A Cross-National Comparison of the Spatial Structure of Internal Migration by Level of Educational Attainment

Nikola Sander & Jana Vobecká

April 30, 2012

Wittgenstein Centre (IIASA, VID/ÖAW, WU),
Vienna Institute of Demography of the Austrian Academy of Sciences

Paper prepared for the Annual Meeting of the Population Association of America, May 3-5 2012, San Francisco, CA.

DRAFT PAPER. PLEASE DO NOT CITE.

Abstract

Considerable research has been devoted to the study of the 'brain drain' and the international migration of the educated from developing to developed countries. Much less attention has been given to the study of internal migration by education, and how its determinants and spatial structure differ between countries. This is despite its implications for human capital formation and economic development at the regional level.

This paper presents a comprehensive cross-national comparison of the spatial structure of interstate migration by level of educational attainment. Using census migration flow data from the 2000 round of censuses, migration among 20-49 year olds is analysed along the four dimensions: intensity, connectivity, impact and distance (see Bell et al. 2002). Five measures are used to capture these dimensions: (a) crude migration probabilities as a measure of intensity of migration; (b) the coefficient of variation as a measure of migration connectivity; (c) migration effectiveness index and the aggregate net migration probability as measures of the impact of migration; and (d) distance-decay parameters estimated using spatial interaction models as a measure of the distance of migration. Differences in the measures of spatial structure by level of education are compared across six counties, one of each continent: Australia, Brazil, Malaysia, South Africa, Switzerland, and the United States.

The results reveal systematic differences across education levels in the intensity of interstate (or longer-distance) migration in all countries except, whereas education has little impact on the intensity of intrastate (or short-distance) moves. Differences by education for interstate flows are most pronounced for young adults moving to metropolitan areas, even when controlling for other socio-economic factors such as marital status and income. At the system-wide level, there was no clear pattern of difference by education in migration connectivity, indicating that movements among the highly-educated were as spatially concentrated and resulted in a similar degree of population redistribution as movements among the less educated. The aggregate net migration probability as a measure of migration impact increases with level of education in all countries except Brazil, while the migration effectiveness index did not correlate with education. These findings suggest that the impact of migration among university-graduates on the redistribution of population is driven by the intensity, rather than the efficiency of their movements. As expected, the distance-decay effect declined with rising levels of education, confirming earlier findings that movements among university-graduates are less deterred by distance than those among individuals with primary- and secondary schooling.

1 Introduction

In the twenty-first century, the United States, like most other countries of the world, will experience an unprecedented rate of population ageing, due to declining fertility and increasing longevity. The increase in the proportion of the population aged 65 and over will be paralleled by a shrinking and ageing workforce. Declining workforce productivity can, at least partly, be offset by increasing levels of education among working-age populations. While national policies aim at general improvements in workforce productivity due to investments in education and training, there are strong regional differences in workforce size and composition. At the regional level, these differences are largely due to internal migration processes and patterns.

Considerable research has been devoted to the study of internal migration and human capital, mainly in North America and Europe (Castorina et al., 2010; Florida, 2002; Hansen and Niedomysl, 2009; Waldorf, 2009; Whisler et al. 2008). The empirical findings presented in those studies indicate that highly educated people are more mobile and move predominantly towards metropolitan centres with high amenity values (Basker, 2002; Castorina et al., 2010; Whisler et al., 2008). Highly educated people are attracted by job opportunities and higher wages in urban areas, which enables them to make a net gain from moving, even if costs of living are higher, Castorina et al (2010) and also Waldorf (2007) note that the migration decision making process among highly educated people may be self-reinforcing, in that agglomerations of the highly educated represent a pull factor for potential migrants. Such a process, however, renders policy interacting difficult. Federal and state governments aim to attract and retain skilled people to stimulate regional economic growth, and a net-loss of human capital through migration is associated with declining attractiveness of regional economies. In the context of population ageing and increasing global demand for skilled labour, knowledge of where the 'talented' population will live in the future is vital for regional economic development, and also for the development of strategies to ensure the provision of higher education.

At the global scale, little attention has been given to the way intensities and spatial patterns of internal migration differ by level of education, which is partly due to the lack of harmonised and consistent data, but also reflects the difficulties associated with capturing the complexity of spatial patterns using statistical measures. The existing literature on cross-national comparisons of internal migration has focused on the overall levels of mobility (Long, 1991), distance of migration (Long et al., 1988), age structures (Rogers et al., 1978) and, more recently, the spatial structure of migration (Bell and Muhidin, 2009). This paper presents a cross-national comparison of interregional migration, disaggregated by level of educationala attainment.

Given the differences in the size the administrative regions that are used for the collection of migration data, the Modifiable Areal Unit Problem (MAUP) cannot be avoided without creating customised geographies (Openshaw, 1984). Therefore, attention is focused on relative differences in intensities and spatial structure by education level, rather than comparing migration intensities directly across countries. Given the findings presented in the literature, we expect to find enduring regularities in differences in intensities and patterns by level of education. The analytical approach to establishing the spatial structure of internal migration is based on earlier work by Bell et al. (2002) and Bell and Muhidin (2009), who argue that migration can be analysed along four dimensions: intensity, connectivity, impact and distance. Five measures are selected here that are relevant to skilled migration: (a) crude migration probabilities (CMP) as a measure of the intensity of migration; (b) the coefficient of variation (CV) as a measure of migration connectivity; (c) the migration effectiveness index (MEI) and the Aggregate Net Migration Probability as measures of the impact of migration; and (d) distance-decay parameters estimated using spatial interaction models as measures of the distance of migration. To confirm that the differences in migration intensity and spatial structure highlighted in this paper are in fact due to education (and not income or other proxies), we use logistic regression to examine the determinants of interstate migration.

The paper begins with a summary of the data, followed by an assessment of migration intensity and the determinants of interstate migration. Next, we draw attention to differences and similarities in migration connectivity, migration impact and distance moved by level of education.

