A Modified Gravity Model of Immigration to Canada; 1970-2013

By

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1. Introduction and Overview

Much of the research attempting to model immigration flow has borrowed heavily from two major theoretical positions: the simple gravity and standard labour market models. This paper attempts to combine elements from both of these positions and estimate the resulting modified gravity model (MGM) for long run, unilateral immigration to Canada. It is found that the variables in the model focusing on Canadian economic circumstances were suitable predictors of immigration, while the conditions in the immigrants' source country appeared insignificant. This result intimates that the screening of applicants is based more on macroeconomic domestic policy, and less on the composition of immigrants as determined by source country circumstances across space and time.

The econometric approach was to use a fixed effects regression with Driscoll-Kraay standard errors on a panel dataset with immigration flow to Canada from nine source countries. This technique was decided upon after tests revealed the existence of heteroskedascity, cross-sectional dependence, and country fixed effects. Much of the literature on this topic use similar approaches, however, no researcher properly addresses the issue of spatial dependence. It is believed that the use of Driscall-Kraay standard errors improves the validity and robustness of the results.

This paper contributes to the literature in two ways. Firstly, it combines and tests elements of the gravity and standard labour market models of immigration. However, it should be noted that in most studies the distinction between these two models is blurred, and often the labour market components are incorporated into the gravity hypothesis (Greenwood & McDowell, 1991; Pederson, Pytlikova, & Smith, 2004). Nonetheless, there are noticeable dissimilarities in the underlying logic for the classic definition of the two models. The standard labour market model

suggests immigrant workers respond to economic conditions and relative capital returns.[1] While in its simple form, the gravity model posits that immigration is a positive function of the "gravitational pull" of each country; related positively to the size and similarity of the two countries and negatively to the distance between the source and destination. Combining these two models is a much more flexible and realistic description of immigrant behaviour. It allows the researcher to examine migration from the perspective of large international trends, as well as micro-level decision making.

Secondly, it is to test these models using single-destination country specific, long term data at a quarterly frequency. Many recent studies incorporate bilateral immigration and a large number of countries from a variety of regions, but typically will not exceed a span of 20 years at an annual frequency. Of course, there are studies on single destination immigration, but typically examine short-run behaviour (Clark, et al, 2007; Karemera, et al, 2000). This paper looks at a forty year span of immigration into Canada, which presents the advantage of examining long term trends at a high frequency. However, it also poses some potential problems; the first being unbalanced data. Given the long time frame represented, portions of data for several countries was difficult or impossible to obtain, the details of which will be discussed further below. The second major issue is that some variables in the classical gravity model perform better using panel data from various countries, especially dummy variables such as common language and contiguous borders. The coefficients on these variables are more reliable when there is a large set of bilateral immigration, as it is analysing cross-country effects, while this paper is focused on the time-varying influences on migration to Canada. In this sense, this study will include

[1] The labour market model is also commonly used to examine the reverse effects, i.e. the impact of immigration on the labour market.

elements that closer resemble the modified gravity model (MGM) proposed by Karemera, Davis, & Oguledo (2000).

The paper shall proceed by first giving a brief summary of the history of Canadian immigration and policy over the period that is to be examined. Section 3 will review the literature and explain the variables used in the simple gravity and standard labour models of immigration, and how they are to be merged in the modified model. Section 4 reports on the data and collection methods used in this study. Section 5 then clarifies the econometric methods employed to estimate the MGM, while section 6 shows the results of the estimation, and discusses the corresponding interpretations and implications. Lastly, section 7 will conclude the study, consider the limitations of this research, and suggest further investigations.

2. History of Canadian Immigration

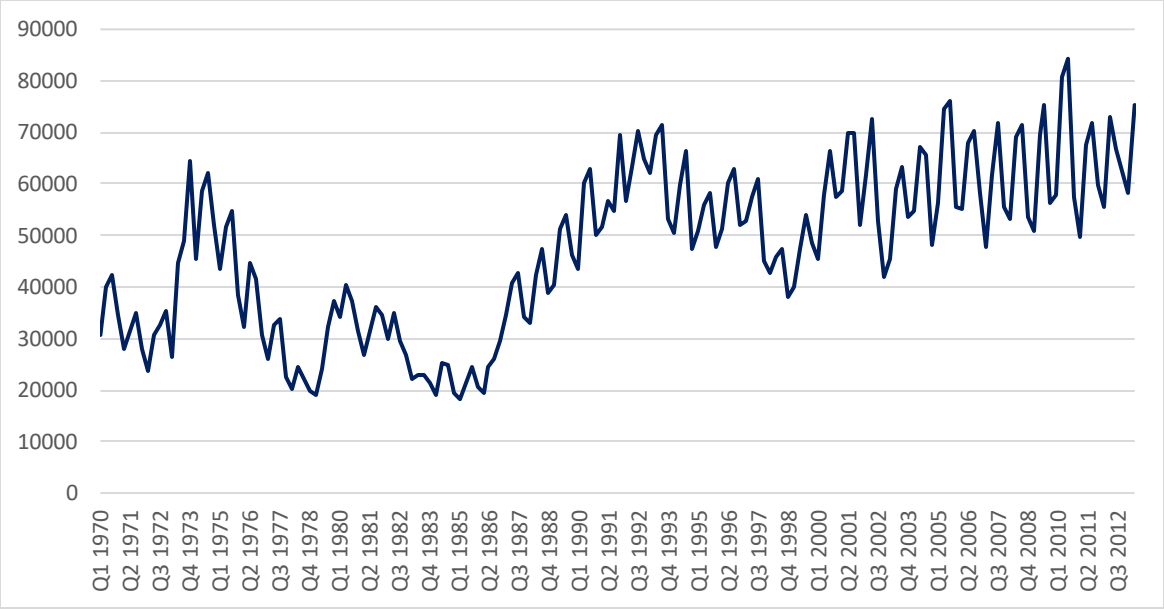
2.1. The 1970s

By the year 1970, Canada had already instituted the point system for immigration, and had recently implemented influencial new elements to its immigration policy. These included the elimination of discrimination based on race or nationality, a provision that allows visitors to apply for immigrant status, and the reduction of the sponsered class to dependent relatives and establishment of a new class of nominated relatives (Knowles, 2007). These liberal changes to immigration, among others in the 1960's, paved the way for a "new era in immigration" to Canada under the Pierre Trudeau government. Through the early 1970's immigration increased, but the sizeable increase in applications[2] and recent reforms to the legislation on appeals led to a disturbing bureaurocratic backlog. With this in mind, the Canadian government instituted a

