Immigrant Stocks and Trade Flows, 1870-1913

David S. Jacks
Simon Fraser University

In this paper, we confront the evidence on immigration and trade during the pre-World War I period in an attempt to determine any trade-creating impacts of immigration. The results strongly diverge from those for the contemporary world in which immigrants have been shown to have a strong pro-trade effect. Using the United States as a testing ground, the results allow us to conclude that, for this period, immigrants were generally ambiguous in their effect on the levels of bilateral trade, regardless of their country of origin. This finding augments early research, for it suggests not a condition of complementarity but rather neutrality between trade and migration in the Atlantic economy of the late nineteenth and early twentieth centuries.

1. Introduction

Undoubtedly, the Heckscher-Ohlin factor-proportions theory of trade has enjoyed marked success in explaining much of the development and evolution of the so-called Atlantic economy of the late nineteenth and early twentieth centuries.[1] Yet, as many authors have noted before, whereas the theory predicts the ability to substitute international trade for factor migration when the latter is restricted, it is relatively silent with respect to the relationship of international trade to factor migration when neither is restricted outright. This study aims to investigate one specific aspect of this theoretical lacuna, namely the relationship between international trade and labour migration in the Atlantic economy from 1870 to 1913.

Previous research on the subject has come to two separate but related

[1] A. Estevadeordal and A. M. Taylor, "Testing Trade Theory in Ohlin's Time", in Findlay, Jonung, and Lundahl (eds), *Bertil Ohlin: A Centennial Celebration, 1899–1999*, (Cambridge 2002); K.H. O'Rourke and J.G. Williamson, 'Late Nineteenth Century Anglo-American Factor Price Convergence,' *Journal of Economic History* 54 (1994), pp. 1-25; and K.H. O'Rourke, A.M. Taylor, and J.G. Williamson 'Factor Price Convergence in the Late Nineteenth Century,' *International Economic Review*, 37 (1996), pp. 499-530.

conclusions: Collins *et al.* find a complementarity between aggregate trade and immigration flows for the period, while Dunlevy and Hutchinson find a complementarity between source-country-specific trade and immigration stocks.[2] In this paper, only the implications of the latter proposition will be considered explicitly as it is closer in spirit to the formulations of classical factors-proportions theory.

The structure of the paper is as follows. In the second section, the basic theoretical framework of our empirical workhorse - the gravity equation - is considered. This is followed by a discussion of previous findings and the new data-set brought to bear on the issue in sections three and four. Section five presents estimates from the gravity equation on the effects of immigrants stocks while section six concludes.

2. The gravity equation in theory

From its earliest formulations in the works of Pöyhönen and Tinbergen, the gravity equation for describing international trade flows has always held a tenuous position in the field of international economics.[3] There is no doubt that the equation holds a certain intuitive appeal with its strong and clean empirical validation and its shameless parallelism to Newtonian physics, but it remained somewhat a statistical anomaly until the early contributions of Linneman and Leamer and Stern, and especially the later contributions of Anderson and Bergstrand.[4]

[2] W.J. Collins, K.H. O'Rourke, and J.G. Williamson, 'Were Trade and Factor Mobility Substitutes in History?' *NBER Working Paper no. 6059* (1997); J.A. Dunlevy and W.K. Hutchinson, 'The Impact of Immigration on American Import Trade in the Late Nineteenth and Early Twentieth Centuries,' *Journal of Economic History* 59 (1999), pp. 1043-1062.
[3] P. Pöyhönen, 'A Tentative Model for the Volume of Trade between Countries,' *Weltwirtschaftliches Archiv* 90 (1963), 93-99; J. Tinbergen, *Shaping the World Economy*, (New York 1961).
[4] J.E. Anderson, 'A Theoretical Foundation for the Gravity Equation,' *American Economic Review*, 69 (1979), pp. 106-116; J.H. Bergstrand, 'The Gravity Equation in International Trade,' *Review of Economics and Statistics* 67 (1985), pp. 474-481; J.H. Bergstrand, 'The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade,' *Review of Economics and Statistics* 71 (1989), pp. 143-153; J.H. Bergstrand, 'The Heckscher-Ohlin-Samuelson Model, the Linder Hypothesis and the Determinants of Bilateral Intra-industry Trade,' *Economic Journal* 100 (1990), pp. 1216-1229; E.E. Leamer and R.M. Stern, *Quantitative International Economics*, (Boston, 1970); H. Linnemann, *An Econometric Study of International Trade Flows*, (Amsterdam 1966).

What the latter articles achieved was a movement away from previous approaches which sought to ground the gravity equation in strictly Walrasian, general equilibrium models and, hence, reduced its empirical tractability by leaving no clear implications for bilateral trade flows and by allowing the analysis of only global trade flows. By assuming product differentiation by country of origin (i.e. the Armington assumption), Anderson was able to explain the multiplicative form of the equation and to allow for greater analytic levels of disaggregation.[5] Bergstrand continued much in the same vein by adding sufficient twists and turns to suggest the applicability of the gravity equation to a number of preference and substitution structures - constant-elasticity-of-substitution and Cobb-Douglass preferences – as well as to a number of appropriate models of trade – the classical Heckscher-Ohlin factor endowments approach, the 'New Trade Theory' based on monopolistic competition, and a hybrid model of different factor proportions among monopolistically competitive sectors.[6]

Since our concern does not lie in utilizing the gravity equation as a means of testing the empirical validity of either the classical Heckscher-Ohlin theory or the 'New Trade Theory' approach, we are on safe ground in making the following assumptions about the gravity equation.[7] First, we will assume that, following Bergstrand, in a *N*-country world typified by identical constant-elasticity-of-transformation technologies across countries and production using a given endowment of labour from a country's own native population augmented by stocks of immigrant populations, labour can be transformed from producing foreign goods to domestic goods at variant elasticity or can be transformed from producing different foreign goods at constant elasticity so that:

(1) $$L_i = \left\{\left[\left(\sum_{k=1}^{N} X_{ik}^{\phi}\right)^{1/\phi}\right] + X_{ii}^{\delta}\right\}^{1/\delta}, \; i = 1,\ldots, N \textit{ and } k \neq i,$$

where L_i equals a single factor of production available to country *i*

[5] J.E. Anderson, 'A Theoretical Foundation for the Gravity Equation.'
[6] J.H. Bergstrand, 'The Gravity Equation in International Trade'; 'The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade'; 'The Heckscher-Ohlin-Samuelson Model, the Linder Hypothesis and the Determinants of Bilateral Intra-industry Trade.'
[7] A.V. Deardorff, 'Determinants of Bilateral Trade' *NBER Working Paper no. 5377* (1995).

