The international mobility of highly educated workers among OECD countries*

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In this study, we specify and estimate an augmented gravity model of the determinants of bilateral migration flows across OECD countries. Our specific focus is on the migration of highly educated workers (HEWs), and the impact on migration of bilateral trade and foreign direct investment (FDI). We argue that transnational corporations are efficient, direct channels for the movement of HEWs across international borders. Our results confirm the importance of FDI and trade as determinants of migration flows: both are complements to migration. We also find that migration of HEWs is greater between countries with large populations and less when geographic, linguistic and religious "distances" are relatively large. Migration is also influenced by labour market conditions. Specifically, migrants tend to leave countries where economic conditions are relatively poor (high unemployment; low GDP per capita) and move to areas where conditions are better. Finally, the results indicate that there are important differences in the determinants of migration outcomes by level of education. In particular, we find evidence that bilateral trade and FDI have a greater impact on the migration of HEWs. In addition, highly educated migrants are more influenced by the "pull" of economic conditions in host countries, while those with less education are more heavily influenced by the "push" of economic factors in their home countries.

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1. Introduction

While the forces of globalization that have increased flows of goods and capital also appear to have facilitated the international mobility of highly

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educated and skilled workers (Lopes, 2004; Docquier and Lodigiani, 2007), the precise determinants of the international flows of such workers are not yet clear, in part because consistent international data on the migration patterns of highly educated workers (HEWs) have been unavailable until recently. Therefore, although there is a substantial literature on migration, both within and between nations (recent examples include Pedersen et al., 2004; Gonzalez and Maloney, 2005; Mayda, 2005; Peri, 2005; Docquier and Marfouk 2006), there are relatively few studies that focus specifically on HEWs.[1] As a result, there is a substantial amount of theorizing about the determinants of HEW migration with relatively limited accompanying empirical evidence. In particular, there is limited evidence regarding the impact of trade and foreign direct investment (FDI) on the international flows of HEWs.

The primary purpose of this study is to specify and estimate a model of international migration using relatively recent OECD data that distinguish migrants by education levels and country of origin. We employ a gravity model specification to estimate the determinants of bilateral migration among OECD countries using data for both sending and receiving countries, while focusing particularly on the impact of bilateral movements of trade and FDI. We also add explanatory variables that account for cross-county differences in economic, geographic and cultural "distance". The model is estimated for both HEWs and other migrants in order to identify what might be unique about the impact of trade and FDI on HEW migration.[2]

It can be argued that transnational corporations (TNCs) are efficient, direct channels for the movement of HEWs across international borders. Specifically, the internal labour markets of TNCs can be used to re-locate people across international borders, particularly HEWs with knowledge or skills that can be efficiently shared across the locations in which the TNC operates. For example, Mahroum (1999) notes that the migration of managers and executives often originates with temporary intra-corporate transfers that, later, turn into longer term, or even permanent moves. Thus, the extent of bilateral FDI can have a potentially important influence on bilateral migration flows. To the extent that TNCs use internal labour

[1] For relatively recent studies, see Peri (2005) and Docquier and Marfouk (2006).

[2] It should be noted explicitly that the OECD data identify migrants, and not strictly employed migrants. That is, the data do not specifically identify workers, but more accurately potential workers. While it seems reasonable to conclude that most highly educated migrants obtain employment in host country labour markets, the foregoing distinction should be borne in mind. Nevertheless, for convenience, we may occasionally refer to highly educated "workers" rather than the more precise highly educated "individuals".

markets to reallocate managers and technical personnel who are resident in different countries across transnational production units around the world, FDI and the migration of HEWs will be complements.[3] Docquier and Lodigiani (2007) find evidence of such complementarity in that the emigration of skilled migrants appears to encourage future inflows of FDI to the home countries. Using United States Census data, Kugler and Rapoport (2007) find that skilled migration and FDI inflows are negatively correlated contemporaneously, but past skilled migration is associated with an increase in current FDI inflows. Buch et al. (2003) find a relatively strong link between the stocks of German migrants and the stocks of FDI abroad but the link between the immigration of foreigners to Germany and FDI inflows is weaker. Aroca and Maloney (2004), on the other hand, find that FDI and labour flows are substitutes in the case of Mexico. Hence, there is no strong consensus on whether FDI and labour flows are complements or substitutes and there are very few studies of the empirical linkage between FDI and the migration of HEWs specifically.[4]

At a general level, both the migration of HEWs and FDI flows represent movement across borders of relatively mobile factors of production that are directly or indirectly human capital intensive. Factors that conceptually influence the migration decisions of HEWs are similar in many cases to those that conceptually influence FDI movements, particularly the degree of economic and social development of sending and receiving countries, and the sizes of the sending and receiving countries' economies. In theory, FDI and international migration might be substitutes or complements, and the relationship could be different for HEWs and other migrants (Kugler and Rapaport, 2007). FDI and migration might be substitutes, for example, if FDI results in migrant workers in the home country being displaced by local workers in the host country. Alternatively, FDI and the migration of HEWs might be net complements if TNCs use internal labour markets to reallocate managers and technical personnel who are resident in different countries across transnational production units around the world.

Similarly, trade and migration are likely to be linked directly. The efficient exploitation of information about trade opportunities and key success factors in importing and exporting activities may require the physical movement of HEWs across countries. Effectively, labour

[3] An offsetting factor might be noted. If FDI increases real wages in the host country, outbound migration might be reduced at the margin.

[4] The latter two studies focus on total immigrants and not specifically HEWs.

mobility is an instrument for diffusing information about geographically segmented markets (Combes *et al.*, 2005). At the same time, FDI is indirectly linked to the migration of HEWs through the relationship between trade and FDI. A substantial share of international trade takes the form of intra-firm trade carried out by TNCs, and for that reason trade and FDI tend to be complements (Globerman and Shapiro, 2002). The implication for models of HEW migration is that trade-creating FDI can be expected to encourage HEW migration flows.[5]

In sum, we suggest that a key input to the efficient operation of TNC global networks is the effective diffusion of information and skills within the TNC that requires substantial intra-corporate transfers of HEWs among TNC affiliates. These transfers create a complementary relationship between the mobility of HEWs and both FDI and trade flows.

In fact, a key empirical finding of our study is that HEW migration is strongly complementary to FDI and trade flows suggesting that the migration of HEWs is increasingly an aspect of the global production systems created and operated primarily by TNCs. We also find that while local economic conditions in the home and host countries are important determinants of migration for individuals at all levels of attained education, the "pull" factor of host country conditions is apparently more significant the higher the individual's formal education level. Both physical and cultural distances between host and home countries influence migration, although not identically across different levels of education.

The remainder of the article proceeds as follows. Although it is somewhat unusual to begin with a discussion of data, we do so in section 2, where we describe the OECD migration data employed in our empirical analysis. The data report *stocks* of immigrants and emigrants for 29 OECD countries. Immigration and emigration data are reported for three categories of educational attainment. The stock data therefore reflect the cumulative flow of both permanent and temporary potential workers at different educational levels over past decades, as reflected in 2000 Census data or equivalent sources.

[5] The potential for the participation of migrants in trade networks to increase trade by reducing transaction and other types of information costs is discussed by Gould (1994), Rauch and Trindade (2002) and Docquier and Lodigiani (2007), among others; however, this potential is not explicitly linked to intra-industry trade among TNC affiliates.

Section 3 presents a simple model of international migration decisions which we use to derive an equation to be estimated, based on the gravity model. In the gravity equation, the logarithm of the number of foreign born persons in any one country that originate in a second OECD country are regressed on a number of variables that measure characteristics of both countries. Section 4 discusses the specification of that equation, mainly with respect to the choice of explanatory variables.

Section 5 presents and discusses the empirical results. The results suggest that the international migration of individuals is well-explained by a model that includes both economic and non-economic variables. As noted above, we find that bilateral movements of goods and capital are positively related to bilateral movements of people. Thus, the globalization of economic relationships is important to our understanding of international migration. Although we expected these relationships to be more important for HEWs, we find that they affect all international migration. Nevertheless, some differences exist between the determinants of HEW migration and total migration. A summary of our findings is presented in section 6.

2. The OECD database

Our empirical analysis is based on recently published OECD data on migration patterns for individuals possessing different levels of education.[6] These data are collected in a uniform way, thereby addressing some previous problems surrounding earlier studies of international migration patterns. In particular, many countries previously reported data only for the number of foreign nationals, rather than the number of foreign-born. A focus only on foreign nationals is likely to understate considerably the number of immigrants (Dumont and Lemaitre, 2004).[7] Moreover, it might distort comparisons across countries to the extent that the ratio of foreign nationals to total immigrants varies across

[6] The underlying data are described in J.C. Dumont and G. Lemaitre (2004, 2005). Peri (2005) uses this data set for his empirical model of international migration. A similar database has been constructed by Docquier and Marfouk (2004, 2006). However, Docquier (2006, p. 5) reports a very high correlation between the Docquier-Marfouk and Dumont-Lemaître estimates of emigration rates by educational attainment (between .88 and .91) for 2000.

