMENT GROWTH – 1971-2001

The focus of this study is the impact of transport modes – via the continental accessibility they provide (whose measurement was explained in part II) – on local employment growth. Results are presented in stages. We begin by presenting the results of the factor analysis – also described in part 2 – which allows us to identify four statistically independent measures of continental accessibility, each associated with a unique mix of transport modes. This is followed by an examination of the relationship between the four (unique) accessibility variables and the spatial distribution – location – of employment by industry for the year 2001. We then move to the core element of our analysis: the relationship between accessibility and growth – for the three decades between 1971 and 2001 – by industry and by modal mix.

3.1 Four Distinct Accessibilities (Modal Mixes)

Each of the four types of accessibility has been calculated twice, with distance and distance squared. We therefore have eight different measures of accessibility, many of which are quite highly correlated (table 3.1). This correlation is not surprising because, whatever the transport infrastructure along which we choose to calculate accessibility, a remote area will remain remote, and a central one will remain central.

Table 3.1
Correlations between the Eight Accessibility Measures

	air_r2	roads1	roads2	rail1	rail2	ports1	ports2
air_r1	**0.73**	0.00	0.55	0.32	0.48	0.63	0.58
air_r2		-0.36	0.00	-0.02	0.01	0.06	0.01
roads1			**0.77**	0.43	0.60	**0.93**	**0.88**
roads2				0.52	**0.75**	**0.76**	**0.71**
rail1					**0.91**	0.61	0.60
rail2						**0.81**	**0.78**
ports1							**0.99**

Note: Correlations of 0.7 and over are highlighted.

This high inter-correlation poses problems if one is seeking to analyse how these different types of accessibility combine to produce local development results.

Therefore, a principal component analysis has been performed on these eight variables. Such an analysis groups variables together according to their degree of correlation: it produces new variables (called components) with which certain of the original variables are highly correlated and with which others are not correlated. A useful property of these components is that they are not correlated between themselves, making them ideally suited for inclusion in a regression analysis.

Although principal component analysis is, admittedly, a fairly complex statistical technique, the results – presented on table 3.2 – are unambiguous and not difficult to interpret. Four distinct factors[13] emerge from the analysis, which together explain 98.5% of all variance in continental accessibly between observations (places). In other words, these four factors allow us to account for almost all variance in accessibility between places. As noted in part 2, the reason for the factor analysis is to ensure that variables used to measure the various transport modes – via the accessibility they provide – act independently of each other, with no overlap. The results tell us that four (statistically) independent "accessibilities" exist, each indicative of a unique set of transport modes.

Table 3.2
Four Types of Modal Mix

1. Correlation of each accessibility variable with the four components					
	C1	**C2**	**C3**	**C4**	**Communality**
air	0.35	0.21	**0.69**	**0.58**	96.9%
air (time^2)	-0.02	0.00	0.12	**0.99**	99.3%
road	**0.70**	0.34	**0.60**	0.10	97.0%
road (time^2)	0.43	0.28	**0.84**	0.14	99.0%
rail	0.28	**0.94**	0.15	0.03	99.2%
rail (time^2)	0.48	**0.77**	0.40	0.06	98.2%
ports	**0.88**	0.33	0.34	0.04	99.7%
ports (distance^2)	**0.90**	0.32	0.27	0.01	98.8%
2. Variance explained					
	C1	**C2**	**C3**	**C4**	**TOTAL**
Variance	2.68	1.93	1.92	1.35	7.88
% variance	34%	24%	24%	17%	98.5%
3. Contribution of each type of accessibility to each component					
	C1	**C2**	**C3**	**C4**	
air	5%	2%	**25%**	**97%**	
road	**25%**	10%	**55%**	2%	
rail	11%	**77%**	10%	0%	
port	**59%**	11%	10%	0%	
4. Component names					
C1	Road, port (and rail) accessibility				
C2	Rail (and road and air) accessibility				
C3	Road, continental air (and rail and port) accessibility				
C4	Regional (and continental) air accessibility				

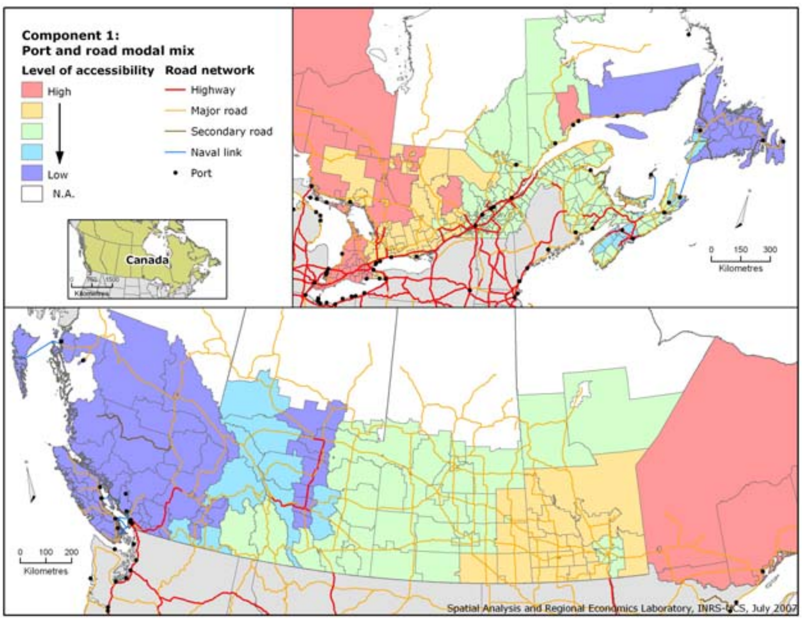
The four dimensions do not simply break down along the lines of the four types of infrastructure used to calculate accessibility.

[13] We use "factor" and "component" interchangeably: we performed a principal component analysis, so the correct statistical term is component.

First, road and port accessibility go hand in hand. Second, rail accessibility does not combine with any other sort of accessibility: thus, component 2 is a simple dimension that measures accessibility to markets via the rail system. Third, high road accessibility (both local and regional) combines with good continental air accessibility. This type of combination probably characterises metropolitan areas and areas that we have called central in the CPS model. Finally, some regions benefit from good air access (both regional and continental) but nothing else.

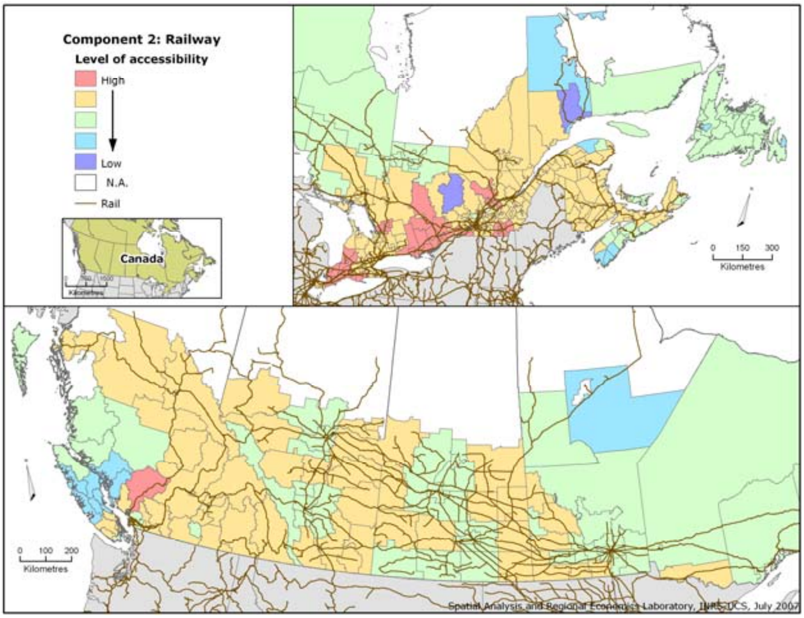
Each component is a composite variable. Henceforth, we shall refer to the four components – 1, 2, 3, 4 – as *modal mixes*. Each modal mix, we see, is characterized by one or two dominant transport modes, which in turn allows us to name them. The fact that each modal mix has an identifiable dominant component means that – at least in terms of accessibility provided – the various transport modes have distinct impacts. Roads do not affect accessibility in exactly the same manner as rail lines, for instance. However, the fact that each is, precisely, a *mix* signifies that the various modes are not totally disconnected from each other. This is almost self-evident. A harbour without a road leading to it is of little use. The only exception (but not entirely) is air accessibility – modal mix 4 – in which one transport mode totally dominates. This is not entirely surprising. Isolated airports can exist, especially in the more peripheral parts of Canada.

Map 3.1
Road, Port (and Rail) Accessibility

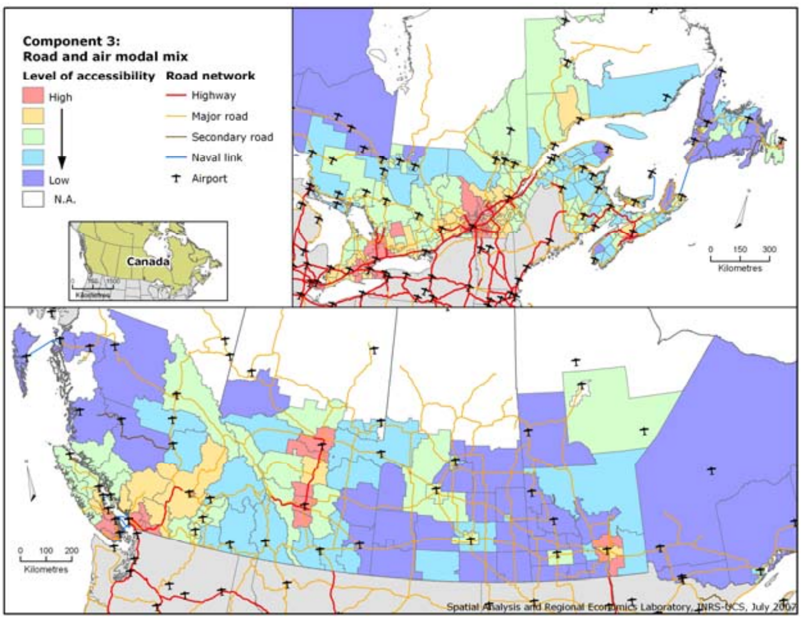


Note: Central Canada is most accessible because of the great lakes and because of the tendency for ports to be located on the eastern seaboard (see appendix 2). Local differences in accessibility are taken into account in the model to the extent that East-West, North-South and Prairie variables account for the geographic distribution observed in map 1.

