Vancouver Centre of Excellence

Research on Immigration and Integration in the Metropolis

Working Paper Series

#98-21

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December 1998

RIIM

Research on Immigration and Integration in the Metropolis

The Vancouver Centre is funded by grants from the Social Sciences and Humanities Research Council of Canada, Citizenship & Immigration Canada, Simon Fraser University, the University of British Columbia and the University of Victoria. We also wish to acknowledge the financial support of the Metropolis partner agencies:

- Health Canada
- Human Resources Development Canada
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Immigrants and the Trade of Provinces

Keith Head, John Ries, and Don Wagner

Faculty of Commerce and Business Administration
University of British Columbia

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This paper has been reviewed by Don DeVoretz and copyedited by S. Sydney Preston.

Abstract: Canada is a relatively open economy in terms of both trade and immigration. This paper investigates the affects of immigration on Canada's pattern of trade. We employ unique province-level trade data with over 150 trading partners over the period 1992–1995 to discover whether the partial correlation reported by Head and Ries (1998) can stand up to more demanding statistical tests. We derive three alternative functional forms capturing the relationship between immigration and trade based on the proposition that immigrants use their connections and superior "market intelligence" to create trade opportunities that non-immigrants would not have otherwise exploited. We estimate each model identifying immigrant effects based on cross-province patterns in immigration and trade. The results corroborate our earlier findings that immigrants are positively associated with trade, although these effects are somewhat lower than our previous study. We use our coefficients to calculate trade created per immigrant and find that, even in our most conservative specification, immigrants account for over 10% of Canada's exports.

Key Words: bilateral trade, gravity, immigrants, national borders, trade,

1. Introduction

According to the 1996 Census, one out of every six Canadian residents was born outside of Canada. This high level of immigrant population can be expected to exert significant influence on the Canadian economy. Academic research has traditionally focused on the effect immigrants have on the labour market and social services. This paper continues our research on another aspect of the economy immigrants may influence—international trade.

We employ provincial trade and immigration data to relate immigration levels to imports and exports with more than 150 trading partners over the period 1992-1995. Using a gravity model framework, we posit three alternative specifications reflecting immigrant influence on trade. The first specification assumes a constant elasticity between trade levels and immigration levels. The second specification, the "propensity" model, posits that an immigrant's propensity for trade creation is a constant multiple of non-immigrants' propensity. The third model allows the immigrant effect to decrease as the number of immigrants in a province rises. All of the specifications control for the income of provinces and trading partners, the distance between them, as well as time-invariant, unmeasured provincial characteristics that influence trade. We also include a variable reflecting common language overlap as well as Canadian-partner country fixed effects. The former tests whether knowledge of a language is the prime factor in the immigration effect, whereas the latter capture relationships between Canada and foreign countries that simultaneously influence trade and immigration.

There are several intuitive and theoretical reasons for believing that immigrants play an important role in expanding Canada's foreign trade. One of the bases for this belief is that immigrants face smaller trade barriers than non-immigrants. For example, immigrants already know the language spoken in their land of origin. They tend to be familiar with their previous country's business laws and practices. They may already have established networks of customers and/or suppliers. They would be more familiar with customers' preferences. A non-immigrant may find potential trading opportunities infeasible because the costs of familiarization with the foreign environment may be too costly, while an immigrant might be able to profitably carry out the same trade. In addition, immigrants may expand imports because they have preferences for certain goods produced in their country of origin. These preferences may be based on tastes developed before immigration. Moreover, immigrants might expand Canadian exports due to Canada's immigration policy. Canadian policy tends to favour immigrants who will expand Canada's economy, and ideally will boost Canada's exports. Finally, Canadians observe that trade with certain countries, such as Hong Kong and China, has grown substantially in recent years at a time when immigration from those countries has also grown.

Two previous papers have estimated the significance and magnitude of the effect immigration levels have on trade. Gould (1994) compiled U.S. national trade data and found a statistically significant relationship between immigration and trade. Similarly, Head and Ries (1998) tested the hypothesis with Canadian national trade data and obtained a similar conclusion. However, we now have trade and immigration data at the province level, allowing us to introduce fixed country effects into our statistical tests. A concern about the Head and Ries study was that there may be political factors or other national factors that affect both immigration and trade and thus give results that wrongly appear to suggest that immigration promotes trade. For example, both immigration and trade with Hong Kong and Great Britain may be attributable to Commonwealth links. Without employing fixed country effects, we might erroneously link high trade with these countries to immigration when the trade might actually be attributable to a commonwealth link. Similarly, low levels of trade and immigration with North Korea reflect the closed North Korean economy, not that low immigration generates low trade outcomes. By introducing fixed country effects, we can examine trade and immigration variation among the provinces and thus control for national level factors.[1]

This paper is organized as follows. Section 2 introduces the gravity model of trade. We use the model in a slightly different way from the conventional practice, and explain our reasons for doing so. Section 3 describes Canadian immigration trends and expands on why we hypothesize that Canadian immigrants boost Canada's foreign trade.

[1] Gould (1994) uses fixed country effects in his analysis of U.S. national data. Thus he examines variation over time rather than in bilateral trading relationships.

Section 4 describes how we incorporated language in our statistical tests and section 5 describes our specifications and reports our results. Section 6 concludes the paper.

2. The Gravity Model

2.1 Description of the Gravity Model

The gravity model is an effective tool for empirically measuring the effects of various factors on trade levels.[2] Some economists are skeptical about the model, but it has drawn some theoretical support.[3] Moreover, the model provides a remarkably good fit. In statistical tests, it typically produces an R squared of about 0.7. The gravity model is the best tool we have to measure immigration's effect on trade levels.

The gravity model predicts that trade is proportionate to each trading partner's economic weight (usually measured by GDP) and is negatively correlated with the distance between the traders. The standard gravity equation is:

$T_{ei} = (Y_e\, Y_i / Y_w) \times (D_{ei}^{\beta 1} \times \Phi_{ei}) \times e^{\varepsilon ei}$

where: T_{ei} = trade from exporter e to importer I, Y_e = GDP of exporter, Y_i = GDP of importer,

Y_w = GDP of the world, D_{ei} = distance between countries e and i, $\beta 1$ = some parameter that we expect to be negative, Φ_{ei} = a factor capturing the effect of trade barriers other than distance, ε_{ei} = the error term.

Taking logs logs of the left and right sides of the equation, yields a log linear specification.

A useful way of understanding the gravity model is as follows:

Predicted Trade	=	Potential Trade	X	Discount Factor Reflecti Trade Barriers

[2] For example, Wei and Frankel (1994) employed the gravity model to measure the effect that regional trading blocs have on trade. McCallum (1995) and Helliwell (1996 and 1997) used the model to measure the effect that the Canada-US border has on trade, relative to inter-state and inter-provincial trade.

[3] In the past, many economists dismissed the model due to a lack of theoretical underpinnings. However, theoretical support has now been provided by Linneman (1966), Leamer & Stern (1970), Anderson (1979), Krugman (1979), Bergstrand (1985) and Deardorff (1995). Yet, the theory supporting the model relies on certain assumptions. One assumption pertains to preferences and/or production mixes. This issue will be addressed in section 2.3 of the paper. Another assumption is that the tradability of all goods are equally responsive to distance.

“Potential trade” refers to the trade that would occur if no barriers to trade existed. In the gravity equation above, potential trade is ($Y_e Y_i / Y_w$). If there were no barriers to trade, we assume that a country’s output would be sold to various countries in proportion to those countries’ GDP. Similarly we assume that the goods a country consumes would be purchased from various countries in proportion to those countries’ GDP.