[7] In a small number of cases, the foreign born classification may reflect the separation of previously integrated countries. Thus, defining migrants on the basis of country of birth may be especially problematic for some countries such as the Czech Republic and Slovakia which used to be one country.

countries. The OECD database provides an internationally comparable data set with detailed information on the foreign-born population of OECD countries, by country of origin and by level of education. Thus, this data set allows a reliable means to compare immigrant populations across countries and, importantly, to identify the migration patterns of HEWs.

The OECD data report stocks of immigrants and emigrants in 29 OECD countries based on country of birth. For most countries, the data were collected from population censuses or population registers that identified people by country of birth and level of education. In some cases, such as the Republic of Korea and Japan, where country of birth was not available, nationality was used as a proxy measure for country of birth. For most countries, the data are recorded as of 2000, and for most countries the data were obtained from population census for the year 2000. For the 29 countries participating in the data collection, fairly detailed data were obtained. The objective was to minimize the number of residual categories ("Other"). As a result, 227 OECD and non-OECD countries and areas were identified as "countries of birth" for each of the 29 OECD countries. By focusing on country of birth, the OECD data provide a more comprehensive measure of international migration than earlier databases because they include all migrants, and not just those who are permanent residents. For the purposes of this study, we focus on the bilateral flows among OECD countries.[8]

The education and skill qualifications were based on the International Standard Classification of Education System (ISCED). Since data were unavailable for all countries on a sufficiently detailed basis, the ISCED system was used to create three broad categories of education: less than upper secondary (ISCED 0/1/2); upper secondary and post-secondary non-tertiary (ISCED 3/4) and tertiary (ISCED 5/6). A residual category was also created for "unknown status".

Evidently, creating the data involved a variety of judgments, including those regarding how to define countries.[9] Perhaps the most important point to note is that the immigration data are stocks, not flows. The stock data therefore reflect the cumulative flow of permanent and temporary workers over past decades as reflected in 2000 Census data or equivalent sources. It is likely that the stock of immigrants reported

[8] We focus exclusively on OECD countries because reliable data on bilateral FDI flows for the period of this study were available only for those countries.

[9] Many of these issues are discussed more fully in Dumont and Lemaitre (2004).

in 2000 census migrated in the 1980s and, particularly, in the 1990s. For one thing, a substantial percentage of immigrants who migrated in earlier decades are likely to be deceased. For another, temporary immigration based upon work-related visas was substantially greater in the 1990s than in earlier decades. The implication is that the most relevant determinants of the immigrant stocks reported in the OECD database are likely to reflect economic and other conditions prevalent in the 1980s and 1990s, rather than much earlier periods.

Table 1 provides a summary of some elements of the data. Specifically, it reports the percentage of foreign born, the major OECD country of origin for foreign born, the percentage of foreign-born immigrants possessing a tertiary education and the percentage of expatriates possessing a tertiary education. As can be seen in column 1 of table 1, there is considerable variation across countries in the percentage of foreign-born with the "settlement" countries of Australia, Canada and New Zealand having foreign-born populations as a share of total population well above the OECD mean. It is also seen that Luxembourg and Switzerland have foreign-born populations that exceed 20 percent of total population, while some European countries, including Austria, Germany and the Netherlands, have percentages that exceed that for the United States. As noted by Dumont and Lemaitre (2004), the percentages reported in column 1 are appreciably higher than those obtained when immigration is measured on the basis of foreign-born nationals, and this is particularly true for Europe.

The immigrants originated from over 200 counties and areas, but in this study we focus only on OECD countries of origin. Column 2 identifies the most prominent OECD country of origin for each of the OECD countries in the sample. For the most part, these are also the largest source countries in general, e.g. the United Kingdom It can also be seen that the largest source country is often characterized by former colonial ties, (the United Kingdom is the largest source country for Australia, Canada and New Zealand), by contiguous borders (Germany with Austria and Poland), or by previous history (Czech Republic and Slovakia; the United Kingdom and Ireland). In addition, the importance of Turkish immigrants, often as guest workers, across Europe is clearly evident. Columns 3 and 4 illustrate the propensity of the highly educated to migrate. Specifically, the mean percentage of foreign-born with a tertiary education is well above the population means for the sample countries, as is the percentage of expatriates with a tertiary education.

Table 1. OECD Sample Characteristics

	(1) Percentage foreign born	(2) Major OECD country of origin	(3) Percentage of foreign born with tertiary education	(4) Percentage of expatriates with tertiary education
Australia	23.0	United Kingdom	42.9	43.6
Austria	12.5	Germany	11.3	28.7
Belgium	10.7	France	21.6	33.8
Canada	19.3	United Kingdom	38.0	40.0
Czech Republic	4.5	Slovakia	12.8	24.6
Denmark	6.8	Turkey	19.5	34.6
Finland	2.5	Sweden	18.9	25.4
France	10.0	Portugal	18.1	34.4
Germany	12.5	Turkey	15.5	29.5
Greece	10.3	Germany	15.3	16.1
Hungary	2.9	Slovakia	19.8	28.7
Ireland	10.4	United Kingdom	41.0	23.5
Italy	n.a.	n.a	n.a.	12.4
Japan[1]	1.0	United States	n.a.	48.9
Republic of Korea[1]	0.3	Japan	32.2	43.2
Luxembourg	32.6	Portugal	21.7	26.2
Mexico	0.5	United States	37.8	5.6
Netherlands	10.1	Turkey	17.6	34.0
New Zealand	19.6	United Kingdom	31.0	40.6
Norway	7.3	Sweden	31.1	32.1
Poland	2.1	Germany	11.9	25.7
Portugal	6.3	France	19.3	6.5
Slovakia	2.5	Czech Rep.	14.6	13.8
Spain	5.3	France	21.8	18.0
Sweden	12.0	Finland	24.2	37.8
Switzerland	22.4	Italy	23.7	35.8
Turkey	1.9	Germany	16.6	6.3
United Kingdom	8.3	Ireland	34.8	39.2
United States	12.3	Mexico	25.9	48.2
Total	7.8		22.8	28.9

Source: Compiled by the authors from the OECD Database on Immigrants and Expatriates which is described in Dumont and Lemaitre (2005).

The immigration data employed in this study therefore cover 29 OECD countries for which bilateral data are available.[10] Two types of migration data were available: foreign born (the number of foreign born in country *i* originating in country *j*) and foreign nationals (the number of foreign nationals in *i* originating in *j*). Within each category, the data identify migrants by their level of education (high, medium and low). In this study, we employ foreign born as the measure of international migration because using foreign nationals understates the degree of immigration (Dumont and Lemaitre, 2004). However, as is seen in table 2, these measures are highly correlated, particularly across comparable

[10] The countries are listed in table 1. Italy was not included as a home country, because data were not available, but was included as a source country.

education categories. For example, the correlation coefficient for total migration (FORT and NATT) is r = 0.849, whilst that for high education (FORH and NATH) is r = 0.808.[11] The correlation coefficients among educational categories are also quite high. Thus, countries receiving high levels of one type of migrant from another country tend to receive more of all types of migrants.[12]

Table 2. Means and Correlation Matrix, Immigration Variables*

	Mean (sd)	FORT	FORH	FORM	FORL	NATT	NATH	NATM	NATT
FORT	23298 (258445)	1.000							
FORH	4253 (17717)	.687	1.000						
FORM	6219 (58312)	.993	.740	1.000					
FORL	12076 (189012)	.994	.611	.977	1.000				
NATT	20637 (106012)	.849	.827	.868	.814	1.000			
NATH	5084 (22860)	.425	.808	.470	.356	.802	1.000		
NATM	7291 (37196)	.765	.814	.804	.721	.962	.811	1.000	
NATL	7867 (54493)	.948	.696	.941	.696	.936	.560	.845	1.000

Source: Authors.

VARIABLE DEFINITIONS:
FOR: number of foreign born in country *i* originating in country *j*. FORT= total, FORH=high education, FORM=medium education, FORL= low education.

NAT: number of foreign nationals in country *i* originating in country *j*. NATT= total, NATH=high education, NATM=medium education, NATL= low education

* The number of observations for the calculation of correlation coefficients is 606. For means and standard deviations, n = 747 for FOR and 606 for NAT.

3. Modelling international migration

The conceptual foundation of economic models of migration is the assumption that an individual will seek to migrate from one location to another only if the expected present value of the anticipated

[11] Given this high correlation, it is not surprising that the empirical results do not change in any material way when foreign nationals is used as the dependent variable for model estimation.

[12] This does not gainsay the fact that some countries (e.g. the United States and the United Kingdom) enjoy higher ratios of HEWs to total workers compared to other countries, e.g. France and Germany. See Peri (2005).

benefits exceeds the expected present value of the anticipated costs. The substantive theoretical and empirical issues therefore involve the identification of the important determinants of the anticipated benefits and costs.

A basic framework of a model of migration is provided in Gonzalez and Maloney (2005). In their model, the potential migrant chooses among a set of possible destinations. If *j* is the region of origin and *i* is the migration region chosen, the migration decision reflects the value of the function identified in equation 1:

$$(1) \quad I^* = V_i - V_j - C \ ,$$

where I* is the potential migrant's overall level of welfare in any of *k* countries, V_i is an indirect utility function reflecting the pecuniary and non-pecuniary attributes of living and working in specific country *i*; V_j is an indirect utility function reflecting the attributes of living and working in specific country *j*; and C is a measure of the direct and indirect costs of migrating between the two countries.