(=domestic plus immigrant labour), X_{ik} equals country *i*'s good supplied to country *k*, X_{ii} equals country *i's* good supplied to the domestic market, δ equals $(\eta+1)/\eta$ where η is the elasticity of transformation between any two goods in country *i* and $(0<\eta<\infty)$, and ϕ equals $(\gamma+1)/\gamma$ where *g* is the constant elasticity of transformation among exportable goods and $(0<\gamma<\infty)$.

Via profit maximization coupled with the constant-elasticity-of-transformation technology constraints, we arrive at N^2 first-order conditions and $N^*(N-1)$ bilateral export supply equations:

$$\textbf{(2)}\quad X^{S}_{ij} = Y_i P^{*\gamma}_{ij}\left[\left(\sum_{k=1,k\neq 1}^{N} P^{*(1+\gamma)}_{ik}\right)^{1/(1+\gamma)}\right]^{-(\gamma-\eta)}\left\{\left[\left(\sum_{k=1,k\neq 1}^{N} P^{*(1+\gamma)}_{ik}\right)^{1/(1+\gamma)}\right]^{1+\eta} + P^{*(1+\eta)}_{ii}\right\}^{-1},$$

where $P_{ik}{}^*$ equals $P_{ik}/(T_{ik}C_{ik}Z_{ik})$ or the price received for selling *i*'s product in the *k*-th country, P_{ik} equals the price of *i*'s product sold in the *k*-th market, T_{ik} equals one plus the *ad valorem* rate of tariffs and/or border effects on *i*'s product sold in the *k*-th market, C_{ik} equals a trade cost factor assumed to be a function of distance and $(C_{ik}\geq 1)$, Z_{ik} equals the costs associated with gaining foreign market information about country *k* in country *i* and $(Z_{ik}\geq 1)$, and Y_i equals total income paid to labour (i.e. $wage_i{}^*L_i$). What this formulation then implies is that:

1) a country's supply of its differentiated product to any other given country depends on its own income, the price differential between the home market price and the importing country's price, and the price differentials between the home market price and all other importing countries' prices – that is, we expect greater export supply to any other country the larger the exporting country's GDP is and the larger the importing country's price gap is relative to all other trading partners.

2) only with both perfect information and no barriers to trade or $T_{ik}=C_{ik}=Z_{ik}=1$, will the law of one price hold.

Our second assumption on consumption again follows Bergstrand; here, we will invoke the assumption of identical utilities, U_j, across countries where:

$$\textbf{(3)}\qquad U_j = \left\{\left[\left(\sum_{k=1}^{N} X^{\theta}_{ik}\right)^{1/\theta}\right]^{\psi} + X^{\psi}_{ii}\right\}^{1/\psi}, j = 1,\ldots, N \textit{ and } k \neq j,$$

and X_{kj} equals country k's good demanded by country j, X_{ij} equals the good that is produced and demanded domestically, ψ equals $(\mu\text{-}1)/\mu$ where μ is the constant-elasticity-of-substitution between domestic goods and imported goods in the host country and $(0<\mu<\infty)$, and θ equals $(\sigma\text{-}1)/\sigma$ where σ is the constant-elasticity-of-substitution among importable goods and $(0<\sigma<\infty)$.

Utility maximization coupled with the income constraints yields $(N+1)$ first-order conditions and $N^*(N\text{-}1)$ bilateral aggregate import demand equations:

$$\textbf{(4)}\quad X^{D}_{ij} = Y_i P_{ij}^{-\sigma}\left[\left(\sum_{k=1,k\neq 1}^{N} P_{kj}^{*(1+\sigma)}\right)^{1/(1+\sigma)}\right]^{-(\sigma-\mu)}\left\{\left[\left(\sum_{k=1,k\neq 1}^{N} P_{kj}^{*(1+\sigma)}\right)^{1/(1+\sigma)}\right]^{1+\mu} + P_{ii}^{*(1+\mu)}\right\}^{-1},$$

with the straightforward interpretation that any country's demand for any other country's product will depend on its own income, the price differential between its own product and that of the exporter's product, and the price differentials between its own product and all other foreign products available.

Thus, with the equilibrium condition, $X_{ij} = X_{ij}^{D} = X_{ij}^{S}$, and some relatively mild assumptions to reduce the 2^*N^2 solutions for price and quantity - namely that individual bilateral trade flows are small relative to total trade, that (as a consequence of the former) individual bilateral prices are given, and that equilibrating movements in price and quantity in one market have small effects on income and price in other countries - we arrive at our expression for the value of aggregate trade flows:

$$\begin{aligned}\textbf{(5)}\quad P_{ij} X_{ij} + {} & Y_i^{(\sigma-1)/(\gamma+\sigma)} Y_j^{(\gamma+1)/(\gamma+\sigma)} C_{ij}^{-\sigma(\gamma+1)/(\gamma+\sigma)} T_{ij}^{-\sigma(\gamma+1)/(\gamma+\sigma)} Z_{ij}^{-\sigma(\gamma+1)/(\gamma+\sigma)} \text{ x} \\ & \left(\sum_{k=1,k\neq 1}^{N} P_{ik}^{*(1+\gamma)}\right)^{-(\sigma-1)(\gamma-\eta)/(1+\gamma)(\gamma+\sigma)} \left(\sum_{k=1,k\neq 1}^{N} P_{kj}^{1+\sigma}\right)^{-(\gamma+1)(\sigma-\mu)/(1-\sigma)(\gamma+\sigma)} \text{ x} \\ & \left[\left(\sum_{k=1,k\neq 1}^{N} P_{ik}^{*(1+\gamma)}\right)^{-(1-\eta)/(1+\gamma)} + P_{ii}^{1+\eta}\right]\left[\left(\sum_{k=1,k\neq 1}^{N} P_{kj}^{1-\sigma}\right)^{(1-\mu)/(1-\sigma)} + P_{jj}^{1+\gamma}\right]^{-(\gamma+1)/(\gamma+\sigma)}\end{aligned}$$

where the right-hand side terms can be taken (in order) as the income of the exporting country; the income of the importing country; transportation costs, tariffs and/or border effects; information costs; an export price index for the exporting country; an import price index for the importing country; an index of domestic prices for the exporting country; and an index of domestic prices for the importing country. As such, we will take the above expression as our basic equation for estimation. However, before we begin, we may do well to consider the results of previous similar investigations.