[2] Caused by the reforms of 1967.

period of debate and public hearings on the future of immigration policy. The results of these discussions, although frequently plagued with extremism from both sides of the argument, eventually led to a moderate view on immigration policy. This perspective was the basis for the Immigration Act of 1976,[3] which was the foundation of Canadian policy on immigration for almost two and a half decades. The main contribution of the Act was to clearly define the objectives of immigration policy: giving refugees a distinct class; emphasizing non-discrimination and family reunification; and perhaps most importantly, ensuring that immigration policy was closely integrated within the current economic, social and cultural aspirations of the Canadian people (Hawkins, 1991).

Figure 1. Total Immigration per quarter to Canada, 1970-2013



As seen in Figure 1, despite this new moderate view, immigration dropped off significantly in the late 1970's. This reflected the more restrictive admission requirements amidst a worsening recession (Kelley & Trebilcock, 2000). It may also indicate that migrants,

[3] Employed more concretely under the Immigrations regulations of 1978

particularly skilled workers, viewed Canada as a less attractive destination which then compelled the point system to screen out a large portion of the less qualified pool of applicants.

2.2. The 1980s

The 1980's was a period of turbulance for Canadian immigration. The prelude to the decade saw a surge in the number of immigrants to Canada. Even as immigration dipped in the early 1980s, the middle produced political, environmental, and economic calamities in the developing world and the number of international refugees rose from 2,775,314 in 1975 to 11,699,562 in 1985 (UNHCR, 2016). Illegal immigration also became problematic as globalization made communication and transportation much easier. The increasing stock of immigrants also caused more applications within the family class (Dirks, 1995). Nevertheless, the early 1980s saw a dramatic drop in the natural growth rate of population, and as the birth rate in the developing world began to be viewed as problematic, the attractiveness of Canada by "economic migrants" was also rising rapidly. All of these factors culminated to a dramatic increase in immigration to Canada during the latter half of the 1980s.

2.3. The 1990s

Facilitating a further increase in immigration, the Conservative government loosened restrictions and then later abandoned the traditional practice of adhereing to long-run immigration policy by crafting a five year plan. While this plan was criticized for favoring economic development rather than a humanitarian agenda, it nonetheless maintained relatively high immigration numbers. After several years of high immigration, the Economic Council of Canada strongly advised the government to adjust policy for a more gradual approach to population stabilization. This suggestion, as well as a realization by many policy makers that the

Immigration Act of 1976 was instituted during a time of drastically different social and economic conditions, led to the proposal of Bill C-86. Tabled in June 1992, this bill sought to tighten immigration restrictions amidst the rising flow of potential immigrants, although emphasis was unquestionably put on the effiency of the immigration apparatus.

When the Liberals took office in the autumn of 1993, Canada was still experiencing large immigration flows as well as high unemployment. The debate over the appropriate level of immigration was heated, and many felt the government was not properly screening applicants (Knowles, 2007). Xenophobia became more commonplace, and a shift toward neo-liberal policies amidst a recession caused the public's suspiciousness of immigration (Dirks, 1995), but the government initially announced that immigration levels would remain at their current numbers. The new focus in the latter half of the 1990s, however, would be on the composition of immigrants, as well as those attempting to manipulate the Canadian immigration system. This renewed emphasis on individual immigrants (as apart from family class) and reducing costs would reduce the overall intake (Kelley & Trebilcock, 2000).

2.4. The 2000s and Later

In the early 2000s, despite the attention to terrorism and alleged criminal activity by immigrants, the government decided to continue to keep high immigration levels. This once again incited controversy, especially with cities like Toronto and Vancouver claiming their immigration intake was providing serious economic stress, particularly on their welfare programs (Knowles, 2007). Nonetheless, Picot & Hou (2014) found that in terms of family income, new immigrants seemed to be integrating better than in the past two decades. The major piece of legislation of the time, the Immigration and Refugee Protection Act, simply updated and redefined regulations attempting once again to boost efficiency. Skilled workers began to once

again take a prominent role in the debate over immigration policy, and to this day the economic consequences of immigration has been a key talking point both in academia and in the public (Latif, 2015).

2.5. Perspective

An important concept to consider is that the Canadian government controls the volume of immigration through official legislation, as well as constant review of how economic and social circumstances interact with migration flows. It is clearly true that the economic circumstances of potential migrants and of their prospective destination, drives the composition and flow from each country. It is also true, however, that one of the core arguments for an accurate model of immigration rests on the assumption that the national economic and political narratives- the contemporary values of the Canadian people that lawmakers deem relevant for policy- are developed and moulded by some of the variables represented in the following regressions.

3. Explaining and Modelling Immigration

This paper combines elements from both the traditional gravity and the standard labour model of immigration. These variables represent the fundamentals of the Canadian economic or political arena, as well as the circumstances in the source country.

Perhaps the most famous under this theoretical umbrella is the Borjas (1987, 1991) model. This model argues that migration is more probable if the attributes of the migrant are more valued in the destination country than the origin nation, minus the costs of relocating. This implies that the education level and skills of the migrant have significant influence on the decision of workers. Studies have expanded on this concept, such as the Clark, Hatton, & Williamson (2007) model which identify other components of migration costs. Costs such as

individual specific refer to the support base already in the destination country, and is closely related to network effects such as those studied by Pederson, *et al.* (2004). The Han-Ibbott (2005) model of immigration also states that mobile agents will migrate to the area in which their human and financial capital has the highest return. This implies that exchange rates may play a role in the decision mechanism for migrants. A stronger origin country currency decreases the cost of moving, but it is detrimental for remittance flow to the origin nation.