The “discount factor reflecting trade barriers” is the second component of the gravity model. This factor represents 1 minus the proportion of potential trade that is blocked by trade barriers. By “trade barriers”, we mean anything that can interfere with trade. The term refers both to government-imposed barriers (such as tariffs and quotas) and to natural barriers (such as transportation costs and the inability to communicate).

The “natural” barriers are strongly correlated with distance. For example, as distance increases,

1. shipping costs increase,
2. responsiveness to customers’ orders decreases,
3. products age more (which is a concern for perishable products),
4. the ability to communicate decreases (because languages of distant countries will usually be less familiar than those of countries that are nearby), and
5. familiarity with opportunities decreases.

For these reasons, distance appears to be a good proxy for many “natural” barriers to trade.

Other barriers to trade could also be incorporated into the model if suitable measures or proxies of such barriers can be found. However, government-imposed barriers, such as aggregate tariffs,[4] quotas, and red tape are very difficult to quantify. In the gravity model above, the ‘discount factor reflecting trade barriers’ is ($D_{ei}^{\beta 1}$ x Φ_{ei}). Certain factors may reduce the size of the discount. For example, the ability to speak a common language may reduce barriers. The presence of immigrants bringing knowledge of their home countries may also lower the discount.

[4] Tariffs on any one product are easy to quantify, but they are hard to aggregate because they vary a lot across products and at a very detailed level.

2.2. Restructuring the Gravity Model

Researchers using the gravity model typically use each partner's GDP as an independent variable. That is, they run regressions of the form

$$\ln T_{ei} = \beta_1 \ln Y_e + \beta_2 \ln Y_i + \beta_3 \ln D_{ei} + \ldots + C + \varepsilon_{ei}$$

However, the theory supporting the gravity model indicates that trade should be directly proportional to each trading partner's GDP (after adjusting for distance and other factors). As a result, theory stipulates that β_1 and β_2 ought to equal one. Statistical tests consistently corroborate the theory; they regularly estimate β_1 and β_2 to equal approximately 1.

In light of the above, we modify the gravity model. Since there really is no reason to doubt that trade is proportional to the trading partners' GDP, it makes sense to divide the left hand side and the right hand side of the gravity equation by the term $Y_e\ Y_i\ /\ Y_w$. So we create a new variable, G_{ei}, which is as follows:

$$G_{ei} = T_{ei} / (Y_e\ Y_i / Y_w) = D_{ei}^{\beta 1} \times \Phi_{ei} \times e^{\varepsilon ei}$$

Now the dependent variable no longer represents trade, but rather represents the proportion of potential trade that is realized.

Advantages to this modification are:

1. The revision prevents errors in GDP measurement from biasing our estimates of the parameters in the gravity model. This is important, because most economists doubt the accuracy of the reported GDP amounts of many countries. These inaccuracies can bias our parameter estimates. Restructuring the model prevents this bias.
2. A country's GDP is partially dependent on trade. As a result, the standard format of the gravity model has a problem with simultaneous equations. Trade is partially dependent on income and income is partially dependent on trade. Moving GDP to the left hand side of the equation eliminates this problem.
3. The restatement of the model focuses the equation on the barriers to trade, which is what we really intend to examine in our statistical tests.

Disadvantages to making this modification are:

1. The model loses flexibility; the data can no longer attribute a parameter other than 1 to the GDP.
2. If we allowed the data to determine the parameter, and we obtained a parameter estimate significantly different from 1, this result would alert us to the possibility that we are missing an important variable.
3. The dependent variable's interpretation is slightly more complex than that of the standard gravity equation. Exports (or imports) is a simpler concept than "the proportion of potential trade that is realized."
4. Trivially, the modified model no longer looks like "gravity."

We believe the first two advantages strongly outweigh the other considerations. Accordingly, we make this modification. Naturally, our R squared statistics will decrease substantially from the results that the standard format of the gravity model generates, since much of the gravity equation's explanatory power likes in the income component of the model.

2.3. Differences in Consumer Preferences and Production Patterns across Canada

In their simplest forms, the supporting theoretical models assume that consumer preferences are identical across countries. Deardorff (1998) has considered cases where consumer preferences and production patterns vary across countries. In such cases, potential trade may be higher or lower than ($Y_e Y_i / Y_w$), depending on the degree to which country *e* produces the kinds of goods country *i* prefers.

Consider trade in good *j*. Suppose country *i* spends θ_{ij} of its income on good *j*, and country *e* derives γ_{ej} of its income from the production of good *j*. With no barriers to trade, country *e*'s exports to country *i* in good *j* will be:

$$T_{eij} = Y_e Y_i \, \gamma_{ej} \, \theta_{ij} \, / \, \Sigma_i \theta_{ij} Y_i.$$

Aggregate exports from country *e* to country *i* will therefore be:

$$T_{ei} = \Sigma_j T_{eij} = Y_e Y_i \, \Sigma_j [\gamma_{ej} \, \theta_{ij} \, / \, \Sigma_i \theta_{ij} Y_i].$$

Note that if consumer preferences are identical across countries, the θ_{ij} is constant across all *i*, and $T_{ei} = Y_e Y_i / Y_w$. The same result occurs if production mixes are identical across countries. Potential trade can only deviate from (Y_eY_i/Y_w) if *both* consumer preferences *and* production mixes vary across countries.

Deardorff goes on to show that even where both the exporter's production mix and the importer's preferences deviate from the world average, the expected potential trade will nevertheless tend towards (Y_eY_i/Y_w) if these deviations are not correlated.

On the other hand, if countries have correlated differences in preferences and production mixes that correspond with a variable we wish to study, our statistical tests could generate a biased coefficient for that variable.

In summary, the potential trade part of the model will be appropriate if at least one of the following is true:

1. production mixes are similar across exporters (i.e. all exporters produce the same types of goods in roughly the same proportions);
2. preferences are similar across importers; or
3. differences in importers' preferences and exporters' production mixes are not correlated with the variables on which our study focuses.

Below we assess each of these criteria. We find that the first criterion appears to be false. The other two criteria, however, do not appear to pose a significant problem, though we cannot conclusively demonstrate that they are true.

2.3.1. Production Mixes

There clearly are differences in production patterns, across foreign countries and across Canadian provinces. Countries and provinces tend to specialize in the production of certain types of goods. Among provinces these differences are very pronounced. Forestry products dominate British Columbia's exports. The Prairie Provinces' major exports are agricultural products and oil. Ontario and Quebec export manufactured goods. And the Maritime Provinces export forestry, fishery and oil products. So we clearly cannot assume that Canada's production patterns are similar among provinces. Similarly we cannot assume foreign countries' production mixes are similar to each other.

2.3.2. Importers' Preferences

Next we look at importers' preferences. We subdivide this issue into several categories – consumer preferences among provinces, demand for intermediate goods across provinces, consumer preferences among foreign countries, and demand for intermediate goods across foreign countries.

We believe that consumer tastes are similar across Canada. Canadians across the country have a similar level of affluence. While cultures vary somewhat across the country, they likely do not materially affect the types of goods that people buy. It seems unreasonable to believe that there are material differences in consumer tastes among the provinces that would bias our results.[5]

However, we need to consider more than the imports of final consumer goods. Much trade is in intermediate goods. While we are confident that variations in consumer tastes will not bias our results, we cannot be so confident that the demand for intermediate goods is similar across provinces.

The demand for intermediate goods depends on what goods each province's industries need. Fortunately, when we consider the provinces' main industries, we can find some reasons to believe that there are similarities in the demand for intermediate goods. One reason is that the provinces' specializations are resource based; the primary inputs to these industries are not imported. The second reason is that the main inputs that these industries do need to import are heavy machinery, so these industries are quite similar in that regard.

