***Population density and labour productivity in Canada***

In ancient times, many civilizations arose around a single, central city. For a citizen, a city was not just a center of trade and the nexus of social life, it was at the core of his very identity. These days, there is no need to be quite so dramatic about things, but there is still something special about metropolitan areas that so many people are drawn to them. In economic terms, there is much evidence of a correlation between population density and economic activity.

Puga (2010) refers to the density effect on labour productivity as "agglomeration economics," and there is a great deal of literature suggesting that these agglomeration effects are independent from other factors that may encourage people from moving to a city. Accounting for factors such as a desire to move towards pleasant weather, and the "sorting" effect of productive people moving to productive places, population density alone has a positive effect on labour productivity.

Abel, Dye, and Gabe (2011) analyzes the density effects on productivity in 363 statistical metropolitan areas in the United States for the years 2001-2005. They find that on average, when the density of a city doubles, output per worker increases by 2-4%. The authors identify "knowledge spillovers" as a key component in the density effect. They also find that density has a greater effect on high human capital areas. Highly educated people tend to transfer information amongst themselves when they interact, increasing productivity.

In the Canadian context, there are a few fundamental differences that should be discussed. Canada is much larger than the United States in land mass, but with only a tenth of the population. There are also significantly fewer statistically-defined metropolitan regions in Canada, with only 33, and they tend to be smaller. In 2016, the 20th largest metropolitan area in the United States was St. Louis, with nearly 3 million inhabitants. In the same year, St. John's, with only 200,000 residents, was the 20th largest urban area in Canada, smaller than any city in the top 200 in its southern neighbor.

These statistical areas also do not coincide with any political divisions: for example, Mississauga is lumped together with Toronto, despite the two being administratively independent. Finally, there is no consistent cutoff point between metropolitan and non-metropolitan regions, even within each country.

With these limiting factors in mind, it is still useful to perform a similar analysis to Abel (2011) on Canadian cities, even if only to identify the differences between the two countries. As a result, definitions and methods in that study are used as a guideline for our own analysis.

We measure human capital (*H*) based on the number of people in a region aged 25 and above with at least a bachelor's degree, factored by the size of the labour force. Rather than the traditional aggregate measure of population density we instead use a population-weighted measure (*D*), which gives us a more reasonable estimate of the density experienced by the average inhabitant.

Binary indicator variables are used to classify *H* and *D* as either high (1) or low (0) depending on whether they are above or below average. Running a linear regression for

$$Y_i = \beta_0 + \beta_1 H_i + \beta_2 D_i + \beta_3 H_i D_i$$

we obtain some rather interesting results.

Table 1. Average effects of density and human capital.

| | Low *D* | High *D* | Difference |
|---|---|---|---|
| Low *H* | 79301 | 89352 | 10051 |
| High *H* | 93544 | 96023 | 2479 |
| Diff-in-diff | | | -7572 |

In contrast to the American data in 2001-2005, higher population density in Canada seems to have a greater effect in low human capital areas than in high human capital areas, to the tune of $7,500. However, due to the high variation among cities with the same features, we cannot be confident of these numbers at even the 90% level.

For example, Oshawa, with low population density and low human capital, has long been suffering from a decline in manufacturing. Conversely, Sudbury is in the same density and human capital group, but it has nearly twice the productivity as Oshawa.

It is not too difficult to identify a main suspect for these problems: natural resources. Why is St John's as productive as Toronto, despite its low density? Oil. Perhaps unsurprisingly, the city with the highest productivity during 2009-2013 was Calgary, which averaged over $121,000 per worker. It has high density, high human capital, *and* a strong oil and gas sector.

In resource intensive areas, a 4-year bachelor's degree may not be the most relevant measure of worker skill. Studies on knowledge spillover effects have tended to focus on traditional definitions of high human capital. But even if we expand our measure of human capital, heterogeneity of opportunities in different regions will continue to cloud any attempts at generalization. For instance, in both Sudbury and Oshawa, the number of people with higher education doubles if we expand our definition to include everyone with any post-secondary degree or certificate. Compounding these issues, Statistics Canada does not have industry specific GDP data for metropolitan areas.

There is still much work to be done on this subject. Abel (2011) makes the critical assumption that metropolitan areas within the same country would, in general, have homogeneous economic properties. Yet Canada has a much smaller sample size of metropolitan regions, and among them only a half dozen have more than 1 million inhabitants, compared to over 50 in the United States.

Canada's small population is spread heterogeneously over a diverse landscape, and it would be reasonable to assume that in a general analysis, we cannot make the same assumptions that we would with the United States. The limitations of Statistics Canada may prevent us from researching some details, but a greater focus on industry-specific effects on density and productivity in this country is certainly warranted. At the very least, the disproportionate effects of natural resources production should be incorporated into any future research.

(*I can provide all the original StatCan data and calculations*)