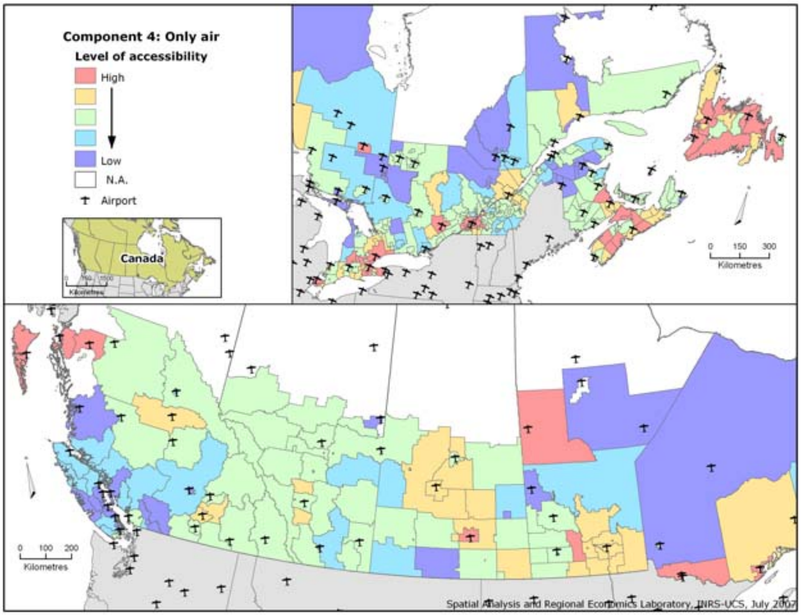
Map 3.2
Rail (and Road and Air) Accessibility



Map 3.3
Road, Continental Air (and Rail and Port) Accessibility



Map 3.4
Regional (and Continental) Air Accessibility



Maps 1, 2, 3, and 4 illustrate, respectively, how the four factors – modal mixes – play out over space. Staying with modal mix 4 (Air, alone), we see that some of the highest values[14] are indeed registered in peripheral parts of Canada: Newfoundland, the Yukon, Nunavut, etc. But, we also see that large urban centres and their surroundings – Toronto, Montreal, Ottawa, Winnipeg…. – rank highly on modal mix 4. Thus, this factor captures an accessibility that characterizes both communities that are highly (almost solely) reliant on air communications and those that have very good continental air connections. The fact that factor 4 stands alone signifies that this accessibility – to airports as such – is not related (statistically speaking) to any of the other accessibilities, associated with other transport mode mixes. Modal mix 3 also includes a significant airport component, but this time *with road* accessibility – the chief component – as well as with harbour and rail components. This time – map 3 – the highest values are almost exclusively found in the largest urban centres and their surrounding, which is what one would expect. On the other hand, continental rail accessibility – modal mix 2 (map 2) – is highest in the traditional manufacturing heartland: southern Ontario and southern Quebec, but also parts of the Lower B.C. Mainland. Harbour (and road accessibility) – modal mix 1 (map 1) – is, somewhat unexpectedly, highest in central Canada. This is more easily explained if the map in appendix 2 is referred to: there are many major ports in and around the Great Lakes,

[14] In technical terms, these values are called factor scores.

down the eastern seaboard (most accessible to central Canada) and along some of the US's great rivers (also more accessible to central Canada). This pattern to some extent reflects the industrial development of North America (most ports were founded during the 19th and early 20th centuries). As we shall see, the importance of modal mix 1 (harbours and roads, but with also a significant rail component) is growing over time as a determinant of community employment growth.

In the following sections, we examine how these four accessibilities are related to local employment structures and growth. We begin with structure; that is, the location of employment – by industry – across communities.

3.2 Continental Accessibility and Industry Location

Table 3.3 gives the strength and the direction of the statistical relation between continental accessibility and location quotients[15] for ten industry classes in 2001, with respect to the four accessibility variables, one for each modal mix. It also gives the total variance – of industry location quotients – explained by the augmented Coffey-Polèse-Shearmur (CPS) model as well as the share explained by the combined impact of the four accessibility variables (last two columns). The ten industries are listed in descending order of the contribution of the four accessibility variables to the explanation of each industry's location equation.

To understand how these results should be read, let us at look the results for the primary sector. The standardised regression coefficient for the primary sector on modal mix 3 is 12.5% (strength) with a negative sign (direction); this indicates that local employment specialization in the primary sector is negatively associated with the continental market accessibility provided by the North American road and highway network and associated airports: for every one standard error increase in Roads (& Air) modal mix there is a 0.125 standard error decrease in Primary sector location quotient. The result is not surprising. We would expect less accessible – smaller and more remote – communities to be more specialized in primary sector activities: agriculture, forestry, fishing, drilling, and mining. Table 3.3 also shows that no significant relationship exists between the location of employment in the primary sector and the other three modal mixes. On the other hand, the variables *already* contained in the CPS model are fairly successful in predicting the location of primary employment, with a total r^2 of 60.0%, of which only 0.3% is due to the four modal mixes. The reason is not difficult to understand: primary employment is concentrated in small and peripheral communities (beyond a one hour reach of a major urban areas), two variables already integrated in the model.

[15] The quotient, let us recall, measures the degree to which employment in a particular industry is concentrated in a given community.

Table 3.3
Strength (standardised regression coefficient) and Direction of the Relationship between Industry Location Quotients (2001) and Continental Accessibility by Modal Mix*

Employment in	Modal Mix: ① Harbours (& Roads)	② Rail	③ Roads (& Air)	④ Airports (alone)	Variance Explained by Model (r^2): All Variables	4 Accessibility Variables**
Wholesaling	41.0%	15.0%	59.6%	29.1%	38.6%	*15.7%*
Public Sector	-51.6%	-17.5%	-45.4%	-21.3%	45.5%	*11.5%*
FIRE	24.4%	19.0%	43.8%		43.1%	*7.2%*
Producer Services			40.4%	9.4%	64.3%	*5.4%*
Construction	20.7%	12.8%	41.6%		36.9%	*5.3%*
Manufacturing	17.2%	16.6%		13.4%	54.9%	*3.1%*
Communications			21.3%		37.7%	*1.5%*
Transportation				12.3%	18.0%	*0.6%*
Primary Sector			-12.5%		60.0%	*0.3%*
Consumer Services			11.6%		46.3%	*0.1%*

* Only statistically significant results (90%+) are shown.

** r^2 attributed to the introduction of accessibility variables

Note: The table should be read as follows: for 1 standard error increase in the 'Harbours and Road' component score there is a 0.41 standard error increase in wholesale location quotient.

On the whole, results in table 3.3 are consistent with what one would expect. The behaviour of the wholesaling sector is revealing. Wholesaling exhibits the highest positive coefficients for three modal mixes out of four, with rail (modal mix 2) the only exception, although the relationship remains positive and statistically significant. It seems entirely logical that distribution and marketing centres – constituents of wholesaling – should be concentrated in the most accessible locations with the best transport infrastructures and that the four accessibility variables should have a high explanatory power compared to other variables; the opposite of what is observed for the primary sector.

The location of manufacturing employment is positively associated with three of the four modal mixes. In other words, specialization in manufacturing – the principal export base for the majority of Canadian communities – is positively related to continental accessibility. However, no positive statistical relationship exists for modal mix 3 (roads and air). This is no accident. Modal mix 3 is the most closely associated with city size (recall Map 3). City size as well as the distinction between close – *central* – cities and those located beyond an hour's drive of a major metropolis – *peripheral* places – is a key element of the CPS model, let us recall. Manufacturing in Canada tends to concentrate in small and mid-sized cities located within easy travelling distance of major metropolitan areas, which in part is why the four accessibilities contribute so little to the explanation of the location quotient, similar to what was observed for the primary sector, but for the opposite reason (in this case, central locations are favoured). The results on table 3.2 should not be interpreted as meaning that modal mix 3 is not important for manufacturing, but rather the relationship is mediated via their proximity (or not) to a major city that ranks well on modal mix 3.

The relationship between modal mix 3 and city size is highlighted by the coefficients for producer services and for FIRE (Finance, Insurance, and Real Estate), which are positive in both cases. FIRE also shows a positive relationship – although not as strong – with modal mixes 1 and 2. The location of firms in these two high-order (often tradable) services is affected – it appears – by considerations of continental accessibility. The relationship with air accessibility (a component of both modal mix 3 and 4) is noteworthy, especially for producer services, confirming our earlier discussion of the importance of face-to-face communication.

Finally, a word is in order on public sector employment, which includes education and health. All the coefficients are negative. In other words, public sector employment plays a countervailing role, counter-balancing the centralizing forces inherent in the search – by firms – for the most accessible locations. Public sector employment is proportionally concentrated in the *least* accessible places. Stated differently, the least accessible communities are proportionally the most dependent on public sector jobs. This also should come as no surprise. Even when employment declines or job opportunities dry up in the private sector, governments will be loath, for understandable reasons, to close down hospitals, schools, and other public services. It is far easier to close a store than a hospital. Visibly, accessibility is *not* the primary consideration behind the location of public sector jobs.

3.3 The *Incremental* Impact of Continental Accessibility on Local Employment Growth.

The previous section dealt with location. We now turn to the impact of accessibility on *growth*, the primary focus of this study.

The four indicators – modal mixes – of continental accessibility necessarily overlap with other factors that influence local employment growth. In part 1 we distinguished between geo-structural factors – difficult to change – and "local" factors, often of a more sociological and institutional nature. It may well be that the positive relationship between, say, road accessibility and growth is in part an illusion, an outcome of other more fundamental (geo-structural) factors subsumed under the road accessibility variable (modal mix 3, mainly). Once we take account of all the other factors influencing growth, the impact of accessibility may well disappear. Road accessibility, as measured, may simply be a proxy for urban size, for example. *The question, in sum, is this: does accessibility produce an independent, incremental, impact on employment growth, above and beyond other factors*?

In order to capture this incremental impact of transport infrastructures – via the accessibilities they provide – on community employment growth, the four accessibility variables (modal mix factors) were added on to the Coffey-Polèse-Shearmur (CPS) growth model, as was explained in part 2. It is useful to recall that the CPS growth model already integrates a number of geographical attributes that are in principle related to accessibility, notably city size, proximity (or not) to a major metropolitan area, and regional location. Thus, the incremental impact captured by the augmented CPS model – which integrates the four accessibility variables – is a minimum, which most probably underestimates the true impact of accessibility. The fact that a community falls within a one-hour travel radius (or not) of a major Canadian metropolitan area is, we know, already filtered out by the model. The incremental impact that the model captures – staying with the same example – is that attributable to greater or lesser *continental* accessibility *within* the same class of communities. Also, if the difference between classes can be entirely accounted for by differences in mean continental accessibility, the class variable will lose its significance and/or a multicollinearity problem will arise. All this may seem overly technical. The point however is this: the incremental impact that the augmented CPS model seeks to identify is a true "added value", in a manner of speaking, capturing local employment growth explained above and beyond that explained by other variables, including geographical variables.

The detailed results for the augmented CPS model are given in Appendix 1. The results in Appendix 1 for the four accessibility variables refer exclusively to the *additional,* incremental, explanatory power attributable to their introduction in the model. Thus, looking at total employment growth for 1991-2001, the augmented CPS model explains 44.3% of the variance in community employment growth for that period, of which 6.5 percentage points are attributable to the four accessibility variables. The four modal mixes thus account for 14.7% (6.5 / 44.3) of the explanatory power of the model.

In order to illustrate the workings of the model, *unfiltered* results – which do *not* include the other variables in the CPS model – are also given for total employment, manufacturing, and producer services (figures 3.1 through 3.6). Each figure compares the unfiltered results, above, with those of the augmented CPS model, below. For the three examples given, the inclusion of other variables (that is, those in the core CPS model) significantly alters the perception of how transport infrastructures – via the accessibility they provide – affect growth. But, contrary to what one might expect, the inclusion of other variables does not necessarily reduce the (positive) impact of transport infrastructures on growth.

The results for manufacturing and for total employment growth are revealing in this respect. The straight *unfiltered* relationship between continental accessibility (four modes combined) and total employment growth is strong, as one would expect (figure 3.1 **a**). This holds for all three periods from 1971 to 2001. More accessible communities are indeed at an advantage. However – this is the important finding – the impact does not disappear once other variables are added in (figure 3.1 **b**). A true *incremental* impact exists, above and beyond considerations of city size, region, and other factors. The fact that the relative weight of the incremental impact has declined somewhat over the last period (1991-2001), while the total explanatory power of the model has grown, means that other variables – for example the centre-periphery split between places close to and far from big cities – have grown in importance as determinants of local employment growth. More revealing still is the comparative strength of the relationship with each of the four modal mixes (figure 3.2 **a** and **b**). Looking at modal mix 1 (harbours and roads), the straight, unfiltered, results suggest a negative or negligible impact on growth: there is a strong regional pattern to this variable (western and eastern Canada have low accessibility, central Canada high accessibility) that is not connected to employment growth. However, once this regional effect is filtered out the impact of ports on growth becomes positive (as well as statistically significant in the latter two time periods).