3. The gravity equation in practice

In this section, rather than trying to delineate the entirety of the empirical work done on the gravity equation in the past forty years, what is sought is a look into how previous researchers have dealt with the question at hand. Namely, were immigrant stocks – as opposed to immigrant flows – and international trade complementary in the period prior to the First World War?

What we will take as our fundamental basis of comparison is Dunlevy and Hutchinson.[8] The article's authors probe the correlation between the unprecedented wave of goods and immigrants which arrived on America's shores in the period from 1870 to 1913. Indeed, as the authors note, this veritable flood was truly impressive with the real annual volume of trade more than quadrupling from $835.8 million in 1870 to $3,614 million in 1913 while annual immigrant flows more than tripled from 2.8 million in the 1870s to almost 8.9 million in the 1900s.

Specifically, the authors assert that they find 'empirical evidence, independent of the factor-proportions framework, regarding the relationship between imports and immigration by building on a recent literature that argues that the presence of an immigrant stock in a host country is trade creating between the host and origin countries'.[9] They also outline three arguments why one might *a priori* believe to find such a link between immigrant stocks and imports: immigrants may have a greater preference for home-country products; immigrants may be in possession of better information regarding arbitrage opportunities between the host and home countries, product differentiation, and/or

[8] J.A Dunlevy and W.K. Hutchinson, 'The Impact of Immigration on American Import Trade', *Journal of Eonomic History,* 59, 1999, pp. 1043-1062.
[9] *Ibid*., 1044.

the existence of specific immigrant preferences; and finally, immigrants may be able to negotiate better ethnic networks with respect to issues of culture, trust and, presumably, language.

In considering a more holistic interpretation of the effects of immigration on trade one would necessarily want to include arguments regarding export and, as a consequence, aggregate volume of trade effects. And, of course, with just a little imagination, one can alter the last two arguments for import augmentation to the export case as well.

In any case, their means of assessing the validity of these claims is through the use of a data set on 78 different commodities from a maximum of 17 countries, representing roughly 50% of total U.S. imports, observed at five-year intervals over the 1870 to 1910 period which provides the basis for their claim of a broad pro-import immigration effect.

In terms of equation **(5)** above, what the authors take as their basic estimating equation is one which tries to capture elements of all but the sixth and eighth elements, i.e. the export price index and domestic price measures for the exporting country. Thus, we have directly:

$$\textbf{(6)} \quad ln(MUS_{j,t}) = \alpha + \beta_1\, ln(Migstk_{j,t}) + \beta_2\, ln(Dist_j) + \beta_3\, (Rlinc_{j,t}) + \beta_4\, ln(Jcap_t) + \beta_5\, ln(Pop_{j,t}) + \beta_6\, (UScap_t) + \beta_7\, ln(PopUS_t) + \beta_8\, ln(Rlprice_{j,t}) + \beta_9(t) + \beta_{10}\, (English)$$

where t denotes time, $M_{US,j,t}$ equals the value of imports into the U.S. from country j, $Migstk_{j,t}$ equals the U.S. resident immigrant stock from country j, $Dist_j$ equals the distance from country j to the United States, $Rlinc_{j,t}$ equals per capita income in country j relative to U.S. per capita income, $Jcap_t$ equals per capita income in country j, $Pop_{j,t}$ equals the country j's population, $UScap_t$ equals U.S. per capita income, $PopUS_t$ equals U.S. population, $Rlprice_t$ equals the ratio of the U.S. unit value of aggregate imports relative to the U.S. consumer price index adjusted for tariff and transport costs and is, therefore, neither commodity nor trade-partner specific, t is a time trend, and *English* is a dummy variable for English speaking countries, i.e. a dummy for Britain or Canada. Their OLS regression results for this estimating equation (plus an error term) are reported in *Table 1* below in column (I).

What we then find there is a reported coefficient on the U.S. immigrant stock variable of 0.29 with a t-statistic of 8.70, suggesting a positive and highly statistically significant relationship between the level of U.S. import flows and immigrant stocks. Furthermore, as presented in the paper, this relationship appears to be robust across levels of disaggregation in trade partners (Old Europe, New Europe, and Non-Europe), across formulation of the estimating equation by differencing, across time (or at least up to the turn of the century), and across select commodity groups (processed foodstuffs, semi-manufactures, and manufactures for consumption). Thus, in Dunlevy and Hutchinson's study, the immigrant-link hypothesis seems to be strongly confirmed.

4. Data for the gravity equation by annual observation

Before proceeding directly to the estimation of the gravity equation by our annual observations, a few words should be reserved to review the fundamental differences between the data presented here and that used previously by Dunlevy and Hutchinson.

Broadly speaking, the essential characteristics of the two data sets are the same in that we employ very similar measures to Dunlevy and Hutchinson; yet at a more detailed level, it is believed that the present data set bestows a number of advantages as opposed to the earlier one. Chief among these advantages, of course, is the deliberate view towards constructing observations on an annual, rather than a quinquennial, basis. To Dunlevy and Hutchinson's credit, they do, presumably, try to remedy this situation by increasing the number of observations per year. However, given that the very nature of the trade data for many of the commodity-level observations displays little or no real variation, there may be some econometric merits of a long-panel such as the one used in this study.

Rather than dwell on every aspect of the data construction, the reader is referred to the appendix attached below, comprising a list of data descriptions and sources. However, two points are worth drawing out here in fuller detail. First, the relative price measure utilized in this study consists of the simple ratio of exporting country domestic price indices to U.S. domestic price indices.[10] While admittedly a very imperfect measure of the relative price effects which we wish to capture, it does at least allow for variation from country-to-country and from year-to-year. One should contrast this, then, with the relative price figure used by previous researchers, typically the U.S. unit value index scaled by the U.S. average tariff rate and an index of transportation costs and weighted by the U.S. consumer price index which allows for only temporal and not cross-sectional variation.

Second, in all previous studies known to the author, the immigrant stock variable has been the decisive factor in limiting the scope of analysis to time-aggregated statistics. What was sought in this paper was to somehow relate the decadal observations on immigrant stocks to the annual observation on immigrant flows.[11] To this end, intercensal years were assigned increases (or decreases) in stock proportional to their share of total intercensal immigration. Specifically, for the intervening years in which the immigration stock of any given nationality increased, the gain in immigration stock in any given year was calculated as:

$$\textbf{(7)}\ \textit{Annual Gain} = \left(\frac{\textit{immigration in year t}}{\textit{sum of immigration in decade d}}\right) \times (\textit{change in decadal stock})$$

Whereas for the intervening years in which the immigration stock of any

[10] As these are all set to 100 in 1913, we are confronted with two alternatives in estimation: dropping the 1913 observations across the board or running fixed effects. In what follows, results for the latter alternative are reported; estimation along the first line resulted in virtually no difference.