Next we consider whether we can assume consumer preferences are similar across foreign countries with respect to the products those countries would buy from Canada. Because our model uses fixed country effects, this assumption is not altogether unreasonable. We need not assume, for example, that Angola's consumption patterns are similar to Japan's. We just need to assume that the types of goods Angola demands from Canada are similar to the types Japan demands. The differences between Angola's and Japan's consumption might be met by non-Canadian suppliers. For example, developing

[5] We hypothesize, however, that immigrants' preferences differ from those of non-immigrants. This hypothesis is part of the reason we expect a link between immigration and imports.

countries might spend a greater proportion of their income on locally grown food. As a result, such a country might trade less, as a percentage of GDP, than a developed country might. The use of fixed country effects in our model eliminates the distortion that this difference in consumption patterns might otherwise have caused.

Finally we turn to foreign countries' imports of intermediate goods. Here we look again to Canada's primary industries and find some reasons to believe that foreign countries' demands for such goods will not be very biased toward certain countries. Of Canada's primary resource-based industries, fisheries and grains are close to being consumer goods. Forestry and oil products are inputs for a wide spectrum of industries. So there is little reason to believe that these exports will be unduly focused on certain countries. There is, however, some difficulty with Ontario's and Quebec's manufactured goods, which are likely primarily demanded by the more industrialized countries.

2.3.3. Correlation Between Possible Biases and Immigration or Language

If these variations in production mixes and importers' preferences are not correlated with immigration, the variations will not distort our results. Unfortunately, it is easy to envision a correlation. For example, among the provinces manufactured goods tend to be produced in urban Ontario and Quebec. Immigrants tend to settle in large cities. Industrialized countries may be more likely to trade in industrialized products. If we count all immigrants (rather than only recent immigrants), most immigrants come from industrialized countries. As a result, our statistical tests may attribute to immigrant links what is really attributable to variations in production mixes and importers' preferences.

However, there are several reasons to believe that the above relationship will not materially bias our results. First, there are quite a few industrialized countries with varying levels of emigration into Canada. These variations among many industrialized countries help diffuse this problem. Second, our use of fixed country effects further helps to diffuse this problem. If industrialized countries trade more in industrial goods, this extra trade is reflected in the fixed country effects.

Obviously, we cannot list every possible correlation one could envision. Nevertheless, after considering whether there may be patterns of trade that are correlated with immigration, and after considering fixed country effects, we believe that our statistical tests will not be materially affected by variations in production mixes and importers' preferences.

2.4. Province-Level Data

2.4.1. Benefits of Fixed Effects

In a previous study, Head and Ries looked at the immigration effects on Canada's trade. They did so by employing a standard logged gravity model and including as an independent variable the log of the number of immigrants in Canada from the particular trading partner. Their analysis appears to show that increasing immigration from a particular country increases trade with that country, with elasticities of approximately 0.1 for exports and 0.3 for imports.

As with any regression analysis, there is a risk that Head & Ries' study does not measure what it appears to measure. There may be alternative hypotheses that might explain this result. One hypothesis is that a handful of countries with high levels of immigration into Canada (such as Great Britain and Hong Kong) drive the result. There may be other relationships between Canada and the foreign country that influence both immigration and trade.

The risk that we are measuring factors other than immigration can be greatly reduced by introducing fixed country effects into the model. We can do this because we have provincial level immigration and trade data. For example, consider trade with Hong Kong. Most immigrants from Hong Kong settle in Ontario or British Columbia.[6] If there is an immigration effect, Hong Kong's trade with these provinces (after accounting for province size and distances) should be greater than its trade with other provinces. By using provincial data and fixed country effects, we eliminate the possibility that we attribute to immigration an increase in trade that really is attributable to some other special relationship between Canada and another country.

[6] In 1995 about 250,000 immigrants from Hong Kong were living in Canada. About 50% of those immigrants lived in Ontario and 32% lived in British Columbia.

Of course, we still have the risk that there are special relationships between the other country and a particular province, but we believe such relationships are less significant. The primary special relationships normally involve issues at the national level, such as political relationships and tariff levels.

In addition to enabling us to use fixed country effects, the use of provincial level data is appealing for another reason. We can consider language variation, since Quebec is predominantly French-speaking while the other provinces are predominantly English-speaking. We consider 28 other languages as well to capture the first language of most immigrants. Appendix I lists these languages.

2.4.2. Measurement Problems

Unfortunately, we have a trade measurement problem in our provincial data. Some of the import trade data is allocated to the wrong province. Statistics Canada says the following about its import statistics:

> Import statistics by province of clearance indicate the province in which goods were cleared by Customs either for immediate consumption or for entry into a bonded Customs warehouse. This may not always coincide with the province in which goods are consumed.[7]

For our purposes, we would have liked the imports to be reported in the province in which the goods are consumed.

We analyzed the trade patterns of some specific products to see whether we could identify any potential problems. Automobile imports were clearly not reported on the basis of consumption, but on the basis of the port of entry. (Virtually all automobiles imported from Europe are reported as Nova Scotia's imports; virtually all automobiles imported from the United States show up as Ontario's imports; and virtually all automobiles from Japan are included in British Columbia's imports.) Other products (such as wine) appear to be reported on the basis of the province of consumption.

In the case of exports, Statistics Canada says:

[7] Statistics Canada - No 65-006, pg xiv., Jan.-Dec. 1994.

> … for most commodities, trade data are presented by province of origin which represents the province in which the goods were grown, extracted or manufactured.

We have not noted any industries in which the export trade patterns look unreasonable. We have no practical way of countering this problem. All we can do is remain cognizant of these errors when interpreting the results of our statistical tests.

2.4.3. Small Provinces

Some of the provinces are quite small. To avoid attaching too much weight to the effects of small provinces, we group them into regions. Our groupings follow Statistics Canada's normal groupings of the provinces. The "provinces" we use are:

1. British Columbia,
2. the Prairie Provinces (Alberta, Saskatchewan and Manitoba),
3. Ontario,
4. Quebec, and
5. the Maritime Provinces (New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland).

Throughout this paper, the term "provinces" refers to these three provinces and two regions. For each foreign country, there are 5 observations per year. If we treat each of the four years (1992–1995) as independent, then each foreign country will have 20 observations (5 provinces times 4 years). When we do not treat each year as independent from the others, then each foreign country will have only 5 observations.

2.5. Zeros

Zeros in trade data should not be ignored. The zeros may bias our coefficient estimates if we do not take steps to counter this problem. The reason for this bias relates to the functional form we use to run our statistical tests. The dependent variable in the standard logged gravity equation is $\ln(T_{ei})$. The problem is that if $T_{ei} = 0$, then $\ln(T_{ei})$ is undefined. Computerized regression programs typically ignore observations with undefined values. Casting out these observations triggers a selection bias. Some researchers try to sidestep this problem by making the dependent variable $\ln(T_{ei}+1)$. But, this form still exaggerates the significance of trade level fluctuations that are at zero. For example, in real life there is little difference between trade of 0 and trade of $1,000, even between small trading partners. Yet this difference will affect our regressions markedly—much more than the difference between $10 million and $1 billion.[8]

We use a Probit estimation to compute each observation's probability that there will be zero trade, and use those probabilities to compute Mills' Ratio for each observation to correct the bias that would otherwise arise.

3. Canadian Immigration and Why We Expect a Link to Trade

3.1. Description of the Immigration Environment in Canada

3.1.1. Numbers and Sources

Canada has a substantial number of immigrants. At the time of the 1996 census, immigrants comprised 17% of Canada's population. (The US's immigrant population is 8% of its total.)

In the 1950s, 80% of immigrants came from Europe. Now most come from Asia. In 1996–97, 66% of immigrants came from Asia. The most common sources of recent arrivals (since 1980) are Hong Kong, India and China. But the most common sources of immigrants—when we do not restrict ourselves to recent arrivals—are Great Britain, Italy and the United States.