Figure 3.1
Relationship between Continental Accessibility (Four Modal Mixes) and Total Local Employment Growth. *Unfiltered* Impact (a) and *Incremental* Impact (b)

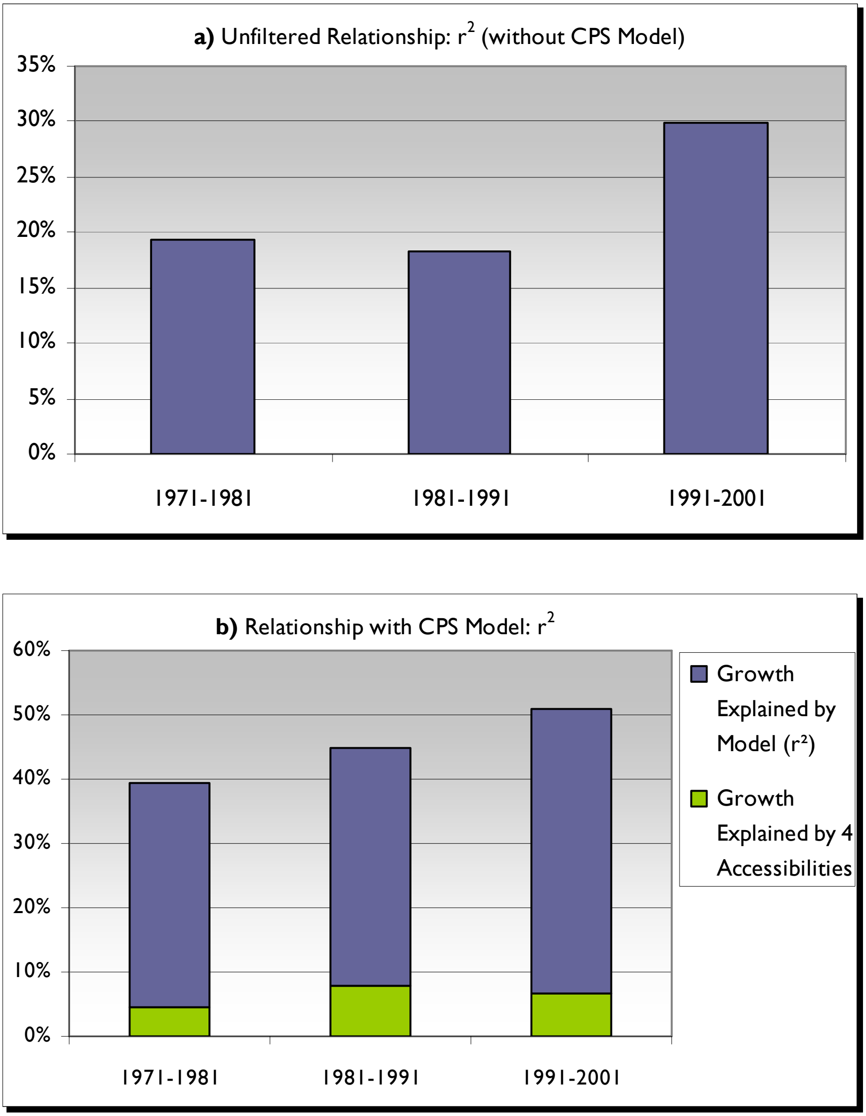
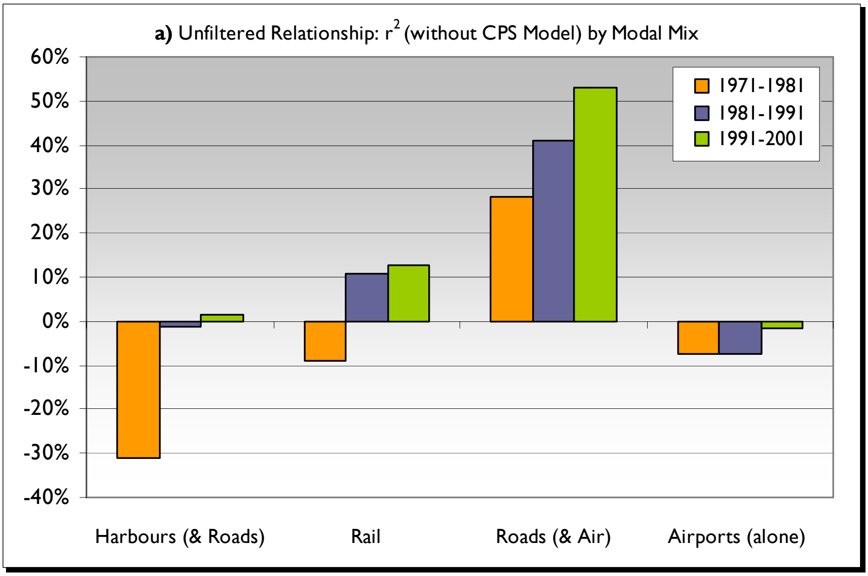


Figure 3.2
Relationship between Continental Accessibility and Total Local Employment Growth by Modal Mix. *Unfiltered* Impact (a) and *Incremental* Impact (b)



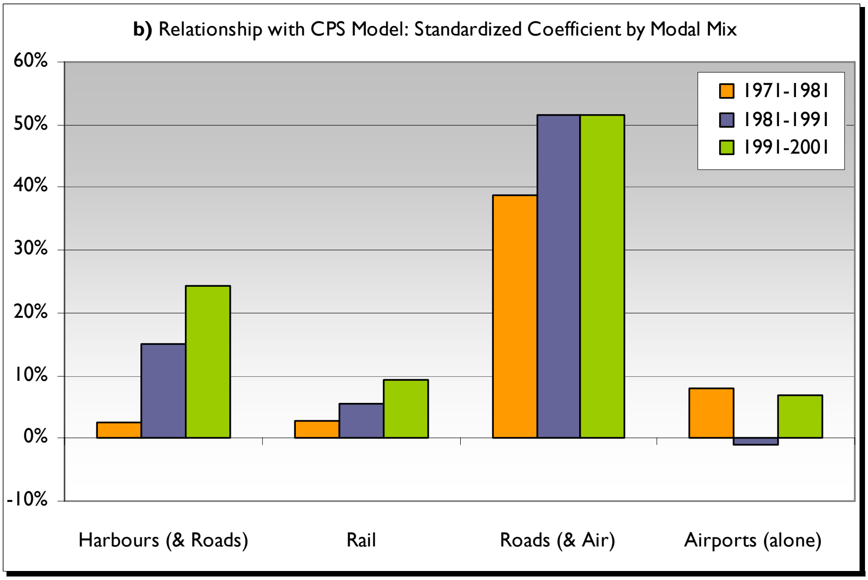
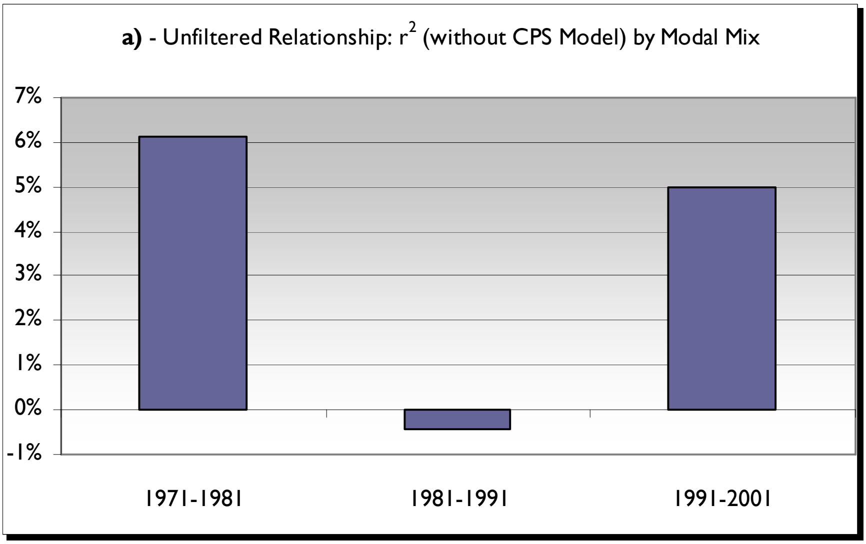


Figure 3.3
Relationship between Continental Accessibility (Four Modal Mixes) and Growth in Manufacturing Employment. *Unfiltered* Impact (a) and *Incremental* Impact (b)



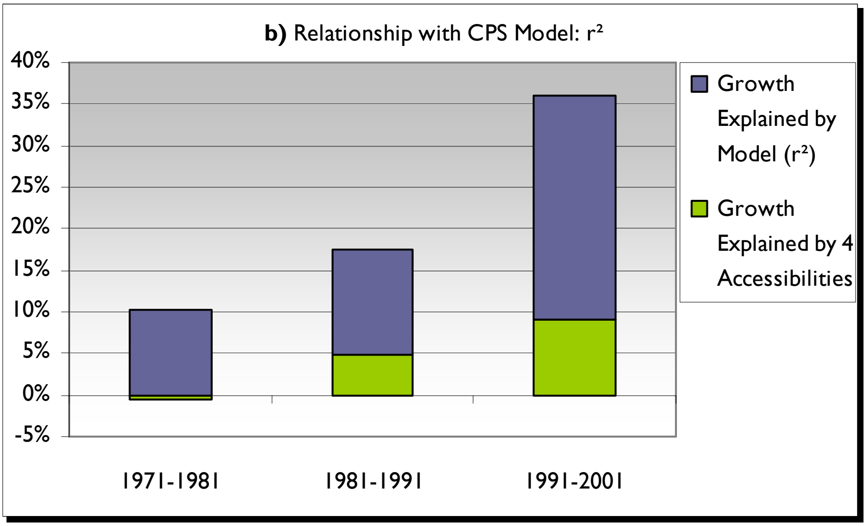
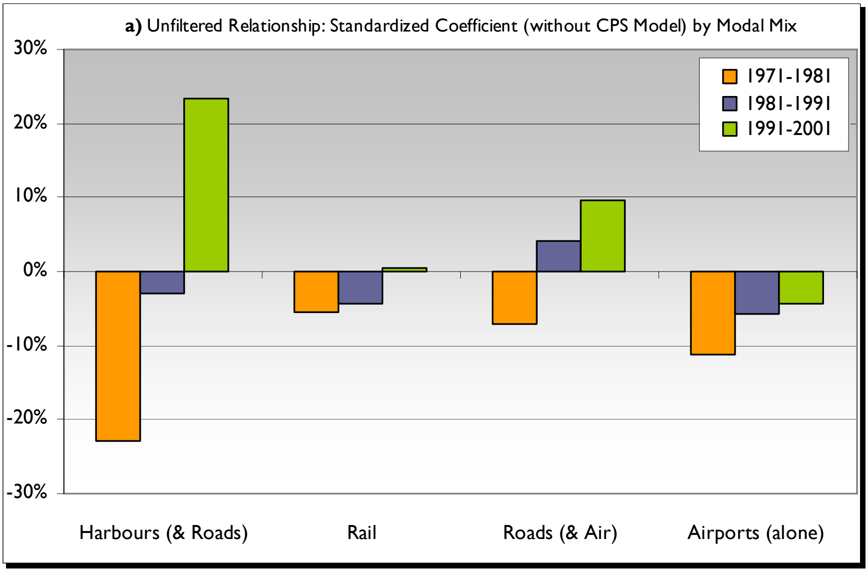


Figure 3.4
Relationship between Continental Accessibility and Growth in <u>Manufacturing</u> Employment by Modal Mix. *Unfiltered* Impact (a) and *Incremental* Impact (b)