The utility of living and working in any country *j* is assumed to be a linear or log-linear combination of location characteristics denoted as a vector X in equation 2:

$$(2) \quad V_j = (X_j)B + \varepsilon_j \ ,$$

where B represents a vector of coefficient values reflecting the importance of the individual location attributes of country *j* to the utility of living and working in country *j* and ε represents random determinants of the indirect utility of living and working in country *j*.

If any specific destination region is more desirable than a specific originating region, and if the migrant has sufficient resources to move, migration from *j* to *i* will take place. That is, migration will take place if the expected value of I* is greater than zero. From equation 1, the expected value of I* will be greater than zero if the expected value of $(V_i - V_j - C)$ is greater than zero. Equivalently, by virtue of substituting equation 2 into equation 1, the likelihood of migrating from region *j* to region *i* is expressed by equation 3:

$$(3) \quad \text{Prob } (I^* > 0) = \text{Prob } ((X_i)B + \varepsilon_i - (X_j)B - \varepsilon_j) - C)) > 0 \ .$$

Assuming that the ε terms are randomly distributed around a mean value of zero, equation 3 suggests that if we observe actual migration from region *j* to region *i*, it is because the weighted value of

the attributes of living and working in region *i* impart greater utility than the weighted value of the attributes of living and working in region *j*.[13] That is, observed migration from *j* to *i* (M_{ij}) will be a function of X_i, X_j and C.

$$(4) \quad M_{ij} = f(X_i , X_j , C) .$$

The specification of a migration model therefore requires specifying the vectors X_i and X_j for all sample countries, as well as the precise functional form of the equation. We discuss the X-vectors in the next section, and here focus on functional form, for which we employ a gravity model.

Gravity models have become the standard technique for the empirical analysis of inter-regional and international bilateral flows of capital and goods. The basis of most empirical models of bilateral trade and FDI flows is the "barebones" gravity equation, whereby any interaction between a pair of countries is modelled as an increasing function of their sizes and a decreasing function of the distance between the two countries (Sen and Smith, 1995; Frankel and Rose, 2002). Indeed, the gravity equation has become "the workhorse for empirical studies….to the virtual exclusion of other approaches", (Eichengren and Irwin, 1998, p. 13).[14] While this statement was written with reference to trade flows, the logic of the gravity model also underlies migration studies (recent examples include Karemera *et al.*, 2000; Gonzalez and Maloney, 2005; Mayda, 2005; Peri, 2005) and FDI studies (Hejazi and Safarian, 2001; Hejazi and Pauly, 2005).

The underlying logic of applying the gravity model to migration was first set out by Zipf (1946). Clearly, the likelihood of an individual migrating from any country should increase as the population of that country increases, holding other factors constant. Less obviously, the likelihood of that individual migrating to any specific country should increase as the total population of the specific country increases, to the extent that potential receiving countries have implicit or explicit targets, or quotas, on allowable numbers of immigrants that, in turn, are functions of total population of potential host countries.[15]

[13] In a cross-section of paired countries, migration from region *j* to region *i* would indicate that region *i* is preferable to all other possible regions for the relevant observations.

[14] Frankel and Rose (2002) also note that the gravity equation as applied to international trade is one of the more successful empirical models in economics.

[15] For additional discussion of how the supply and demand for migrants can be linked to the sizes of the sending and receiving countries, see Karemera *et al.* (2000).

Accordingly, we employ a gravity model specification such that bilateral flows from *j* to *i* are directly proportional to the "mass" of *i* and *j*, and inversely proportional to the "distance" between *i* and *j*, where distance can be interpreted to include geographic, cultural and economic distance. Thus, we estimate variations of equation 5:

$$(5) \qquad M_{ij} = f\left((POP_i \times POP_j), D_{ij}, L_{ij}, Z_{ij} \right) .$$

In the equation, M_{ij} represents migration from country *j* to country *i*; POP is the population of each country;[16] D is vector of terms representing measures of geographic and socio-cultural distance between *i* and *j*; the L terms represent economic distance in terms of labour market differences (unemployment rates and average real wages); and the Z's reflect other attributes of countries *i* and *j* that might plausibly affect migration between the two countries. In our case, the Z vector includes measures of bilateral trade and FDI, as well as a dummy variable equal to unity when the United States is the receiving country. These variables are discussed in the next section.

4. Model specification: independent variables

The dependent variables M_{ij} have been discussed above, and are based on the OECD data. The full set of explanatory variables included in the model, with their predicted impact on migration, is summarized in table 3, and the variables are more fully defined in table 4. Before considering each variable, three broad comments are in order.

First, although we have not to this point explicitly distinguished HEW migration from other migration, we do so in table 3. Although the hypothesized direction of the impact of each explanatory variable is the same for all types of migration, we suggest that the magnitude may differ. We will argue below that an important difference between HEW and other migration is likely to be linked to the trade and FDI variables. However, where relevant, we will also note other cases where the impact of a specific variable might be different for HEWs.

The latter suggest another possibility. Namely, that as more resources are diverted to a growing home population, attractive opportunities available to migrants decline, thereby discouraging migration to growing countries.

[16] In migration models, it is typically population measures that serve as a measure of mass (Zipf, 1946; Gonzalez and Maloney, 2005). In trade and FDI models, GDP is more typically employed. Estimates replacing POP with GDP are similar to those reported below.

Table 3. Expected Signs of Explanatory Variables

Variable	Highly educated migrants (j to i)	Other Migrants (j to i)
Log (POPi*POPj)	+	+
Distance between i and j	-	--
Adjacent Countries	+	++
Common Language	+	++
Common Religion	+	+
Unemployment rates,(i – j)*	-	-
Log GDP per capita,(i – j)*	+	+
Human Development Index (HDI),(i – j)*	+	+
Government revenues as percentage of GDP,(i – j)*	-	-
Former Socialist Country	-	-
United States	++	+
Log (EXPORTSij*EXPORTSji)**	++	+
Log (FDIij*FDIji)**	++	+

Source: Authors.

Country *i* is the host country, and country *j* is the home country. (i – j) indicates that the variables are calculated as differences. Detailed definitions are found in Table 4. The direction of the hypothesized effects are indicated by + (positive) and – (negative), but the magnitudes may differ between highly educated and other migrant samples. Where we hypothesize this to be the case, double signs are used. For example, in the text we suggest that trade and FDI variables should have a more significant impact on highly educated migration, whereas physical distance and common language will be more important for other migrants..

* Denotes labour market variables (L)
** Denotes trade and FDI variables (Z)

Second, in table 3, we present a specification in which the relevant variables are defined as either differences between country *i* and country *j* (as is the case with the labour market variables) or log products (as is the case with the trade/FDI variables). Alternative specifications are possible. For example, in migration gravity models, it is often the case that labour market variables are measured as ratios (Lowry, 1966). We also estimate the models using ratios in place of differences, and the results are similar. Perhaps more important is the issue of whether host and home effects should be entered separately. The variable specification reported in table 3 essentially assumes that home and host effects are equal. This may not be appropriate in a migration equation, since it has sometimes been found that destination area variables have a greater influence on the migration decision than originating area variables (Gonzalez and Maloney, 2005; Peri, 2005). F-tests were not always conclusive with regard to this restriction, and we therefore first present and discuss the restricted model, and later present results using an unrestricted model (where home and host variables are entered separately, and not as differences or products).

Table 4. Variables, Definitions and Data Sources

VARIABLE	DEFINITION	SOURCE
Log (POPi*POPj)	POPi is the populations of the host country; POPj is the population of the home country, averaged 1985−2000 (five year intervals).	United Nations Statistics Division - Common Database
Distance	Log of weighted distance between major cities in each country (in kilometers).	CEPII (see Mayer and Zignano, 2006)
Adjacent Countries	A dummy variable =1 if country i and country j share a common border.	CIA World Fact Book
Common Language	A dummy variable =1 if country i and country j share a common official language.	John Haveman's International Trade Data. http://www.macalester.edu/reasearch/economics/PAGE/HAVEMAN/trade.resources/tradedata.html#Gravity
Common Religion	A dummy variable =1 if country i and country j share a common religion.	Sala-i-Martin (1997) http://www.colombia.edu/~xs23/data.htm
Difference in unemployment rates, ij	Difference in unemployment rates, averaged over the period 1985−2000 (five year intervals).	International Labour Organization, Geneva - LABOURSTA - Labour Statistics Database
Difference in log GDP per capita, ij	GDP per capita measured in terms of purchasing power, averaged over 1985−2000 (five year intervals).	United Nations Statistics Division - Common Database
Difference in Human Development Index (HDI), ij	HDI includes measures of GDP per capita, education and health. Averaged over the period 1996−2000.	Reports on Human Development, United Nations Development Programme
Difference in government revenues as percentage of GDP, ij	Government revenues as a percentage of GDP measured in constant US dollars, and averaged over 1985−2000 (five year intervals).	Penn World Data
Former Socialist Country	A dummy variable = 1 if either country i or country j were formerly officially a socialist country.	Authors' calculation
United States	A dummy variable = 1 if the United States is the host country	Authors' calculation
Log (EXPORTSij *EXPORTSji)	Exports from i to j and from j to i, measured in constant US dollars and averaged over 1985−2000 (five year intervals).	United Nations Statistics Division - Common Database
Log (FDIij*FDIji)	FDI inflows from i to j and from j to i, measured in constant US dollars and averaged over 1994−2000.	OECD - International Direct Investment Statistics Year Book 1989-00

Third, it is important to recall that the dependent variable, M_{ij}, is in fact the stock of people born in country *j* now residing in country *i* in 2000. As noted above, this stock reflects the cumulative migration of people, mainly over the previous 10–20 years. As a consequence, we measure the explanatory variables over that period. Where possible, variables are measured over the period 1985–2000, but in some cases (noted in table 4) shorter time periods were required because of data availability.