The second theory is the gravity model; applied repeatedly in trade literature and more recently in empirical immigration studies (Gallardo-Seljas, et al, 2006; Lewer & Van den Berg, 2008). Representing IMM_{ij} as the total immigration from country j to country i, and DIST as the distance between both countries, the basic gravity model is of the form:

$$IMMij = f[\ (GDPi \cdot GDPj)\ /\ DISTij\ ] \qquad (1)$$

Accordingly, Lewer and Van den Berg (2008) model immigration in the following regression format, where lower case indicates the logarithm of the variable:

$$imm_{ij} = a_0 + a_1 (pop_i \cdot pop_j) + a_2 (rely_{ij}) + a_3 (dist_{ij}) + a_4 (stock_{ij})$$

$$+ a_5 LANG_{ij} + a_6 CONT_{ij} + a_7 LINK_{ij} + u_{ij} \qquad (2)$$

Where $rely_{ij}$ is the ratio of destination to source country per capita incomes, $pop_i \cdot pop_j$ is the product of the populations in destination and source country, and $stock_{ij}$ represents the amount of origin country migrants currently living in the destination country. *LANG*, *CONT*, and *LINK* are binary variables that take the value of 1 if the two countries share a common official language, a contiguous border, and colonial links, respectively.

Immigration is also often thought of as being a function of supply and demand characterstics, as such, Karemera, Davis, & Oguledo (2000) model migration in the form

$$Mij = a_0 \cdot S_j^{a_1} \cdot D_i^{a_2} / R_{ij}^{a_1} \quad (3)$$

Where Mij is migration from country j to country i, $S_j^{a_1}$ is the supply of mobile workers from country j, $D_i^{a_2}$ is the demand for mobile workers in destination country i, and $R_{ij}^{a_1}$ are factors either facilitating or impeding potential migrants. Both the standard labour and gravity models can be thought of in this way. The following are typical arrangements of the logarithm of the two models that will be used for this study, expanded from equation (3) to include relevant but commonly used variables.

$$imm_{ij} = b_0 + b_1 \cdot (u_i) + b_2 \cdot (fx_{ij}) + b_3 \cdot (\sigma_j^2) + b_4 \cdot (y_j / y_i) \quad (4)$$

$$imm_{ij} = c_0 + c_1 \cdot [(pop_i \cdot pop_j)/dist_{ij}] + c_2 \cdot (fx_j) + c_3 \cdot (stock_{ij})$$

$$+ c_4 \cdot (connect_{ij}) + c_5 \cdot (P_{ij}) \quad (5)$$

Equation (6) represents the standard labour model and (5) is the gravity model. As before, imm_{ij} is immigration from country j to country i, u_i is the change in unemployment in Canada, fx_{ij} is the foreign exchange rate of return in terms of the Canadian dollar (CAD),[4] σ_j^2 is the exchange rate volatilty, and y_j is the real GDP per capita in source country j. In the gravity model pop_i is the population in country i, $stock_{ij}$ is the stock of immigrants from country j already residing in country i which will be proxied for by simply using autoregressive variables, $connect_{ij}$ is some measure of how connected the two countries are in terms of international

[4] i.e. X CAD= 1 unit of foreign currency. So if the rate of return is positive, it implies that the currency is becoming stronger against the CAD.

relations,[5] and P_{ij} is a vector of dummy variables representing policy and trade deals that may encourage or impede immigration. Combining these models gives the regression equation used in this paper:

$$imm_{ij} = \delta_0 + \delta_1 \cdot (u_i) + \delta_2 \cdot (fx_j) + \delta_3 \cdot (\sigma_j^2) + \delta_4 \cdot (y_j) + \delta_5 \cdot (y_i)$$
$$+ \delta_6 \cdot (pop_j) + \delta_7 \cdot (pop_i) + \delta_8 \cdot (stock_{ij}) + \delta_9 \cdot (connect_{ij})$$
$$+ \delta_{10} \cdot (P_{ij}) + e_{ij} \quad (6)$$

Where e_{ij} is the error term. This model will henceforth be referred to as the modified gravity model. Reasons for the inclusion of each variable, as well as expected signs of the coefficients, will now be discussed.

3.1. Unemployment

Many researchers have examined the impact of migration on unemployment, as this is a politically fuelled debate. Some studies suggest that there is a short-run adverse effect of migration on unemployment in Canada, but this impact is eliminated in the long run as immigrants are integrated into the workforce and obtain relevant skills given labour demand dynamics (Islam, 2007; Latif, 2015). There is convincing evidence that the causality more potently flows in the other direction, however (i.e. changes in unemployment impact migration flows). Consequently, unemployment is a component of the standard labour model, however, results are mixed. Harrell & Boisvert (2009) found both foreign and domestic unemployment rates were significant but only depending on the model that was used. Beine, Bourgeon, & Bricongne (2013) find that among developed nations, employment appears to have a significant

[5] This was attempted with several variables, which will be discussed below.

positive effect on migration flows. Boubtane, Coulibaly, & Rault (2011) find that in only one of the 22 OECD countries (including Canada) unemployment appeared to negatively affect immigration. In this study, Canadian unemployment is controlled for in the MGM, while source country unemployment is only included in a separate estimation due to the inavailability of data for certain countries. Han and Ibbott (2005) suggest that higher rates of unemployment in a destination country, relative to the origin country, should deter a move such that $\delta_1 < 0$.

3.2. Exchange Rate and Exchange Rate Volatility

The immigrant's choice of destination may be influenced by the exchange rate through several means. Firstly, the general economic condition of a nation is often reflected in the movements of exchange rates, as well as agent's expectations for future conditions of the country. The utility maximizing immigrant will likely choose the country with the most promising conditions.