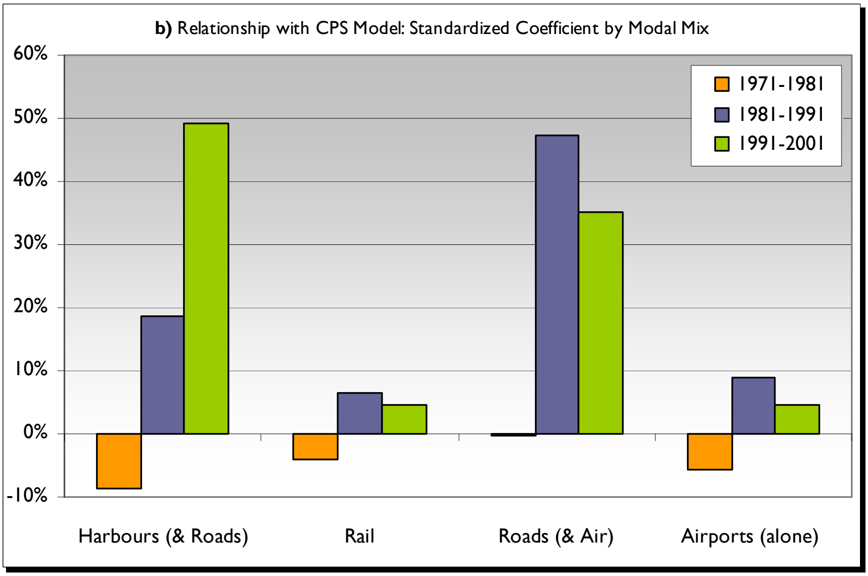
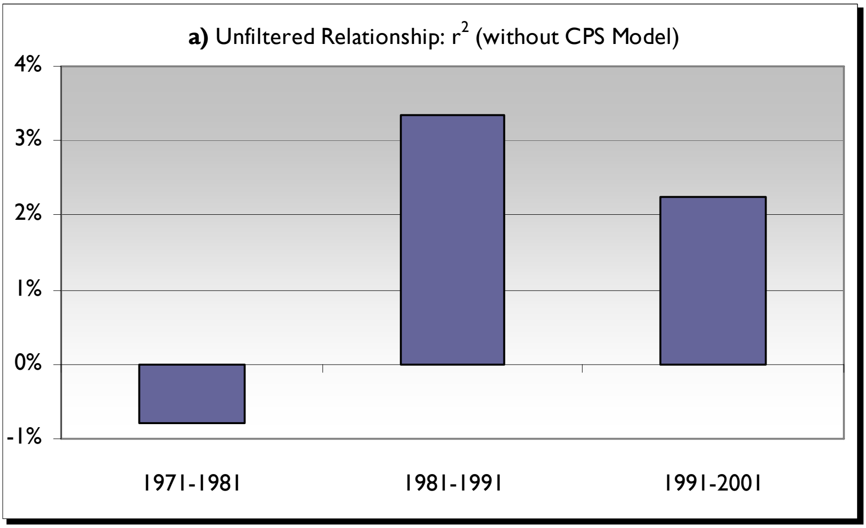


Figure 3.5
Relationship between Continental Accessibility (Four Modal Mixes) and Employment Growth in <u>Producer Services</u>. *Unfiltered* Impact (a) and *Incremental* Impact (b)



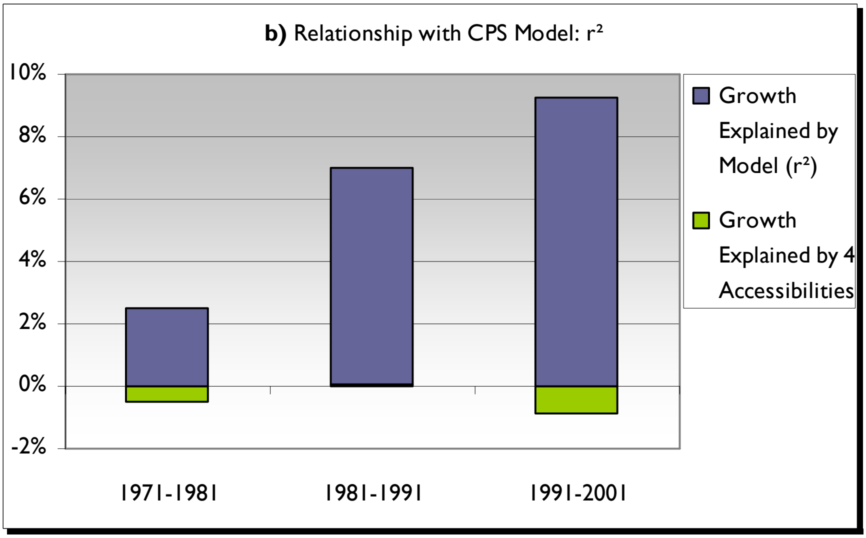
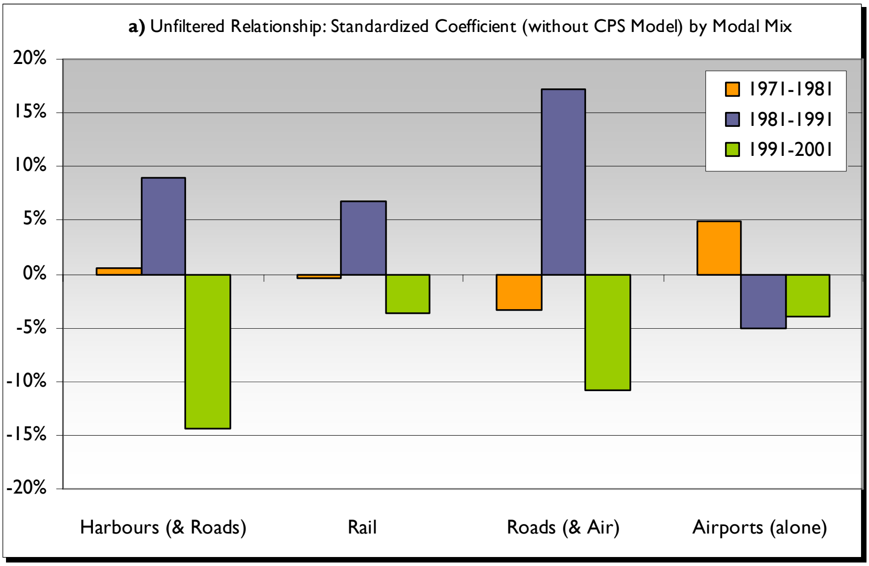
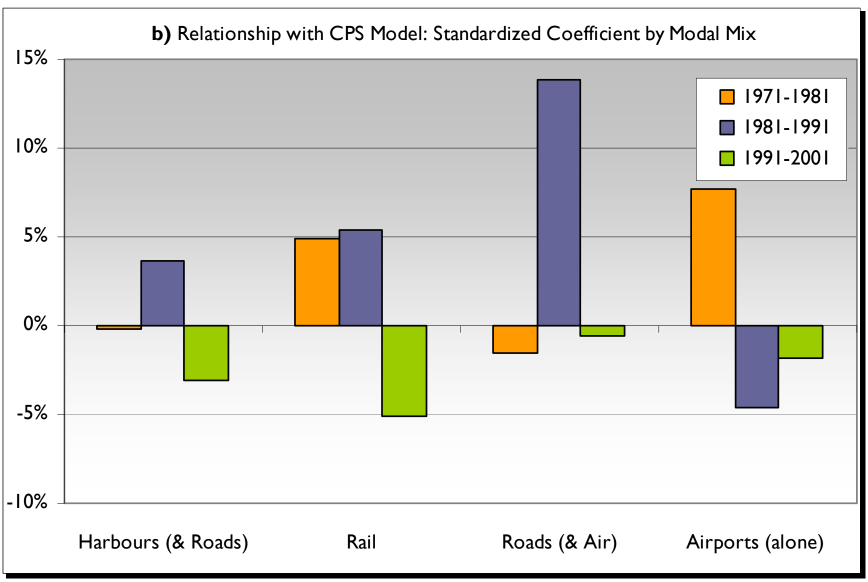


Figure 3.6
Relationship between Continental Accessibility and Employment Growth in <u>Producer Services</u> by Modal Mix. *Unfiltered* Impact (a) and *Incremental* Impact (b)





For roads (and airports) – modal mix 3 – the addition of other variables tends to consolidate and even increase their positive impact on growth. For airports (alone) – modal mix 4 – the addition of other variables tends to reverse the signs from negative to positive, as in the case of harbours (though never statistically significant). The explanation is undoubtedly of a similar nature. One would not expect communities whose sole or principal accessibility is by air – generally isolated communities – to be terribly dynamic. Not only does this serve to remind us that air accessibility *per se* – if not also associated with other infrastructure – does not guarantee growth, but also that the impact of transport infrastructures can be different in different settings. This is precisely the type of difference that the augmented model seeks to filter out.

The results for manufacturing are even stronger (figure 3.3). The unfiltered results for the combined impact of the four accessibility variables show a positive impact on employment growth for two of the three periods (figure 3.3 **a**). But, the portrait changes considerably once other factors are filtered out. The positive impact of accessibility increases systematically over the three time periods (figure 3.3 **b**), about which more will be said shortly. Equally, when moving from the unfiltered to the filtered results for manufacturing employment growth (figure 3.4 **a** and **b**), the results improve noticeably, especially for modal mixes 1 and 3 (harbours and roads; roads and air). The strength of the relationship for roads and air is not statistically significant in the first case (for any time period), but becomes so once other factors are accounted for; the strength of the relationship with ports is also much stronger (and growing) for the incremental impact than for the unfiltered one. Here again the incremental effects are often greater than those obtained by simply looking at direct relationships.

Before commenting on the incremental results in greater detail, it is worth comparing the unfiltered and incremental results for producer services (figures 3.5 and 3.6). None of the incremental results are statistically significant. Indeed, for producer service employment growth, the contribution of accessibility to the explanatory power of the augmented model is negative: adding these variables to the model merely decreases the model's power relative to the number of explanatory variables. The *unfiltered* results, however, suggest a positive overall impact since 1981 (figure 3.5 **a**) as well as significant relationships – both negative and positive – for modal mixes 1 and 3 (figure 3.6 **a**). This is a good illustration of how the augmented CPS model works to factor out elements which can lead to erroneous interpretations. What the unfiltered results mainly capture in this case is the impact of city size; naturally, bigger cities will generally rank higher on the four accessibility variables, especially those related to road and air transport. A positive direct relationship with employment growth (since 1981) is thus unsurprising. But, this is different from measuring the *incremental* impact of accessibility, given city size. Once city size and proximity to a metropolitan area are included, the relationship disappears. By the same token, the sharp downturn in the unfiltered results after 1991 – making for a negative relationship – for modal mixes 1 and 3 is in part a reflection of the 1989 real estate slump, which chiefly affected the largest cities (especially Toronto) and hit the producer service and financial sectors the hardest. At the risk of repetition, the negative – *unfiltered* – relationships pictured on figure 3.6 **a** are not necessarily picking up the impact of accessibility, but rather of other factors, notably city size, since the relationship ceases to be significant once city size is accounted for. Producer services also provide a good illustration of the difference between explaining location (the previous section) and explaining growth. The CPS model is quite successful in explaining producer service location, but much less so for growth.

Summing up: the results show that transportation infrastructure – via the accessibility it provides – has an identifiable positive *incremental* impact on local employment growth, above and beyond other measurable factors that contribute to employment growth. A comparison with direct, unfiltered, estimates of the impact of accessibility – which do not take other variables into account – reveals that the incremental effects of continental accessibility on local employment growth are often even greater than what direct relationships would suggest.

3.4 The Impact of Continental Accessibility on Local Employment Growth by Industry and by Modal Mix

In this section, we examine the results by industry and by modal mix in more detail. Our comments refer to the results of the augmented Coffey-Polèse-Shearmur model, that is, to the impact of continental accessibility once other factors have been accounted for (the reader is again referred to Appendix 1).

3.4.1 The impact on total and on manufacturing employment growth

The most striking results are those for total employment and for manufacturing, especially as they relate to modal mix 1 (harbours and roads) and modal mix 3 (roads and air). It is worth taking a second look at figures 3.1 **b** and 3.3 **b**. For total employment, the augmented CPS model is surprisingly successful in explaining growth:[16] an adjusted r^2 of 44.3% for 1991-2001. Its explanatory power has grown over time, which suggests, as noted earlier, that the variables contained in the model are increasingly important as determinants of local employment growth. In addition to the centre-periphery split – which favours places close to big cities – this also suggests that city size *per se* increasingly

[16] The results may not seem "surprisingly" high to the reader. But they are. Attempts at statistically explaining local economic growth (whether measured by income, production or employment) – especially for small territorial units – seldom attain high r^2 outcomes. Growth at the local level is highly idiosyncratic, influenced by (almost) an infinity of factors, as we attempted to explain in part II.

matters. In the Canadian context, it is useful to recall that the possible countervailing negative effects of city size (via increased pollution, congestion, crime, etc.) are probably minor. As noted in part I, Canadian cities – even metro Toronto – are still small by world standards. Canadian cities have a long way to go before reaching the dimensions – and problems – of Tokyo, New York or London.