2 Data

There is, as yet, no comprehensive database of internal migration around the globe. Nevertheless, over recent years, public use sample files from population censuses have been made available by the University of Minnesota. The IPUMS database currently holds information from 185 censuses in 62 countries. However, not all censuses collect information on internal migration, and comparisons are hindered by differences in the way migration is measured. The most common measures are 5-year interval and lifetime migration. Also used are 1-year and 10-year intervals, and previous residence (no fixed interval). Moreover, education systems vary across countries. Although IPUMS provides an international recode of the level of educational attainment (which is used here), inconsistency problems may arise if countries changed their education system in recent decades (e.g. Argentina).

In the analysis presented here, we therefore confine attention to six countries that measure migration using the 5-year interval (place of residence at the Census compared with 5 years ago) and that did not fundamentally change their educational system in recent decades. We use state-to-state migration flows, disaggregated by age and education from the 2000 round of censuses for Brazil, Malaysia, South Africa and the United States. In addition, we use migration flows by age and education between 60 Statistical Divisions of Australia from the 2006 Australian census, and flows by age and education between 184 districts from the Swiss 2001 population census. The latter two datasets were kindly provided by the Australian Bureau of Statistics and the Swiss Federal Statistical Office.

3 Migration Intensity

Following Rees et al. (2000), the analysis of migration intensities is confined to individuals who were alive and resident in their home country at the time of the census and five years earlier, so that a conditional probability of migration is calculated, rather than a migration rate. The Crude Migration Probability (CMP) is calculated as:

$$CMP = (M/PAR) * 100 \tag{1}$$

where the migrant count *(M)* in a given period is expressed as a percentage of the population at risk *(PAR)* at the beginning of the period.

3.1 Aggregate intensities

As a first step towards a better understanding of the differences in migration intensities by education, this section focuses on aggregate measures of migration. A distinction is made between intrastate and interstate moves. Using the IPUMS international recode for educational attainment, intensities of migration are compared across four educational groups: less than primary completed (hereafter: no education), primary completed, secondary completed, and university completed. The results of the analysis of aggregate intensities by type of move for the census period 1995-2000 (2001–06 for Australia) are shown in Figure 1 and Table 1.

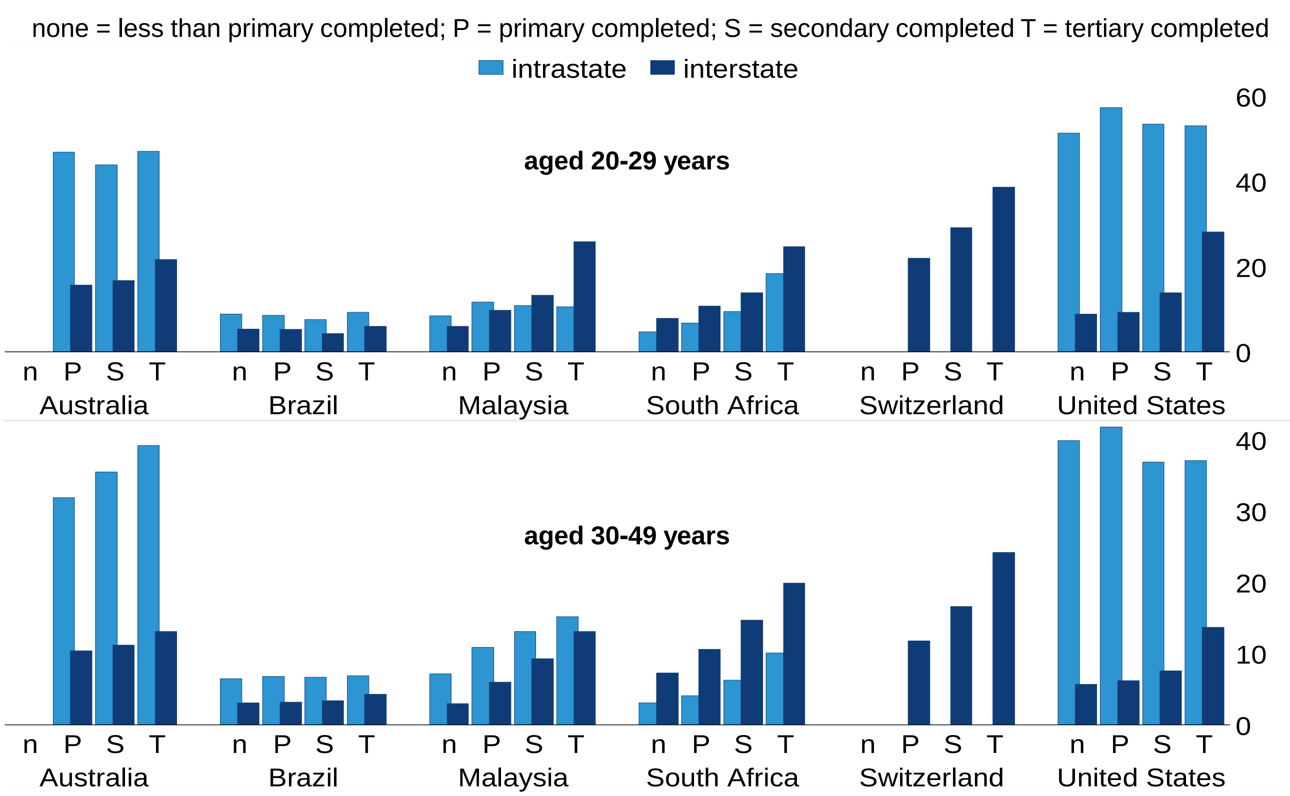


Figure 1: Overall Migration Intensity by age group

Table 1: Migration probabilities (%), by type of move and level of educational attainment