Secondly, as expounded in various literature, a stronger destination currency is also useful in the scenario that the immigrant wishes to send remittances back to their origin country (Artal-Tur, et al., 2011; Higgins, Hysenbegasi, & Pozo, 2004). The impact of exchange rates is perhaps the most pervasive and volatile influence on relative wealth. For example, in 2008, just the latter two quarters of the year the USA-Canada exchange rate increased from 1.0127 to 1.2345 CAD per one USD. This implies that an immigrant to Canada from the United States would have a relative decrease in her wealth (in terms of remittances) of almost 22 percent! Certainly, a decrease in relative wealth is not desirable, and it also raises the issue of whether the volatility of exchange rates is included in the decision mechanism of immigrants. A stronger currency is attractive, but if large swings in the value of the currency are frequent it may deter a foreigner from seeking work and wealth in the destination country. Jackman (2013) showed that

remittance flows from immigrants is negatively affected by the volatility of exchange rates, and therefore the amount they work is reduced which, if predicted a priori, may alter new immigrants preferred destination.

The third impact that exchange rates can have relates to the costs of migrating. If some of the costs (such as application fees, visa charges, etc) are in the destination country's currency, a weaker origin country currency implies that these fees are relatively more expensive. It also implies that the total wealth that an immigrant has accumulated is less valuable when the CAD is strong, which can essentially be considered another cost of migrating. This potentially creates a barrier to enter for some migrants, and at best implies a motivating factor to consider other destinations.

The gravity model usually considers migrating costs as the expenses undertaken in the process of transportation (Bodvarsson & Van den Berg, 2013). It may thus reasonable to assume that a stronger foreign currency (fx_j increases) would result in an increase in immigration under this theory ($c_2 > 0$). However, the standard labour model gives convincing arguments that workers will consider higher valued remittances as well as better expectations about the Canadian economy, which in turn implies that $b_2 < 0$. The sign of δ_2 is therefore somewhat ambiguous, and previous studies have been inconclusive (Keita, 2014; Harrell & Boisvert, 2009). The volatility in exchange rates are less ambiguous, and should have a negative effect (Higgins, Hysenbegasi, & Pozo, 2004; Jackman, 2013) as immigrants will be less confident about the future value of remittances, implying that $\delta_3 < 0$.

3.3. GDP Per Capita

While income inequality remains a potent and sensitive topic among many countries including Canada, large income differences on an international level can also have a persuasive influence on workers across the globe. A higher wage is obviously a pull factor for potential migrants, and could be included in both the gravity model and the labour market model under their classical definitions. Similarly, lower income in the origin country are a push factor. Wages have been found to be a significant explanatory variable in multiple studies (Ortega & Peri, 2012; Karemera, Davis, & Oguledo, 2000). Clark, Hatton, & Williamson (2007) include a relative income term in their regression results, but the sign of the coefficient depends on which country has the higher GDP per capita. This may lead to confusing results, even though one would assume the country with the lower per capita GDP would experience emigration. To eliminate ambiguity, this study separates source country and Canadian real GDP per capita, so that the coefficients are negative and positive, respectively (i.e. $\delta_4 < 0$, $\delta_5 > 0$).

3.4. Populations

The size of the populations of the source and destination countries is an integral part of the gravity model. The larger the population of the origin, the greater the base of potential migrants. The more people in the destination country, the larger and more diverse is the labour force and opportunities for newcomers. Therefore, δ_6 is expected to have a positive sign. This result has been empirically supported, although mostly in bilateral panels with multiple destination countries (Lewer & Van den Berg, 2008; Lewer & Gretz, 2014), with the notable exception of Karemera, Davis, & Oguledo (2000). Clark, Hatton, & Williamson (2007) also use population, but only as a weight for other variables. In the model for this paper, distance was attempted as a weight on population to incorporate the costs of migrating. This is because, as previously mentioned, the unilateral migration flows in this paper prohibit the use of some variables used in

the gravity model. In this case, the distance between source and destination countries which is typically used as a proxy for costs has little relevance because it is constant over time. It is omitted in the results as it does not allow the model to explain more of the variation in immigration and will only alter the constant, which is of little value when comparing the coefficients of determination. According to the gravity model, Canadian population, too, should have a positive sign as it can be representative of a larger labour market that will attract foreign workers ($\delta_7 > 0$). However, a negative coefficient would not be entirely mystifying, and previous research have shown this is a possibility (Karemera, Davis, & Oguledo, 2000), which is explained by a scarcity of resources that create a disincentive to migrate.

3.5. Network Effects

The stock of immigrants from a specific country already residing in the destination country is a desirable feature for the prospective immigrant such that $\delta_8 > 0$. A familial, or at least familiar, base of people can be a source of lowering costs (Keita, 2014), an easier way to bypass immigration laws in the receiving country, and can be an integration framework into the workforce which increases the returns to the migrant's human capital. In this paper, due to the less reliable data on the stock of immigrants from each source country, the lagged values of the flow of immigration were used as a simple proxy for the stock of migrants. This is intuitive as the lagged value should account for the previous migrants already living in Canada, who themselves considered the previous migrants, and so on. Of course, this is not a perfect method as it is unclear the effect of long-term and established communities from the origin country, but it has the additional benefit of controlling for autocorrelation. In the regression results below the lagged values are not shown, but are controlled for with a maximum lag of four periods.

The δ_9 coefficient is supposed to show the effect of better cultural or economic relations between source and destination country. Initially, this was attempted using data on the number of temporary travellors to Canada. Unfortunately, this was highly suspect for endogeneity, specifically simultaneous bias: the more people living in Canada the more family from the source country that will wish to visit them, and it is then likely that some of that family tries to extend their visit permanently through immigration. Testing endogeneity through the Durbin-Wu-Hausman test showed that there was strong evidence of endogeneity, however the weak instruments available limited the efficiency of an instrumental variable regression. Therefore, a different variable entirely was chosen: level of exports. It is hoped that exports to the source country proxy closer relations between the two nations. It may also fit nicely into the framework of the labour market model because it is assumed that the two nations could have complementary industries, allowing for human capital of migrants to be valued in the receiving nation. Most other gravity models use adjacency, dummy variables for common language, and colonial links to estimate the connection (Greenwood & McDowell, 1991; Karemera, Davis, & Oguledo, 2000; Lewer & Gretz, 2014). A notable exception is Pederson, et al. (2004) that shows that greater trade can increase migration flows between source and destination countries. This is an encouraging reason that exports can capture some of the network effect in immigration, and that this effect is positive ($\delta_9 > 0$).