The most popular destination provinces for immigrants are Ontario (where 25% of the 1996 population were immigrants) and British Columbia (where 24% of the 1996 population were immigrants).

3.1.2. Classifications of Immigrants

The classification of immigrants has varied over the last few decades. Currently, the major classes of immigrants are as follows:

- Family assisted – 52.1% (1992–1995) (individuals sponsored by family members who are Canadian citizens or residents);

[8] ln(1,001)-ln(1)=6.9, but ln(1,000,000,001)-ln(10,000,001)=4.6.

- Independent – 19.8% (1992–1995) (includes assisted relatives and self-employed individuals);
- Refugee – 12.0% (1992–1995);
- Entrepreneur – 6.4% (1992–1995) (Entrepreneurs must establish a business in Canada that employs at least one person other than a family member);
- Investor – 4.2% (1992–1995) (An investor must make an investment of $250,000–$500,000 (depending on various factors)); and
- Other Categories – 5.5% (1992–1995).

Independent, entrepreneur and investor immigrants are all admitted on economic grounds. Admission into Canada is based on a point system that is intended to measure the degree to which the prospective immigrant can contribute to the Canadian economy. The primary objective of the economic immigration program is to increase employment in Canada, particularly in regions of high unemployment. However, one of the secondary objectives is to improve Canada's trade position. Immigration officials look more favourably on entrepreneurs who will export, or who will produce in Canada goods that were previously imported.

3.2. Why We Expect an Immigration Link

3.2.1. Theoretical

There are two primary theoretical reasons why we might expect a positive correlation between immigration and trade.

The first reason applies only to imports, not exports. Immigrant consumers may have a preference for certain goods that are produced in their country of origin. For example, immigrants may prefer ethnic foods produced in the country from which they immigrated.

The second reason applies both to imports and exports. There are some barriers to international trade that might not apply to immigrants, or that might be less costly to immigrants. Such costs might include:

- unfamiliarity with business laws in the other country,
- unfamiliarity with business customers in the other country,

- unfamiliarity with supply sources in the other country,
- difficulty in establishing business networks in the other country,
- unfamiliarity with the special needs and preferences of customers in the other country,
- unfamiliarity with the language of the other country.

Immigrants from the particular country would be less affected by these barriers—or might not be affected by some of them at all. Thus immigrants would be in a better position than other people to conduct trade with their countries of origin.

3.2.2. Informal Observation

In Canada it is widely believed that there is a link between immigration and trade.[9] It is easy to find anecdotal evidence of immigrant businesspeople who conduct trade with their countries of origin. In addition, the substantial immigration from Asia, coupled with the rise in trade with Asian countries, supports this belief. Many Canadians consider this link to be obvious.

3.2.3. Immigration Policy Reasons

Canada's immigration policy favours entrepreneurs and other people who will expand Canada's economy. Immigrants of the entrepreneur classification must persuade immigration officials that they can and will set up a suitable business. Very often, such businesses involve exporting, since one of the competencies of an immigrant will usually be knowledge of the home country's market. In a sense, then, expansion of exports is almost a condition of immigration for some individuals.

4. Language

Since it is testable, we hypothesize that part of the advantage immigrants have in carrying out trade with their countries' of origin is knowledge of the language. To carry out this test, we computed a common language variable. For a particular country–province pair, this variable equals the probability a randomly chosen person from the foreign country and a randomly chosen person from the province, can speak the same language. For example,

[9] See, for example, Time (Canadian edition) – "Asia's New Capital", pg 31, Nov 17/97.

suppose the foreign country is Morocco and the province is Quebec. In Morocco, 20% of the population speaks French and 74% speaks Arabic. In Quebec 92.4% speaks French and 1.1% speaks Arabic. As a result, the common language variable for Morocco–Quebec observations would equal 0.193 (20% x 92.4% + 74% x 1.1%).[10] (See Appendix I for a description of my sources of language data.)

The way we introduced the language variable into our model depended on which specification we used for immigration. Our full specifications are listed below in our description of our results.

5. Statistical Results

We test the links between immigration and trade using three different models. The first model is the simple log model that Head and Ries used in their 1998 paper. We then derive two new models to predict how immigration might affect trade. These two models are based on the reasoning described in section 3.2 above. We then run statistical tests using specifications based on each of these models.

We have obtained data on each province's trade with each foreign country and on immigration to each province from each country. Sources for our data are reported in Appendix I.

For each specification we run twelve tests. Six of the tests are for exports and six are for imports. Out of the six tests, the first two consider neither fixed country effects nor language effects. The next two consider fixed country effects, but still do not consider language effects. The last two constitute the full model; they consider fixed country effects and language effects. Each of these models has two tests because we run one test under the assumption that each year's observations are independent of other years' observations and we run another test in which all four years' data are averaged into a single observation for each country-province pair.

The reason we run tests under both assumptions is that a country-province pair's trade for a year is neither independent nor completely dependent upon the pair's trade for

[10] This formula double counts individuals who speak both languages. We do not adjust for this double counting because we do not have the data necessary to do so. This measurement error is likely material.

the other three years.[11] So we believe that the true standard errors and levels of significance of our estimates lie somewhere between the values computed when we assume all four years are independent, and the values computed when the four years are collapsed into one observation for each country-province pair. Thus, these two tests bracket the true results. It is difficult, however, to accurately peg where the true standard errors and levels of significance would lie in that range. Based on our findings using the Cochrane–Orcutt process on our OLS regression (reported in Appendix II) we think the true standard error may lie approximately half way between the standard errors obtained in the bracketing tests. Our rationale is outlined in Appendix II.

5.1. Head and Ries Specification

Head and Ries (1998) used a simple log specification. In this paper we adapt their specification to incorporate provincial data and adopt a dependent variable of $\ln(G_{fp})$ as described in section 2.2. Our specification is as follows:

No fixed country effects: Reported in columns 1 and 2 of Tables 1 and 2

$$\ln G_{pf} = \beta_1 \ln(IMM_{pf}+1) + \beta_2 \ln D_{pf} + \beta_3 MILLS_{pf} + \beta\Lambda_{pf} + \varepsilon_{ei}$$

With fixed country effects: Reported in columns 3 and 4 of Tables 1 and 2

$$\ln G_{pf} = \beta_1 \ln(IMM_{pf}+1) + \beta_2 \ln D_{pf} + \beta_3 MILLS_{pf} + \beta\Lambda_{pf} + FE_f + \varepsilon_{ei}$$

With fixed country effects and language effects:

Reported in columns 5 and 6 of Tables 1 and 2

$$\ln G_{pf} = \beta_1 \ln(IMM_{pf}+1) + \beta_2 \ln D_{pf} + \beta_3 MILLS_{pf} + \beta\Lambda_{pf} + FE_f + \beta_4 LANG_{pf} + \varepsilon_{ei}$$

where IMM_{fp} = the number of immigrants from foreign country f living in province p, D_{pf} = the distance between the province and the foreign country, β = the row vector of coefficients for the respective elements in Λ_{pf}, Λ_{pf} = the column vector of dummy variables for provinces, years (when we treat each year's trade as a separate observation) and the constant, $MILLS_{fp}$ = Mills' ratio (see Appendix III), FE_f = fixed effect for country f, and $LANG_{fp}$ = the common language variable described in section 4.

[11] As reported in Appendix II, using the Cochrane–Orcutt process to account for autocorrelation, we obtained a ρ of approximately 0.59 on exports and 0.66 on imports. ρ represents the correlation between a year's error term and the previous year's error term.

Head and Ries chose the simple log specification because it is simple and it has the attractive feature that β_1 can be interpreted as an elasticity. However, these attractive features come at the expense of consistency with theory. There really doesn't seem to be any theoretical justification for believing that trade should be proportional to the number of immigrants from that country to the power of some coefficient. Yet, this specification produces very strong results.