Equally striking for total employment is the growing strength of the positive relationship with modal mix 1 (harbours and roads) and with modal mix 3 (roads and air). Rail also becomes significant in the last period. In short, continental accessibly, whether by water, roads, rail or air is – over time – becoming increasingly important as a determinant of local employment growth. Another way of saying the same thing is that relative location is more – not less – important today than thirty years ago. Not only is distance not dead, but it seems its importance is growing. Reasons why this might be so were discussed in the first part of this study. But, the results on figures 3.1 and 3.2 – notably as they relate to the road and highway network – suggest that it is not only increased Canada-US trade as such that is at play, but also the geographical pattern of that trade. Truck transport is most cost-efficient and practical for non-bulk trade over short and middle-range distances (up to approximately a 1,000 km, although this varies greatly with circumstances) and for goods that need to be delivered to customized and time-sensitive markets. The growing importance of road accessibility is, in other words, consistent with what we know about the patterns of provincial-state trade. Canadian provinces trade most heavily with neighbouring states. B.C.'s first customer is Washington; Ontario's and Quebec's chief customers are, respectively, Michigan and New York.

As trade with neighbouring US markets – often most efficiently reached by truck – accounts for an ever increasing share of local GDP, it should come as no surprise that the importance of (continentally calculated) road accessibility is also growing. This is also consistent with the growing shift to manufacturing practices where local operations – assembly, tooling, production, etc. – are part of a broader supply chain of plants and distribution centres.[17] The majority of Canada-US trade is intra-firm trade, taking place within the same organization. In the first part of this study we noted the growing importance of trade corridors in the United States, which generally follow the contours of Interstate Highways, linking major metropolitan areas (Lang and Dhavale 2005, The Economist 2006). Two major corridors (I-65 and 1-75, between Mobile and Detroit; I-85 and I-95, between Atlanta and Boston) have their northern end-points on or near the Canadian border. The North American automobile industry is largely concentred along an integrated production and supply chain stretching from Mobile to Oshawa. By the same token, New York or Boston-

[17] A recent survey of logistics, published by the Economist (2006a), points to the pivotal and growing role of supply chains in manufacturing.

based pharmaceutical or electronics companies will more often than not favour Canadian locations which are closest to their chain of production, which in this case would be southern Québec, in and around the Montreal area.

The results for *manufacturing* on figures 3.3 **b** and 3.4 **b** are consistent with this interpretation. The signs are negative for modal mixes 1 and 3 during the 1970's when much manufacturing in Canada was still resource-related (sawmills, smelting, fish processing, etc.) and less oriented to US markets. However, the signs become positive in the following decade, growing in strength in the 1990's for modal mix 1, but decreasing slightly for modal mix 3. The results for modal mix 1 suggest that it is the combination of harbours and roads which is increasingly the crucial factor. The relationship between trade and harbours is self evident. As trade grows so does the importance of ports and, of course, of the road networks into which they are linked (a harbour without road connections is even less useful than an airport without road connections). Simply put, growth in manufacturing employment has been highest in recent times in places which exhibit the highest continental market potentials – as defined by combined harbour, air and road accessibility. The statistically non significant results for modal mix 2 (where rail is the predominant mode) would seem to reinforce our earlier comments on the importance of trucking for Canada-US trade and the concomitant importance of highway-based trade corridors. Continental integration – since the FTA, notably – has often served, it would appear, to strengthen trade relationships, and corresponding manufacturing employment growth, between places on both sides of the border that are relatively close to each other, and thus best served by trucks. In Canada, this would tend to favour – for manufacturing growth – small and mid-sized communities in Southern Ontario and in Southern Quebec, probably not too far from Toronto or Montreal, situated on highways leading to US markets and trade corridors.

The role of rail should not be minimized, however.[18] Continental accessibility by rail does matter; but, road and highway accessibility matters more, at least for more firms (with more employment), it would seem. The sign for rail (modal mix 2) for total employment growth is positive in 1991-2001, although weak. Much depends on the product being shipped. Bulk goods are, as rule, more efficiently shipped by rail. In this respect, the growing importance of road relative to rail accessibility is undoubtedly also a reflection of the types of goods being shipped, which, as noted earlier, are increasingly time-sensitive and non-standardized.

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[18] It should be remembered that modal mixes 1 and 3 also contain rail components (recall Table 3.2).

3.4.2 The Impact on Local Employment Growth in other Industries

The summary results by industry – growth explained by the four combined accessibilities – are given on table 3.4. The same results are presented visually on figure 3.7, in descending order of impacts for 1991-2001. The relatively low values for the explanatory power of (combined) accessibility for most industry classes should come as no surprise. Statistically explaining local growth, as noted earlier, is notoriously difficult, all the more so at a detailed industry level, where industry-specific and accidental factors increasingly enter into play.[19]

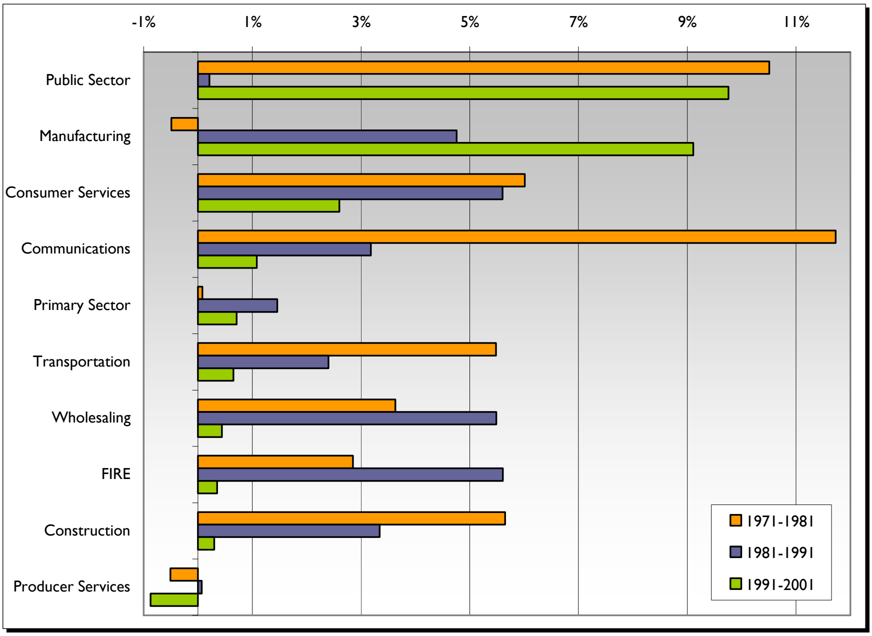
Table 3.4
Relationship (r^2 increase) between Continental Accessibility and Employment Growth: Combined Impact of Four Modal Mixes

	1971-1981	1981-1991	1991-2001
Primary Sector	0.08%	1.46%	0.71%
Manufacturing	-0.5%	**4.8%**	**9.1%**
Consumer Services	**6.0%**	**5.6%**	**2.6%**
Producer Services	-0.5%	0.1%	-0.9%
Construction	**5.7%**	**3.3%**	0.3%
Transportation	**5.5%**	**2.4%**	0.7%
Communications	**11.7%**	**3.2%**	1.1%
Public Sector	**10.5%**	0.2%	**9.8%**
Wholesaling	**3.6%**	**5.5%**	0.4%
FIRE	**2.9%**	**5.6%**	0.4%

Note: This table presents the increase in adjusted r^2 attributable to the four accessibility variables combined. In some cases, due to the negligible impact of accessibility and the increase in degrees of freedom taken by the model, the adjusted r^2 slightly decreases. Of course, the unadjusted r^2 can only increase when extra variables are added.

[19] A comparison between the explanatory power (r^2) – by industry – of the model for *location* and for *growth* provides a good illustration of the difficulties of explaining growth. The model is systematically more successful in explaining location.

Figure 3.7
Relationship (r^2 increase) between Continental Accessibility and Employment Growth by Industry. Combined Impact of Four Modal Mixes



The results in table 3.4 and figure 3.7 *appear* to show that the impact of accessibility on growth in most sectors is declining over time. This is not always the case: what the results show is that the *incremental* impact of accessibility on growth (in the context of the CPS model) is declining. However, over the same three decades the marginal impact of accessibility has been declining, there has been a marked *increase* in the significance of centrality (location close to a metropolitan area) in terms of explaining employment growth in certain sectors. Central areas are, of course, the most accessible to markets: and whilst differences in relative accessibility *within* regions (be they central or peripheral) have a decreasing impact on employment growth, differences *between* central and peripheral regions are becoming more marked. Thus, the decrease in marginal impact of accessibility in some cases reflects an *increase* in the impact of general accessibility that is captured in the CPS model by centrality and maybe by certain other geographic variables.

With this important point in mind, we now turn to the results. Over time – for the three decades studied – the results for manufacturing are the most systematic, as noted above, the explanatory power of continental accessibility rising sharply between 1971 and 2001. The overwhelming majority of US-Canada trade is in manufactured goods; the growing sensitivity of manufacturing jobs to *continental* accessibility is the predictable outcome of changing trade patterns. The products – goods and services – of most other industries (the primary sector excluded) are not continentally traded, at least not massively. Employment growth in many instances is an indirect – induced – effect of growth in manufacturing or primary exports. These can be support services, provided on the spot or at a distance. The results for the transportation sector (see Appendix 1, notably for modal mixes 1 and 3) suggest that its employment growth – of which trucking is a component – is positively associated with continental accessibility.[20] This is consistent with our earlier observations on the interdependency of transport modes. Growth in one mode will often propel growth in another. For example, courier services, one of the fastest growing industries in Canada, employ both trucks and airplanes. This is also consistent with the consolidation of highway-based trade corridors – supply and production chains – that facilitate growth in manufacturing and in transport-related employment. However, the decreasing explanatory power of accessibility over time for local growth in transport-related employment (table 3.4; figure 3.7) may be due to rising labour productivity in this sector (trade generates proportionally less and less jobs) and to the growth of transport services that are provided at a distance, or a combination of both.

The only other sector which shows a positive relationship with modal mixes 1 and 3 for the most recent periods is consumer services, of which retailing is the primary component.[21] These are truly induced activities, generated by growth elsewhere in the local economy. Consumer services largely follow the general trend, with results that are not all that different from those for total employment. By the same token, this is the sector for which the augmented CPS model is the most successful, with an explanatory power of 44.3% in 1991-2001, the same as for total employment. The decreasing *marginal* impact of accessibility on growth in consumer services is strongly connected with faster growth of these services in (accessible) central areas.

The lack of a significant relationship with producer services over the whole period plus the disappearance in 1991-2001 of a statistically significant relationship with FIRE (finance, insurance, and real estate) cannot be attributed to the interplay between accessibility and centrality variables. It is worth recalling that it is the relationship with *growth* in employment that is being analyzed. Once this is understood, the results for FIRE and for producer services are less surprising. These high-order services are concentrated (recall table 3.3) in places with high road and air accessibility potentials – the largest urban centres, as a rule – fuelling the growth of large cities. Rapid (total) employment growth in large urban centres is partly the result of the concentration of these two dynamic services sectors –

[20] Note the constant, but declining, strength of the positive relationship with road and air accessibility, going from 0.49 in 1971-1981 to 0.19 in 1991-2001, both significant at the 95% level.

[21] Respectively, coefficients of 0.17 and 0.35. The coefficient for Air is also positive (Appendix 1).

especially producer services – in large urban centres, not necessarily of faster *growth* (in these industries) in large cities.[22] Because these are often new services, the normal process of diffusion will mean that growth is sometimes faster in regional service centres as the new services are more widely adopted in outlying places, although – at any given moment in time – employment in the industry is concentrated in the largest urban centres.