[11] Ideally, one would want to use annual observations on net immigration flows as opposed to the gross flows found in W.F. Wilcox, *International Migrations*, (New York 1929). Yet these figures simply do not exist for the vast majority of countries over the whole period and do not exist for some countries at all. However, the analysis is not fundamentally jeopardized by this situation in that immigrant stock levels calculated on the basis of available net immigration figures fall within 1% of the levels calculated on the basis of gross immigration figures. Thus, for the UK, for which net immigration figures are available for 1870-1920, the correlation between estimated stocks based on gross and net immigration flows is .997719.

given nationality decreased, the loss in immigration stock in any given year was calculated as:

$$\textbf{(8)}\ \textit{Annual Loss} = \left(\frac{\dfrac{(\textit{sum of immigration in decade } d)}{(\textit{immigration in year } t)}}{\sum_{t=1, t\in d}^{10} \dfrac{(\textit{sum of immigration in decade } d)}{(\textit{immigration in year } t)}}\right) x\ (\textit{change in decadal stock})$$

$$= \frac{(\textit{change in decade stock})}{\textit{immigration in year } t \sum_{1, t\in d}^{10} \dfrac{1}{\textit{immigration in year } t}},$$

where zero values for *immigration in year t* were replaced by values of one.

5. Empirics

5.1. Estimation of the Gravity Equation by Annual Observation. Our first step in analyzing the relationship of trade to immigration stocks was then to re-estimate equation **(6)** above with the new annual data set. The results of this exercise are reported in column II of *Table 1* below. As might be expected, what we find there is broad comparability to the results of Dunlevy and Hutchinson but with much more tightly estimated coefficients. This specification also has the benefit of producing a positive coefficient on the relative income variable (as many variants of standard trade theory predict that as two countries converge in relative income, the volume of trade should increase) and highly significant coefficients on U.S. per capita income, U.S. population, time, and especially the relative price variable.

If for the moment we go on to consider the same estimating equation as **(6)** above explicitly in the context of analyzing U.S. exports and the U.S. aggregate volume of trade, we find the regression results reported in columns V and VIII. Once again, we find highly significant coefficient estimates with all the relevant variables correctly signed. One might also make note of the fact that, comparing the coefficient on relative price, we find that it retains its significance and that it changes sign in a consistent manner in each case across the import, export and volume of trade regressions. Thus, it is negative and significant when considering imports (higher foreign prices discourage domestic purchases of foreign goods), positive and significant when considering exports (higher foreign prices encourage foreign purchases of domestic goods), and statistically indistinguishable from zero when considering the aggregate terms of trade.

Of course, before we spend too much time touting the superiority of this specification, even casual inspection of the figures would surely yield the observation that the immigrant stock variable continues to contribute positively and significantly to the explanation of trade variations, suggesting strong affirmation of the maintained hypothesis of trade creation via immigration flows. Indeed, even though the current specification results in a slightly smaller coefficient, the standard error bands associated with the two estimates are overlapping. One should also notice, in particular, the shared dummy variable on the English language across the regressions. The justification for including language variables in the gravity equation is that they capture transaction and information-costs advantages that might exist between nations with common languages as well as the pro-trade effects of shared cultural and legal systems.

If, instead of estimating equation **(6)**, we estimate a very similar gravity equation model with the only difference being a substitution of an Adjacency dummy for the English language dummy, one finds a strong effect on the causal relationships implied in columns I, II, V, and VIII.[12]

Considering now the results reported in columns III, VI, and IX which incorporate the Adjacency dummy, the import equation coefficient on

[12] In what follows, the Adjacency dummy may be thought of as a Canadian dummy; for although it was initially constructed to account for the like effects of U.S. trade originating in Canada and Mexico, the lack of observations on Mexican prices necessitated its application to Canada only.

the immigrant stock is 0.003 with a t-value of 0.15 while the export coefficient on the immigration stock is –0.005 with a t-statistic of 0.12 and the volume of trade coefficient on the immigration stock is –0.02 with a t-statistic of 1.57. Overall the regressions perform as expected, with the only possible exception being the positive and significant coefficients estimated for the level of imports on the distance variable. Most likely though, this anomaly can be explained by an appeal to relative factor endowments, i.e. the U.S., especially in this period, was likely to import those goods for which no U.S. substitutes existed and which were by necessity widely dispersed geographically. This interpretation is implicitly borne out by the negative and significant coefficients for exports and the volume of trade on distance.

Clearly then, the hypothesis of complementarity in immigration stocks and trade flows is on not-too-firm a ground at this point. Furthermore, perhaps to guard against potential sample bias as the new data set includes Australia/New Zealand, columns IV, VII, and X report the results of including dummies for Australia/New Zealand, Canada, and the United Kingdom. The results of these columns represent highly consistent estimates with those in III, VI and IX, suggesting that the failure to distinguish Canada from its peers succeeds in destroying much of the information embedded in the trade and immigrant figures. The reason is that Canada is probably best thought of as a nation with which the U.S. would have a very high volume of trade naturally, and as a nation which acted as a stepping-stone, as it were, into the U.S. for immigrants from other nations.[13] Thus, failing to control for Canada would naturally induce a high degree of correspondence between trade flows and immigrant stocks and bias estimation in favour of maintaining the hypothesis of complementarity between the two. What is hoped for future research then is a means of disentangling the 'true' Canadian immigrant stock from the more or less transient immigrant stock attributed to Canada merely by the vagaries of trans-oceanic migration.

[13] To give an indication of the possible misrepresentation of the level of 'true' Canadian immigration, we can note that the average ratio of Canadian immigrant stock (resident in the United States) to Canadian population for the period 1871-1911 was nearly 20.

5.2. Estimation of Alternate Specifications. At this point, we can take for granted the fact that econometric validation of the hypothesis of complementarity between immigrant stocks and trade flows is at the very best extremely sensitive to specification issues and most likely non-existent. But before we take an overly strong stance one way or the other, we should consider two additional aspects of the argument.

In the first place, concern over the existence of unit roots in our variables as well as serial correlation might suggest a cross-sectional approach. Also, one might want to examine the persistence through time of any relationship between trade flows and the levels of immigrant stocks. To this end, regressions of trade flows on migrant stock, relative income, foreign income, foreign population, distance, and the Adjacency dummy on an annual basis were run. In *Figures 1, 2*, and *3* below, we report the results of these exercises for imports, exports and the volume of trade, respectively. Here we find some indication of an initial significant relationship dying off, but the figures point only to a positive relationship between exports and migrant stocks and between the volume of trade and migrant stocks at some scattered intervals of time. Thus, there seems no reason to believe that the relationship between trade and migration stocks was particularly strong in one period relative to another.