The coefficients for $\ln(IMM_{fp}+1)$ are very similar to those of Head and Ries (1998). For exports, we obtain a coefficient of 0.146 or 0.133 when fixed effects are not considered.[12] This result is fairly close to Head & Ries' result of 0.099. When we introduce fixed country effects the coefficient estimate decreases to about 0.08.[13] It appears that even with fixed country effects our results are statistically significant. Columns 3 and 5 of Table 1 report that these coefficients are greater than zero at a significance level in excess of 99%. However the significance figures are based on the assumption that each year's residual is independent of other years' residuals. As shown in Appendix II, there is strong evidence that this assumption is false. Columns 4 and 6 report the results when we take a conservative approach and average the four years' observations. This approach eliminates the problem of serial correlation over time, but at the expense of losing observations. These tests produce a significance level of approximately 90%. However, since the different years do provide additional information which is ignored in this approach, the significance levels reported in columns 4 and 6 are excessively conservative. We believe the true significance levels lie somewhere between those of columns 3 and 5 and those of columns 4 and 6. Thus we conclude that the coefficient estimate has a significance level in excess of 90% and may be around 95%.

The coefficient for $\ln(IMM_{fp}+1)$ can be interpreted as an elasticity. A coefficient of 0.08 implies that a 10% increase in immigrants from a country will be associated with a 0.8% increase in exports to that country.

[12] Table 1, columns 1 and 2.

[13] Table 1, columns 3 to 6.

We now turn to imports, reported in Table 2. Without fixed country we estimate the coefficient for ln(IMM_{fp}+1) at approximately 0.4.[14] This result is again fairly close to Head and Ries' result of 0.309. The introduction of fixed country effects reduces our coefficient estimate to about 0.2.[15] This coefficient is statistically significant at the 95% level or better. A coefficient of 0.2 implies that a 10% increase in immigrants from a country is associated with a 2% increase in imports from that country.

In columns 5 and 6 we consider language effects. In both Tables 1 and 2 language effects are not statistically significant. This finding surprised us, since our prior expectation was that language barriers were a major barrier to trade.

Our tests also surprised us in another way. The introduction of fixed effects increases the magnitude of the coefficient estimate for the log of distance. This result surprised us because it implies that distance poses a greater barrier within Canada than it does between Canadian shores and a foreign country. This inference follows from the fact that the effect of distance between Canada and a foreign country is fully captured by the fixed country effects. For example, fixed country effects fully reflect the fact that Poland is farther than Ireland from Canada. The distance variable therefore reflects the trade resistance associated with the fact that, for example, Ireland is farther from British Columbia than from Quebec. There are several possible explanations for the increased magnitude in the distance coefficient.

Inaccurate Data

As stated in section 2.4.2. of the paper, our data does not always attribute imports to the province in which the goods were consumed. If a significant proportion of imports is reported in the province nearest to the exporter, rather than in the province of consumption, the absolute value of the distance coefficient would naturally be inflated. This explanation would seem rather convincing except for the fact that the unusual distance coefficient occurs not only in the import regressions, but also the export

[14] Table 2, columns 1 and 2.

[15] Table 2, columns 3 to 6.

regressions. As reported earlier, we found no reason to believe reporting errors exist in the export data.

We conducted a simple little test to see whether the inaccurate reporting of auto imports might be inflating our distance parameters. (Auto trade comprises about 20% of Canada's imports.) In our simple test we removed the primary auto-exporting countries from the regression (the United States, Japan and Germany). When we did this, we surprisingly found that the absolute value of the distance coefficient actually increased.[16] So it appears that the magnitude of the distance coefficient is not fully explained by this measurement error.

Cross-Canada Transportation Costs

Another explanation is that shipping to Canada by sea is not very costly, while shipping within Canada (by rail or truck) may be costly.

Substitution Effects

Another possibility (which only applies to exports) is that the products of the west coast and the products of the east coast are substitutes of each other. The main industries at both ends of the country are forestry and fisheries. Thus it would seem unlikely that Europe would buy lumber from British Columbia when it can be obtained from the Maritime provinces. Similarly, it would seem unlikely that the Maritime provinces would export to Asia goods that can be purchased from B.C. But the high distance parameter occurs both for imports and exports. So this explanation does not satisfy us.

Our best explanation is that all of the above reasons contribute to the high distance coefficients.

The estimated errors on the coefficient estimates approximately double when we collapse the four years' data into one observation for the entire four years. This is expected because the denominator of the formula for standard error has the term of the square root of n (minus the degrees of freedom).

[16] The results of this regression are not shown. The absolute value of the coefficient estimate increased marginally from 1.45 (Table 2, column 3) to 1.47. Meanwhile the coefficient on the log of immigrants (plus 1) decreased from 0.224 to 0.213.

5.2. "Increased Propensity" Specification

5.2.1. Derivation

We now introduce two new specifications and provide some theoretical justification for them. Our first specification assumes that a representative immigrant has a propensity to trade that is 1+z times as much as a representative non-immigrant. We would expect an immigrant to be more likely to conduct trade with his/her country of origin for the reasons described in section 3.2.

1. Immigrants enjoy a lower cost of trade than non-immigrants. Because immigrants face lower costs, they can carry out some trade that non-immigrants cannot carry out.
2. For imports, we would expect that the immigrant would have a higher propensity to trade than a non-immigrant because the immigrant might have a preference for goods produced in his/her country of origin.
3. Canada's immigration policy seeks entrepreneurs who are more likely to trade than the average person.

Based on the above, we would assume that total trade would be

$$T_{pf} = [(IMM_{pf}/POP_p)\ (Y_p\ Y_f/\ Y_w)\ R_{pf}\ (1+z) + (1 - IMM_{pf}/POP_p)\ (Y_p\ Y_f/\ Y_w)\ R_{pf}] \text{ x } e^{\varepsilon fp}$$

where

POP_p = the population of province p, and

$$R_{pf} = D_{pf}^{\beta 1} \text{ x } e^{FEf + \beta\Lambda + C}$$

This equation simplifies to the specification of

$$G_{pf} = R_{pf}\ [1+z(IMM_{pf}/POP_p)] \text{ x } e^{\varepsilon pf}$$

where

$$G_{pf} = T_{pf} / (Y_p\ Y_f/\ Y_w).$$

Unfortunately, this specification cannot be transformed into a linear relationship. This specification must either be solved iteratively (using a maximum likelihood estimation) or using an approximation. $[1+z(IMM_{pf}/POP_p)]$ can be approximated by $e^{z(IMMfp/POPp)}$ provided z and (IMM_{pf}/POP_p) are sufficiently small. Unfortunately, for major sources of immigrants, these numbers are not sufficiently small. For example, our estimates of z range from 18 to several thousand, and (IMM_{pf}/POP_p) can be as high as

0.046 in the case of British Columbia/United Kingdom observations. So if we considered a z of say 50 and the case where $(IMM_{pf}/POP_p)=.046$, the approximation $e^{z(IMM_{fp}/POP_p)}$ is 3 times as big as $[1+z(IMM_{pf}/POP_p)]$.

We run our statistical tests for this specification in two ways. We first use the approximation so that we can use an ordinary linear regression and later we use a maximum likelihood estimate to calculate z in the term $[1+z(IMM_{pf}/POP_p)]$.

