The Structure and Determinants of International Migration Flows: Harmonizing Inconsistency and Panel Data Analysis

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INTRODUCTION

The volume of immigration to highly developed nations has grown significantly over the last four decades. Today, about 60% of the world's immigrant population resides in relatively developed regions while only 33% resides in less developed regions, and the remaining 7% live in the least of all developed regions (Lowell, 2007). According to Howe and Jackson (2006), net immigration accounts for roughly 40% of total population growth in the United States and about 90% of total population growth in the EU-15 countries. And Coleman (2006) argued that a third demographic transition may be underway in Europe and the United States due to high levels of immigration and persistent below replacement level fertility. Moreover, it is highly likely that the current increasing pattern of immigration into the developed countries will continue in the foreseeable future (Coleman, 2006).

The impact of international migration is not limited to demographics; it is felt throughout economies, cultures, and political systems around the world. Hence, the demand for reliable methods that can help us to understand the determinants of bilateral international migration flows is greater than ever before. Nevertheless, there are far fewer studies on the topic than there are studies on, for example, the consequences of international migration, and this striking discrepancy is perhaps due to a paucity of data on cross-national migration streams (Mayda, 2005; Vogler & Rotte, 2000).

In addition to unavailability of data, it is very difficult to compare international migration data between countries for the following reasons. First and foremost, the threshold of duration of stay to be counted as a migrant varies from country to country. For example, Denmark defines immigrants as those who obtain residence permit or work permit of at least 3 months while Netherlands defines the duration as 6 months and United Kingdom requires at least 1 year

(Singleton, 1999; Lemaitre, 2005). Recognizing this problem, the United Nations (1998) recommends member countries define all entrants whose period of residence is at least one year regardless of the reason of admission for entry as long-term migrants and persons whose residence between three months and one year as short-term migrants. Nevertheless, it is not only extremely difficult to adapt or change national systems to meet the recommendation, but also there is little incentive for countries to commit to it (Lemaitre, 2005). Secondly, there are huge variations in migration data collection practice and methodologies across countries. In countries such as Belgium, Germany, and Sweden, migration statistics are generated from population registers while other countries, e.g. Australia, Canada, New Zealand, and United States, use residence permits to count the number of migrants, and U.K. maintains migrations data based on a survey. The different method of data collection makes a big difference in enumeration of migrants. For instance, foreign students may be recognized as migrants in the former countries whereas those are not considered as migrants unless they hold the so called green card in the latter countries. Figure 1 displays a conceptual framework for understanding the relationship between timing criteria and volume of migration flows (Raymer & Abel, 2008). It is clear that the length of timing is inversely associated with the volume of migration flows. The permanent criterion once widely used among former USSR countries reports the fewest number of migrations while the last country of residence, which is equivalent to no time criteria, explains large volume of migrants.

[Figure 1 about here]

These problems can lead to a large discrepancy in the number of migrants for same origin and destination country depending on which country reports. This problem is often referred as the “double-entry matrices (Kupiszewska & Nowok, 2005).” For instance, in 2002, Italy reported that they received 291 migrants from Denmark whereas Denmark reported they sent 777 migrants to Italy. Without a reliable method that helps judge which data is more accurate, it would not be possible to estimate international migration flows. Moreover, immigration policies based on these confusing statistics would be misleading.

Recently, Raymer and Abel (2008) suggested a method for harmonization based on expert knowledge and series of regression models as shown in the figure 2. In essence, Raymer and Abel harmonize international migration flows reported by different countries by adjusting toward statistics from four Nordic countries (Denmark, Sweden, Finland, and Norway) which are empirically proven that they produce the most reliable international migration statistics in the world (Kupiszewska & Nowok, 2005). These countries maintain a system of cross validation of number of migrants among them. They are relied on the following key assumptions: 1) the residual net migration totals reported are correct; 2) immigration data are better than emigration data within each country; and 3) emigration data is better than no data.

[Figure 2 about here]

METHODS

Data. The present analysis uses "International Migration Flows to and from Selected Countries: The 2008 Revision" from the United Nations Population Division. This document contains panel data on the flows of international migrants as recorded by 16 countries (Australia, Belgium, Croatia, Denmark, Finland, France, Germany, Hungary, Iceland, Italy, New Zealand, Norway, Spain, Sweden, the United Kingdom, and the United States). Various independent variables are taken from multiple sources: World Bank, IMF, United Nations, Freedom House, Penn World Tables, etc. We consider purchasing power parity (PPP) adjusted GDP per capita, unemployment rate, potential support ratio (PSR), distances between two capital cities, land locked location, former colonial link, and official language to test neoclassical economic theory.