In the second place, one might think that, by considering essentially only one form of the gravity equation, we might be taking the strictly multiplicative form of the underlying structural model too seriously.[14] To this end, we will consider an alternate formulation of the gravity equation which Gould found particularly relevant in analyzing the effects of the immigration stock on trade flows in the contemporary United States.[15] Referring back to equations **(2)** and **(5)** above, where we took $Z_{US,j}$ as equal to the costs associated with gaining foreign market information about country *j* in the U.S., we can now posit a specific form for the variable in which immigrants provide foreign market information that decreases the transaction costs to trade at a decreasing rate, so

[14] D. Hummels, *Toward a Geography of Trade Costs*, (Chicago 1999).
[15] D.M. Gould, 'Immigrant Links to the Home Country,' *Review of Economics and Statistics* 76 (1994), pp. 302-316.

(9) $$Z_{US,j} = A \exp\{-\rho(M_{US,j} / (\theta + M_{US,j}))\}$$

where A is a constant and (A>0), ρ determines the size of the immigrant information effects on transactions costs and (ρ>0), $M_{US,j}$ is the size of country j's migrant stock in the U.S., and θ determines the curvature of the function or alternatively the sensitivity of transactions costs to the size of the immigrant stock and (θ>0). As a result, our estimating equation becomes

(10) $$\ln T_{US,j} = \beta_1 \ln USGDP + \beta_2 \ln GDP_j + \beta_3 \ln USPop + \beta_4 \ln POP_j + \beta_5 \ln P_{US} + \beta_6 \ln P_j + \beta_7 (M_{US,j} / (\beta_8 + M_{US,j})) + \varepsilon$$

where $T_{US,j}$ represents variously the level of imports, exports or aggregate bilateral trade, the first two terms represent GDP figures, the third and fourth terms represent population figures, the fifth and sixth terms represent GDP deflator figures, the seventh term represents the immigrant information variable, the eighth term represents the information sensitivity parameter, and ε represents the error term.

Panel regression results for equation **(10)** with U.S. aggregate values of imports, exports and the volume of trade are reported in *Table 2* below. Overall, the exercise provided few surprises: U.S. GDP was a positive and significant determinant of import and volume of trade values; the coefficient on foreign GDP was positive and significant across all trade measures; and the price measures performed as expected with higher domestic prices encouraging imports and discouraging exports, higher foreign prices discouraging imports and encouraging exports, and ambiguous effects of both measures on the volume of trade. The only unusual feature then of the estimated coefficients is the insignificant, relatively small (and even negative) coefficients of export and volume of trade values on the immigrant information variable and the information sensitivity parameter. This comes in marked contrast for the typical values found in Gould which were generally positive and highly significant.

To transform these results into a perhaps more intuitive form, we can consider their implications for the marginal effects of immigrant links on the volume of trade. Taking the partial derivatives of equation **(10)** with respect to the U.S. immigrant stock results in

$$\textbf{(11)} \qquad \frac{\delta \ln T_{US,j}}{\delta M_{US,j}} = \frac{\beta_7 \beta_8}{(\beta_8 + M_{US,j})},$$

implying that the short-run change in import, export or volume of trade values attendant upon an additional immigrant from country *j* in 1913, the last year of our sample is

$$\textbf{(12)} \qquad \frac{\delta \ln T_{US,j}}{\delta M_{US,j}} = \frac{\beta_7 \beta_8}{(\beta_8 + M_{US,j})} \quad \text{x} \quad T_{US,j,1913},$$

where, in the case of aggregate U.S. import, export and volume of trade values, we simply substitute the sums of these values for the $T_{US,j}$ values and the sum of immigrant stocks from all countries in our sample for the *j*-th country values, thereby ignoring for now any country-specific variation.

The consequent dollar value changes in U.S. import, export and volume of trade values in 1913 are reported in the last row of *Table 3* below and, to say the least, are highly irreconcilable with the hypothesis of trade-creating linkages of immigrant stocks. What they imply is that an indiscriminate (to the country of origin) increase in the U.S. immigrant stock in 1913 would have had no discernible impact on the volume of trade between the U.S. and the rest of the world. Furthermore, to dissuade a perhaps natural suspicion that these results are due to some sort of aggregation bias, country-specific regressions were run based on equation **(10)** above. The consequent changes in the value of trade flows on a country-by-country basis are reported in the upper portion of *Table 3* below. Although the estimates demonstrate a wide range of values (both positive and negative), the associated t-statistics demonstrate that for almost the entirety of the sample the panel-wide estimates are indeed representative.[16] Almost paradoxically, we find the only unambiguously positive effects of migrant stocks on import, export and volume of trade values is the case of the United Kingdom, for which there seems no compelling reason to believe its immigrants would

[16] Calculation of the variance, standard error, and t-values of the estimates was based on the discussion of the delta method found in W.H. Greene, *Econometric Analysis*, (Upper Saddle River 1997), pp. 278-279.

have a more pronounced pro-trade effect than any other nation, due to its massive immigrant stock in 1913 (nearly 25% of the sample total), its shared language and culture with the United States, and its long and sizeable commercial history with the United States.[17]

6. Conclusions

From the preceding exercises, then, what we find are results wholly unlike the situation in the contemporary world in which immigrants appear to be trade-creating as indicated by Gould and others. The picture which has now emerged allows us to conclude tentatively that, for the pre-World War I period, immigrants were generally ambiguous in their effect on the levels of bilateral trade, regardless of their country of origin. This finding, of course, represents a slightly new twist, in that it suggests not a condition of complementarity but rather one of neutrality between trade and migration in the Atlantic economy of the late nineteenth and early twentieth centuries.

REFERENCES

J. E. Anderson, 'A Theoretical Foundation for the Gravity Equation', *American Economic Review*, 69, 1979, pp. 106-116.

J.H. Bergstrand, 'The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence', *Review of Economics and Statistics*, 67, 1985, pp. 474-481.

————————, 'The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade', *Review of Economics and Statistics*, 71, 1989, pp. 143-153.

————————, 'The Heckscher-Ohlin-Samuelson Model, the Linder Hypothesis and the Determinants of Bilateral Intra-industry Trade', *Economic Journal*, 100, 1990, pp. 1216-1229.