5.2.2. Regression Results – Use an Approximation

As indicated above, the first set of tests for this specification employ the approximation. Our regressions are run on the following equations. The results of our regressions are reported in Tables 3 and 4. The specifications are as follows:

Columns 1 and 2:

$$\ln(G_{pf}) = \beta_1(IMM_{pf}/POP_p) + \beta_2 \ln D_{pf} + \beta\Lambda_{pf} + \beta_3 MILLS_{pf} + \varepsilon_{pf}$$

Columns 3 and 4:

$$\ln(G_{pf}) = \beta_1(IMM_{pf}/POP_p) + \beta_2 \ln D_{pf} + \beta\Lambda_{pf} + \beta_3 MILLS_{pf} + FE_f + \varepsilon_{pf}$$

Columns 5 and 6:

$$\ln(G_{pf}) = \beta_1(IMM_{pf}/POP_p) + \beta_4 LANG_{fp} + \beta_2 \ln D_{pf} + \beta\Lambda_{pf} + \beta_3 MILLS_{pf} + FE_f + \varepsilon_{pf}$$

Columns 1 and 2 report results when neither fixed country effects nor language effects are considered. Columns 3 and 4 introduce fixed country effects (FE_f), and columns 5 and 6 add the language effect.

For exports (Table 3), when fixed country effects are not considered, the estimated coefficient for IMM_{fp}/POP_p is over 30. (It is 39.8 if we assume each year is independent [column 1] and 32.2 if we average into a single observation the four years' trade and GDPs [column 2].) This estimate implies that an immigrant is over 30 times more likely to export to his/her country of origin than other people are. These results appear to be significant to the 95% level.[17] Table 10 shows how these results translate into dollars. The results of this statistical test suggest that immigrants account for $16 billion (US) out of $150 billion (US) of Canada's annual exports.

The estimates for imports are even higher (Table 4); they are approximately 100. (The coefficient is 94.5 [column 1] if we assume each year's observations are serially independent of other years' observations, and is 104.6 [column 2] if we average the four years into a single observation.) These results are statistically significant to the 99% level. These results suggest that immigrants import from their home countries about 100 times as much as other Canadians do. As reported in Table 10, this test suggests that $51 billion (US) out of $139 billion (US) of Canada's imports are attributable to immigrants.

These coefficient estimates are large. However, we obtained these results without considering fixed country effects. So there is a risk that these relationships are attributable to factors that increase both immigration and trade.

Next we consider fixed country effects. Incorporating fixed effects reveals that our initial results may be inflated. Our results are weakened in two ways. First, the coefficient estimates decrease. For exports (Table 3), they decrease from the 30's to the 20's (columns 3 and 4). For imports (Table 4), they decrease from about 100 to about 20 or 30 (columns 3 and 4). Second, the level of significance weakens. For exports (Table 3), the coefficient remains statistically significant if we can assume each year is independent (column 3), but not if we collapse the 4 years' data into a single observation (column 4).

For imports (Table 4), the coefficient is not statistically significant, regardless of our assumption concerning the independence of years.

In the last two columns, we add in the language effect. This modification brings the coefficient for the immigration effect down even further, and also weakens the significance of the results.

To summarize, the introduction of fixed country effects eliminates the significance of immigration on imports, and probably on exports as well.

The common language coefficient estimates are generally not statistically significant.

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[17] The significance level in column 1 is greater than 99.9%, and in column 2 is about 93%. If we use the argument described in Appendix II we can probably conclude that the true significance would be at least 95%.

5.2.3. Results - Maximum Likelihood Specification

The "increased propensity" specification was rerun using a maximum likelihood estimate method of estimating the parameters. Tables 5 and 6 show these results for exports and imports respectively.

The equation for columns 1 and 2 is[18]:

$$\ln(G_{pf}) = (1 + \beta_1 IMM_{pf}/POP_p) + \beta_2 \ln D_{pf} + \beta\Lambda_{pf} + \varepsilon_{pf}$$

Introducing fixed countries effects for columns 3 and 4 gives us:

$$\ln(G_{pf}) = (1 + \beta_1 IMM_{pf}/POP_p) + \beta_2 \ln D_{pf} + \beta\Lambda_{pf} + FE_f + \varepsilon_{pf}$$

Finally, the inclusion of language effects for columns 5 and 6 yields:

$$\ln(G_{pf}) = (1 + \beta_1 IMM_{pf}/POP_p) + (1 + \beta_4 LANG_{pf}) + \beta_2 \ln D_{pf} + \beta\Lambda_{pf} + FE_f + \varepsilon_{pf}$$

We immediately observe that the immigration parameters increase and their significance decreases. The results are so large that they appear implausible.[19] It is difficult to believe that the average immigrant has a propensity to import that is over 100 times that of a non-immigrant (let alone several thousand times).

These implausible immigration results in Tables 5 and 6 are not statistically significant when we consider fixed country effects.

5.3. "Probability Specification"

5.3.1. Derivation

Our last specification is the probability specification. This specification is rooted in the idea that an immigrant may face lower costs to trade than non-immigrants, due to connections to business networks. Not all immigrants would have such connections, so we assume each immigrant has a probability p of having the connections necessary to advantageously carry out a trade. The probability specification assumes that there are a multitude of trading opportunities between a country and a province. The size of the trading opportunities are assumed to be proportional to the GDP of the exporting

[18] Mills' Ratio was dropped in the MLE computations due to the complexity involved in doing MLE's.

[19] The fact that the estimates have increased should not be surprising. For tables 3 and 4, we used $e^{z(IMM_{fp}/POP_p)}$ as an approximation of $[1+z(IMM_{pf}/POP_p)]$. The approximation tends to exaggerate the effect of observations where the immigrant per capital ratio is large. Therefore, z is depressed to offset this exaggeration and get the closest fit. Figure 1 shows a graph comparing these specifications.

province (or country) and proportional to the GDP of the importing country (or province). These trading opportunities can be divided into two classes – the easy opportunities and the hard opportunities. There are α times as many hard opportunities as easy opportunities. The easy opportunities do not require the facilitation of an immigrant. We assume that trade is carried out for all the easy opportunities.

The hard opportunities require the facilitation of an immigrant. Moreover, the immigrant needs to have skills, knowledge or connections for a particular industry both in the country of origin and in the Canadian province. For a specific hard trade opportunity, one immigrant has a probability p of being able to facilitate the trade. So the probability that there exists at least one immigrant who can facilitate a potential hard trade opportunity is $1-(1-p)^{IMM_{pf}}$. This specification implies that there are diminishing returns on immigration.

The full model would be:

$$G_{pf} = R_{pf}\,[1+\alpha(1-(1-p)^{IMM_{pf}})] \times e^{\varepsilon_{pf}}$$

Like the previous specification, this model cannot be estimated with an ordinary linear regression. It requires an iterative solution. We use a maximum likelihood estimation.

5.3.2. Results

The "probability" specification was run using a maximum likelihood estimate. The equations for columns 1 and 2, columns 3 and 4 and columns 5 and 6 are as follows:

$$\ln(G_{pf}) = [1 + \alpha(1-(1-p)^{IMM_{pf}})] + \beta_2 \ln D_{pf} + \beta\Lambda_{pf} + \varepsilon_{pf},$$

$$\ln(G_{pf}) = [1 + \alpha(1-(1-p)^{IMM_{pf}})] + \beta_2 \ln D_{pf} + \beta\Lambda_{pf} + FE_f + \varepsilon_{pf}, \text{ and}$$

$$\ln(G_{pf}) = [1 + \alpha(1-(1-p)^{IMM_{pf}})] + (1 + \beta_4 LANG_{pf}) + \beta_2 \ln D_{pf} + \beta\Lambda_{pf} + FE_f + \varepsilon_{pf}.$$

The results of these statistical tests are reported on Tables 7 and 8.

Our results for both variables (α and p) are statistically significant or close to significant in columns 1,2,3 and 5 of Tables 7 and 8. That is, they are significant when we do not consider fixed country effects.[20] Moreover, they are also significant with fixed

[20] Columns 1 and 2.

country effects provided that observations from each year are treated as independent.[21] However, when we average the four years and use fixed country effects, our results are no longer statistically significant.