Analysis. Our analysis is organized in three steps. First, following Raymer and Abel (2008)'s lead, we harmonize the available international migration data among the 16 countries. We start with two matrices of international migration flows: one is reported by receiving countries (Table 1a) and the other is reported by sending countries (Table 1b). Please note that these two matrices present the same direction of migration flows. It might be helpful to read the first table vertically while the second one horizontally. We selected year 2002 not only because most of the 16 countries have inflows and outflows data in that year although the earliest data is available from 1950, but also because Raymer and Abel used data collected from 2002 to 2005. Tables 1a and 1b clearly illustrate the double entry matrice problem. When comparing the two matrices, the Nordic countries have relatively similar figures although those are not exactly same. Cells in light gray color represent missing flows, and ones in dark gray colors are structural zeros.

[Table 1a about here]

[Table 1b about here]

To fill in the missing cells, we use a population-averaged generalized estimating equation (GEE) estimator, with which the user can add time-independent variables and can specify panels' within-group correlation structure (Liang & Zeger, 1986; Pedersen et al., 2008; Hardin & Hilbe, 2003). This is where our approach is different from Raymer and Abel. They estimated marginal totals by using OLS (Ordinary Least Square) model and similar sets of covariates as ours. They was able to use OLS based on the assumption that net migration, which is equivalent to marginal totals in the matrix, reported by national statistical offices are deemed correct. However, UN migration data are not only drawn from national censuses, but also from surveys such as UK

International Passenger Survey. Hence, unlike Raymer and Abel, we decided to fill the missing cells first and adjust the two matrices later.

One of the key advantages of GEE over other methods is that we can gain efficiency in the estimation of parameters by including a hypothesized structure to the within-panel correlation (Hardin & Hilbe, 2003). Here, we chose to specify an autoregressive within-group correlation structure because there was a significant indication of its presence.[1] Also, a negative binomial distribution of the dependent variable is assumed on the grounds that the dispersion of dependent variable is significantly greater than the mean (Walker, 2009). Table 2 presents descriptive statistics for variables used in the analysis and the table 3 reports the results of the estimation. Then, we get a predicted value for each missing cells. Note that we used coefficients from the inflow model for the cells in Table 1a, which are reported by receiving countries, and outflow model coefficients to Table 1b, missing cells reported by sending countries. We assume that the effect of each covariate is different for inflow and outflow.

[Table 2 about here]

[Table 3 about here]

Now we have complete sets of international migration flows among the 16 countries. The results are presented in Table 4a and Table 4b. Please note that 4 countries, France, Spain, UK, and USA only provide inflow statistics, and their missing cells are concentrated on the bottom of the Table 4b. Also, Croatia and UK do not produce even the inflow data for most of the origin countries.

[Table 4a about here]

[Table 4b about here]

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[1] We used XTSERIAL routine in Stata 10.1 to test the presence of within-group autocorrelation. The null hypothesis of the test is that there is no autocorrelation. Both in inflow and outflow models, the null hypothesis was rejected ($p<0.0001$).

Next step is to compute the adjustment factors for each country by following Raymer and Abel (2008). In essence, their proposed method is to compute the extent which available migration statistics are different from the four Nordic countries and to apply the result to each flow. The result is presented at that Table 5. For example, the immigration adjustment factor for Iceland is that sum of the numbers reported by the four countries is divided by the sum of the same flows reported by Iceland ([1076+37+292+419]/[1092+42+394+433]=0.930). The factor is applied to all subsequent inflows to Iceland, e.g. Belgium to Iceland reported by Iceland: 34*0.930 = 32. Once all the immigration (inflow) and emigration (outflow) are adjusted for Iceland, it is deemed to be correct and fixed. Hence, the adjusted statistics are used for calculation of adjustment for the next country, Belgium in this case. The iterative process continues until the last country statistics are adjusted.