Country	Age group	Education	Total moved	intrastate	interstate
Australia	20-29	less than primary			-
		primary completed	62.6	46.9	15.7
		secondary completed	60.7	43.9	16.8
		university completed	68.8	47.1	21.7
	30-49	less than primary			-
		primary completed	42.3	31.9	10.4
		secondary completed	46.7	35.5	11.2
		university completed	52.4	39.2	13.1
Brazil	20-29	less than primary	14.3	8.9	5.4
		primary completed	13.9	8.6	5.3
		secondary completed	11.9	7.6	4.3
		university completed	15.3	9.3	6
	30-49	less than primary	9.6	6.5	3.1
		primary completed	10	6.8	3.2
		secondary completed	10.1	6.7	3.4
		university completed	11.2	6.9	4.3
Malaysia	20-29	less than primary	14.5	8.5	6
		primary completed	21.5	11.7	9.8
		secondary completed	24.2	10.9	13.3
		university completed	36.5	10.6	25.9
	30-49	less than primary	10.2	7.2	3
		primary completed	16.9	10.9	6
		secondary completed	22.3	13.1	9.3
		university completed	28.3	15.2	13.1
South Africa	20-29	less than primary	12.6	4.7	7.9
		primary completed	17.6	6.8	10.8
		secondary completed	23.4	9.5	13.9
		university completed	43	18.4	24.7
	30-49	less than primary	10.4	3.1	7.3
		primary completed	14.7	4.1	10.6
		secondary completed	21.1	6.3	14.7
		university completed	29.9	10.1	19.9
Switzerland	20-29	less than primary			-
		primary completed			22
		secondary completed			29.2
		university completed			38.7
	30-49	less than primary			-
		primary completed			11.8
		secondary completed			16.6
		university completed			24.2
United States	20-29	less than primary	60.2	51.4	8.9
		primary completed	66.7	57.4	9.3
		secondary completed	67.4	53.5	13.9
		university completed	81.3	53.1	28.2
	30-49	less than primary	45.6	39.9	5.7
		primary completed	48	41.8	6.2
		secondary completed	44.5	36.9	7.6
		university completed	50.8	37.1	13.7

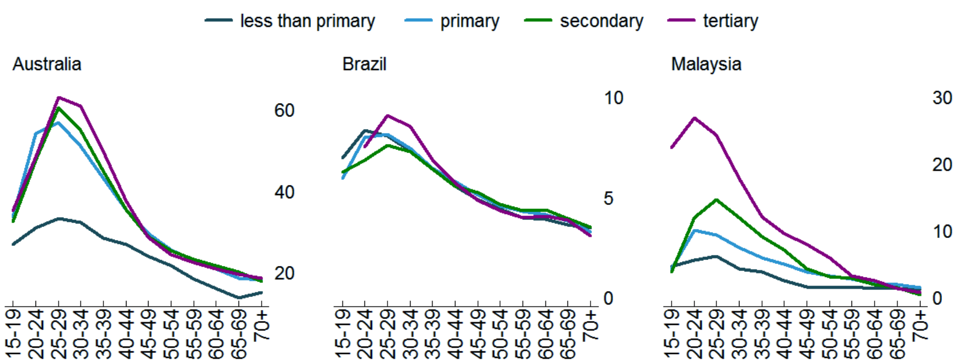
Across all types of moves, university graduates exhibited the highest probabilities of moving, except for intrastate migration in Brazil, Malaysia and the United States. As expected, the positive correlation between migration intensity and education was stronger for interstate moves than for intrastate moves. The average propensity to move interstate over the 5-year interval among 20-49 year olds was 8.7 per cent for primary educated, 11.9 per cent for those with secondary schooling, and 15.3 per cent among university graduates. The difference in interstate migration intensity between primary and university educated was largest in Malaysia (7.5 per cent primary; 19.7 per cent university), followed by the United States (7.2 per cent primary; 17 per cent university).

3.2 Age profiles of migration

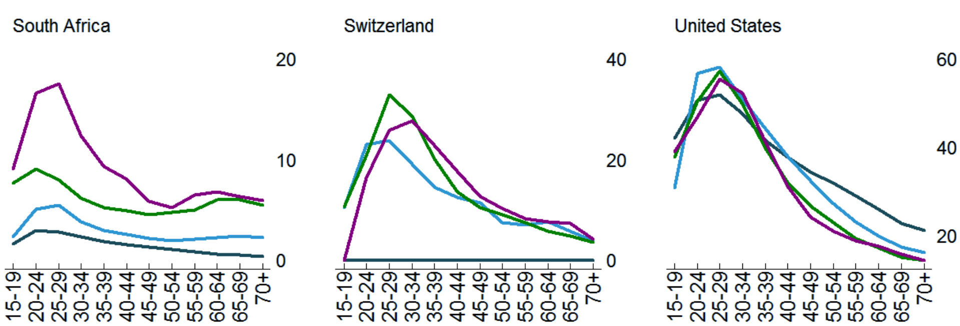
To evaluate the differences by education in the effect of age on migration, migration propensities by 5-year age groups are compared for several types of moves, including the intrastate and interstate moves we evaluated in the previous section. To shed light on the age pattern of movement to metropolitan centres, we use a metropolitan/non-metropolitan dichotomy for those countries where information was available in the IPUMS sample. The types of moves analysed in this section are: moved intrastate, moved interstate, and moves between metropolitan and non-metropolitan area.

Figure 2 sets out migration probabilities by age, education for intrastate movements and Figure 3 shows the migration age profiles for interstate migration. The profiles closely resembles those found in other western societies and are in line with the literature stating that migration probabilities are highest among young adults and decline with age, rising again slowly for the oldest age groups. As expected, longer-distance migration is selective of young adults with a university degree. This pattern persists in all six countries under study.

Yet, education-selectivity for the age group 20-49 years not only differs by distance moved, but also by type of move. Figure 4 shows migration age profiles of movements between metropolitan regions for Australia and the United States. While the differences by education in the profile for intrastate movements within or between metropolitan areas are small in both countries, the age profile for interstate movements between metropolitan areas shows substantial differences in the propensity to move by education.