For the FIRE sector, the disappearance of a statistically significant relationship after 1991 (for modal mixes 1, 2, and 3: see Appendix 1) can be partly explained by the 1989 real estate and financial collapse, alluded to earlier. By the same token, the composite positive impact of accessibility on employment growth in FIRE all but disappeared during the same period (figure 3.7), with a parallel reduction of the explanatory power of the CPS model. Employment growth in the financial sector was very slow during most of the 1990s, notably in the traditional large metropolitan centres of finance and corporate control. Up until then, the FIRE sector had been one of the fastest growing components of the Canadian economy. This is a useful reminder that the causal relationships presented in this study are very sensitive to context.

For wholesaling, the lack of a strong relationship with continental accessibility – a declining one at that – seems *a priori* surprising, considering the importance of market access for this service. Recall the positive relationship between the four accessibility variables and *location* in 2001 (table 3.3). But for *growth*, a positive, but declining, relationship is observable for modal mix 3 only.[23] The most probable explanation is the regional nature of distribution in Canada. The principal consideration fuelling the growth of wholesaling – sometimes in new locations – is, it is reasonable to assume, access to regional markets, *not* continental markets. To take one example, the Moncton urban area is growing as a wholesaling and distribution centre for the Maritimes; but growth there has little to do with its position within North America, which is fairly peripheral. However, Moncton is strategically located in the Maritime Provinces. By the same token, Quebec – for obvious reasons – is very much a distinct market in terms of distribution, publicity, and marketing; largely centered on Montreal, well positioned to serve that market, but again rather peripheral from a continental viewpoint. For wholesale we also note that centrality, significantly associated with growth before accessibility variables are introduced, loses its explanatory power in favour of road and air accessibility: this is a case where wholesale is growing faster in central areas *because they are accessible*. When accessibility is introduced it is a better explanatory factor than centrality (probably because it combines centrality with some of the regional considerations mentioned earlier):

22 This process is explained in greater detail in Polèse and Shearmur (2006a).

23 The coefficients for the three time periods are, respectively: 0.37, 0.51, and 0.22 (Appendix 1).

it does not increase the overall r^2 because it decreases the explanatory value of centrality and of certain other variables that partly captured accessibility.

The construction industry and the communications sector do not warrant much comment. The former is very sensitive to local business cycles while it is difficult to see any strong *a priori* link between the communications sector – of which local postal and telephone services are the largest employment components – and continental accessibility. We have no reasonable explanation why the relationship which was so strong during the 1971-1981 decade then suddenly collapsed afterwards, although the coefficients for modal mixes 1 and 2 resurfaced in the last time period, becoming statistically significant and positive again. Both postal and telephone services have undergone dramatic technological and organizational changes in the last three decades, which may in part lie behind these results, evidence again of the contextual nature of the relationships presented here and the difficulty of modeling local employment growth for specific industries.

Finally, the relatively strong showing of public sector employment – plus the dramatic fluctuations between the three decades (figure 3.7) – is somewhat of a mystery. The most plausible explanation relates to changing public finances, both provincial and federal. The 1980's and early 1990's were, on the whole, a period of constrained public expenditures, with frequent deficits and cut-backs. What the results on figure 3.7 suggest is that the "natural" tendency for public sector employment (which includes health and education) is to grow proportionally more rapidly – or decline less rapidly – in the most accessible places, notably as determined by modal mix 3 in recent years. But that "natural" process was interrupted during the 1980's. In times of constraint, it is easier to cut back on centralized administrative employment – less visible to the public – than to cut local services (schools, post offices, hospitals, etc.). However, once the period of constraint is past, public sector employment growth – especially white collar employment – is again concentrated in the most accessible places. We saw earlier that the geographic distribution of public service employment tends proportionally to favour the least accessible places: location is negatively associated with all four transport modes in 2001 (recall table 3.3). What figure 3.7 suggests is that the trend over time is in the opposite direction. While public service employment plays a compensatory role – observed at one moment in time – the trend, it appears, is towards a concentration of public service employment in the most accessible locations.

3.4.3 Summary

Transport infrastructures – via the accessibility they provide – have a clear positive independent, *incremental*, impact on local employment growth. In almost all cases, the introduction of the four continental accessibility variables adds – in varying degrees – to the explanatory power of the econometric model applied in this study. The impact is most noticeable for total employment growth and for employment growth in manufacturing. Modal mixes with roads as an important component exert the most noticeable impact, but with harbours and airports as important accompanying modes.

The incremental impact of transport infrastructure on local employment growth has increased in importance since the 1980s, especially for manufacturing. As exports account for an ever growing proportion of local economic activity everywhere, it is entirely normal that factors related to trade – and which more so than transport infrastructures? – should gain in importance. In closed economies, accessibility to outside markets is of minor importance. But, in open economies – such as that of Canada's communities – the opposite will be true. This is one of the ironies of modern economies. At the same time that transport costs are falling, the importance of transport infrastructures is growing.

The incremental impact of continental accessibility on growth is not negligible. For local manufacturing employment growth, the introduction of accessibility variables raises the explanatory power of the model by more than a third during the 1991-2001 decade. Some 9% of local manufacturing employment growth is explained by the composite impact of the four accessibility variables. All modal mixes – save solitary air access – show a very strong statistical relationships with manufacturing employment growth. In short, for employment growth in manufacturing, it really does matter – independently of other considerations – whether a community is well-connected by road, rail, and water to the rest of the continent, certainly since the 1990's.

Three conclusions flow from our results. *First*: The gap between communities that are "well-connected" to serve North American markets and those that are not is likely to widen in the future. This is good news for communities – small cities as well as large – in Southern Ontario, in south-western Quebec, and in parts of the Maritimes and the B.C. Lower Mainland; but bad news for those in Canada's peripheral regions. *Second*: Growth, most noticeably in manufacturing employment and in related transport industries, will tend to coalesce along trade and transport corridors. The prime example in Canada has always been, and remains, the Windsor-Quebec City corridor.[24] Other examples are the Edmonton-Calgary-Lethbridge corridor in Alberta and the Halifax-Moncton-Fredericton corridor, around which growth in the Maritimes, such as it is, is increasingly coalescing. *Third*: Investments in transport infrastructure that *significantly* improve the combined continental road, water, rail, and air accessibility of a community should facilitate local employment growth, especially in manufacturing. However, the optimism implicit in the preceding sentence needs

[24] Recent evidence suggests that the growth inducing effects may be moving further east along the Trans-Canada highway, as far as Rivière-du-Loup and perhaps even beyond, which is good news for communities on Quebec's traditionally lagging Lower St Lawrence.

to be tempered by the word *significantly* (which is why it is in italics), since accessibility is not only determined by the state of local – or proximate – infrastructure, but by the entire continental network.

Finally, at a non-local level, our results suggest that investments in infrastructure that improve continental accessibility have an overall positive growth effect on the Canadian economy (besides steering internal shifts within Canada), but whose scope we cannot measure.

APPENDIX

Appendix 1 – Detailed Results

Relationship between Continental Accessibility and Employment Growth. By Industry and by Accessibility (Modal Mix). Three Periods

Augmented Coffey-Polèse-Shearmur Growth Model

The first set of rows under each industry heading shows the strength (standardized regression coefficient) and the direction of the relationship for each modal mix.

The second set of rows refers: (a) to the combined impact of the four modal mixes and (b) of all variables (in the CPS Model) on employment growth, and (c) to % contribution of the former to the latter.

	1971-1981	1981-1991	1991-2001
Total Employment			
1. Harbours (& Roads)	0.03	0.15**	0.24**
2. Rail	0.03	0.05	0.09*
3. Roads (& Air)	0.39**	0.51**	0.51**
4. Airports (alone)	0.08	-0.01	0.07
a) Growth Explained by Four Accessibilities (r^2)	4.6%	8.0%	6.5%
b) Growth Explained by Complete CPS Model (r^2)	34.7%	36.8%	44.3%
c) Contribution of Four Accessibilities as a % Growth Explained	*13.2%*	*21.7%*	*14.7%*
Primary			
1. Harbours (& Roads)	0.00	-0.10	-0.03
2. Rail	0.06	0.06	0.03
3. Roads (& Air)	0.14	0.16	0.21*
4. Airports (alone)	0.10	-0.03	0.07
a) Growth Explained by Four Accessibilities (r^2)	0.08%	1.46%	0.71%
b) Growth Explained by Complete CPS Model (r^2)	12.72%	10.58%	5.05%
c) Contribution of Four Accessibilities as a % Growth Explained	*0.63%*	*13.80%*	*14.06%*

	1971-1981	1981-1991	1991-2001
Manufacturing			
1. Harbours (& Roads)	-0.09	0.19**	0.49**
2. Rail	-0.04	0.07	0.05
3. Roads (& Air)	0.00	0.47**	0.35**
4. Airports (alone)	-0.06	0.09	0.04
a) Growth Explained by Four Accessibilities (r^2)	-0.5%	4.8%	9.1%
b) Growth Explained by Complete CPS Model (r^2)	10.3%	12.8%	26.9%
c) Contribution of Four Accessibilities as a % Growth Explained	*-4.8%*	*37.3%*	*33.8%*
Consumer Services			
1. Harbours (& Roads)	-0.08	0.03	0.17**
2. Rail	-0.05	0.03	0.03
3. Roads (& Air)	0.32**	0.40**	0.35**
4. Airports (alone)	-0.04	0.10	0.14**
a) Growth Explained by Four Accessibilities (r^2)	6.0%	5.6%	2.6%
b) Growth Explained by Complete CPS Model (r^2)	39.4%	24.4%	44.3%
c) Contribution of Four Accessibilities as a % Growth Explained	*15.2%*	*23.0%*	*5.9%*
Producer Services			
1. Harbours (& Roads)	0.00	0.04	-0.03
2. Rail	0.05	0.05	-0.05
3. Roads (& Air)	-0.02	0.14	-0.01
4. Airports (alone)	0.08	-0.05	-0.02
a) Growth Explained by Four Accessibilities (r^2)	-0.5%	0.1%	-0.9%
b) Growth Explained by Complete CPS Model (r^2)	2.5%	7.0%	9.3%
c) Contribution of Four Accessibilities as a % Growth Explained	*-20.6%*	*1.0%*	*-9.4%*

	1971-1981	1981-1991	1991-2001
Construction			
1. Harbours (& Roads)	0.21**	0.13*	0.03
2. Rail	-0.04	0.07	-0.09
3. Roads (& Air)	0.46**	0.25**	-0.09
4. Airports (alone)	0.04	-0.08	0.03
a) Growth Explained by Four Accessibilities (r^2)	5.7%	3.3%	0.3%
b) Growth Explained by Complete CPS Model (r^2)	41.8%	40.5%	31.0%
c) Contribution of Four Accessibilities as a % Growth Explained	*13.5%*	*8.2%*	*1.0%*
Transportation			
1. Harbours (& Roads)	0.25**	0.11	0.17**
2. Rail	0.11**	0.08	0.04
3. Roads (& Air)	0.49**	0.31**	0.19**
4. Airports (alone)	0.13**	-0.01	0.02
a) Growth Explained by Four Accessibilities (r^2)	5.5%	2.4%	0.7%
b) Growth Explained by Complete CPS Model (r^2)	23.5%	18.6%	24.7%
c) Contribution of Four Accessibilities as a % Growth Explained	*23.3%*	*12.9%*	*2.6%*
Communications			
1. Harbours (& Roads)	0.39**	-0.10	0.16*
2. Rail	0.05	-0.06	0.09
3. Roads (& Air)	0.64**	0.17	0.30**
4. Airports (alone)	0.23**	-0.11*	0.09
a) Growth Explained by Four Accessibilities (r^2)	11.7%	3.2%	1.1%
b) Growth Explained by Complete CPS Model (r^2)	24.8%	10.6%	6.2%
c) Contribution of Four Accessibilities as a % Growth Explained	*47.3%*	*30.0%*	*17.5%*