[Table 5 about here]

The adjusted migration matrix is presented at the Table 6. The first impression is that the final matrix is similar to the inflow matrix (Table 1a) mainly due to small sizes of adjustment factor. In Raymer and Abel's study, adjustment factors for some countries such as Poland, Slovakia, and Romania exceeded 25 and they dropped those countries. And we think our UN migration data is relatively well performing. Nevertheless, we could not ascertain the order of quality of each country's migration data. This iterative method is heavily relied on the assumption that a research or an expert knows the data quality. If the order of adding country to the four Nordic countries, e.g. adjusting Germany to the 4 country instead of Iceland, is changed, the outcome might differ substantially.

[Table 6 about here]

CONCLUSION

We find the following: (1) by harmonizing inconsistencies in migration flows, we believe that we arrive at more accurate estimates of international migration flows, and (2) by using panel data analysis techniques, we correct for time independent origin-destination specific characteristics and improve model estimation to get more reliable estimate for missing flows. In this study, we attempted to extend and augment MIMOSA. Most of the previous efforts for harmonization were focused in European countries. However, we believe the harmonization of international migration statistics must be achieved at the global level.

References

Coleman, D. (2006). Immigration and ethnic change in low-fertility countries: a third demographic transition. *Population and Development Review*, 32(3):401-446.

Howe, N. & Jackson, R. (2006). Long-term immigration projection methods: current practice and how to improve it. Center for Retirement Research, working paper 2006-3. Center for Strategic and International Studies (CSIS). Washington D.C.

Kelly, J. J. (1987). Improving the comparability of International migration stastistics: Contributions by the conference of European stastisticians from 1971 to date. *International Migration Review*, 21(4):1017-1037.

Kupiszewsak, D., & Nowok, B. (2005). *Comparability of statistics on international migration flows in the European Union*. Working Paper 7/2005. Central European Forum For Migration Research (CEFMR). Warsaw, Poland.

Lemaitre, G. (2005). The comparability of International migration statistics: problems and prospects. *Statistics Brief No. 9*, Organization for Economic Co-operation and Development (OECD), Paris, France.

Lowell, B. L. (2007). *Trends in international migration flows and stocks, 1975-2005*. Social, Employment, and Migration Working Papers No. 58. Organization for Economic Co-operation and Development (OECD), Paris, France.

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

Massey, D. S., Arango, J., Hugo, G., Kouaouci, A., Pellegrino, A., & Taylor, J. E. (1993). Theories of international migration: a review and appraisal. *Population and Development Review* 19(3): 431-466.

Massey, D. S. (2006). *Patterns and processes of international migration in the 21st century: lessons for South Africa*. African Migration and Urbanization in Comparative Perspective. Johannesburg: Witts University Press.

Raymer, J., & Abel, G. (2008). *The MIMOSA model for estimating international migration flows in the European Union*. Joint UNECE/Eurostat Work Session on Migration Statistics. Geneva, Switzerland.

Raymer, J., & Rogers, A. (2007). Using age and spatial flow structures in the indirect estimation of migration streams. *Demography*, 44(2): 199-223.

Raymer, J. (2007). The estimation of international migration flows: a general technique focused on the origin-destination association structure. *Environment and Planning*, 39:985-995.

Raymer, J., & Willekens, F. (Eds.). (2008). *International migration in Europe: Data, models, and estimates.* New Jersey: John Wiley & Sons Inc.

Singleton, A. (1999). Combining quantitative and qualitative research methods in the study of international migration. *International Journal of Social Research Methodology*, 2(2): 151-157.

United Nations. (1998). *International Migration Policies*. United Nations, New York.

United Nations. (2006). *International Migration Report 2006*. United Nations, New York.

Vogler M. & Rotte, R. (2000). The effects of development on migration: theoretical issues and new empirical evidence. *Journal of Population Economics*, 13:485-508.