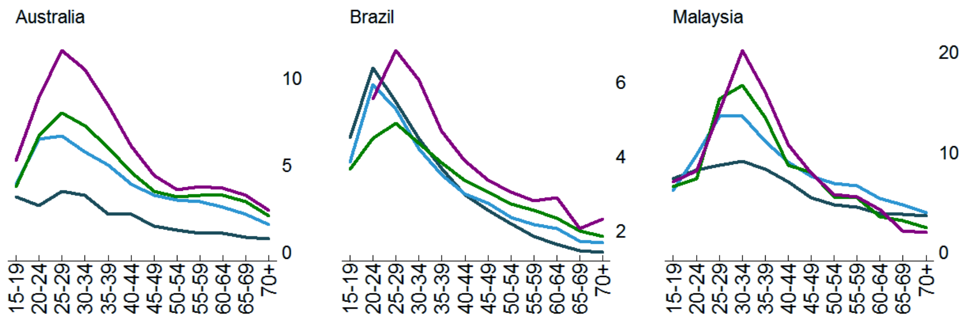


(a) Australia, Brazil and Malaysia

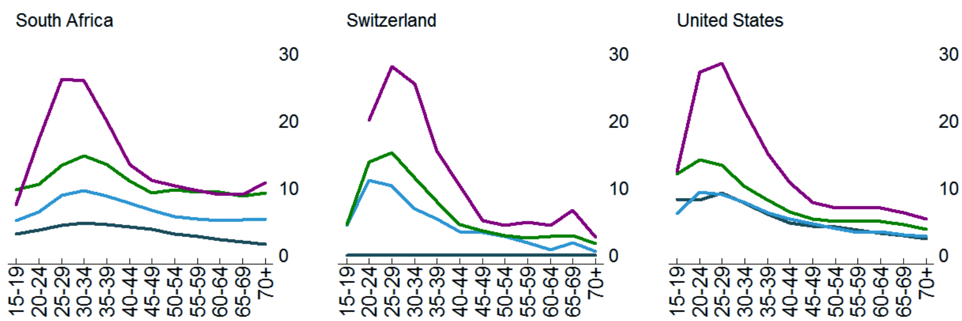


(b) South Africa, Switzerland and United States

Figure 2: Migration probabilities (%) by age group and education: moved intrastate

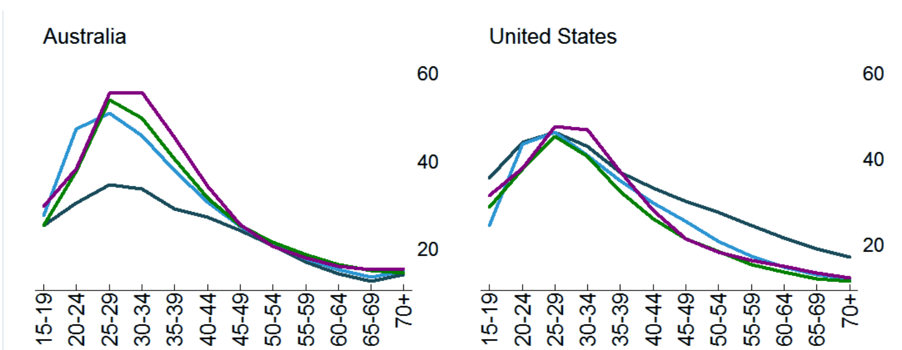


(a) Australia, Brazil and Malaysia

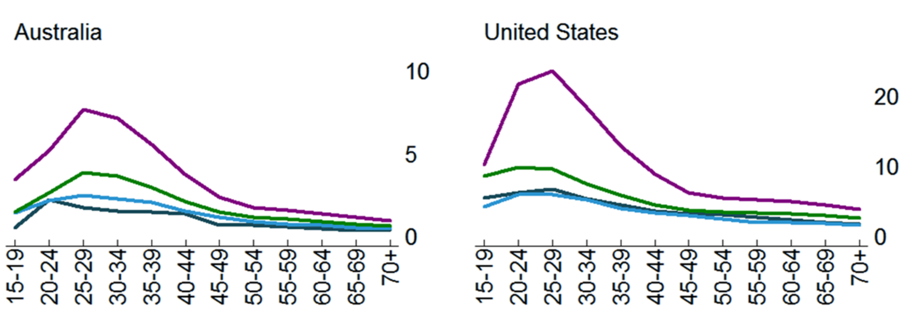


(b) South Africa, Switzerland and United States

Figure 3: Migration probabilities (%) by age group and education: moved interstate



(a) moved intrastate, within/between metropolitan regions



(b) moved interstate, between metropolitan regions

Figure 4: Migration probabilities (%) by age group and education for Australia and the United States: moved between metropolitan regions

To understand the relative importance of educational attainment as a determinant of migration, we employed a logistic regression model that takes into account also other socio-economic and demographic characteristics that may influence the likelihood of migration as control variables. We were interested in individual determinants and the strength of the factor of educational attainment in the migration decision. Specifically, we aim to answer the following questions: (1) In which types of moves does educational attainment play a crucial role and in which ones is its role less important whilst controlling for other variables that may influence migration? (2) What are the other important predictors of migration likelihood on the individual level?

We apply binary logistic regression to a representative sample of the US population from the 2000 census extracted from IPUMS. Since this is still work in progress, we present here solely the results for the United States. We do not yet have the results from the logistic regression for the other five countries.

The dependent variable in the logistic regression model is a binary indicator (moved/did not move in the five years prior to the census). In the analysis of migration intensities by age presented earlier, it was demonstrated that differences between educational groups are much more pronounced for interstate moves between metropolitan areas than for intrastate moves. Hence, we run the logistic regression separately for two types of moves: intrastate moves between metropolitan areas and interstate moves between metropolitan areas. As explanatory variables we include the following socio-demographic factors that, based on a review of the relevant literature, we expect may play a role in the individual migration decisions. All explanatory variables are coded as dummies. (* denotes the reference category)

- Educational attainment: We distinguish three educational attainment categories described earlier: primary*, secondary and tertiary.
- Age: We distinguish six age group categories: 20-24*, 25-29, 30-34, 35-39, 40-44, 45-49. These are the age groups with the highest migration intensity. We expect that migration is particularly selective of 20-29 year olds. We exclude the population aged 50 and over since their migration intensity is negligible.
- Number of children aged 5 and less: We distinguish individuals without small children*, with one child and with two or more children aged 5 and less. We expect that individuals without small children are more likely to move interstate, whereas individuals with children living at home are more likely to undertake an intrastate move, e.g. in response to altered housing needs.
- Marital status: We distinguish singles*, married, divorced and widowed individuals.
- Nativity: We distinguish the US-born* and foreign-born individuals. We expect that foreign-born individuals are more likely to undertake a job-related move.
- Income level: We distinguish five income categories: quintiles of the yearly income distribution (after tax) in 2005 in thousand US dollars: less than 15*, 15-32.5, 32.5-55, 55-75, 75 and more. We expect that people with high income show a higher propensity to move.
- Disability: We distinguish individuals with no disability or with disability not preventing work*, and with disability that prevents and cause difficulty to work. We expect that individuals with disability will have lower probability of moving interstate.