Most studies proxy migration costs using various measures of distance. Dostie and Leger (2004) suggest that the physical distance between origin and destination locations might be a good proxy for the costs associated with migrating from one location to another. Gonzalez and Maloney (2005) link physical distance to moving costs but see networks of migrants from the same home country as an important factor influencing the costs directly or indirectly borne by immigrants associated with assimilating into the host country. Pedersen *et al.* (2004) and Mayda (2005) use dummy variables for countries that share common borders and common languages as proxies for migration costs. Presumably, employment should be easier to secure when the migrant already possesses host country language skills; however, since HEWs are more likely to have acquired other languages, a common language at the country level may be a less relevant determinant of HEW migration.[17]

We include four "distance"-related variables (physical distance, adjacent country, common language and common religion). Physical distance accounts for both transportation and communications costs. The expected effect on migration is negative, because the costs of acquiring information, communicating with potential employers and travelling between the originating and destination countries will increase with physical distance. We suggest, however, that the impact of physical distance will be less for HEWs, who are both better able to afford the pecuniary costs associated with travel and have better access to transaction-cost reducing means of communication and information gathering (such as the Internet).[18] For international migration, it is not obvious how to measure physical distances, since distances will also be functions of location within countries. Accordingly, we use the weighted distance measure provided by CEPII as described in Mayer and Zignano (2006). In addition, however, we also include a dummy variable for geographic adjacency to account for the ease of movement across common borders. Other things equal, adjacency should encourage migration. For similar reasons as above, we expect the effect of geographic adjacency to be weaker for HEWs than for other migrants.

[17] A number of authors have noted that foreign students enrolled in host country educational institutions obtain country-specific knowledge that, in turn, reduces the costs normally associated with migration to that host country as an HEW in the future (Tremblay, 2004). In some cases, foreign students may retain their residency in the host country by converting their visa status upon obtaining permanent employment.

[18] Arguably, physical distance, *per se*, should increasingly be a less important influence on migration decisions as costs of communicating with family and friends in the home country, as well as costs of traveling between home and host countries, decline in real terms.

In addition to physical distance measures, we account for the effects of non-physical distance by including two variables reflecting specific socio-cultural differences between countries. One is a dummy variable identifying whether countries *i* and *j* share a common language. A second dummy variable identifies whether the two countries share a common religion. We expect that countries sharing common languages and religions will experience greater bilateral migration flows. Of these variables, the one most likely to differ in impact between HEW and other migrants is the language variable. To the extent that HEWs are more likely to acquire capabilities in languages other than those of their home country, the effect of common official languages may be weaker for HEWs.

We also include a dummy variable for countries that were officially socialist over parts of the relevant time period. Such countries had in place restrictions on the movement of people, both inward and outward, that would result in lower levels of migration, all other thing equal. We therefore include this term as a control variable and expect its sign to be negative.[19]

A specific assumption in most models of migration is that prospects of higher real income levels associated with labour market employment are the main anticipated benefit associated with migration (Head and Ries, 2004). The OECD (2002) highlights the presumed importance of labour market conditions in noting that differences in skills premia, job opportunities and career opportunities are key drivers of the mobility of highly qualified individuals in the new global economy.

Most econometric analyses of bilateral migration flows do find that labour market conditions, as measured by relative unemployment and wage rates, are important determinants of migration decisions (Pedersen *et al.*, 2004; Gonzalez and Maloney, 2005; Mayda, 2005). We employ four broad measures of labour market conditions, although two are somewhat indirect. The first is the difference in unemployment rates between *i* and *j*. Unemployment rate differences between countries are likely to provide a meaningful demarcation between countries in terms of

[19] The dummy variable for "socialist countries" is meant to capture the immigration and emigration policies of those countries. It may also, in part, capture the measurement problems created by the division of Czechoslovakia as discussed in footnote 7. It is acknowledged that a focus on former socialist countries ignores potentially important differences in immigration and emigration polices across other countries in our sample; however, it is extremely difficult to measure and compare such policies across countries for purposes of regression analysis.

the likelihood of finding employment within any period of time and with normal search behaviour.[20] For this variable, it is plausible that a migrant from country *j* will react to information about unemployment rates in country *i* differently from information about unemployment in country *j*, perhaps because it is easier to verify information about labour market conditions in country *j*. In this case, it might be appropriate to allow for the estimation of separate coefficients for the two unemployment variables. On the other hand, if the migrant's criterion strictly involves a comparison of labour market conditions between countries, holding other determinants of migration constant, then the ratio specification of the unemployment rates is arguably more appropriate. Because HEW migrants are more likely to have access to information, the assumption of equal coefficients is more likely to be justified for HEWs.

Another labour market-related variable is real per capita income in countries *i* and *j*. Higher per capita incomes are indicators of higher average wages. Higher values of real per capita income therefore signal the potential for higher real incomes to potential migrants from lower income countries. The use of purchasing power equivalent exchange rates to convert per capita income values into United States dollars for purposes of defining the variable mitigates any measurement error that might result from not incorporating cost-of-living measures explicitly into the migration equation. In addition, real per capita income also implicitly measures a variety of economic and social amenities that might influence migration decisions. For example, education and health care infrastructure is likely to be more advanced in high-income countries. We try to isolate the labour market- related influence of real per capita income from the indirect (amenity) influence by using the UN index of human development (HDI) as an additional variable. In fact, the two variables are highly correlated, and we ultimately employ them as separate measures.[21] The general hypothesis is that larger differences in income per capita or HDI in favour of the host country will encourage migration.

[20] Unemployment rate differences across countries may vary by education and skill level. However, consistent data on unemployment rates by education/skill level are not available for our sample period.

[21] As with the unemployment variable, there is a specification issue regarding the per capita income variables. Namely, should the variables be entered separately and thereby be allowed to take on separate coefficients, or should the relevant variable be specified as a ratio of per capita income values of the countries involved? As in the case of unemployment rates, we try both specifications.

Borjas (1987) argues that what matters for migration incentives are not just the average incomes in the destination and origin countries but the dispersion of incomes. While Borjas has in mind dispersion across skill levels, dispersion across workers within skill levels might also be relevant. Simply put, migration might be encouraged if the income rewards to "better performance" are relatively high compared to the rewards for "average" performance, even holding skill level constant. This phenomenon might help explain why the United States attracts relatively large numbers of immigrants at all skill levels even after differences in average wages between the United States and other countries are taken into account. The relatively large income dispersion in the United States, both within and across educational attainment levels, in comparison to other high-income OECD countries, could act as an inducement to migrants to the extent that those interested in migrating see themselves as having above-average talent for their educational cohort.[22] To acknowledge this possibility, we include a dummy variable whose value equals unity when the United States is the receiving country and zero otherwise.

Different tax rates may be an important component of the migration decision, particularly for HEWs, although the evidence is equivocal on the importance of tax rate differences as an incentive for HEW migration (Globerman, 1999, Wagner, 2000). An indirect effort to estimate the influences of taxes on migration decisions is made by including a variable measuring the share of government revenues in GDP in country *i* relative to that same ratio for country *j*. In the absence of explicit and relevant marginal tax rates for each of the sample countries, the share of government revenues in GDP is used as a proxy for the average tax rate facing workers in that country; however, to the extent that the progressivity of tax rates varies across countries, this average measure will fail to identify accurately differences in marginal tax rates, particularly for (higher income) HEWs. Other unique circumstances of HEWs in different national tax jurisdictions may also make this average tax rate proxy a biased measure of the tax burden facing HEWs in specific countries. The hypothesis is that migrants will move from high- to low-tax jurisdictions, other factors held constant.

A particular focus of this study is the inclusion in the migration equation of variables relating to trade and FDI. As suggested above, the internal labour markets of TNCs can be used to relocate people

[22] For some recent data on income distribution patterns in OECD countries, see Forster and d'Ercole (2005).

across borders, and this is particularly true for HEWs with idiosyncratic knowledge of host and home country conditions, or with technical and managerial skills that are especially valuable to the home or the host country affiliate. Thus, we include a term for the degree of bilateral FDI between i and j, and expect it to have positive impact on bilateral migration, particularly for HEWs. We initially employ a specification in which FDIij and FDIji are entered in multiplicative form, because it is the total interaction that should determine migration flows.