Table 1a. Base data reported by destination countries

2002	to															
From	Denmark	Finland	Sweden	Norway	Iceland	Belgium	NZ	Germany	Australia	Italy	Hungary	Croatia	France	Spain	UK	USA
Denmark		360	4250	3232	1093	328	111	2294	88	291	15	0	627	0	0	614
Finland	332		3532	1249	42	510	58	2026	34	253	61	0	413	0	0	429
Sweden	1110	3255		4552	394	526	216	2883	148	378	41	77	949	1730	0	1387
Norway	1812	1048	6374		433	317	111	1156	56	208	57	0	423	0	0	435
Iceland	1498	45	485	609		0	18	234	1	19	0	0	45	0	0	93
Belgium	179	151	387	198	34		83	2479	91	1807	46	0	4762	3141	0	782
NZ	63	13	136	0	13	0		412	12368	34	0	12	109	0	11900	1129
Germany	1921	854	2699	1572	195	2966	1037		759	11376	337	1340	6647	13757	0	8961
Australia	334	115	647	263	23	206	13389	2132		578	0	217	499	397	37200	2576
Italy	603	227	508	217	39	2310	166	24379	139		72	179	4876	4967	0	2605
Hungary	123	100	274	0	7	273	53	16531	81	485		0	506	0	0	1284
Croatia	15	3	150	0	5	95	33	12738	321	1310	53		235	0	0	3805
France	637	281	877	513	47	8135	483	13207	313	4894	235	0		8200	0	3824
Spain	727	525	1166	757	58	1503	91	9233	92	2316	18	0	4031		0	1376
UK	934	870	3120	1628	197	2543	19548	10239	12488	4843	326	0	9444	27249		16421
USA	1490	825	3482	1852	283	2701	3347	16688	1324	4548	398	244	4634	4016	26600	

Notes: NZ=New Zealand, UK=United Kingdom. Dark gray cells are structural zeros. Light gray cells are missing values.

Table 1b. Base data reported by origin countries

2002	to															
From	Denmark	Finland	Sweden	Norway	Iceland	Belgium	NZ	Germany	Australia	Italy	Hungary	Croatia	France	Spain	UK	USA
Denmark		376	4337	3325	1076	523	210	2700	979	777	119	27	1474	1722	4317	3010
Finland	384		3591	1186	37	222	17	730	191	183	132	2	380	724	980	1015
Sweden	1260	2692		1540	292	81	55	713	260	216	148	41	362	230	783	807
Norway	3309	1056	6357		419	157	0	679	204	162	0	0	420	1099	1300	1378
Iceland	1663	51	498	619		25	10	184	28	32	0	6	65	49	239	326
Belgium	297	278	334	200	0		0	2049	134	1551	161	16	3577	1098	1898	2484
NZ	92	32	127	69	5	58		488	24647	124	18	22	316	70	12410	2361
Germany	2974	2658	3876	1753	268	4565	756		3368	36535	16411	13728	19815	16681	16662	28758
Australia	52	37	69	0	0	0	6251	288		204	77	95	177	84	3928	791
Italy	126	149	186	109	0	1170	9	7416	326		129	333	2417	849	2741	2875
Hungary	7	8	5	4	0	4	0	57	0	13		15	30	4	31	80
Croatia	0	0	14	0	0	0	0	1446	13	24	0		0	0	0	16
France	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0
Spain	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
UK	0	0	0	0	0	0	17000	0	46800	0	0	0	0	0		35500
USA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Notes: NZ=New Zealand, UK=United Kingdom. Dark gray cells are structural zeros. Light gray cells are missing values.

Table 2. Descriptive Statistics for Variables in the Inflow and Outflow Models.

	Inflow					Outflow				
	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
Log migrants	48832	4.77	2.53	0	12.50	28826	3.78	2.43	0	12.30
Log population (destination)	48832	16.76	1.65	12.41	19.53	28826	16.12	1.95	3.91	21.01
Log population (origin)	48832	15.83	2.07	3.91	21.01	28826	16.04	1.35	12.41	18.23
Log distance between capitals (km)	48832	8.62	0.88	4.39	9.88	28826	8.50	0.98	4.39	9.88
Log land area (destination)	48832	13.63	1.89	10.33	16.12	28826	12.17	2.28	1.61	16.65
Log land area (origin)	48832	11.90	2.45	1.61	16.65	28826	12.55	1.25	10.33	15.86
Log potential support ratio (destination)	48832	1.61	0.20	1.25	2.06	28082	2.31	0.59	1.14	4.27
Log potential support ratio (origin)	46978	2.35	0.57	1.14	4.27	28826	1.54	0.18	1.25	2.02
Log percent of urban population (destination)	48832	4.35	0.11	4.00	4.58	28082	3.88	0.57	0.79	4.61
Log percent of urban population (origin)	46978	3.84	0.58	0.79	4.61	28826	4.37	0.12	4.00	4.58
Landlocked (destination)	48832	0.01	0.08	0	1	28826	0.15	0.36	0	1
Landlocked (origin)	48832	0.15	0.36	0	1	28826	0.01	0.11	0	1
Border	48832	0.03	0.16	0	1	28826	0.03	0.18	0	1
Common official language	48832	0.19	0.40	0	1	28826	0.11	0.32	0	1
Colonial link	48832	0.04	0.20	0	1	28826	0.03	0.18	0	1
Log gross domestic product per capita based on purchasing-power-parity (destination)	39522	9.94	0.36	8.69	10.77	22673	8.49	1.30	4.91	11.30
Log gross domestic product per capita based on purchasing-power-parity (origin)	36213	8.37	1.31	4.91	11.30	24240	9.90	0.37	8.69	10.77
Log unemployment rate (destination)	41032	1.87	0.59	-0.92	3.10	14527	1.85	0.79	-1.77	3.98
Log unemployment rate (origin)	21958	1.85	0.81	-1.77	3.98	23006	1.76	0.67	-0.92	3.10