Two regression models were estimated separately for each type of move: Model 1 includes only Education as independent variable. Model 2 includes Education as well as all other control variables. The parameter estimates, significance levels and goodness-of-fit statistics for Model 1 are shown in Table 2. The exponentiated coefficients Exp(B) can be interpreted as hazard ratios and show the influence of a variable category compared with a reference level of that variable (e.g. the relative odds of an outcome for individuals with secondary education compared to those with primary education).

Table 2: Logistic regression, Model 1, by type of move

Type of move	Education	Odds ratio
interstate, metro to metro	Secondary	1.63***
	University	4.05***
intrastate, metro to metro	Secondary	0.92***
	University	1.03***
interstate, non-metro to metro	Secondary	1.35***
	University	2.33***
intrastate, non-metro to metro	Secondary	1.00***
	University	1.33***
intrastate, non-metro- to non-metro	Secondary	0.72***
	University	0.41***

* Primary education is reference category

The results for Model 1 suggest that education has a strong impact on the likelihood of moving interstate between metropolitan areas (odds ratio: 4.05 for university graduates), whereas the differences in movement propensities across education groups are small for intrastate moves between metropolitan areas. For the purpose of this analysis, we therefore confine attention to those two types of moves. Figure 5 shows the odds ratios estimated with Model 2 for intrastate and interstate moves. The results for the explanatory variables confirm our hypothesis that intrastate migration is not driven by education. Intrastate moves are associated with married couples with children and a high income. Foreign-born had a higher likelihood of moving within the same state compared to natives. Being well-educated and having a disability did not increase this risk of moving. For interstate moves, education has a strong positive impact on the likelihood of moving, even when controlling for other socio-demographic determinants. Interstate migrants are less likely to be married, to have children, to be native born, to have a low income, and to suffer from disability.

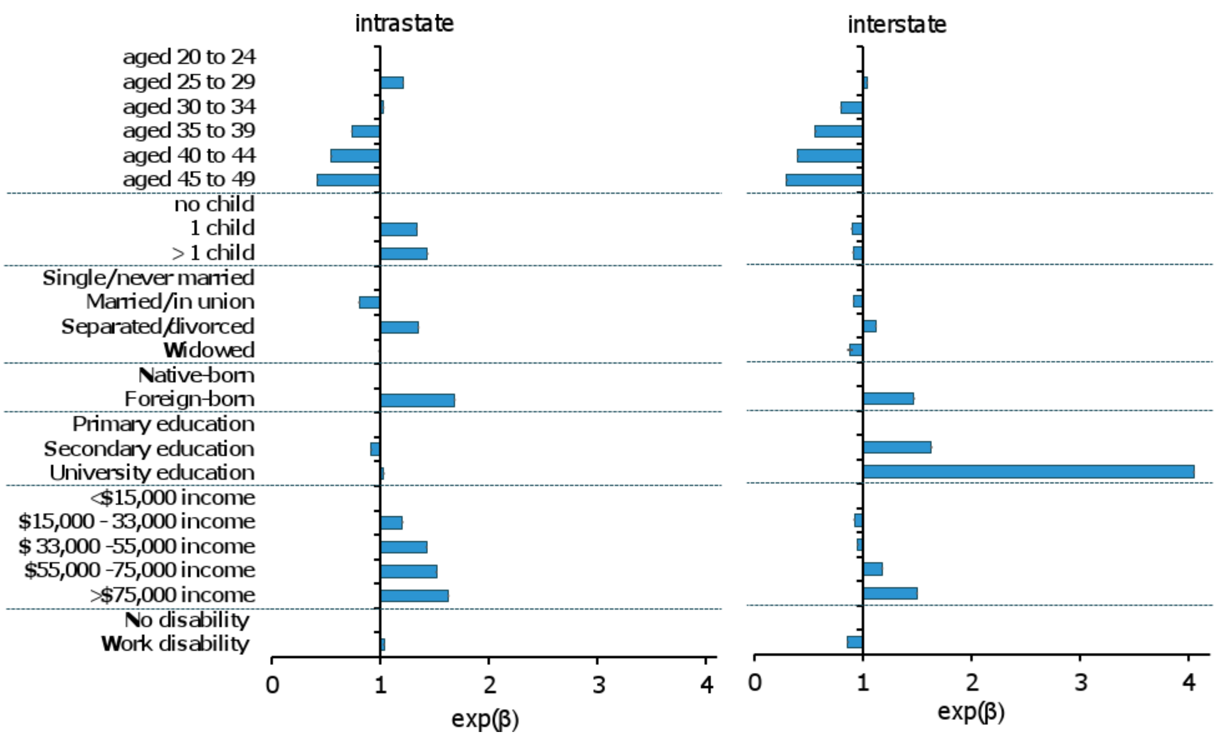


Figure 5: Logistic regression, odds ratios, moved intrastate/interstate vs. did not move, all estimated parameters significant at 1% level

3.3 Net-migration

It is well documented in the literature that skilled migrants move predominantly to metropolitan destinations with ample job-opportunities and high quality of living (Castorina et al., 2010; Florida, 2002; Hansen and Niedomysl, 2009; Waldorf, 2009; Whisler et al. 2008). Relative differences in in- and out-migration propensities by education thus result in regions becoming brain-rich or brain-poor. It is important, however, to distinguish between regions suffering general population decline (with net-losses in all education groups), and regions suffering selective losses of the better educated population (with gains of lower educated and losses of better educated). The latter may have even more devastating results for the local economy and socio-economic structure of the resident population than the former pattern of migration selectivity.