3.6. Policy and Trade Agreements

Immigration policy is another factor that is commonly cited as significant in international migration (Mayda, 2010; Ortega & Peri, 2012). However, this may not be as obvious as one would expect. As Mayda (2010) notes, "restrictive immigration policies are often characterized by loopholes that leave room for potential migrants to take advantage of economic incentives."

As previously alluded to, even in times of restrictive immigration policy such as the early 1970s just before the creation of the Immigration Act of 1976, immigration policy may not actually be reflective of the ground-level operations. Family reunification, a common emphasis in Canadian immigration policy, has been known to complicate official policy (Knowles, 2007). This study attempted to use dummy variables for two major domestic policy initiatives in Canada, Bill-C86 in 1992 and the Immigration and Refugee Protection Act (IRPA) tabled in 2002, but neither were shown to be appropriate and did not remain in the model. The Immigration Act of 1976 was deemed too early in the set of data, especially considering only two countries have data for more than one year before this Act. The IRPA was significant depending on the specifications but because it coincided so closely with the creation of the Euro, which was also controlled for, the collinearity was too strong and was likely capturing too much of other influences. The creation of three major trade agreements with Canada were included as a single dummy variable in the panels with the corresponding countries. These deals were the 1989 Canada-US Free Trade Agreement which was superseded by NAFTA, the Canada-Australia Trade and Economic Cooperation Agreement signed in November of 1995, and the Canada-Philippines 1996 Foreign Investment Promotion and Protection (FIPA) Act. Other agreements, such as the 2016 Hong Kong FIPA, Trans-Pacific Partnership, and the ongoing negotiations for the Comprehensive Economic and Trade Agreement with the European Union are outside the time range of this paper, but would be interesting once the data becomes available.

4. Econometric Methodology

The average rate of return on monthly exchange rates, as well as the estimated volatility, are included in the MGM. Volatility was estimated using the rate of return on daily exchange rates

and estimating a GARCH(1, 1) model, and taking quarterly averages from the conditional variance prediction. The model is formally written as the following:

$$Y_t = \sum_{i=1}^{\rho} L_i Y_{t-i} + \varepsilon_t \quad (7)$$

$$\varepsilon_t = \sum_{i=1}^{n} K_i \varepsilon_{t-i} + \nu_t \quad (8)$$

$$\nu_t \sim N(0, h_t) \quad (9)$$

$$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \nu_{t-i} + \sum_{i=1}^{p} \beta_i h_{t-i} \quad (10)$$

Where Y_t is the change in exchange rates, ε_t is determined autoregressively, h_t is the variance of the error term, and ν_t is an i.i.d. error term.

As aforementioned, models similar to equation (6) may suffer from some serious econometric issues. Missing data can pose several problems such as the loss of efficiency, especially when not at random. The missing values in this panel data set are both random and non-random, for example, annual data was only available for the first several years for income in Hong Kong and was therefore cyclical, but exporting data to the Philippines did not exist at all for 2004-2013. Baltagi (2005) suggests that if $N \rightarrow \infty$ the missing data is ignorable, but if not either listwise deletion or simple imputation may be appropriate. Listwise deletion was used in this study, which meant that when including foreign unemployment in the regression the entire panel for India was ignored. There are other smaller sections of missing data, but they seemed to be fairly random reporting issues that statistical packages can easily handle properly. For other missing data, such as population statistics that were measured on a yearly basis obtained from OECD database, intropolation was applied assuming a constant yearly growth rate.

After various checks, the data used in this study was shown to suffer from numerous statistical issues that needed to be accounted for. First, immigration was tested for

autocorrelation. This was done using the Wooldridge test for serial correlation in panel data models, the F-statistic for the test was 507.802, which obviously easily rejects the null of no first-order autocorrelation. Autocorrelation functions of each of the panels seemed to also show evidence of higher-order serial correlation, of at least the second order. As mentioned, using lagged values of immigration in the regression was the simple method employed in this paper to control for the stock of immigrants of a particular source country already in Canada, and the maximum lag for any one panel was set to four.

Due to the unbalanced nature of the data, many unit root tests are invalid. The Fisher-type test developed by Choi (2001) is the only test available that does well with unbalanced data. Running this test on the immigration data with lagged second-order autocorrelation does not reject the null that all panels contain unit roots. However, Cerreto (2001) duly notes that unit root and cointegration tests can often be invalid in the presence of cross-sectional dependence because they assume it does not exist, unless specified. Unfortunately, the Fisher-type test can only subtract the cross-sectional mean, but cannot actually control for spatial dependence. Cross-sectional dependence may be caused by worldwide shocks to economies that have distinct effects on country specific variables. The increasing interconnectedness of the global economy often results in spillover effects that cause cross-sectional dependence, which then result in biased and inconsistent findings (Huang, 2008). There is an especially strong probability for the existence of cross-sectional dependence in this dataset due to, among other things, the closeness of the European countries especially after the creation of the European Union. Indeed, all variables rejected the null of cross-sectional independence after performing a Pesaran CD test. Unfortunately, it is still ambiguous whether the dependent variable is stationary. Using standard

unit root tests on individual countries leads to the rejection in some cases but not in others, therefore, differencing was not deemed appropriate.[6]