	1971-1981	1981-1991	1991-2001
Public Sector (Includes Health and Education)			
1. Harbours (& Roads)	-0.24**	0.07	-0.07
2. Rail	0.08	-0.01	0.03
3. Roads (& Air)	0.26**	0.11	0.48**
4. Airports (alone)	0.13**	-0.07	-0.02
a) Growth Explained by Four Accessibilities (r^2)	10.5%	0.2%	9.8%
b) Growth Explained by Complete CPS Model (r^2)	41.7%	14.6%	32.5%
c) Contribution of Four Accessibilities as a % Growth Explained	*25.2%*	*1.4%*	*30.0%*
Wholesaling and Storage			
1. Harbours (& Roads)	0.17**	0.13	0.03
2. Rail	-0.08	0.04	0.06
3. Roads (& Air)	0.37**	0.51**	0.22*
4. Airports (alone)	0.02	0.13*	0.09
a) Growth Explained by Four Accessibilities (r^2)	3.6%	5.5%	0.4%
b) Growth Explained by Complete CPS Model (r^2)	18.7%	15.5%	8.6%
c) Contribution of Four Accessibilities as a % Growth Explained	*19.4%*	*35.3%*	*5.1%*
Finance, Insurance and Real Estate (FIRE)			
1. Harbours (& Roads)	-0.22**	0.19**	0.08
2. Rail	-0.12**	0.23**	-0.06
3. Roads (& Air)	0.02	0.46**	0.17
4. Airports (alone)	0.00	0.09	0.00
a) Growth Explained by Four Accessibilities (r^2)	2.9%	5.6%	0.4%
b) Growth Explained by Complete CPS Model (r^2)	19.7%	14.0%	6.5%
c) Contribution of Four Accessibilities as a % Growth Explained	*14.5%*	*40.1%*	*5.4%*

* Statistically significant between 90 and 95%; ** above 95%

Appendix 2 – Methodology: Building the Digital Transport Networks

The primary objective of this methodological appendix is to succinctly describe the various stages that were necessary for the construction of the Canada-US spatial data used in this report. These data include the various transport infrastructure networks (road, rail, ports and air) from which accessibility measures are derived.

1. Spatial Boundaries Used

The various accessibility measures are calculated for a subdivision of space based upon census divisions in Canada and counties in the USA (figure 1). For Canada data for census agglomerations of over 10,000 are also added (these are subtracted from the census sub-divisions within which they are located). A total of 3,523 spatial units are used.

Figure 1
Geographic Units in North America, 2001

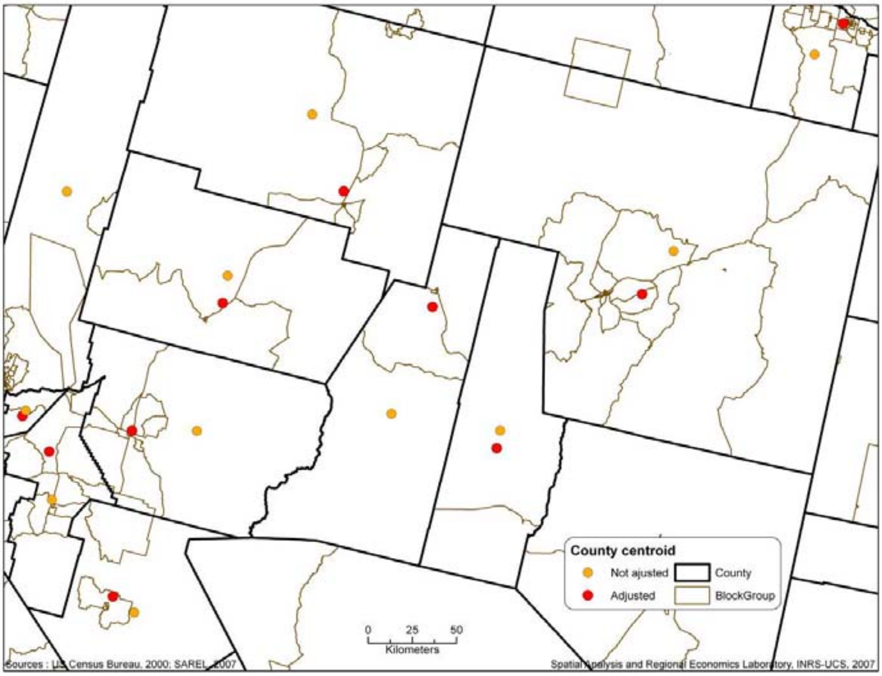
The construction of distance matrices along the various networks is based upon the centroids of these spatial units. To take into account the spatial distribution of population *within* these units, centroid coordinates are adjusted using *block group* and *block* information for Canada and the US respectively. These are finer spatial units for which population (but little other) data are available.

$$\left(\overline{x_i}, \overline{y_i}\right) = \left(\frac{\sum_{b \in i} w_b x_b}{\sum_{b \in i} w_b}, \frac{\sum_{k \in i} w_b y_b}{\sum_{b \in i} w_b} \right) \qquad \text{(Equation 1)}$$

Where:

w_b = total population of block-group b entirely within county or DR i.
x_b and y_b = X and Y coordinates of block-group b.

Figure 2
Example of Adjusted Centroid in California



2. Digital Transport Networks

2.1. Road network

To build the road network we use ESRI data for 2001[25] from which highways and main roads are selected. These data are validated by comparing them to the digitized data from DMTI and to various Canadian and US road atlases. In certain parts of the territory (where the road network is sparse or absent),[26] and also in cases where an island must be joined to the mainland, we ad some segments to the network.[27] These segments represent secondary roads and ferry links that are extracted from the ESRI and DMTI files or that are digitized from paper road atlases.

After structuring the road network, a road typology is created associating a given speed to each type of road. For highways and principal roads a specific speed for each US state is allocated.[28] For Canada, the same speed is used in all provinces.[29] For secondary roads and ferry links,[30] the same average speeds are used throughout the network (table 1 and figure 3). These speeds are used to transform the distance matrix into a time matrix.

Table 1
Road Typology and Speed Limits

Description	Typology	Speed
Highways	1	Depends on province / state
Main roads	2	Depends on province / state
Secondary roads	3	70 km/h
Ferries	4	30 km/h

25 ESRI Data & Maps, Media Kit, 2002.

26 Particularly in the Rockies and in central parts of USA.

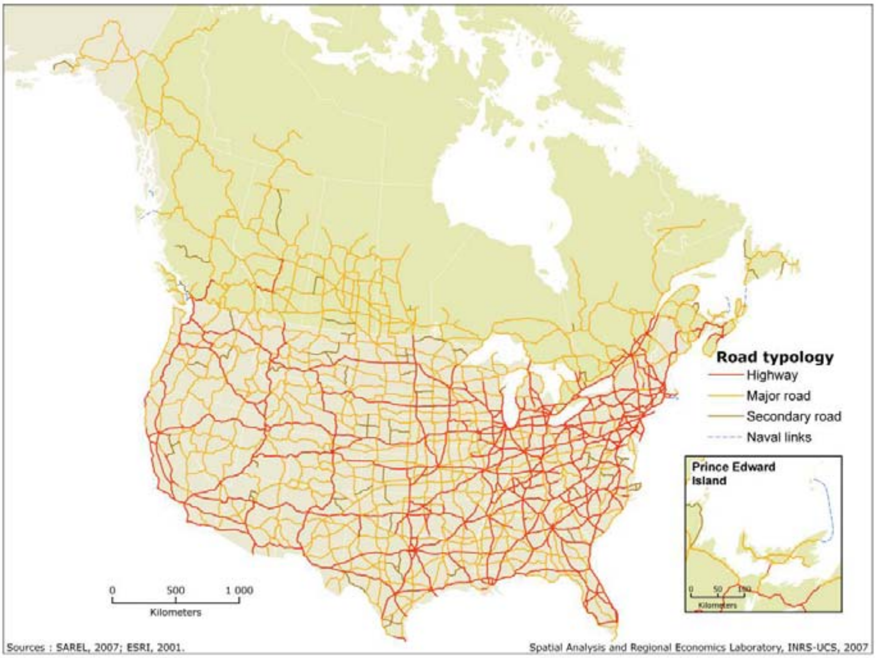
27 Vancouver Island, Magdeleine Islands, Prince Edward Island, Newfoundland.

28 http://en.wikipedia.org/wiki/Speed_limits_in_the_United_States

29 http://en.wikipedia.org/wiki/Category:Roads_in_Canada

30 http://www.marine-atlantic.ca/en/index.shtml et http://www.bcferries.com.

Figure 3
Primary Road Network in North America, 2001



2.2 Rail network

Two data sources are used to build the rail network: the DMTI data[31] for Canada and a geographic file from *National Atlas*[32] for the US. Just as we did for the road network we generalized the segments and structured the topology of the network (in other words we made sure that each segment connected with the network). We opted for a single speed throughout the whole network, based on an average speed of 42 km/h, in accordance with the results of another study.[33]

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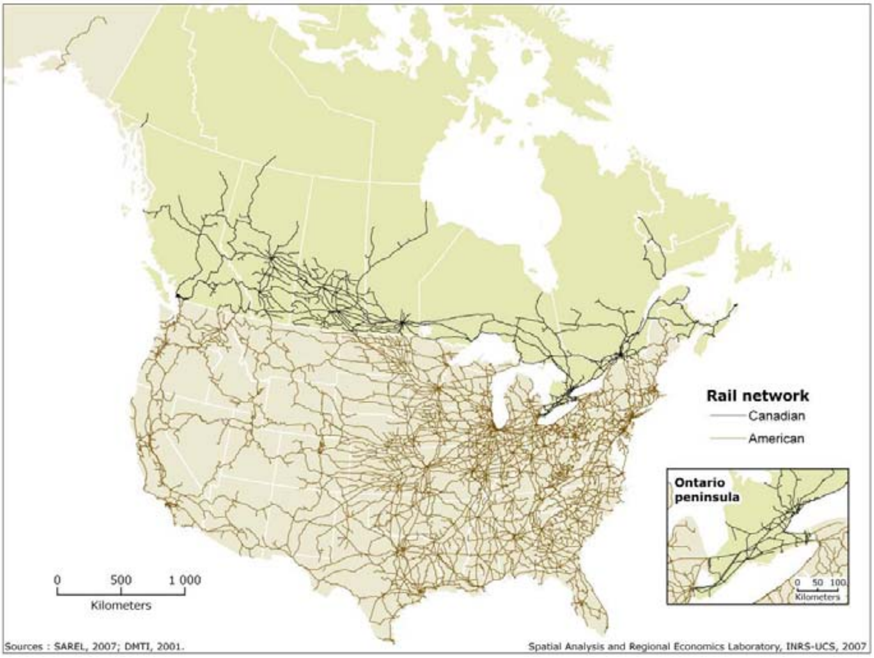
31 DMTI's « canrail » digital file.

32 http://nationalatlas.gov/atlasftp-na.html

33 http://www8.cpr.ca/cms/Francais/Investors/Analysts/default.htm

Figure 4
Rail Network in North America, 2001



Since the rail network does not cover all of North America, two modifications are made to the network in order to avoid having unconnected spatial units.

First, all spatial units within 200km of the network (along roads) are deemed to be connected to the network. A speed of 60km/h is assumed to reach the network, but the time thus derived is then raised to the power of 1.25 – thus, the further a region is from a rail track the longer it takes to reach it, and this time increases faster than distance. Second, within Canada, 35 spatial units are further than 200km from a rail track. For these units a constant measure of accessibility is assigned which is inferior to the lowest accessibility calculated for connected spatial units.