To better understand the link between migration and human capital, we calculated net-migration probabilities among 20 to 49 year olds by education in each country. The pattern of net-migration intensity and education differentials is visualised using bicomponent mapping, which translates the three-dimensional image containing space, education and migration intensity into a two-dimensional map (Schroeder, 2009). Principal Component Analysis was used to identify the first two components for each indicator, which were calculated at state-level. Using the three quantiles for each component, a three-by-three matrix of mean trends was constructed, based on the intersections of each pairing of PC 1 (intensity) and PC 2 (education) quantiles.

The bicomponent map for Australia (Figure 6) consists of three elements: the map, the bicomponent trend matrix and the component loadings chart. The map indicates the group membership of regions set out in the bicomponent trend matrix. The matrix shows the mean indicator values (e.g. net-migration propensities) for each of the nine classes (i.e. the intersections of the two groups of quantiles) with 95 per cent confidence intervals. The loadings chart shows that the first component indicates the overall migration intensity (high or low indicator values across all education groups). High loadings on the second component indicate a higher propensity to move among university-graduates compared to the less-educated. The map highlights strong differences in net-migration intensities by level of education, especially between university-graduates and less-educated Australians.

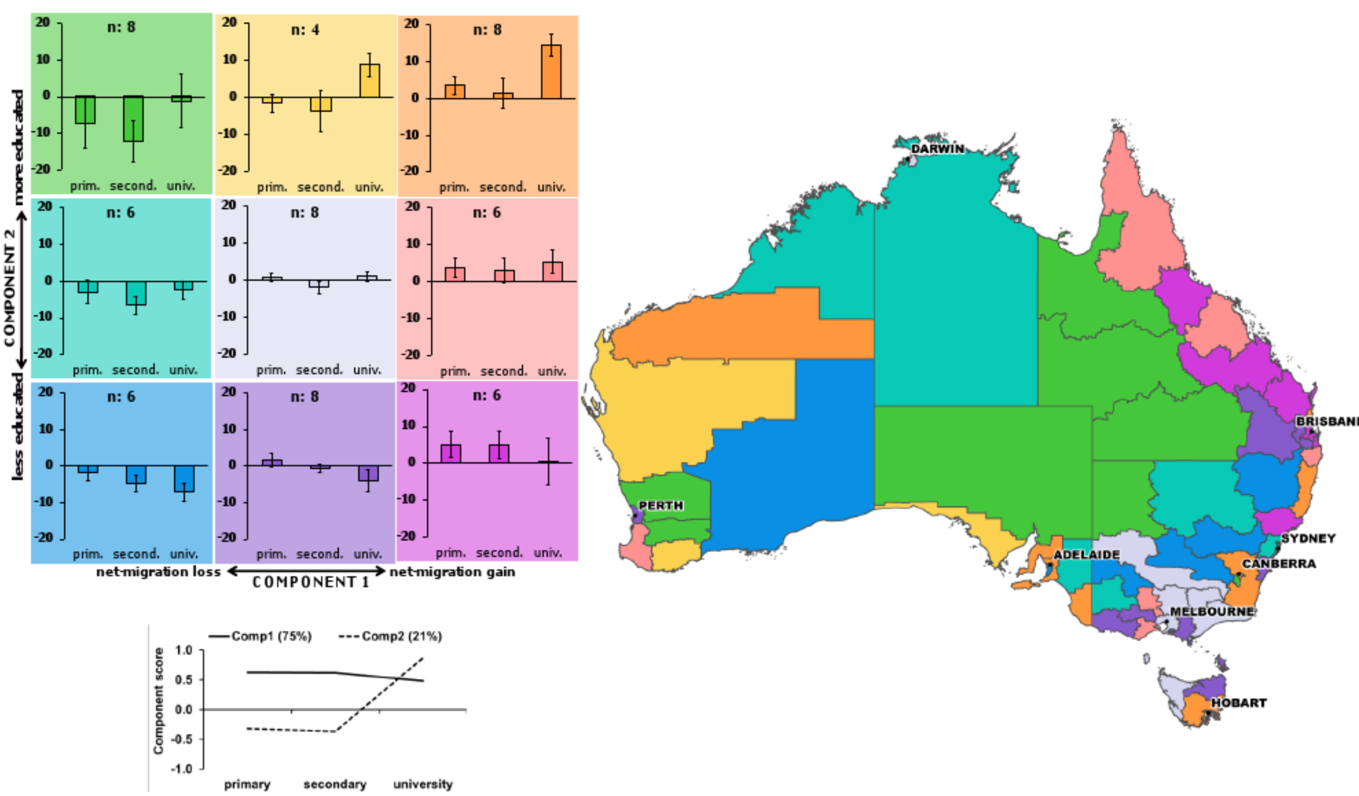


Figure 6: Bicomponent maps of net-migration probabilities, Statistical Divisions, Australia, 2001-06

The numbers of regions in each cell of the bicomponent matrix of mean trends are very evenly distributed, suggesting that the pattern of education differentials is mixed. Net gains are stronger for the better educated in the popular coastal destinations in New South Wales, South Australia and Tasmania (orange field), whereas net gains for university-graduates are weaker in coastal destinations in central Queensland (pink field). These findings suggest that university-graduates undertake amenity moves to coastal destinations within commuting distance to metropolitan centres that are characterised by high house prices. The analysis further demonstrates that net-losses in the capital city of Sydney are less pronounced among university-graduates (turquoise field), confirming the findings presented in the literature that the better educated are likely to remain in urban regions (Ritsila and Haapanen, 2003). On the other side of the spectrum, net-losses are stronger among the better educated compared to less educated people in the remote and inland areas (blue field). Exceptions to this trend of rural out-migration are the mining areas of Australia, which offer attractive salaries and have a strong demand for skilled labour. Inland areas of the Northern Territory, Queensland and Western Australia (WA) recorded net-gains of university-graduates (orange and yellow fields), or only moderate losses (green field). The aggregate picture is of brain-rich regions in high-amenity coastal destinations, the capital city of Sydney and in remote inland mining areas, whereas brain-poor regions dominate in the agricultural regions in inland Queensland, New South Wales and Victoria.