The potential relevance of the multiplicative specification can be illustrated as follows. Imagine that a company based in country j acquires a company based in country i. The acquiring company might well transfer managers and other HEWs to the acquired company to assist in the transfer of parent company technology and other firm-specific assets. At the same time, the acquired company might transfer managers and other HEWs to the acquiring company to assist in the integration of operating systems and other aspects of consolidation. Similarly, if a company from country i were to acquire a company in country j, the former might also transfer HEWs from j to i to assist in the integration of the two companies. Thus, FDI flows from i to j might be indirectly linked to migration of HEWs from j to i; however, it seems plausible that the FDI flow from j to i is the more important influence on HEW migration from j to i. Hence, we also employ a specification that focuses on the FDI flow from j to i exclusively.

Similar considerations apply to bilateral trade. Much international trade takes the form of intra-firm trade carried out by TNCs, and such trade may require employees with specialized knowledge about local markets. The effective diffusion of information within the TNC network might involve substantial intra-corporate transfers of HEWs among TNC affiliates, contributing to international migration. Even in the case of arms-length trade, migrants with knowledge of trading conditions in different countries have potentially valuable human capital to employers in trading partner countries. Thus, we expect a positive effect of bilateral trade on migration, and, in particular, on HEWs. Because FDI and trade tend to be complements, it may be difficult to separate the effects of the trade and FDI variables in capturing the enhanced returns to mobility associated with a greater demand for HEWs as agents that facilitate international business.

As specified, the estimated equation assumes that causality runs from FDI/trade to migration. However there is some evidence to suggest

that causality might also run in the opposite direction.[23] Given the relatively small share of the total work force that consists of immigrants in most countries, and the even smaller HEW portion of the workforce, our inclination is that any statistical influence running from migration flows to FDI or trade is likely to be quite weak, and that ordinary least squares estimation of the migration equation, including FDI and trade as independent variables, is unlikely to be troubled by significantly biased coefficients. In addition, although the migration of HEWs from country *j* to country *i* might make country *i* a more attractive location in which to locate from the perspective of foreign investors, there is no obvious reason to believe that the migration of HEWs from *j* to *i* would make country *j* a more desirable location for MNC affiliates. Hence, by specifying the relevant independent variable as the product term of the bilateral FDI flows, the potential endogeneity of the FDI variable should be mitigated. Nevertheless, we do test for exogeneity of the FDI and trade terms, and estimate the migration equation using instrumental variables as necessary.

The inclusion of the trade and FDI terms also limits the need to consider other potentially relevant variables frequently included in models of international trade or FDI. One such variable is whether countries *i* and *j* belong to a free trade area or a common market. A second is whether the countries share a common currency.[24] The inclusion of such variables is likely to be superfluous once trade and FDI are included in the model, since both trade and FDI should be strongly and positively related to conditions such as membership in a common market or use of a common currency. Formal trade agreements such as NAFTA might still be relevant independent variables to the extent that they incorporate provisions that ease restrictions on the migration of HEWs between

[23] Head and Ries (2004) note the potential for two-way causality between the migration of HEWs and FDI stocks. Specifically, the activities of TNCs in a country should promote increases in HEWs. At the same time, TNCs will be attracted to locations with a relative abundance of HEWs, as the FDI literature tends to suggest (Eaton and Tamara,1994; Mody and Srinivasan,1998; Checchi *et al.* (2007). In addition, the presence of relatively large numbers of foreign-born HEWs in a host country might promote increased trade between that country and parent countries of the migrants, especially if the migrants possess proprietary knowledge about foreign markets that lowers transaction and information costs associated with international trade. For a theoretical discussion of this possibility, see Globerman (1994). See Gould (1994), Rauch (2001), Rauch and Trinidade (2002) and Head and Ries (2001) for some empirical evidence on the linkage between migration and subsequent changes in international trade.

[24] For examples of the use of these variables in trade models, see Chen (2004) and Slangen *et al.* (2004).

countries. However, almost all of these agreements are encompassed by the variables indicating common borders and/or common language.

The definition of each variable, together with the source of the data, is reported in table 4. The major issue with respect to the data pertains to the bilateral FDI data. These data were obtained from the *International Direct Investment Statistics Year Book 1989-2000,* published by the OECD. These data are, in turn, obtained from national statistical sources, often in local currencies. As a consequence for many countries there are two available estimates of FDI: outflows from *i* to *j*, as recorded by *i*, and inflows from *i* to *j*, as recorded by *j.* While in principle these numbers should be the same, that is often not the case, and in some cases the discrepancy is large. We adopted the convention of using the data as recorded by the host country, on the grounds that countries are more likely, and more able, to track inflows accurately. However, this also means that inflows and outflows are often recorded in different currencies and therefore sensitive to exchange rate values. We used both nominal and PPP United States dollar exchange rates to convert reported FDI values, although there were no significant differences in results using either method. However, of all the data employed in this study, the FDI data are possibly subject to the largest measurement errors.

5. Estimation results

We first examine results using the most parsimonious specification, in which all relevant variables are expressed as either differences or log products. We later consider alternative specifications and the problem of endogeneity.

Table 5 reports the means and standard deviations (in parentheses) for the independent variables, as well as the correlation coefficients among the independent variables. The simple correlation coefficients are quite low with a few exceptions. One is the .703 correlation coefficient between the product term for bilateral exports between countries *i* and *j* and bilateral FDI between the two countries. The relatively strong positive correlation between bilateral trade and bilateral FDI is unsurprising. As noted earlier, the bulk of international trade among developed countries is carried out by TNCs, and most previous studies indicate that FDI and trade are complements. Another strong correlation exists between the differences in per capita GDP between countries and the difference in scores of the HDI in the two countries. This is also not surprising given that the HDI includes GDP per capita. As a consequence, however, we do not use HDI and GDP per capita in the same equation. We do include

Table 5. Means and Correlation Matrix, Independent Variables

	Mean (sd)	1	2	3	4	5	6	7	8	9	10	11	12
1. Log (POPi*POPj)	5.30 (2.14)	1.000											
2. Distance	7.99 (1.16)	.176	1.000										
3. Adjacent Countries	0.08 (0.27)	.054	-.424	1.000									
4. Common Language	0.07 (0.26)	.057	-.016	.298	1.000								
5. Common Religion	0.44 (0.49)	-.016	-.299	.233	.164	1.000							
6. Unemployment Rates (Difference)	-.153 (5.11)	.103	.013	-.005	.026	.099	1.000						
7. Log Per Capita GDP (Difference)	.006 (0.64)	-.223	-.005	-.025	-.057	-.072	-.263	1.000					
8. HDI (Difference)	.002 (0.06)	-.152	-.008	.006	.003	.001	-.107	.687	1.000				
9. Government Revenues (Difference)	-.012 (5.64)	.054	-.012	-.006	-.014	-.157	-.021	-.040	-.230	1.000			
10. Former Socialist Country	.27 (0.44)	.117	-.250	.081	-.121	.168	-.017	.051	.026	-.024	1.000		
11.Log (EXPij*EXPji)	10.13 (4.31)	.394	-.394	.393	.214	.195	.002	-.023	.003	.041	-.117	1.000	
12.Log (FDIij*FDIji)	11.72 (7.78)	.174	-.273	.235	.160	.245	.008	.030	.025	.031	-.200	.703	1.000

Source: Authors.

both FDI and trade in the same equation, but as reported below, the outcome is problematic.

Table 6 reports regression results for two groups of migrants. Our primary focus is on highly educated migrants in a sample country *i*, born in another country *j* (FORH). These results are reported in columns (1)–(5). We compare these results to a second sample, the total number of low education migrants in country *i* who originated in country *j* (FORL).[25] These results are reported in columns (6)–(10).[26]

Equations (1), (2), (5) and (6) report regression results of an augmented gravity equation that excludes the bilateral export and bilateral FDI variables. The odd-numbered equations report estimates using HDI, while the even numbered ones replace that term with GDP per capita. In all four equations, all coefficients have the expected signs, and all are statistically significant, with the exception of the government revenues term. Although this particular result may reflect measurement error owing to the limitations on interpreting this variable as a measure of relative tax rates in the two countries, it is consistent with most previous research suggesting that differences in tax rates may not be significant influences on migration decisions.[27]

For the most part, all of the other independent variables in the four equations are statistically significant at the .05 level. Of particular interest, higher unemployment rates in the host country relative to the home country discourage migration, while higher relative standards of living/GDP per capita in the host country encourage migration. Variables serving as proxies for lower costs of migration (physical distance, adjacency, common language and common religion) all perform as expected, i.e. lower costs of migration significantly promote increased migration. However, we do not find that physical distance is a lesser deterrent to HEWs, as we had hypothesized. In contrast, the effects of language and religion are similar for both groups. Also, countries which were once officially "socialist" both sent and received lower number

[25] We also estimated the same equations for the total sample of migrants, and for all migrants who are not HEWs. These results do not change our conclusions.

[26] Because country-pair data were missing in specific cases, the total number of observations is less than the potential number (29 x 28 = 812) country-pair observations.

[27] Our measure of government revenues may also fail to accurately identify public social expenditures which could influence migration decisions. However, the HDI term might be an indirect measure of public social expenditures.