W.J. Collins, K.H. O'Rourke and J.G. Williamson, 'Were Trade and Factor Mobility Substitutes in History?', *NBER Working Paper #6059*, 1997.

[17] One possible point for consideration is that over the whole period we have both a relative and absolute decline in the stock of UK immigrants, suggesting that the immigrant information variable and information sensitivity parameter are indeed correctly capturing the diminishing marginal effects of immigration.

A.V. DEARDORFF, 'Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?', *NBER Working Paper #5377*, 1995.

J.A. DUNLEVY and W.K. HUTCHINSON, 'The Impact of Immigration on American Import Trade in the Late Nineteenth and Early Twentieth Centuries', *Journal of Economic History*, 59, 1999, pp. 1043-1062.

A. ESTEVADEORDAL and A.M., TAYLOR, "Testing Trade Theory in Ohlin's Time", in Findlay, Jonung, and Lundahl (eds), *Bertil Ohlin: A Centennial Celebration, 1899*–1999, (Cambridge, MIT Press 2002), pp. 121-43.

D.M. GOULD, 'Immigrant Links to the Home Country: Empirical Implications for U.S. Bilateral Trade Flows', *Review of Economics and Statistics*, 76, 1994, pp. 302-316.

W.H. GREENE, *Econometric Analysis,* (Upper Saddle River Prentice Hall, 1997)

D. HUMMELS, *Toward a Geography of Trade Costs,* (Mimeo, University of Chicago 1999).

D. JUSTINO, 'A evolução do produto nacional bruto em Portugal, 1850-1910 – algunas estimativas provisórias', *Análise Social*, 23, 1987, pp. 451-461.

E.E. LEAMER, R.M. STERN, *Quantitative International Economics,* (Boston, Allyn and Bacon 1970).

H. LINNEMANN, *An Econometric Study of International Trade Flows,* (Amsterdam, North-Holland 1966).

A. MADDISON, *Monitoring the World Economy, 1820-1992,* (Paris, Development Centre of the OECD 1995).

K.H. O'ROURKE, and JG. WILLIAMSON, 'Late Nineteenth Century Anglo-American Factor Price Convergence: Were Heckscher and Ohlin Right?', *Journal of Economic History*, 54, 1994, 1-25.

K.H. O'ROURKE, A.M. TAYLIR and J.G. WILLIAMSON, 'Factor Price Convergence in the Late Nineteenth Century', *International Economic Review*, 37, 1996, pp. 499-530.

P. PÖYHÖNEN, 'A Tentative Model for the Volume of Trade between Countries', *Weltwirtschaftliches Archiv*, 90, 1963, pp. 93-99.

Statistical Abstract of the United States, (Washington, GPO, various years).

Statistical Abstract of the United States from Colonial Times to the Present, (Stamford, Fairfield Publishers 1965).

J. TINBERGEN, *Shaping the World Economy: Suggestions for an International Economic Policy,* (New York, The Twentieth Century Fund 1961).

W. F. WILCOX, *International Migrations,* (New York, NBER 1929).

J.G. WILLIAMSON, *American Growth and the Balance of Payments, 1820-1913* (Chapel Hill, UNC Press 1964).

Appendix

Immigrant Stocks and Trade Flows, 1870-1913

DATA DESCRIPTIONS AND SOURCES

The full array of countries considered is Australia/New Zealand, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Sweden, Switzerland, and the United Kingdom. Taken together, trade and migration between these countries and the U.S. represent nearly 70% of the total U.S. volume of trade and nearly 70% of the total immigrant stock of the U.S. in 1913. India, Mexico, Spain, and a conglomerate of South American countries (Argentina, Brazil, Chile, Venezuela) have to be excluded at this time due to a lack of data, but are hoped to be incorporated in the future.

$Imports_{j,t}$: the value of U.S. imports originating in country *j* in year *t*, measured in 1913 real dollars. Current dollar values were taken from the *Statistical Abstract of the United States* for various years and divided by an index of U.S. import prices found in Williamson (1964).

$Exports_{j,t}$: the value of U.S. exports and re-exports to country *j* in year *t*, measured in 1913 real dollars. Current dollar values were taken from the *Statistical Abstract of the United States* for various years and divided by an index of U.S. export prices found in Williamson (1964).

$VT_{j,t}$: the value of U.S. bilateral volume of trade with country *j* in year *t*, measured in 1913 real dollars. Current dollar values were taken from the *Statistical Abstract of the United States* for various years and divided by the average of indices of U.S. import and export prices found in Williamson (1964). Trade with Australia/New Zealand was taken as that for British Australasia until 1907 when disaggregation begins. Trade with Canada figures include Newfoundland and Labrador. Trade with Denmark prior to 1875 is reported as trade with Denmark and the Danish West Indies and was transformed by using the 1875-84 proportion of Danish West Indies trade to Danish trade. For Norway and Sweden, in the years when the two countries were reported together, trade figures were disaggregated by using the proportions of Norwegian to Swedish trade in the years 1903-13. For Finland, unobserved trade figures were derived from the proportion of Finnish trade and Baltic Russian trade in the closest five year period.

$Immigrant\ Stock_{j,d}$: the number of immigrants from country *j* in census year *d*, taken from the *Statistical Abstract of the United States from Colonial Times to the Present*. This variable was transformed into annual observations as described in the text, using figures on annual immigration flows in Wilcox (1929). Australian/Kiwi immigration flows were taken as immigration from Oceania prior to 1899 and as immigration from Australia, New Zealand, and Tasmania after 1899. Austrian immigrant flows were taken as the non-Hungarian, non-Bohemian, non-Polish component of reported values. Canadian annual immigration stock necessitated being linearly interpolated between 1890-1900.

Danish immigration stock was taken to include Icelanders. Finnish immigration flows from 1892-1920 were derived from the prevailing average proportion of Finnish flows to Russian and Finnish flows and the observations of Russian immigration for those years; Finnish immigration stocks prior to 1900 were derived from the Finnish proportion of Russian and Baltic immigrants from 1900.

U.S. Population$_t$: the level of U.S. population (in thousands) in year *t* taken from Maddison (1995); likewise for

Population$_{j,t}$. Portuguese population was taken from Justino (1987).

U.S. GDP$_t$: the level of real U.S. GDP (in millions of dollars) in year *t* taken from Maddison (1995); likewise for

GDP$_{j,t}$. Portuguese GDP was derived from Justino (1987) and rescaled to accord with Maddison (1995).

Per Capita Income$_{j,t}$: the ratio of real gross domestic product to population in country *j* in year *t*.