2.3 Ports

To identify and locate North American ports we first identified Canada's 20 major ports as listed in a 2001[34] Statistics Canada study of maritime transport. We also took the liberty of including the port of Churchill given its rising importance

[34] Table 14 : *Transport maritime intérieur et international – Tonnage du fret chargé et déchargé dans les 50 principaux ports canadiens par secteur, 2001* in « Le transport maritime au Canada – 2001 », catalogue no. 54-205

(table 2). To these spatial data we added some data relating to total tonnage[35] and to TFUs (twenty foot units – a measure of container volume).[36]

Table 2
Canadian Ports

1. Vancouver	18. Sault-Ste-Marie	35. Corner Brook
2. Saint John	19. Courtright	36. Colborne
3. Port Hawkesbury	20. Windsor Ontario	37. Bowmanville
4. Sept-Îles/Pointe-Noire	21. Prince Rupert	38. Toronto
5. Montréal/Contrecoeur	22. Port-Alfred	39. Kitimat
6. Come-By-Chance	23. Goderich	40. Hantsport
7. Nanticoke	24. Meldrum Bay	41. Bayside
8. Québec/Lévis	25. North Arm Fraser River	42. Bécancour
9. Port-Cartier	26. Sarnia	43. Whitefish
10. Halifax	27. East Coast Vancouver Island	44. Îles-de-la-Madeleine
11. Fraser River	28. Havre-St-Pierre	45. Campbell River
12. Hamilton	29. Clarkson	46. St. John.s
13. Thunder Bay	30. Crofton	47. Port Credit
14. La côte de Terre-Neuve	31. Trois-Rivières	48. Picton
15. Sorel	32. Belledune	49. Jervis Inlet
16. Howe Sound	33. Nanaimo	50. Little Narrows
17. Baie-Comeau	34. Sydney	Churchill

For US ports we use a file obtained from *U.S. Waterway Data*.[37] The 150 largest US ports have been located using coordinates provided in the file. Information on port tonnage and containers – when available – come from *U.S. Waterway Data*[38] and the *U.S. Department of Transportation*.[39]

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35 *Ibid.*

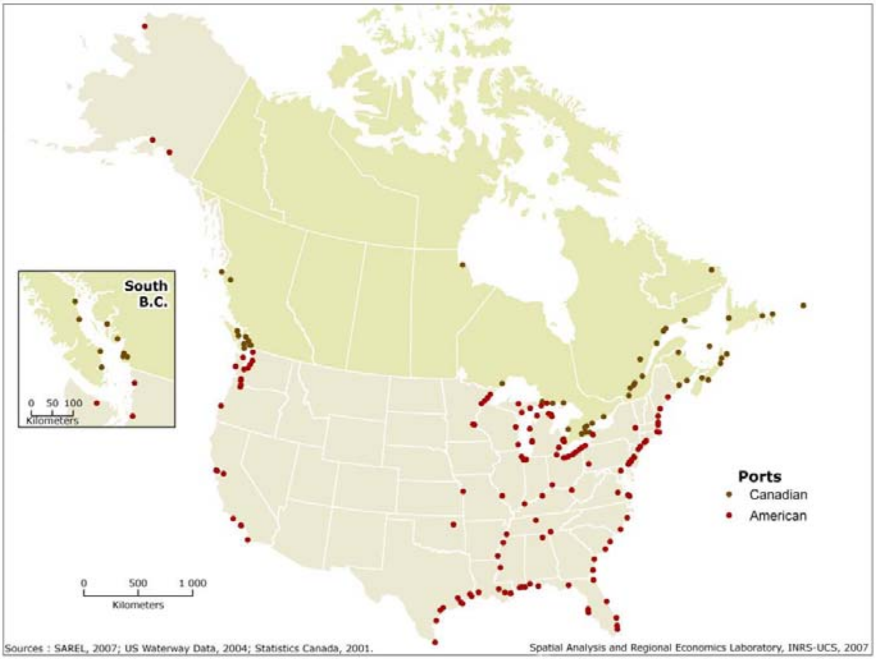
36 Table 3 : *20 principaux ports nord-américains pour les EVP chargés qui ont été échangés avec des ports d'outre-mer, 2001 comparativement à 1992* in « Les futures rivalités entre les ports pour conteneurs du Canada et des États-Unis », Statistics Canada, June 2003, catalogue no. 54F0001XIF.

37 http://www.iwr.usace.army.mil/ndc/data/datappor.htm

38 U.S. Waterway Data, 2004 : http://www.iwr.usace.army.mil/ndc/data/datappor.htm

39 *Container Custom Ports, 1997-2005.xls* from *U.S. Department of Transportation, Maritime Administration*, http://www.marad.dot.gov/.

Figure 5
Principal Ports in North America, 2001



It should be noted that comparable freight and tonnage data were not available for all 200 ports: we therefore could not, at the time of analysis, weight the ports. Thus our measure of accessibility to ports is a simple one: mean distance to all 200 ports. Given the geography of ports (figure 5) it is regions around the great lakes that, on the whole, have best accessibility to ports. However, geographic control variables inserted in our base employment growth model (the CPS model) partly control for these geographic regularities.

2.4 Air transport network

From *Bureau of Transportation Statistics*[40] files, we locate the geographic coordinates of North American airports. We devise a typology of airports and assign a transshipment time that takes into account both airport congestion and likely flight frequency (table 3). The files we use also contain data relating to the number of passengers between different airports for 1999-2000. Thus it is

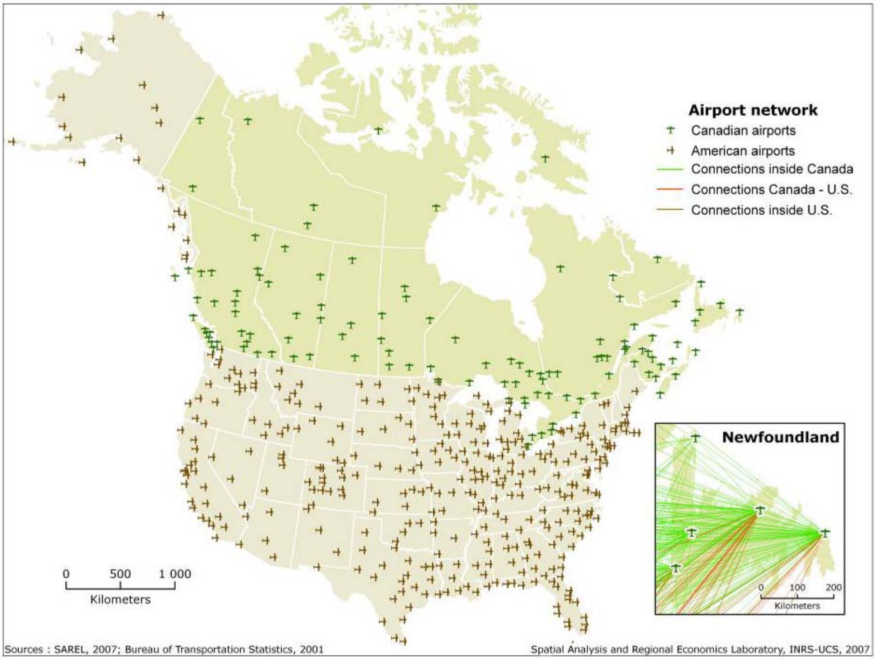
[40] http://www.bts.gov/

possible to establish the existence (or not) of links between each pair of airports (figure 6). Once in the air, a travel speed of 10 min per 100 km[41] is assumed.

Table 3
Airport Typology

Description	Typology	Transshipment
Principal international airports	1	60 minutes
Secondary international airports	2	50 minutes
Transfrontier airports 1	3	40 minutes
Transfrontier airports 2	4	60 minutes
Regional airports 1	5	90 minutes
Regional airports 1	6	120 minutes
Small airports 1	7	240 minutes
Small airports 2	8	480 minutes

Figure 6
Airport Network in North America, 2001



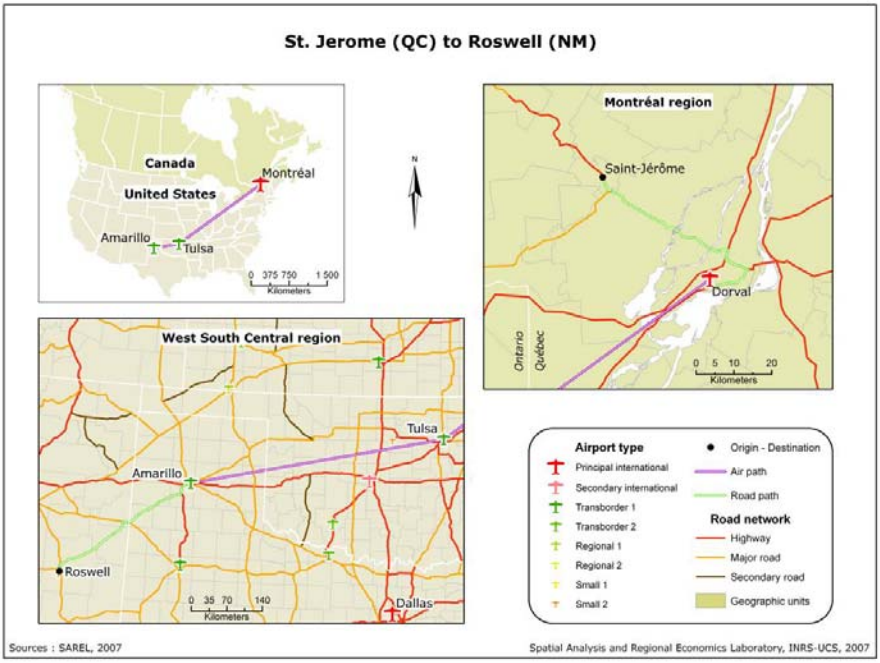
41 This flight speed is estimated because flight times vary considerably due to wind, plane type etc. However factors such as smaller plane size and airport congestion are implicitly included in the estimated transshipment times.

It should be noted that our airport network is bi-modal because both air *and* road links are used. For example, to travel by air from St-Jérôme (Québec) to Roswell (New Mexico) the road network is used to get to Pierre-Elliott-Trudeau airport. After adding transshipment time, air transport is used to get to Amarillo via Tulsa (where an extra transshipment time is added). After adding the Amarillo transshipment time, road transport is used again to reach Roswell. The total trip takes 10 hours (table 4 and figure 7), which we feel is a reasonable estimate.

Table 4
Using Bimodal Network to Travel from Saint-Jérôme (QC) to Roswell (NM)

From	To	Network	Kilometer	Time (minutes)
Saint-Jérôme	Montréal airport	Road	64	39.6
Montréal airport	Transshipment	Airport	—	60.0
Montréal airport	Tulsa airport	Air travel	1 996	199.6
Tulsa airport	Transshipment	Airport	—	40.0
Tulsa airport	Amarillo airport	Air travel	507	50.7
Amarillo airport	Transshipment	Airport	—	40.0
Amarillo airport	Roswell	Road	338	189.4
		Total:	2 905	619,3

Figure 7
Example Using a Bimodal Network



3. Calculation of Distance/Time Matrices

Given these networks, an application called *Distance Matrix Calculation*[42] developed by our laboratory at the INRS (the SAREL laboratory) in 2003 is used. This application, which works with a *Geometric Network* under ArcGis, allows three types of distance to be calculated between each pair of points in a geometric network: Euclidian (straight line), Manhattan (right angle: i.e. North/South axis then East/West axis), and network distances. For all our accessibility statistics it is the network distance (weighted by speed) that is used.

[42] http://arcscripts.esri.com/details.asp?dbid=13207

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TRANSPORT INFRASTRUCTURE AND LOCAL ECONOMIC DEVELOPMENT

A Study of the Relationship between Continental Accessibility and Employment Growth in Canadian Communities

How important are transport infrastructures as determinants of local economic development, especially in the post NAFTA era? This study approaches the question in a novel manner. Transport infrastructures – road and highway networks, harbours, rail, and airports – are considered in terms of the access they provide to North American markets. To isolate their independent, incremental, effect on employment growth across Canada, transport infrastructures are examined within a broader framework, which integrates other determinants of local development: education; urban size; industrial structure; etc. The study finds that transport infrastructures – via the access they provide to continental markets – exert a positive influence on employment growth in Canadian communities. The positive relationship has increased in strength over time, most notably for manufacturing employment in relation to harbours and road and highway networks.

- Cette étude est également disponible en français :
  Infrastructures de transports et développement économique local Étude de la relation entre accessibilité continentale et croissance locale de l'emploi, Canada, 1971-2001




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