On the export side, we estimate α to be about 0.7.[22] This implies that there are fewer hard trading opportunities than easy opportunities.

The estimate for p is about 0.00048 with fixed country effects if we treat all four years as independent observations.[23] However, when the four years are averaged, the probability inexplicably jumps substantially to about 0.4. The latter result appears implausible. The more plausible fixed effects result of 0.00048[24] implies that a province needs 1,444 immigrants from a country to achieve half of its potential hard exports and 4,800 immigrants to achieve 90% of its potential hard exports.[25]

On the import side we have a larger α and a smaller probability, p. With fixed country effects, estimates for α range between 1.35 and 3.48.[26] Thus α is about 2 to 5 times larger for imports than exports. The estimate for p is about 1/3 of the size of the p of exports.[27]

We can partially explain the differences between the export and import results by considering our theories on why we expect a link between immigration and trade. As outlined in section 3.2, we expect immigrants to export more because they have lower transaction costs. Meanwhile we expect immigrants to import more for the same reason plus they have tastes for goods produced in their country of origin. The lower α and higher p we get on exports suggests that trading opportunities become saturated more quickly in exports than in imports. However, the imports generated from taste differences would not get saturated, because additional immigrants will keep wanting more goods from the home country.

[21] Columns 3 and 5.
[22] With fixed country effects, the estimates range between 0.66 and 0.77, as reported in Table 7.
[23] Table 7, columns 3 to 6.
[24] Columns 3 and 5.
[25] $1-(1-0.00048)^{1,444} = 0.5$; $1-(1-0.00048)^{4,796} = 0.9$.
[26] Table 8, columns 3 to 6.
[27] p is estimated to be about 0.00015, as reported in Table 8, columns 3 to 6.

As shown in Table 10, this specification suggests that about over one third of imports are attributable to immigrants.[28] These results are large. We need to stress that these results do not imply that without immigrants Canadian imports would be only two-thirds of their present level. Much of the amount attributable to immigrants may be a result of a substitution effect. Immigrants may divert trade away from other trading partners.

We also note again that language effects are not statistically significant under this specification.

5.4. Developed versus Less-Developed Countries

Up to this point we assumed the immigration effect is the same for all types of immigrants. However, there are reasons to believe that immigrants from a developed country might affect trade differently from immigrants from less-developed countries. Developed countries tend to have a business environment and infrastructure that resembles those of Canada more closely than those of other countries do. As a result the value of being an immigrant may be diminished for conducting trade with developed countries. In addition, developed countries tend to have a stronger legal framework. Trade with less-developed countries requires more familiarity with the reliability of other parties, since there tends to be less recourse to the courts. In addition, the tastes of immigrants from developed countries may more closely resemble those of non-immigrant Canadians, making it more likely that desired goods are supplied by Canadian firms.

Based on this reasoning, we ran tests to see what happens when we allow the coefficients for developed countries to differ from those of less-developed countries. For the purposes of our test we treated members of the OECD as developed and non-members as less developed. Table 9 reports our results and compares them with our previous results.

Most of these statistical tests produced results that accorded with expectations. The immigration coefficient for OECD countries tends to be less than that of non-OECD

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[28] When fixed effects are employed in the probability specification, the amount was computed as $51 billion out of total annual imports of $139 billion.

countries. For example, the first line of Table 9 corresponds with the regression reported in Table 1, column 1. As reported in that table, the estimated elasticity was 0.146 when we did not distinguish between OECD and non-OECD immigration effects. However, when we allow different elasticities for these two classes of countries, we obtain a smaller elasticity of 0.109 for OECD countries and a greater elasticity of 0.177 for non-OECD countries. The tests of most of our other specifications followed this pattern.

Table 9 only reports the results of tests in which each year is treated as independent. As a result, the estimated errors reported in Table 9 are understated. Even using understated estimated errors, few of the OECD results are statistically significant. The non-OECD results are more likely to be statistically significant, since there are many more non-members than members of the OECD.

For imports, the 'increased propensity' model actually produces negative results for OECD countries when fixed country effects are employed, but these estimates are not statistically significant.

5.5. Comparison of the Specifications

Our specifications can best be compared by looking at Figure 1 and Table 10. Figure 1 shows how predicted trade responds to immigration.[29] The steeper, straight line is the MLE of the "Increased Propensity" specification. The flatter curve (which is almost straight in the range shown in this figure) is a convex curve that represents the approximation of the "Increased Propensity" specification. The white concave curve shows the relationship for the "Probability" specification, where there are decreasing returns to scale.

Table 10 shoes the total trade associated with immigration for each specification. These amounts were computed using the coefficients obtained when we distinguished between OECD and non-OECD countries.

The table suggests several things. First, the effect on trade is enormously affected by the specification. In the case of exports, the increased propensity model allocates just

[29] The figure uses the actual independent variables and their estimated coefficients for exports from BC to France.

over 10% of Canada's $150 billion annual exports to the immigration link. Meanwhile, the probability model allocates about 50%. The reason for this can be seen by observing the shape of this specification's curve in Figure 1. A large amount of trade is attributed to the first few immigrants. As a result, the model suggests that removing all immigrants removes much trade.

Secondly, the trade per immigrant is much larger for immigrants from OECD countries than for immigrants from non-OECD countries, despite the fact that the coefficients for the non-OECD countries are larger. The OECD opportunities appear much larger than those of non-OECD countries, so an OECD immigrant can carry out more trade than a non-OECD immigrant, despite having a smaller comparative advantage over non-immigrants. As shown at the bottom of Table 10, about 92% of Canada's exports and 86% of Canada's imports are derived from OECD countries.

A third observation is that results for imports are generally either very large or negative. One should not attach too much weight to the results of this table, since many of the results (particularly the OECD immigration coefficients) are not statistically significant.

The specification that produces the most significant results is the simple log specification despite its lack of theoretical support. The probability model produces results that are more significant than those of the “increased propensity” model, but neither of the newly-developed models produce highly significant results. The relative success of the simple log model over the theory-based models perplexes us.

6. <u>Conclusion</u>

We set out to determine whether previous studies’ findings of links between immigration and trade can survive the introduction of fixed country effects. We also sought to derive theory-based models to describe these links. In addition we introduced language effects into our tests to determine the interaction between language and immigration effects.

The simple log specification from Head and Ries (forthcoming, 1999) performed very well, even with fixed country effects. Our results with new data correspond closely with their results.

The new theoretical models we derived appear not to produce statistically significant results. The data appears to support the "probability" model more strongly than the "increased propensity" model. Like the simple log specification, this model assumes decreasing returns to immigration.

Determining how immigration and trade are linked has proved elusive. Yet, there continues to be strong evidence that the link is there.

Appendix I

Sources of Data

Trade Data

The 1992–1996 trade data was obtained from the strategic website, located at http://strategis.uc.cg.ca/engdoc/main.html.

Since trade is the dependent variable, we technically should not be dropping countries for which no trade data is available. However, there are three countries for which we have independent variable data, but no trade data. These three countries are Aruba, the Marshall Islands and Micronesia. Given that we have 160 countries, the loss of these three countries from the data would not have a discernable effect on the results. So we have dropped them.

Immigration

We obtained from Citizenship and Immigration Canada the number of immigrants to each province from each country for each year. This data was provided by immigrant category. We also obtained the number of immigrants living in each province from the 1986 and 1991 long form census. Based on the data from 1986-1991, we estimated an attrition rate. (The number of immigrants in 1986 plus the number of new immigrants from 1986 to 1991 would be more than the number of immigrants in 1991, because some immigrants would have left the country or died.) Based on this data, we estimated the stock of immigrants in each year in each province. We calculated the attrition rates for each province separately. The attrition rates varied substantially between provinces, likely reflecting the fact that immigrants move from province to province, and some provinces seem to be more popular than others. B.C. showed a very low net attrition rate, while the Maritime Provinces showed a relatively high net attrition rate.