Distance$_j$: linear distance separating country *j* and chief U.S. ports of entry taken from the CIA website. For most observations, this was taken as the distance between capital cities and New York City. For Australia, the distance variable represents the average of the distance from Sydney to New York City and San Francisco. For Japan, the distance variable represents the distance from Tokyo to San Francisco.

English Language$_j$: a dummy variable equal to one if the country *j* is English-speaking; that is, if the country is

either Australia/New Zealand, Canada, or the United Kingdom.

Adjacency$_j$: a dummy variable equal to one if the country *j* shares a border with the United States; that is, if the country is Canada in this case.

Relative Income$_{jt}$: ratio of country *j* GDP per capita to U.S. GDP per capita in year *t*.

Relative Price$_{j,t}$: ratio of country *j* GDP deflator to U.S. GDP deflator in year *t* taken from Maddison (1995). Portuguese GDP deflator derived from Justino (1987) with the assumption that the price growth of 1905-10 extended to 1913 and was then rescaled.

Year$_t$: trend variable ranging from one to forty-four and corresponds to the years 1870, 1871; 1913.

TABLE 1. OLS estimates of the gravity equation

Dunlevy and Hutchinson's Results for All Regions	Results with Augmented Immigration Stocks (and Huber-White Sandwich Estimators)									
Dependent Variable:	**(I) Import Values**	**(II) Import Values**	**(III) Import Values**	**(IV) Import Values**	**(V) Export Values**	**(VI) Export Values**	**(VII) Export Values**	**(VIII) VT Values**	**(IX) VT Values**	**(X) VT Values**
Variables:										
Migrant Stock	0.29***	0.19***	0.003	-0.6*	0.14***	-0.01	-0.005	0.12***	-0.02	-0.11***
(absolute t-value)	(8.70)	(9.49)	(0.15)	(1.79)	(7.36)	(0.68)	(0.12)	(7.57)	(1.57)	(4.57)
Distance (to country j)	-0.79***	-0.13***	0.05**	0.07***	-0.15***	-0.04**	-0.07***	-0.16***	-0.04***	-0.02*
	(11.60)	(7.69)	(2.17)	(2.98)	(7.29)	(2.14)	(3.11)	(9.77)	(2.69)	(1.68)
Relative Income	-0.45***	5.62***	5.42***	6.2^{0***}	1.78***	3.57***	2.49***	2.18***	3.06***	3.27***
	(4.40)	(6.41)	(7.54)	(8.82)	(2.93)	(5.96)	(4.14)	(4.61)	(7.49)	(8.74)
Per Capita Income (j)	1.95***	-2.68***	-2.34***	-2.73***	-1.12**	-1.90***	-1.42***	0.82**	-1.13***	-1.29***
	(7.08)	(6.41)	(4.64)	(5.61)	(2.43)	(3.90)	(3.25)	(2.53)	(3.86)	(4.93)
Population (j)	1.48***	1.60***	1.69***	1.71***	1.15***	1.29***	1.16***	1.27***	1.38***	1.29***
(25.32)	(36.84)	(39.77)	(35.99)	(39.82)	(37.74)	(37.51)	(47.70)	(47.59)	(44.57)	
US Per Capita Income	2.14	6.88***	5.61***	5.95***	2.30***	2.71***	2.24***	3.42***	3.21***	3.31***
	(1.34)	(6.36)	(5.85)	(6.21)	(2.85)	(3.31)	(2.84)	(5.13)	(5.10)	(5.64)
US Population	0.93	6.96**	8.70***	10.39***	-7.88***	-3.47***	-5.57***	-2.40	0.52	1.19
	(0.20)	(2.10)	(3.02)	(3.45)	(2.68)	(1.18)	(1.91)	(1.10)	(0.26)	(0.62)
Relative Price	-0.58*	-4.25***	-3.43***	-3.80***	2.97***	2.43***	2.83***	-0.08	-0.10	-0.30
	(1.70)	(8.17)	(7.50)	(8.51)	(6.04)	(5.17)	(5.31)	(0.27)	0.33)	(1.09)
Time	-0.36	-0.18**	-0.20***	-0.23***	0.15**	0.07	0.11*	0.03	-0.02	-0.03
	(0.71)	(2.47)	(3.18)	(3.57)	(2.40)	(1.06)	(1.83)	(0.73)	(0.40)	(0.64)
English Language	1.49***	0.62***			1.1.56***			1.03***		
	(7.15)	(5.39)			(14.06)			13.27)		
Adjacency			2.69***			2.43***			2.19***	
			(15.31)			(16.69)			(18.37)	
Australia				-0.64***			0.65**			-0.38***
				(3.63)			(2.47)			(3.17)
Canada				2.84***			2.43***			2.41***
				(15.07)			(17.33)			(19.47)
United Kingdom				-0.16			1.63***			1.14***
				(1.40)			(16.17)			(13.19)
Intercept	-32.67	-82.48**	-101.45***	-119.82	87.77***	38.54	63.15**	27.41	-5.05	-10.97
	(1.45)	(2.32)	(3.30)	(3.73)	(2.79)	(1.22)	(2.03)	(1.17)	(0.24)	(0.54)
R-squared	0.21	0.80	0.83	0.83	0.76	0.73	0.77	0.85	0.86	0.88

** denotes statistical significance at the 10 percent level*
*** denotes statistical significance at the 5 percent level*
**** denotes statistical significance at the 1 percent level*