Table 6. The Determinants of International Migration: Regression Results

	High Education Migrants					Low Education Migrants				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log (POPi*POPj)	.582*	.659*	.268*	.539*	.257*	.488*	.687*	.338*	.542*	.334*
	(.031)	(.030)	(.0324)	(.032)	(.031)	(.032)	(.037)	(.043)	(.039)	(.043)
Distance	-.378*	-.405*	-.223	-.252*	.223	-.653*	-.688*	-.198*	-.544*	-.196*
	(.062)	(.061)	(.064)	(.064)	(.064)	(.075)	(.070)	(.087)	(.078)	(.088)
Adjacent Countries	.735*	.690*	.226	.671*	.247	1.238*	1.144*	.858*	1.197*	.888*
	(.247)	(.229)	(.214)	(.241)	(.214)	(.289)	(.2255)	(.286)	(.291)	(.150)
Common Language	1.832*	1.814*	1.421*	1.777*	1.447*	1.531*	1.512*	1.221*	1.451*	1.211*
	(.215)	(.218)	(.184)	(.217)	(.181)	(.269)	(.260)	(.253)	(.278)	(.255)
Common Religion	.543*	.574*	.347*	.391*	.384*	.527*	.584*	.387*	.425*	.421*
	(.122)	(.116)	(.104)	(.123)	(.108)	(.154)	(.144)	(.146)	(.156)	(.150)
Difference in unemployment rates, i -j	-.076*	-.046*	-.062*	-.082*	-.060*	-.063*	-.061*	-.051*	-.067*	-.051*
	(.012)	(.011)	(.010)	(.012)	(.007)	(.014)	(.012)	(.014)	(.015)	(.014)
Difference in Log GDP per capita, i –j		1.102*					1.780*			
		(.104)					(.134)			
Difference in Human Development Index (HDI), i - j	6.811*		5.416*	6.754*	5.283*	12.728*		11.636*	12.585*	11.558*
	(.982)		(.786)	(.957)	(.797)	(1.295)		(1.260)	(1.317)	(1.292)
Difference in government revenues as % of GDP, i -j	-.002	-.005	-.003	-.002	-.003	.010	-.006	.011	-.008	.012
	(.010)	(.009)	(.008)	(.009)	(.008)	(.013)	(.011)	(.012)	(.013)	(.013)
Former Socialist Country	-1.504*	-1.546*	-.485*	-1.151*	-.545*	-1.810*	-1.874*	-1.046*	-1.531*	-1.081*
	(.137)	(.131)	(.135)	(.156)	(.142)	(.171)	(.161)	(.199)	(.196)	(.135)
United States	1.802*	1.328*	.974*	1.465*	.996*	1.712*	1.022*	1.095*	1.431*	1.091*
	(.206)	(.192)	(.183)	(.221)	(.188)	(.321)	(.285)	(.329)	(.350)	(.341)
Log (EXPORTSij*EXPORTSji)			.282*		.305*			.211*		.221*
			(.016)		(.020)			(.025)		(.029)
Log (FDIij*FDIji)				.008*	-.002				.006*	-.001
				(.002)	(.002)				(.002)	(.002)
Intercept	6.118*	5.926*	-8.385*	4.959*	-9.064*	7.748*	7.438*	-3.126*	6.746*	-3.441*
	(.524)	(.498)	(.531)	(.539)	(.980)	(.623)	(.571)	(1.426)	(.661)	(1.502)
Adjusted R Square	.543	.590	.672	.567	.676	.480	.547	.527	.489	.525
Observations	747	746	743	698	698	747	746	743	698	698

Source: Authors.

* Indicates statistical significance at the 5% level; ** indicates statistical significance at the 10% level. Values in parentheses are heteroskedastic-consistent standard errors.

of migrants, other things equal, while the United States received more immigrants of all kinds.

In equations (3)–(5), and (8)–(10), the product terms for bilateral trade and FDI are added, first one at a time and then together. For these purposes, we use the more general HDI measure, but the results are similar when GDP per capita is used in these same equations. When entered alone, both the trade and FDI terms are positive, and statistically significant in all equations. For the most part, all other variables are unaffected by the addition of these terms. In addition, while both terms add to the explanatory power of the model, the addition of the trade term creates a substantial increase in the R^2 (compare columns 1 and 3; 5 and 8). Thus, comparable estimation results for the two sets of coefficients reinforce our interpretation of the linkages between FDI, trade and migration. Specifically, the human capital of HEWs is complementary to other assets possessed by TNCs that facilitate profitable trade and FDI carried out primarily by those same TNCs. Although trade and FDI also affect low education migration, the effects are less pronounced, a result discussed further below.

Equations (5) and (10) include both bilateral trade flows and bilateral FDI flows in the estimating equation. Given the strong correlation between the two variables, there is a concern about multicollinearity, and it is perhaps not surprising that only one is statistically significant: the trade variable. On the surface, the result suggests that trade flows are a more important determinant of HEW migration than FDI flows; however, it is impossible, as a practical matter, to separately identify the impact of trade versus FDI on HEW migration when the bulk of international trade is carried out by TNCs. In addition, the potential measurement issues regarding bilateral FDI noted above contribute to the uncertainty regarding the precise strength of its influence on migration.

A question that might be asked is whether trade carried out by TNCs has a stronger effect on HEW migration than inter-firm trade. To gain some insight into this issue, we replaced the bilateral FDI variable in equations (5) and (10) with an interaction variable, the bilateral trade variable multiplied by the bilateral FDI variable (not reported). In this specification, if the coefficient for the interaction variable is positive and statistically significant, it would indicate that intra-firm trade undertaken by TNCs has a greater impact on HEW migration than trade in general. However, this variable proved not to be statistically significant in either equation. Taken at face value, this latter result suggests that the complementary relationship between migration and

trade is not necessarily enhanced when trade takes the form of intra-firm exports and imports within TNCs.

In general, the results for the low education migration equations are qualitatively similar to those for the highly educated migrants even when the multiplicative trade and FDI terms are added. However, the magnitude and statistical significance of some key coefficients does vary across the sets of equations. Thus, there are some important factors that distinguish HEW migrants from others. The most of important of these are the effects of physical distance, national income (HDI), trade and FDI. HEWs are less constrained by the costs associated with physical distance. They are also less attracted by differences in living standards. The larger coefficient for the HDI term for low education migrants (also found for GDP per capita) implies that less well educated migrants are more responsive to pecuniary income differences across countries, whereas highly educated workers are more likely to move to countries with more comparable standards of living. At the same time, HEWs are more attracted by bilateral trade and FDI (though the latter difference is not statistically significant), as we hypothesized. However, one of the possible expected differences discussed in the previous section is not evident. The coefficient for common language is somewhat greater for the highly educated migrant cohort. Although this result is not what was expected, it perhaps reflects the fact that highly educated migrants are more likely to pursue jobs that require a high degree of literacy, thereby requiring fluency or near-fluency in the language of the host country.[28]

As discussed in the previous section, an important specification issue in gravity models is whether variables expressed as differences or log products should be entered separately. We therefore estimated models in which all relevant variables (unemployment rates, HDI, GDP per capita, government revenues, bilateral trade and bilateral FDI) were included in unrestricted form. For example, in the case of HDI, the unrestricted specification includes both HDIi and HDIj, whereas the restricted specification includes (HDIi - HDIj). In the case of FDI, the restricted specification is log (FDIij*FDIji) whereas the unrestricted specification includes log FDIij and log FDIji individually. However, specifications involving both FDI terms were problematic because the terms are highly collinear and, when entered separately, the coefficient

[28] In their study of international emigration, Docquier and Sekkat (2006) find that "linguistic proximity" is a significant influence on emigration only for high-skill migrants. They also report that high-skill workers are more affected by differences in terms of living standards compared to unskilled workers, although emigration rates for both are negatively related to physical distance and to the unemployment rate at the destination country. Hence, our findings are quite similar to their reported results.

on one or both is not statistically significant. The same was true for the export terms.[29] As a consequence, we could include only one FDI (and export) term in each specification. Given our speculation that flows from j to i are likely to be more important influences on HEW migration, we adopted a final specification that includes only exports and FDI from j to i (home to host).[30] These results are presented in table 7.

Since GDP per capita and HDI could not be included in the same equation, we report separate specifications using each variable. Similarly, since the FDI and trade terms could not be entered together, we report results separately for each. Since the results were similar for all cases, we report the trade equations using GDP per capita, and the FDI equations using HDI. We report each equation for the most highly educated migrants (FORH), and the least highly educated migrants (FORL). The relevant results are found in table 7, columns (1)−(4).

For comparable variables, the results reported in table 7 are not very much different from those discussed above. However, the results in table 7 also reveal greater differences among migrants with different levels of education. In particular, the trade and FDI terms are still more important for HEWs, but the differences are more pronounced and are statistically significant. Moreover, it is clear that "pull" factors (those associated with the host country, *i*) are relatively more influential for highly educated migrants. In contrast, "push" factors (those associated with the home country, *j*) are relatively more important for migrants in the lowest education category. For the most part, unemployment rates, GDP per capita and HDI in country *i* are more important relative to the comparable effects in country *j* for those with the highest levels of education.[31]

These results suggest that highly educated migrants are likely to do well in their home country, and therefore require more positive incentives to re-locate. In addition, they are likely to have more information about host country markets. Those with lower levels of

[29] As a consequence, the outcome of F-tests comparing restricted and unrestricted models depends on the specification. For example, when a restricted model (models reported in table 6) is tested against an unrestricted model which includes both FDI terms, the restricted model is accepted. When only one FDI term is included in the unrestricted model, the latter is accepted.