The fixed effects model is one that many researchers adopted after the use of a Hausman test (Karemera, Davis, & Oguledo, 2000; Lewer & Van den Berg, 2008).[7] Fixed effects models are consistent under stronger conditions than the pooled OLS, such that if evidence of FE are found it cannot be ignored. The regular Hausman test is not valid under heteroscedasticity, however, which indicates that one must first test the models for signs of non-constant variance. Using a modified Wald test that is valid when the assumption of the normality of the residuals is violated, the fixed effects model was found to have heteroscedasticity. Although a Hausman test that is robust to heteroscedasticity is available, it is still unlikely to be accurate in the presence of cross sectional dependence and the forms of within-country clustering that may be present in the data. As suggested by Hoechle (2007), Driscoll-Kraay standard errors have proven to be robust to heteroskedasticity, autocorrelation, and time and spatial dependence. Using the Wooldridge's auxiliary regression with Driscoll-Kraay standard errors yields an F-test statistic of 8.89, leading to a rejection of the null hypothesis that there are no fixed effects at the 1% level. This specification is in line with the findings of previous research showing that unilateral variables result in standard error clustering (Rose & van Wincoop, 2001; Redding & Venables, 2004), and Feenstra (2004) demonstrated that fixed effects can, indeed. eliminate this bias. These findings lead to the conclusion that the undeniably superior model is one with fixed effects and Driscoll-Kraay standard errors.

[6] A Dickey-Fuller test was also performed on total immigration to Canada and rejected the null of a unit root.
[7] Due to most papers examining much fewer years than this study, many only needed to include country-specific fixed effects (Mayda, 2010; Han & Ibbott, 2005; Pederson, Pytlikova, & Smith, 2004).

5. Data

The data was gathered according to availability. The purpose was to examine long-term trends at a high frequency which used Statistics-Canada table 051-0006; showing quarterly immigration from 1970-2013. This dataset contained only fourteen gross immigration series to Canada that were country specific, of which nine were chosen: United States, Great Britain, Germany, France, Netherlands, Philippines, Hong Kong, Australia, and India. Not all countries spanned the whole 43 years, but over this period the countries chosen represented just over a third of total immigration and because listwise deletion was used when missing values in the independent variables were present, the total number of observations was 1231. When including foreign unemployment, for which India had no data available, the observations dropped to 1033. The remaining data was collected from either FRED, OECD, or the government statistics sites of the individual countries.[8]

One hurdle with this dataset was the creation of the Euro and the corresponding exchange rates. For France, Germany, and the Netherlands it would mean that they had the same fluctuations from around the year 2000 to 2013. Accordingly, the rate of return on the real broad exchange rates were used in this period for these three countries, which allows fluctuations to better represent country-specific circumstances.

6. Results

Table 1 shows the results of the simple gravity model, the standard labour model, and the modified gravity model (MGM). The simplified gravity model does not perform well with the given data. Some of the variables were quite sensitive to the model specifications. Note that

[8] See appendix for full list of sources and data description

based on equation (5), after the logs were taken the coefficients should represent the estimated elasticities of each variable with respect to immigration.

Table 1. ***Immigration to Canada***

variables	Standard Labour	Simple Gravity	Modified Gravity
Canadian Unemployment	-0.602 (0.253)**		-0.924 (0.234)***
FX Rate of Return	1.767 (1.259)	1.256 (1.439)	1.559 (1.089)
FX Volatility	-152.642 (89.626)		-120.487 (64.350)*
J's per capita GDP	0.489 (0.463)		-0.225 (0.475)
Canadian per capita GDP	-2.366 (0.637)***		-7.366 (1.032)***
J's population			-1.258 (0.947)
Canadian population			5.483 (1.486)***
pop*i**pop*j*		-0.743 (0.495)	
export		-0.020 (0.109)	0.412 (0.088)***
FIPA		0.130 (0.047)**	0.277 (0.092)**
Euro	0.279 (0.045)***	0.215 (0.043)***	0.411 (0.053)***
N	1257	1288	1231

Note: *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level. The Driscoll-Kraay standard errors are presented in parantheses.

6.1. Exports, GDP Per Capita, and Population

An interesting result is that the proxy for network effects, exports, is neither significant nor does it have the expected sign. Canadian GDP and unemployment are likely to be strongly correlated with exports, and this may induce some multicollinearity in the modified gravity model. However, exports became fairly robust to model specifications after controlling for the economic components that simultaneously help determine exports in the MGM. This quite reasonably sharpened the explanatory power of the variable that was being proxied: the network effect. This is was deemed to be a net improvement to the final model. In the MGM exports were significant at the 1% level, and the coefficient is less than one. This indicates that exports are not very sensitive to immigration in Canada.

GDP per capita (income) was also separated into Canadian and source country variables. Incomes were fairly robust to model specifications, but only Canadian income was significant at the 1% level, while source country income was not significant at any level. Canadian GDP per capita was much larger than 1, indicating a strong sensitivity of immigration to Canadian income. Both variables displayed an inverse relationship with immigration, and while this result is as expected for foreign income, the opposite was anticipated for Canadian GDP per capita. This negative coefficient raises the question of whether the causality runs in the other direction, such that immigration causes average income in Canada to decrease. Running a simple Granger causality test on total immigration to Canada and Canadian GDP per capita, however, indicates that the causality seems to flow from income to immigration.[9] This is surprising given the negative coefficient on Canadian income, although it should be carefully noted that this Granger

[9] The test rejected the null that Canadian income does not Granger-cause immigration to Canada at the 10% level, but did not reject the null that immigration does not Granger-cause GDP per capita.

test included total immigration, where the gravity model only consisted of 33% of total immigration from select countries. Nonetheless, this result suggests that as income in Canada goes down, more immigrants wish to come to Canada. Of course, a story could be told to explain this result: perhaps income is decreasing because the amount of unskilled work is increasing, and immigration is used to fill the demand. Although this particular story does not hold up well with the emphasis that Canadian immigration laws have placed on skills since 1967 (implementation of points system), the refugee intake along with the phenomena of "asylum shopping" could help explain the results.