FIGURE 1. OLS coefficients of US imports on immigrant stock by year

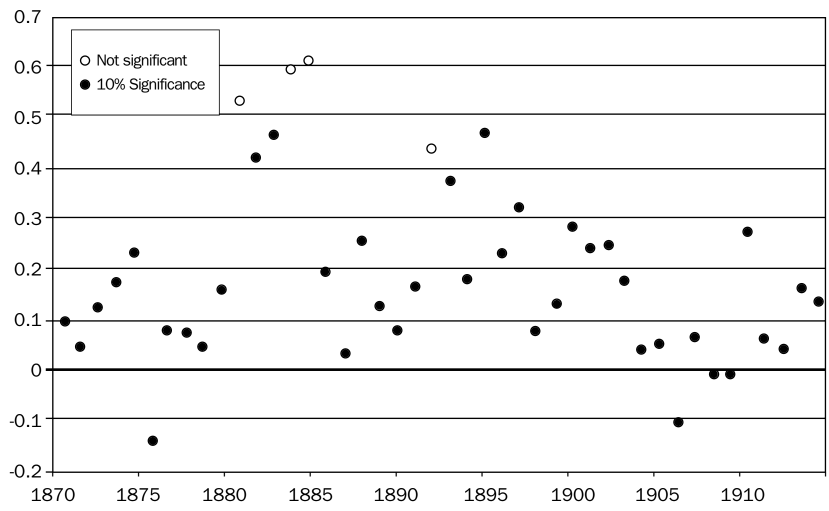

FIGURE 2. OLS coefficients of US exports on immigrant stock by year

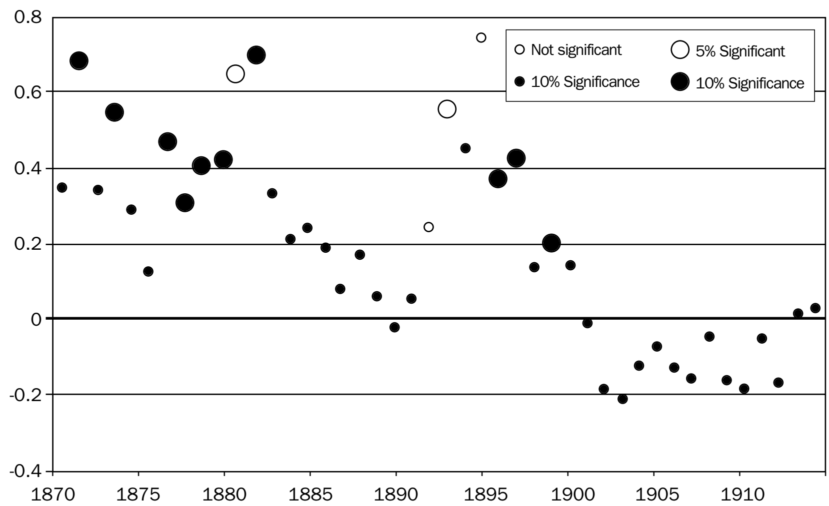

TABLE 2. NLS panel estimates of gravity equation model			
Dependent Variable:	**Import Values**	**Export Values**	**VT Values**
Variables:			
US GDP	2.21***	0.79	1.42**
(absolute t-value)	(4.75)	(0.83)	(1.97)
GDP (j)	1.57***	0.76***	1.12***
	(17.17)	(8.04)	(16.04)
US Population	-2.85***	-0.92	-1.65
	(4.01)	(0.50)	(1.19)
Population (j)	0.69	0.46***	0.16**
	(0.74)	(4.73)	(2.20)
US GDP Deflator	4.20***	-1.54**	0.69
(7.00)	(2.11)	(1.26)	
GDP Deflator (j)	-4.27***	2.24***	-0.54
	(9.26)	(4.79)	(1.51)
Immigrant Information			
Variable	4.24***	2.35	4.59
	(3.96)	(0.22)	(0.58)
Information Sensitivity	1548.38**	-67.84	51.58
Parameter	(2.26)	(-0.24)	(0.47)
R-squared adjusted	0.9947	0.9948	0.9973

** denotes statistical significance at the 10 percent level*
*** denotes statistical significance at the 5 percent level*
**** denotes statistical significance at the 1 percent level*

FIGURE 3. OLS coefficients of US VT on immigrant stock by year

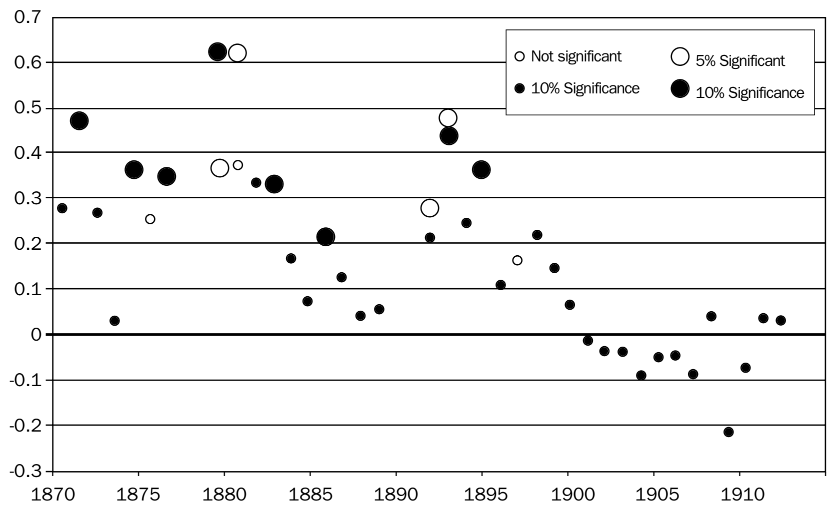

TABLE 3. Dollar value changes in bilateral trade from one additional immigrant in 1913

	Immigrant Stock (1913)	Imports	Exports	VT
		(absolute t-values reported in parentheses)		
Australia				
New Zealand	9,493	644.14 (0.22)	-479.58 (0.14)	92.57 (0.04)
Austria	845,422	34.83 (0.68)	-13.72 (0.07)	15.55 (0.10)
Belgium	56,206	88.65 (0.00)	-179.78 (0.02)	-281.74 (0.02)
Canada	1,189,079	159.72 (0.85)	-39.77 (0.96)	-81.58 (0.37)
Denmark	185,265	-34.05 (0.34)	-30.25 (0.05)	-31.98 (0.05)
Finland	142,981	0.00 (0.00)	0.15 (0.00)	0.15 (0.00)
France	132,582	213.43 (0.42)	-60.08 (0.03)	98.31 (0.03)
Germany	2,308,687	31.14 (0.07)	270.78 (0.40)	274.37 (0.90)
Italy	1,488,842	2.80 (0.19)	-1.20 (0.00)	0.09 (0.02)
Japan	70,848	-1.43 (0.00)	7.58 (0.00)	3.34 (0.00)
Netherlands	125,919	246.55 (0.09)	-195.83 (0.14)	-50.93 (1.03)
Norway	398,012	91.57 (0.26)	-87.30 (0.42)	-11.38 (0.33)
Portugal	63,239	-39.62 (0.06)	218.84 (0.39)	52.57 (0.36)
Sweden	661,072	34.70 (0.36)	2.24 (0.75)	9.46 (0.20)
Switzerland	124,349	177.53 (1.25)	103.10 (0.15)	212.55 (0.92)
United Kingdom	2,554,085	363.54 (4.28)	172.03 (2.14)	497.18 (3.79)
Total (using Panel Estimates)	**10,356,081**	**0.06 (0.00)**	**0.00 (0.00)**	**0.01 (0.00)**