Figures 7 to 11 show the bicomponent maps of net-migration probabilities by education for Brazil, Malaysia, South Africa, Switzerland and the United States. With the exception of Brazil, there is a general trend of spatial concentration of university-graduates in large metropolitan centres (Sydney in Australia, Labuan in Malaysia, Pretoria in South Africa, Zurich in Switzerland).

In Australia and Brazil, non-metropolitan areas with mining or agricultural industries are also attracting graduates at high rates (e.g. Amapa and Rondonia in Brazil). In Malaysia, the capital Kuala Lumpur recorded net-losses among all education groups (green field). Only three Malaysian states recorded net-gains among university graduates (pink and orange fields), resulting in a strong spatial concentration of human capital in the financial centre of Labuan, Selangor (hinterland of Kuala Lumpur) and the north-western state of Pekang. The bicomponent map for Switzerland (Figure 10) shows that university-graduates moved to the inner and suburban areas of the capital Zurich, as well as the metropolitan centres of Bern and Geneva at high rates. Net-gains are also high in selected tourism-dominated alpine districts with high natural amenity values (orange field).

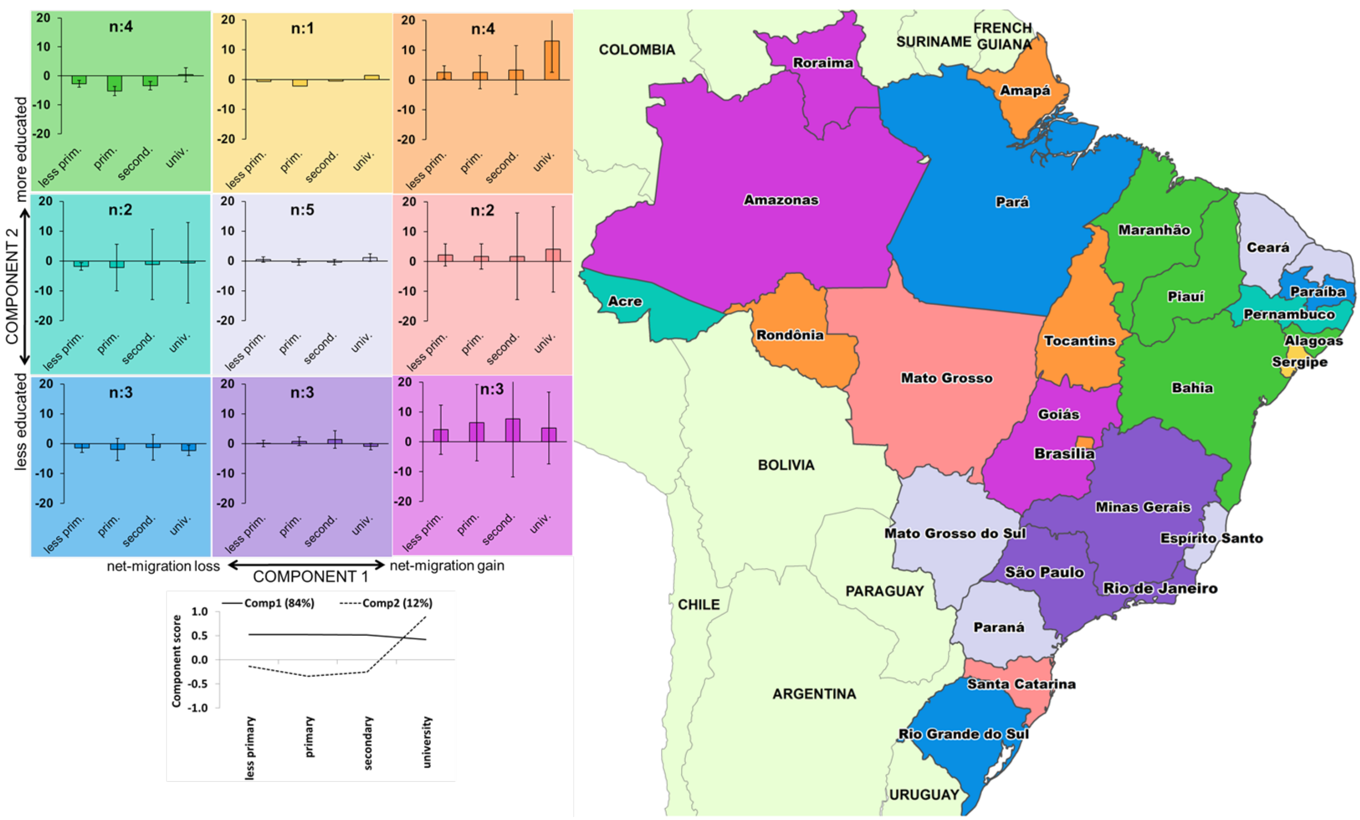


Figure 7: Bicomponent maps of net-migration probabilities, States, Brazil, 1995-2000