Another improvement from the simple gravity model is the separation of Canadian and source country population as suggested by Greenwood (1997). It was suspected that these variables may have opposing and confounding effects. Karemera, Davis, & Oguledo (2000) also separated population, and found a positive and significant coefficient on source country population, and a negative significant coefficient on Canadian population.[10] The results of this paper are almost completely opposite, and origin country population is not significant at any level. As mentioned, positive relationship on Canadian population is not perplexing, and could simply be evidence of the attraction of a larger labour market. It is also not surprising that the results in this paper differ from that of Karemera *et al.* as their research only examined ten years of annual data. Additionally, Canadian population is also much greater than one, which is intuitive as it implies that population is sensitive to migration flow. Given the historical trend of low birth rates in Canada and other developed nations, one would expect population to be driven in some capacity by immigration numbers.

[10] Although this depended on model specification

6.2. Unemployment Rate

In Table 1, the gravity models only include the Canadian unemployment rate. While it is significant at the 1% level in the MGM, it is very sensitive to model specifications. For example, excluding either Canadian income or Canadian population leads to an insignificant coefficient at the 5% level. Again, it is suspected there is some level of multicollinearity, although it is certaintly not uncommon in the gravity model literature for the results to be quite sensitive to the choice of variables (Bodvarsson & Van den Berg, 2013). The question of causation is once again a popular choice of study in the literature, and a Granger causality test shows evidence of unilateral flow from Canadian unemployment to immigration at the 10% level, but not the other way. The causation shows that in the long-run, an increase in labour supply is matched by a corresponding shift in demand. The relationship is inverse, indicating that an increase in Canadian unemployment decreases the flow of immigrants to Canada; an intuitive finding from the perspective of both Canadian policy makers and perspective immigrants. Source country changes in unemployment is also included in the MGM in Table A.1., and it showed an insignificant positive relationship. Several of the other variables in the regression appear to be sensitive to the inclusion of foreign unemployment, this is not surprising because as mentioned this variable has a large number of missing values which severely reduces the total number of observations. Two variables in particular, foreign GDP per capita and Canadian population change to significant and insignificant, respectively. While these changes could be due to the econometric complications caused by a greater level of unbalanced and missing data, it may also be explained by the distorting characteristics of the Indian data. The consistantly low income of India could be depressing the effect of income in other nations in the MGM of Table 1. The relationship may indeed be positive for other countries' immigrants to Canada, as the point

system does account for resources when deciding on applicants. India's workforce may be more inclined to want to take advantage of better labour market and standard of living conditions. Even so, the high level of sensitivity when including this variable certainly has some relation to the econometric issues associated with the increase in missing values. The dissimiliarity of results may also be due to the contrasts in the measurement of unemployment in each source country. The first differences of foreign unemployment were taken for Table A.1., but the movements in unemployment may be caused by different factors depending on the country.[11] For example, in the United States one can be considered unemployed after temporary layoffs whereas in most countries in Europe this is not the case for certain time limits. So if the economy is experiencing an increase in seasonal work, the changes in unemployment would be different depending on if it was the USA or a European country.

6.3. Exchange Rate and Exchange Rate Volatility

Across almost all of the model specifications attempted, one of the few constants was that the rate of return on the Canadian- foreign country exchange was insignificant. The robustness of this result was somewhat surprising, as the variety of influences such as costs and economic prospects, should theoretically be represented in some degree by exchange rates. The positive coefficient is also interesting (although the confidence interval included negative numbers) which shows that as the source country's currency becomes stronger against the Canadian dollar more people decide to immigrate to Canada. The volatility of exchange rates was significant at the 10% level, and had a negative sign on the coefficient. This was as expected, and suggests that potential immigrants respond adversely to a large degree of variance in the exchange rate

[11] See Sorrentino (2000) for a decent overview of some of the differences.

between their origin country and Canada. As mentioned, this is probably the result of the aversion immigrants have to uncertainty in the value of remittances to their source nation, such that sending money back home is not a reliable support apparatus. The coefficient is very large in absolute terms, but this is because the volatility is from the monthly averages of the logarithm of the rate of return on exchange rates, which is a very small number compared to the logarithm of immigration numbers. Regardless, it does indicate a sizeable sensitivity of immigration to the volatility of exchange rates.

6.4. Euro, FIPA, and policy variables

The only two policy dummy variables included in the MGM are for the creation of the Euro in the year 2000, and one representing the signing of three international trade and investment agreements. The Euro dummy was included in all three models because it also signified the change in the exchange rate data for the three European nations to real broad effective exchange rates. Not surprisingly, the dummy was significant across all models and supposedly controlled for the change in the exchange rate data. Interestingly, it is also consistantly positive, indicating that the creation of the Euro likely increased the number of Europeans wishing to immigrate to Canada.

The FIPA variable denoted the 1989 free trade agreement with the USA, as well as two FIPA signings with the Philippines and Australia. It was also robust across models at the 5% level, although it became insignificant when adding foreign unemployment. The positive coefficient is as expected, signifying that bilateral trade deals can be thought of as improving networks between countries, and that these network effects likely increase the willingness of workers and families to migrate to the partner nation.

As mentioned, two other variables for policy in Canada were considered, but were not included. Bill C-86 was not significant in any model, this may be because the focus of the bill was on improving efficiency in the assessment of applicants, not necessarily on changing the dynamics of the potential migrants. The other policy legislation, the IRPA in 2002, coincided too closely with the changing European situation, and therefore probably picked up too many effects that were not a result of the new protection policy.

6.5. Inference

Based on the above results, one can infer that over the long-run, immigration to Canada seems to be more strongly influenced by the pull factors of the Canadian economic circumstance rather than the push factors of the source country. This in line with the hypothesis that because the government controls the number of migrants allowed in, the quotas will be set according to the contemporary values of Canadians. Undoubtedly, the free market forces that intice or repel workers and agents have an affect on the migration from a particular country; and this has been shown in the many studies prior to this one. However, the lopsidedness found in the estimation of the MGM clearly points to a long-run trend in Canadian immigration that is shaped by domestic conditions. This is to say that while the impact of the more well-known policy legislation in Canada was difficult to distinguish, the more frequent changes in perspective of the governing body, driven by the economy, is likely to be more consistantly guiding immigration flow.