Table 3. Negative Binomial GEE Regression Analysis of the International Migration Flows, 1950 - 2007

	Inflow	Outflow
Geographical Determinants		
Log population (destination)	0.849***	0.341***
	(0.044)	(0.083)
Log population (origin)	0.531***	0.855***
	(0.058)	(0.076)
Log distance between capitals (km)	-0.791***	-0.752***
	(0.072)	(0.096)
Log land area (destination)	0.133***	0.162**
	(0.043)	(0.082)
Log land area (origin)	0.026	0.200***
	(0.047)	(0.037)
Landlocked (destination)	-0.407	-0.271*
	(0.438)	(0.159)
Landlocked (origin)	-0.590***	-0.921*
	(0.156)	(0.513)
Border	-0.077	-0.271
	(0.263)	(0.347)
Demographic / Social Determinants		
Log potential support ratio (destination)	0.257	-0.636***
	(0.383)	(0.183)
Log potential support ratio (origin)	-0.376**	1.297***
	(0.190)	(0.424)
Log percent of urban population (destination)	2.058***	-0.497
	(0.340)	(0.313)
Log percent of urban population (origin)	-0.055	2.532***
	(0.180)	(0.338)
Common official language	1.149***	1.382***
	(0.189)	(0.369)
Colonial link	1.285***	2.021***
	(0.323)	(0.495)

Economic Determinants		
Log gross domestic product per capita based on purchasing-power-parity (destination)	-0.417	0.591***
	(0.284)	(0.099)
Log gross domestic product per capita based on purchasing-power-parity (origin)	0.101	0.193
	(0.079)	(0.336)
Log unemployment rate (destination)	-0.409***	-0.065
	(0.049)	(0.048)
Log unemployment rate (origin)	0.051	0.181**
	(0.036)	(0.073)
Constant	-17.007***	-28.644***
	(3.106)	(4.326)
N	18216	11911
QIC	268781.5	152082.8

Notes: Semi-robust standard errors appear in parenthesis. GEE = Generalized Estimating Equation. QIC = quasilikelihood under the independence model criterion All analysis specifies an autoregressive (AR 1) error structure. Coefficients of year-specific dummy variables are not shown.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4a. Inflow matrix with estimation of missing values from inflow negative binomial regression analysis.

2002	to															
From	Denmark	Finland	Sweden	Norway	Iceland	Belgium	NZ	Germany	Australia	Italy	Hungary	Croatia	France	Spain	UK	USA
Denmark		360	4250	3232	1093	328	111	2294	88	291	15	142	627	142	340	614
Finland	332		3532	1249	42	510	58	2026	34	253	61	40	413	111	459	429
Sweden	1110	3255		4552	394	526	216	2883	148	378	41	77	949	1730	1393	1387
Norway	1812	1048	6374		433	317	111	1156	56	208	57	270	423	106	1141	435
Iceland	1498	45	485	609		81	18	234	1	19	38	320	45	12	1235	93
Belgium	179	151	387	198	34		83	2479	91	1807	46	81	4762	3141	202	782
NZ	63	13	136	40	13	60		412	12368	34	39	12	109	232	11900	1129
Germany	1921	854	2699	1572	195	2966	1037		759	11376	337	1340	6647	13757	187	8961
Australia	334	115	647	263	23	206	13389	2132		578	118	217	499	397	37200	2576
Italy	603	227	508	217	39	2310	166	24379	139		72	179	4876	4967	1070	2605
Hungary	123	100	274	270	7	273	53	16531	81	485		60	506	275	1524	1284
Croatia	15	3	150	320	5	95	33	12738	321	1310	53		235	600	6768	3805
France	637	281	877	513	47	8135	483	13207	313	4894	235	38		8200	4405	3824
Spain	727	525	1166	757	58	1503	91	9233	92	2316	18	39	4031		7182	1376
UK	934	870	3120	1628	197	2543	19548	10239	12488	4843	326	118	9444	27249		16421
USA	1490	825	3482	1852	283	2701	3347	16688	1324	4548	398	244	4634	4016	26600	

Notes: NZ=New Zealand, UK=United Kingdom. Dark gray cells are structural zeros. Light gray cells are missing values.