[30] We also estimated models with only the reverse (*i* to *j*) flows of exports and FDI, but do not present them. They are discussed in the text.

[31] This result is also consistent with findings reported in Docquier and Sekkat (2006).

education leave when local conditions deteriorate, and may have less information about potential destinations.

The estimated coefficients for the United States dummy variable are suggestive, inasmuch as they indicate that the United States attracts more of all types of migrants, holding other factors constant. The results are consistent with our speculation that migrants at all educational levels who view themselves as potentially above-average performers in the receiving country see greater economic opportunities in the United States than in other countries beyond the differences suggested by disparities in average wage or income levels.

The results in table 7 continue to indicate that FDI and trade are important determinants of migration flows, and that both variables are more strongly related to the migration of HEWs than other migrants. However, these results focus on the flows from *j* to *i*. When we estimate the equations including only trade and FDI flows from *i* to *j*, the results are weaker, as we had speculated. Although both variables are positive and statistically significant in all equations, the evidence that they have a greater effect on HEWs is weaker. In addition, because of the collinearity associated with these variables, we are unable to say whether the trade and FDI effects are best captured by the total size of the FDI and trade networks (the interactive product term) or by individual bilateral trade and FDI effects. This issue should be pursued in subsequent research.

As discussed above, there is reason to believe that the potential endogeneity of the FDI and trade variables may create biased estimates, and that our results might not be robust to specifications that account for the potential endogeneity of these variables. Thus, unobserved variables may simultaneously affect immigration, trade and FDI, and/or two-way causality may exist. For example, unobserved heterogeneity across countries may result in simultaneous movement of capital, goods and people, or strong trade and FDI links may result from immigration. As a consequence, we adopted an instrumental variables estimation procedure, using a method initially proposed by Evans and Kessides (1993), but more recently employed by Edwards and Waverman (2006) and Cubbin and Stern (2006).

We constructed a rank based instrument for all trade and FDI variables, including the interaction terms reported in tables 6 and 7. For example, following Edwards and Waverman (2006), we sorted the log (FDIij*FDIji) variable into three ranks (1, 2, 3) and so created

an FDI rank index. By construction, this rank index is correlated with the original FDI term, and will also be orthogonal to the error term if exogenous disturbances do not affect a country's rank, a condition that is unlikely to be violated except for observations near the rank thresholds. For this reason, the number of ranks should be relatively small. A regression of this rank index on the FDI variable produced an R^2 of .90. Following Cubbin and Stern (2006), the residual from that equation was used to test for endogeneity, and the predicted value of FDI derived from this equation was used as an instrument for estimation by instrumental variables. A similar procedure was used for FDI_{ij} and FDI_{ji} separately, and

Table 7. The Determinants of International Migration: Additional Regression Results

	(1) HIGH	(2) LOW	(3) HIGH	(4) LOW	(5) HIGH (IV)	(6) LOW (IV)
Log (POPi*POPj)	.480*	.494*	.542*	.508*	.542*	.490*
	(.049)	(.056)	(.032)	(.037)	(.031)	(.037)
Distance	-.025	-.315*	-.281*	-.533*	-.254*	-.496*
	(.071)	(082)	(.062)	(.075)	(062)	(.075)
Adjacent Countries	.415*	1.054*	.713*	1.420*	.718*	1.412*
	(.210)	(.263)	(.233)	(.284)	(.230)	(.283)
Common Language	1.425*	1.208*	1.665*	1.372*	1.648*	1.325*
	(.194)	(.245)	(.203)	(.257)	(.199)	(.252)
Common Religion	.339*	.451*	.337*	.451*	.331*	.403*
	(.103)	(.136)	(.117)	(.152)	(.117)	(.152)
Unemployment i	-.022**	.074	-.089*	-.010	-.083*	.014
	(.013)	(.088)	(.016)	(.021)	(.016)	(.020)
Unemployment j	.066*	.098*	.083*	.146*	.079*	.143*
	(.015)	(.020)	(.018)	(.023)	(.018)	(.021)
GDP per capita i	1.345*	1.795*				
	(.198)	(.244)				
GDP per capita j	-.334*	-1.246*				
	(.130)	(.208)				
HDI i			15.195*	17.013*	14.121*	15.821*
			(1.358)	(1.834)	(1.390)	(1.857)
HDI j			.861	-7.700*	1.157	-8.083*
			(1.509)	(2.220)	(1.468)	(2.173)
Ratio of government revenues	-.003	.001	-.001	-.012	-.001	.011
as percentage of GDP, i -j	(.008)	(.011)	(.010)	(.014)	(.009)	(.013)
Former Socialist Country	-.698*	-1.464*	-.905*	-1.652*	-.857*	-1.531*
	(.135)	(.193)	(.152)	(.207)	(.149)	(.208)
United States	.640*	.805*	1.486*	1.771*	1.389*	1.609*
	(.192)	(.309)	(.209)	(.351)	(.205)	(.347)
Log (EXPORTSij)	.397*	.259*				
	(.047)	(.062)				
Log (FDIij)			.066*	.030	.071*	.027
			(.018)	(.023)	(.016)	(.020)
Intercept	-13.60*	-6.35*	-9.02*	-2.38	-8.95*	-2.06
	(2.12)	(3.12)	(1.92)	(2.75)	(1.93)	(2.77)
Adjusted R Square	.684	.593	.598	.508	.596	.507
Observations	742	742	698	698	698	698

Source: Authors.

* indicates statistical significance at the 5% level; ** indicates statistical significance at the 10% level. Values in parentheses are heteroskedastic-consistent standard errors. HIGH refers to highly educated migrants; LOW to low educated migrants. Log (EXPORTSij) and Log (FDIij) refer to movements from j to i. Columns (5) and (6) present results obtained by using instrumental variables estimation (IV).

for the trade terms. We adopted this technique because of the difficulty in finding suitable and different instruments (different variables that are both correlated with the suspected endogenous variable and uncorrelated with the error term) for *both* the trade and FDI terms.[32]

The results suggest that although the trade and FDI terms are endogenous, the instrumental variables estimates are not different in any material way from the OLS estimates reported in tables 6 and 7. As an example, we provide one set of estimates in columns (5) and (6) of table 7. Other results are similar in that none of the estimated coefficients are impacted in any significant way through estimation by instrumental variables.[33]

6. Summary and conclusions

In this study, we specify and estimate an augmented gravity model of the determinants of bilateral migration flows across OECD countries. Our specific focus is on HEWs, and the impact on migration of bilateral trade and FDI. We argue that TNCs are efficient, direct channels for the movement of HEWs across international borders. This study adds to the literature in two main ways. First, it employs relatively recent data that distinguish migrants by level of education. Second, it includes measures of both bilateral trade and FDI as determinants of bilateral migration flows.

The primary migration data employed in this study are based on the stock of foreign born individuals from country *j* in country *i*, organized by level of education. There is a relatively high level of correlation among the various education categories: countries with high numbers of foreign born from a specific home country tend to have high numbers for all education groups. We speculate that this may be linked to the importance of immigration networks within a host country that provide cultural amenities and other forms of support.

Our results indicate that bilateral migration flows for migrants at all levels of education are well explained by a basic gravity model. In particular, migration is greatest between countries with large populations,

[32] The chosen instruments must still be approached with some caution. In particular, the 2000 immigration stock measure reflects cumulative flows over the preceding 40 years, while the FDI and trade flows are measured over shorter time periods. However, the method does create rankings that are unlikely to have changed in a significant way over the years.

[33] These results are available on request.

and is reduced when geographic, linguistic and religious distances are high. Migration is also influenced by relative labour market conditions. Specifically, migrants tend to leave countries where economic conditions are relatively poor (high unemployment; low GDP per capita) and move to areas where conditions are better. Our results also confirm the importance of FDI and trade as determinants of migration flows. We find that both are complements to migration. In general, we find no evidence that higher levels of bilateral trade or FDI replace movements of labour. This stands in contrast to Gonzales and Maloney (2005) who include both trade and FDI variables in their examination of migration *within* Mexico and find that they are substitutes. Clearly, more research on this issue is required.

Finally, our results indicate that there are important differences in the determinants of migration outcomes, by level of education. In particular, highly educated workers are less constrained by physical distance and are more likely to move to countries with similar standards of living. Importantly, highly educated migrants are more influenced by the "pull" of economic conditions in host countries. In contrast, workers with less education are more heavily influenced by the "push" of economic factors in their home countries. We also find evidence that highly educated migration is more responsive to bilateral trade and FDI flows. All results are robust to correction for the potential endogeneity of trade and FDI variables.