The insignificance of the source country variables may also suggest a level of inconsistancy and hetergeneity with the point system across both time and space. It seems fair to infer that Canadian policy makers decide the size of the immigration flow at a high frequency; but the inability of origin country income, unemployment, or population to predict migration to Canada

may also intimate that the push factors that determine the composition of migrants have different effects depending on the source country. The point system is operated with emphasis on a variety of factors, including job experience and income. One would expect, that as unemployment increases in a country, the job experience of migrants is reduced. Similarly, if the average income of a country decreases, the funds of the migrants from that country should, on average, be lower. Of course, the point system is based on other factors such as education, arranged employment, age, language, etc. It is thus likely that income and unemployment signal only a small part of the conditions considered in the screening process as well. Therefore, the point system may place less weight on the characteristics controlled for in the MGM, or simply emphasize them inconsistantly across time.

7. Conclusion and Discussion

This paper sought to combine elements of the simple gravity and the labour market models of immigration into a modified gravity model, examined over the long run at a high frequency. While the study presented various econometric problems such as heteroskedasticity in the errors, endogeneity, as well as temporal and spatial dependence, the estimation of a fixed effects model with Driscoll-Kraay standard errors and a proxy for the endogenous variable seemed to control for these issues. Most of the coefficients had the expected signs but not all were significant in the MGM. Results showed that most of the variables relating to the Canadian economy were significant, while the source country indicators did not seem to be as prominent in the decision mechanism of migrants. Coefficients were very sensitive to the model specifications, including the choice of variables. This is likely a sign of multicollinearity in the data, as well as the effect of missing values causing listwise deletion which may have skewed the results.

A limitation with this model is that it used unilateral immigration to Canada, and this made it slightly more difficult to estimate some of the network effects called for by the traditional gravity model. While the level of exports has empirical support as a relevent variable and it performed well in this study, the accuracy with which it proxied network effects is not entirely clear.

Additionally, the number of countries included in the panel dataset was only nine, much less than in other similar studies. Although the objective of this paper differed slightly from previous studies such that the quantity of nations are of less importance, the fact that only one third of total immigration was captured may limit the applicability of the findings to the entire spectrum of immigration to Canada.

Long-run studies on the determinants of immigration are very rare in the literature, and this paper presents only a sample. The question remains whether these results can be supported in other countries, not just with regard to Canadian immigration. Another important element that is omitted from this study is whether there is heterogeneity in immigration flows to Canada like that found in Clark *et al.* (2007) and Borjas (1999). This research showed that Canadian circumstances may be the stronger factor, but it does not suggest anything about whether more skilled labour is attracted and it does not differentiate between classes of immigrants such as refugees. The level of education is a common measure of the class of immigrants but was not controlled for in this study. This may help explain movements as a certain portion of immigrants recognize the return to human capital is higher in developed nations such as Canada, while paying less attention to short-run factors like unemployment.

8. References

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9. Appendix

Table A.1. *Immigration to Canada including foreign unemployment*

variables	Standard Labour	Simple Gravity	Modified Gravity
Canadian Unemployment	-0.772 (0.197)***		-0.855 (0.218)***
FX Rate of Return	-1.250 (1.034)	1.256 (1.439)	0.971 (0.995)
FX Volatility	-39.477 (33.779)		-31.258 (34.009)
J's per capita GDP	3.831 (0.551)***		3.765 (0.818)***
Canadian per capita GDP	-6.403 (0.761)***		-8.629 (0.978)***
J's population			-0.574 (0.993)
Canadian population			1.353 (1.778)
$pop_i * pop_j$		-0.743 (0.495)	
export		-0.020 (0.109)	0.147 (0.069)*
FIPA		0.130 (0.047)**	0.159 (0.090)
Euro	0.330 (0.048)***	0.215 (0.043)***	0.426 (0.064)***
Foreign Unemployment	0.403 (0.296)		0.333 (0.293)
N	1059	1288	1033

Note: *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level. The Driscoll-Kraay standard errors are presented in parantheses.

Table A.2. Data sources

Source	variables
CANSIM	Immigration and Exports: all nine source countries
FRED	Unemployment for 8 countries, broad effective exchange rates
Bank of England Statistical Database	Exchange Rates for eight source countries
OECD	Population and GDP for 8 countries
Philippine Statistics Authority	Philippine exchange rates, GDP, and unemployment
Hong Kong Census and Statistics Department	Hong Kong GDP and population

Table A.3. Data availability

Country	Immigration	GDP Per Capita	Population	Exchange Rate	Canadian Imports	Unemployment
Canada		1970q2-2013q2	1970q2-2013q2			1970q2-2013q2
England	1970q2-2013q2	1970q2-2013q2	1970q2-2013q2	1970q2-2013q2	1970q2-2013q2	1970q2-2013q2
France	1975q1-2013q2	1975q1-2013q2	1975q1-2013q2	1975q1-2013q2	1975q1-2013q2	1978q1-2012q1
Germany	1975q1-2013q2	1975q1-2013q2	1975q1-2013q2	1975q1-2013q2	1975q1-2013q2	1975q1-2013q2
Netherlands	1975q1-2013q2	1975q1-2013q2	1975q1-2013q2	1975q1-2013q2	1975q1-2013q2	1983q1-2013q2
Australia	1975q1-2013q2	1975q1-2013q2	1975q1-2013q2	1975q1-2013q2	1975q1-2013q2	1975q1-2013q2
United States	1970q2-2013q2	1970q2-2013q2	1970q2-2013q2	1970q2-2013q2	1970q2-2013q2	1970q2-2013q2
Hong Kong	1986q1-2013q2	1986q1-2013q2	1986q1-2013q2	1986q1-2013q2	1986q1-2013q2	1986q1-2013q2˚
India	1982q1-2013q2	1986q1-2013q2˚	1986q1-2013q2	1982q1-2013q2	1982q1-2013q2	N/A
Philippines	1982q1-2013q2	1982q1-2010q4	1982q1-2010q4	1982q1-2013q2	1982q1-2004q2	1992q1-2013q2˚

˚indicates random missing values