Table 4b. Outflow matrix with estimation of missing values from outflow negative binomial regression analysis.

2002	to															
From	Denmark	Finland	Sweden	Norway	Iceland	Belgium	NZ	Germany	Australia	Italy	Hungary	Croatia	France	Spain	UK	USA
Denmark		376	4337	3325	1076	523	210	2700	979	777	119	27	1474	1722	4317	3010
Finland	384		3591	1186	37	222	17	730	191	183	132	2	380	724	980	1015
Sweden	1260	2692		1540	292	81	55	713	260	216	148	41	362	230	783	807
Norway	3309	1056	6357		419	157	30	679	204	162	170	134	420	1099	1300	1378
Iceland	1663	51	498	619		25	10	184	28	32	14	6	65	49	239	326
Belgium	297	278	334	200	133		62	2049	134	1551	161	16	3577	1098	1898	2484
NZ	92	32	127	69	5	58		488	24647	124	18	22	316	70	12410	2361
Germany	2974	2658	3876	1753	268	4565	756		3368	36535	16411	13728	19815	16681	16662	28758
Australia	52	37	69	6147	156	487	6251	288		204	77	95	177	84	3928	791
Italy	126	149	186	109	224	1170	9	7416	326		129	333	2417	849	2741	2875
Hungary	7	8	5	4	18	4	11	57	44	13		15	30	4	31	80
Croatia	86	94	14	119	14	103	9	1446	13	24	133		317	177	228	16
France	2792	2610	3944	4139	559	26557	267	9055	1054	7157	1826	1699		5870	19297	30476
Spain	1236	1413	2005	2014	346	1952	198	5052	769	6025	970	907	5621		5434	23098
UK	3202	2941	4538	5043	690	8131	17000	12349	46800	8412	1773	1575	24892	7320		35500
USA	7747	11014	14668	14517	3667	9001	14855	28674	48888	25543	5362	4530	218521	172961	759913	

Notes: NZ=New Zealand, UK=United Kingdom. Dark gray cells are structural zeros. Light gray cells are missing values.

Table 5. Adjustment factors for receiving country and sending country, 2002.

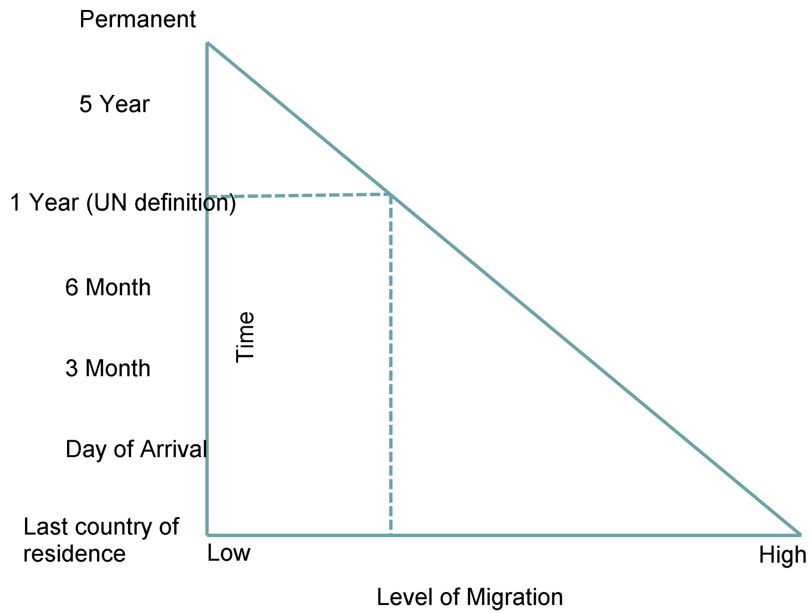
Country	Immigration	Emigration
Denmark	**1.000**	0.976
Finland	**1.000**	0.991
Sweden	**1.000**	1.624
Norway	**1.000**	0.861
Iceland	0.930	0.931
Belgium	1.008	0.997
New Zealand	1.057	0.999
Germany	1.032	1.006
Australia	1.006	1.048
Italy	1.012	1.028
Hungary	1.059	1.030
Croatia	1.004	1.029
France	1.017	1.020
Spain	1.010	1.020
UK	1.030	1.022
USA	1.000	1.000

Table 6. Harmonized international migration flow matrix using GEE estimation and adjustment factors in 2002.