An important policy implication of our results is that macroeconomic performance is an important determinant of migration. In particular, a robust labour market and a rising real income level are strong attractions for migrants, especially HEWs. As is true in so many areas of economic policy, conditions encouraging real economic growth stimulate investment decisions that contribute further to future real economic growth. In this regard, while an increasing number of developed countries have been focusing on specialized programmes to encourage immigration of HEWs, it may well be that conventional public policies focused on promoting long-run real economic growth are more powerful factors encouraging the immigration of HEWs. At the same time, these same policies should also encourage the retention of native-born HEWs

Perhaps the most important policy inference emerging from this study is that policies to promote deeper trade and investment integration have important implications for attracting and retaining HEWs, as well as other migrants. Most trade agreements, particularly bilateral agreements,

have traditionally focused on reducing barriers to the movement of goods and capital. Our results suggest that this focus is incomplete because it ignores a major complement to trade and investment, namely migration. By ignoring or minimizing the importance of provisions for liberalized migration most trade agreements are therefore arguably failing to exploit the full benefits arising from the complementarity among increased international flows of goods, capital and highly educated workers.

References

Aroca, P. and W.F. Maloney (2004). "Migration, trade and FDI in Mexico", Washington, D.C.: World Bank, mimeo.

Borjas, G.J. (1987). "Self-selection and the earnings of immigrants", *American Economic Review*, 77, pp. 531–553.

Buch, C.M., J. Kleiner and F. Toubal (2003). "Where enterprises lead, people follow? Links between migration and German FDI", *Working Paper*, No. 1190, Kiel.

Checchi, Daniele, Gianfranco De Simone and Ricardo Faini (2007). "Skilled migration, FDI and human capital investment", *Discussion Paper*, No. 2795, Bonn: IZA.

Chen, Natalie (2004). "Intra-national versus international trade in the European Union: Why do national borders matter?", *Journal of International Economics*, 63(1), pp. 93–118.

Combes, Pierre-Philippe, Miren Lafourcade and Thierry Mayer (2005). "The trade-creating effects of business and social networks: evidence from France", *Journal of International Economics*, 66(1), pp. 1–29.

Cubbin, John and Jon Stern (2006). "The impact of regulatory governance and privatization on electricity industry generation capacity in developing economies" , *World Bank Economic Review*, 20(1), pp. 115–141.

Docquier, F. (2006). "Brain drain and inequality across nations". Paper prepared for the EUDN-AFD conference on "Migration and Development", Paris, 8 November 2006, mimeo.

Docquier, F. and K. Sekkat (2006). "The brain drain: What do we know?", *Working Paper*, No. 31, Paris: Agence Francaise de Developpment.

Docquier, F. and A. Marfouk (2004). "Measuring the international mobility of skilled workers (1990–2000)", *Policy Research Working Paper*, No. 3381, Washington, D.C.: World Bank.

Docquier, F. and A. Marfouk (2006). "International migration by education attainment, 1990–2000", in C. Ozden and M. Schiff, eds., *International Migration, Remittances and the Brain Drain*, Washington, D.C. and NewYork: World Bank and Palgrave Macmillan, pp. 151–199.

Docquier, F. and Elisabetta Lodigiani (2007). "Skilled Migration and Business Networks" Available at SSRN: http://ssrn.com/abstract=1002649

Dostie, Benoit and Pierre Thomas Leger (2004). "A critical review of the microeconomic migration literature", *Working Paper*, 2004 D-05, Ottawa: Government of Canada, Skills Research Initiative.

Dumont, J.C. and G. Lemaitre (2004). "The OECD database on expatriates and the foreign born", *The Statistics Newsletter*, OECD, October.

Dumont, J.C. and G. Lemaitre (2005). "Counting immigrants and expatriates in OECD Countries: a new perspective", *OECD Social Employment and Migration Working Papers*, No. 25, Paris: OECD Directorate for Employment, Labour and Social Affairs.

Edwards, G.E. and L. Waverman (2006). "The effects of public ownership and regulatory independence on regulatory outcomes", *Journal of Regulatory Economics*, 29(1), pp. 23–67.

Eichengreen, Barry and Douglas Irwin (1998). "The role of history in bilateral trade flows", in Jeffrey Frankel, ed., *The Regionalization of the World Economy*, Chicago: University of Chicago Press, pp. 33–57.

Evans, W. and I. Kessides (1993). "Localized market power in the US airline industry", *Review of Economics and Statistics*, 75(1), pp. 66–73.

Forster, Michael and Marco Mira d'Ecole (2005). "Income distribution and poverty in OECD countries in the second half of the 1990s", *Social, Employment and Migration Working Papers*, No. 22, Paris: OECD.

Frankel, Jeffrey and Andrew Rose (2002). "An estimate of the effects of common currencies on trade and income", *Quarterly Journal of Economics*, May, pp. 437–466

Gonzalez, Patricio Aroca and William F. Maloney (2005). "Migration, trade and foreign direct investment in Mexico", *Research Working Paper*, No. 3601, Washington, D.C.: World Bank.

Globerman, Steven (1994). "Immigration and trade" in Don J. DeVoretz, ed. *Diminishing Returns*, Toronto: C.D. Howe Institution, pp. 243–267.

Globerman, Steven and Daniel Shapiro (2002). "Global foreign direct investment flows: the role of governance infrastructure", *World Development*, 30(11), pp. 1898–1919.

Gould, D. (1994). "Immigrant links to home country: empirical implications for U.S. bilateral trade flows", *Review of Economics and Statistics*, 76, pp. 302–316.

Head, Keith and John Ries (1998). "Immigration and trade creation: econometric evidence from Canada", *Canadian Journal of Economics*, XXXI(1), pp. 47–62.

Head, Keith and John Ries (2001). "Increasing returns versus national product differentiation as an explanation for the pattern of U.S.-Canada trade", *American Economic Review*, 91(4), pp. 858–876.

Head, Keith and John Ries (2004). "Making Canada the destination of choice for internationally mobile resources", *Discussion Paper*, No. 14, Industry Canada, January

Hejazi, Walid and Peter Pauly (2005). "How do regional trade agreements affect intra-regional and inter-regional FDI?" in Lorraine Eden and Wendy Dobson, eds., *Governance, Multinationals and Growth*, London: Edward Elgar, pp. 176–209.

Hejazi, Walid and A.E. Safarian (2001). "The complementarity between U.S. FDI stock and trade", *Atlantic Economic Journal*, 29(4), pp. 420–437.

Karemera, David, Victor Iwuagwu Oguledo and Bobby Davis (2000). "A gravity model analysis of international migration to North America", *Applied Economics*, 32, pp. 1745–1755.

Kugler, Maurice and Hillel Rapoport (2007). "International labour and capital flows: complements or substitutes?", *Economics Letters*, 94(2), pp. 155–162.

Lopes, Sandra (2004). "Canadian business perspectives on the international mobility of skilled labour", *Skills Research Initiative Working Paper*, No. 2004, D-03, Ottawa: Government of Canada.

Lowry, Ira (1966). *Migration and Metropolitan Growth: Two Analytical Models*, San Francisco: Chandler

Mahroun, Sami (1999). "Highly skilled globetrotters: the international migration of human capital", DSTI/STE/TIP, (99) 2/final.

Mayda, Anna Maria (2005). "International migration: a panel data analysis of economic and non-economic determinants", *IZA Discussion Paper*, No. 1590, May

Mayer, Thierry and Soledad Zignano (2006). "Notes on CEPII's distance measures", May 2006 (available at http://www.cepii.fr/distance/noticedist_en.pdf).

Mody, A. and K. Srinivasan (1998). "Japanese and U.S. firms as foreign investors: Do they march to the same tune", *Canadian Journal of Economics*, 31(4), pp. 778–800.

OECD (2002). *Trends in International Migration*, Paris: OECD Editions.

Pedersen, Peder, Mariola Pytlikova and Nina Smith (2004). "Selection or network effects? Migration flows into 27 OECD countries, 1990–2000". IZA DP 1104, April.

Peri, Giovanni (2005). "International Migrations: some comparisons and lessons for the European Union", Davis: University of California, mimeo.

Rauch, J. (2001). "Business and social networks in international trade", *Journal of Economic Literature*, 39, pp. 1177–1203.

Rauch, J. and V. Trinidade (2002). "Ethnic Chinese networks in international trade", *Review of Economics and Statistics*, 84(1), pp. 116–130.

Salt, J. and J. Clarke (1998). "Flows and stocks of foreign labour in the UK", *Labour Market Trends*, July.

Sen, A. and T.E. Smith (1995). *Gravity Models of Spatial Interaction Behavior*, New York: Springer.

Slangen, Arjen, Sjoerd Beugelsdijk and Jean-Francois Hennart (2004). "National cultural distance and bilateral trade flows", Tilburg University, mimeo.

Tremblay, Karine (2004). "Links between academic mobility and integration". Paper presented at "Symposium on International Labour and Academic Mobility: Emerging Trends and Implications for Public Policy", Toronto, 20 October.

Wagner, Don (2000). "Do tax differences contribute toward the brain drain from Canada to the U.S.?". Paper presented at the Canadian Economics Association Meeting, Vancouver.

Zipf, George Kingsley (1946). "The P_1P_2/D hypothesis: on the intercity movement of persons", *American Sociological Review*, II(December), pp. 677–686.