Languages

In our statistical tests, the common language variable for a country–province observation equals the probability that a random person from the foreign country and a random person from the province can speak a common language. Our data on languages spoken in the

Canadian provinces was obtained from the 1991 Canadian (short form) census report. The languages considered were those that were listed in the Canadian census. They include the following:

English	Punjabi	Hebrew
French	Arabic	Urdu
Italian	Greek	Persian (Farsi)
German	Tagalog	Croatian
Chinese	Vietnamese	Japanese
Spanish	Hindi	Korean
Portuguese	Hungarian	Tamil
Ukrainian	Russian	Finnish
Polish	Gujarati	Armenian
Dutch	Yiddish	Romanian

Unfortunately, it is difficult to get reliable, consistent information on what languages are spoken in various countries. We had to use a variety of sources and sometimes used our judgment when the sources did not agree with each other. Our country-by-country data, and our sources for each data entry are available on request.

The following were our sources:

(1) *Ethnologue: Languages of the World* (edited by Barbara Grimes),

(2) *The Encyclopedia of Language and Linguistics* (edited by R.E. Asher),

(3) *The Cambridge Encyclopedia of the English Language* (by David Crystal),

(4) The CIA world fact book country reports (on the world wide web) where we assumed that knowledge of languages corresponds with ethnic groups. This last source was only used for countries that were formerly parts of the USSR, Czechoslovakia or Yugoslavia.

Unfortunately, our data on English speakers is not as consistent as we would have liked. For example, our sources provided no information on how many people in Germany can speak English. This is unfortunate, since clearly a large proportion of Germans can speak English. In general, we had no information on knowledge of English on continental Europe, but we do have information on knowledge of English in other parts of the world, especially Africa and Asia. In the interest of keeping are data as objective as possible, we did not make any adjustments for European countries where from our own personal experience we know there are many English-speakers.

GDP Data

Foreign Countries

The GDPs of foreign countries were obtained from the World Development Indicators CD, produced by the World Bank. Countries for which no such data was available, were excluded from the data. The most significant excluded countries were Afghanistan, Cuba, French Guiana, Myanmar, and North Korea.

Taiwan was missing from the World Bank's data, but is too large an economy to exclude, so we obtained data for Taiwan from the Asian Development Bank's website (http://www.asiandevbank.org).

Provinces

The GDPs of the Canadian provinces were obtained from Statistics Canada. The data were on the CANSIM matrices 2623–2631 and 6949.

Population Data

Foreign Countries

We obtained the populations of foreign countries from the World Development Indicators CD, produced by the World Bank. For Taiwan, we obtained the populations from the Asian Development Bank web page.

Provinces

The populations of the Canadian provinces were obtained from the Statistics Canada web page. (http://www.statcan.ca)

Distances

The distance between a country and a province is the distance between the foreign country's major city and the province's major city. (For the U.S. we use Chicago as the major city, since it is more central than New York.)

Distances between cities were measured as follows:

1. For countries in continental North America we use the great circle distance between the major city of the particular country and the major city of the particular province. Shipping from these countries can occur by land, and the land distance would not differ substantially from the great circle distance.
2. For countries that would use an eastern port, we use the great circle distance between Halifax and the foreign country, and then add the road distance between Halifax and the major city of the particular province. We use this measure in place of strictly using the great circle distance because for Canada's biggest trading partners (apart from the U.S.) the great circle route passes through arctic territory, where no surface shipping can occur. For example, the distance between Great Britain and British Columbia is taken to be the great circle distance between London and Halifax (2,883 miles) plus the road distance between Halifax and Vancouver (3,842). Thus the total distance is 6,725 miles. Had we used the great circle distance between London and Vancouver, it would have been 4,721 miles. So the London-Vancouver distance would have been 1.64 times the London-Halifax distance. However, using our composite distance, the London-Vancouver distance is 2.33 times the London-Halifax distance, which is more realistic in terms of shipping distance. Many goods do not actually get shipped through Halifax, but are brought into Quebec or Ontario through the St. Laurence Seaway. The distance ships travel along this seaway approximately equals the road distance. The countries using the east port include all European countries, all African countries, all South American countries on the east side, all Caribbean countries, and all Middle Eastern countries with access to the Mediterranean Sea.
3. For countries that would use a western port, we use the great circle distance between Vancouver and the foreign county, and then add the road distance between Vancouver and major city in the particular province. The countries we regard as using the western port include all Asian countries (other than those with access to the Mediterranean Sea), all Pacific islands and all western countries in South America.

When we tried using strictly the great circle distance as our distance measure, we obtained distance parameter estimates between –1 and –1.5 when we excluded fixed country effects from our model. (These estimates correspond with normal results.) But the parameter estimates jumped to about –2.5 when we introduced fixed country effects. The introduction of fixed country effects means that the distance variable is no longer reflecting the distance between a province and a foreign country, but is reflecting a province's distance relative to the other provinces.

It turns out that the choice of distance measurements has little effect on the parameter estimates of immigration. This is comforting, because we need to be careful about whether a distortion in distance measures might skew our immigration results.

Appendix II

Serial Correlation

We have data for the four years 1992 to 1995. Regressing residuals on the previous year's residuals revealed that our observations are serially correlated. As a result, running statistical tests as though the years were independent would produce estimated errors that are biased downwards. Handling serial correlation is problematic for two reasons:

1. We only have four years of data. Techniques for handling serial correlation work best when there are more periods.
2. We test our two new models with a maximum likelihood estimate calculation. We are not aware of any good methodology of handling serial correlation in an MLE.

We explored the Cochrane-Orcutt process to see how serial correlation may be affecting our estimated errors. This process involves finding ρ, which is the correlation between the residuals of a particular year and the previous year for a particular province–country pair. We then transformed variables as follows: $x_t^* = x_t - \rho x_{t-1}$ for the years 1993 to 1995, and $x_t^* = x_t(1-\rho^2)^{1/2}$ for 1992. Columns A and B of Table II.1 report the key results of the regressions run with transformed data. For comparative purposes, columns C and D duplicate the corresponding results from Tables 1 and 2.

The estimated errors in column B generally fall approximately half way between the standard errors obtained in the two regressions run without transformed data reported in columns C and D. However, some of the coefficient estimates of column B deviate from the coefficients in columns C and D. It appears that the transformation of the 1992 data distorts the coefficient estimates.

In the tests without fixed country effects, the estimated errors in column B fall approximately half way between the estimated errors in columns C and D. (For example, for exports the estimated error in column B is 0.020, which is about halfway between the estimated errors of column C (0.015) and D (0.026).) In the tests with fixed country effects, the estimated errors in column B lie closer to those of column C than those of column D.

These tests give us some idea how to interpret tests of significance in our paper. In Tables 1 to 8 we run each test first assuming all years are independent and secondly using the average of the four years. We conclude that the significance of these two sets of results form the outer bounds of the true significance.

Appendix III

Mills' Ratio

In the OLS regressions, we have computed Mills' ratio and included that as an independent variable. Mills' ratio is used to reverse the bias that would result from casting out observations that report zero trade.

Mills' ratio is computed by first running a Probit regression to determine the predicted probability that the independent variables will produce trade greater than zero. Mills ratio is then computed as:

$MILLS_{pf} = f[F^{-1}(s_{pf})] / s_{pf}$

where

f() = normal distribution function,

F $F^{-1}()$ = the inverse of the cumulative normal distribution function, and

s_{pf} = the predicted probability that trade will be greater than zero, based on the Probit estimation.

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