2002	to															
From	Denmark	Finland	Sweden	Norway	Iceland	Belgium	NZ	Germany	Australia	Italy	Hungary	Croatia	France	Spain	UK	USA
Denmark		360	4250	3232	1050	510	205	2634	955	758	116	26	1438	1680	4212	2937
Finland	332		3532	1249	37	220	17	723	189	181	131	2	376	717	971	1006
Sweden	1110	3255		4552	474	132	89	1158	422	351	240	67	588	373	1271	1310
Norway	1812	1048	6374		361	135	26	585	176	140	147	115	362	946	1120	1187
Iceland	1498	45	485	609		75	17	218	1	18	35	298	42	11	1150	87
Belgium	179	151	387	198	32		83	2473	91	1802	46	81	4750	3133	201	780
NZ	63	13	136	40	12	61		411	12351	34	39	12	109	231	11884	1127
Germany	1921	854	2699	1572	181	2989	1096		764	11445	339	1348	6687	13841	188	9016
Australia	334	115	647	263	21	208	14149	2200		606	124	228	523	416	39002	2701
Italy	603	227	508	217	36	2328	175	25161	140		74	184	5014	5107	1101	2679
Hungary	123	100	274	270	7	275	56	17061	82	491		62	521	283	1570	1322
Croatia	15	3	150	320	5	96	35	13147	323	1326	56		242	617	6962	3914
France	637	281	877	513	44	8199	510	13631	315	4953	249	38		8362	4492	3900
Spain	727	525	1166	757	54	1515	96	9529	93	2344	19	39	4098		7323	1403
UK	934	870	3120	1628	183	2563	20658	10567	12569	4901	345	118	9601	27530		16779
USA	1490	825	3482	1852	263	2722	3537	17223	1333	4603	421	245	4711	4057	27406	

Notes: NZ=New Zealand, UK=United Kingdom. Dark gray cells are structural zeros. Light gray cells are missing values.

Figure 1. Conceptual framework for relationship between different timings and level of migration flows.



Notes: This figure is directly adopted from Raymer and Abel (2008).

Figure 2. Illustration of Raymer & Abel (2008)'s iterative procedure to harmonize international migration flow with United Nations migration data in 2000**.**

A. Base data

Origin \ Destination	Denmark	Finland	Sweden	Norway	Germany	Belgium	7	8	9
Denmark		360	4250	3232	2700	523			
Finland	332		3532	1249	730	222			
Sweden	1110	3255		4552	713	81			
Norway	1812	1048	6374		679	157			
Germany	1921	854	2699	1572		4565			
Belgium	179	151	387	198	2479				
7									
8									
9									

Very reliable sending country data but adjusted.

Deemed to be very reliable and not adjusted

B. Adjustment factor calculation

Origin \ Destination	Denmark	Finland	Sweden	Norway	Germany	Belgium	7	8	9
Denmark		376	4337	3325	2294	328			
Finland	384		3591	1186	2026	510			
Sweden	1260	2692		1540	2883	526			
Norway	3309	1056	6374		1156	317			
Germany	2974	2658	3876	1753		2966			
Belgium	297	278	334	200	2049				
7									
8									
9									

Divide the sum of the corresponding flows from A by the sum of these flows

Divide the sum of the corresponding flows from A by the sum of these flows

C. Fill in adjusted immigration and emigration data

Origin	Destination: Denmark	Finland	Sweden	Norway	Germany	Belgium	7	8	9
Denmark		351	4146	3153	2634	510			
Finland	332		3499	1237	723	220			
Sweden	1110	3255		7391	1158	132			
Norway	1812	1048	6374		584	135			
Germany	1921	854	2699	1572		2856			
Belgium	179	151	387	198	1430				
7									
8									
9									

Adjusted immigration data

Adjusted emigration data