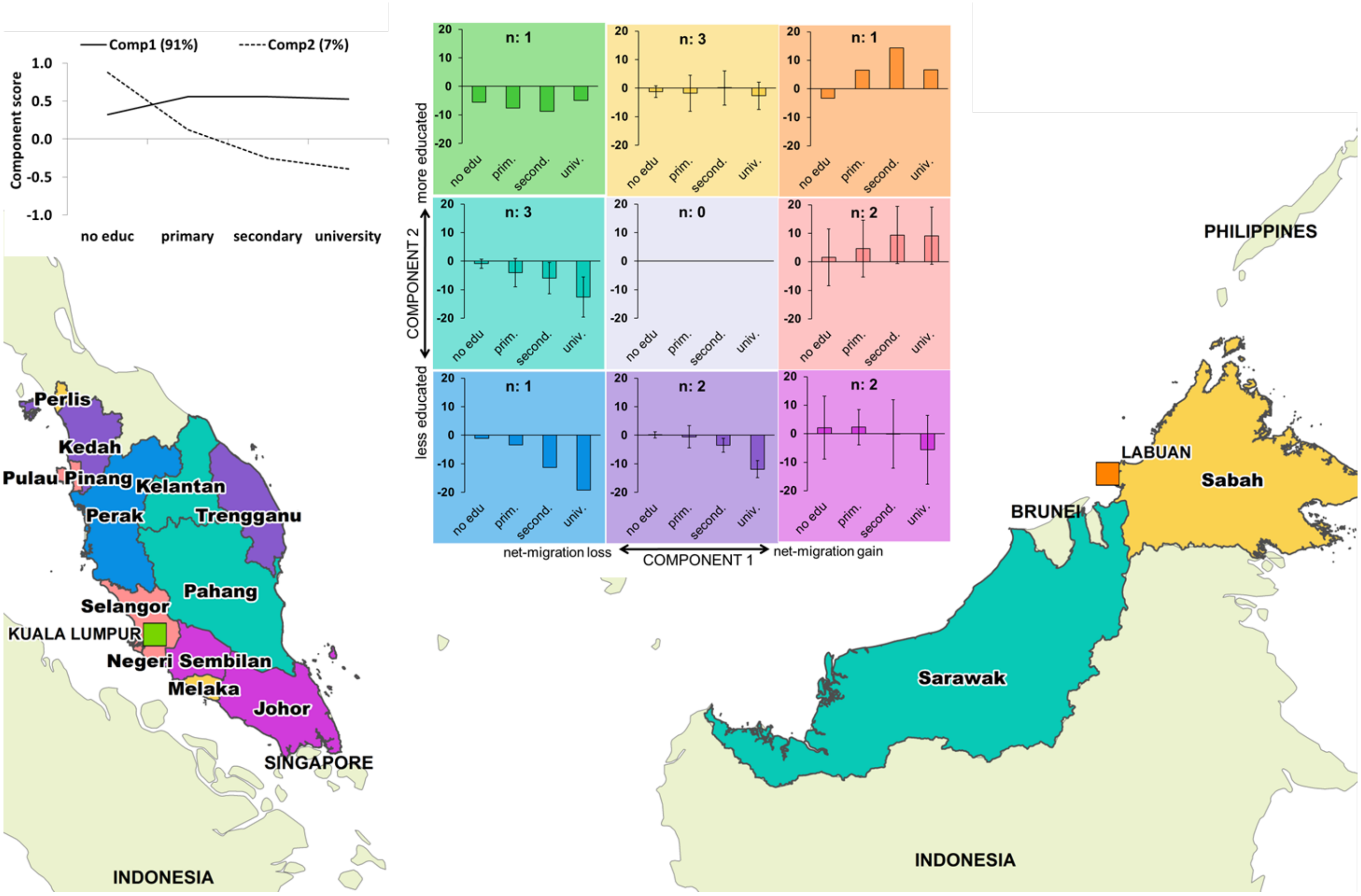


Figure 8: Bicomponent maps of net-migration probabilities, States, Malaysia, 1995-2000

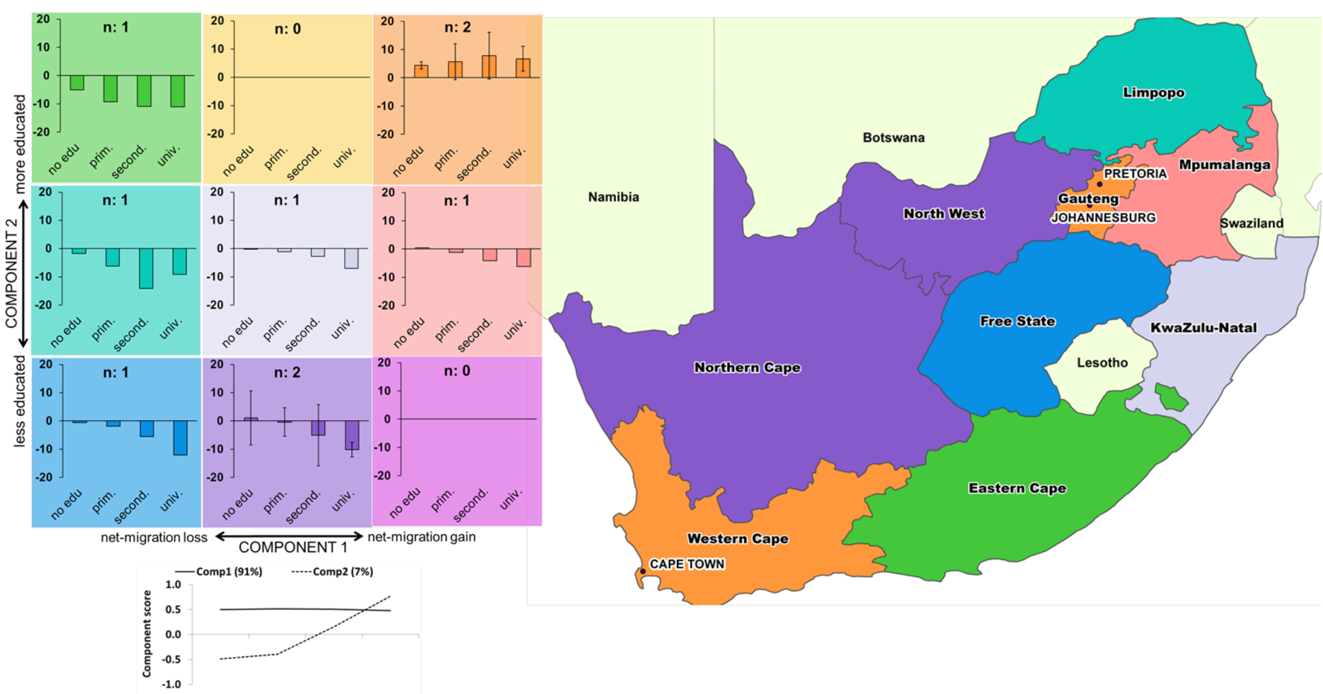


Figure 9: Bicomponent maps of net-migration probabilities, States, South Africa, 1996-2001

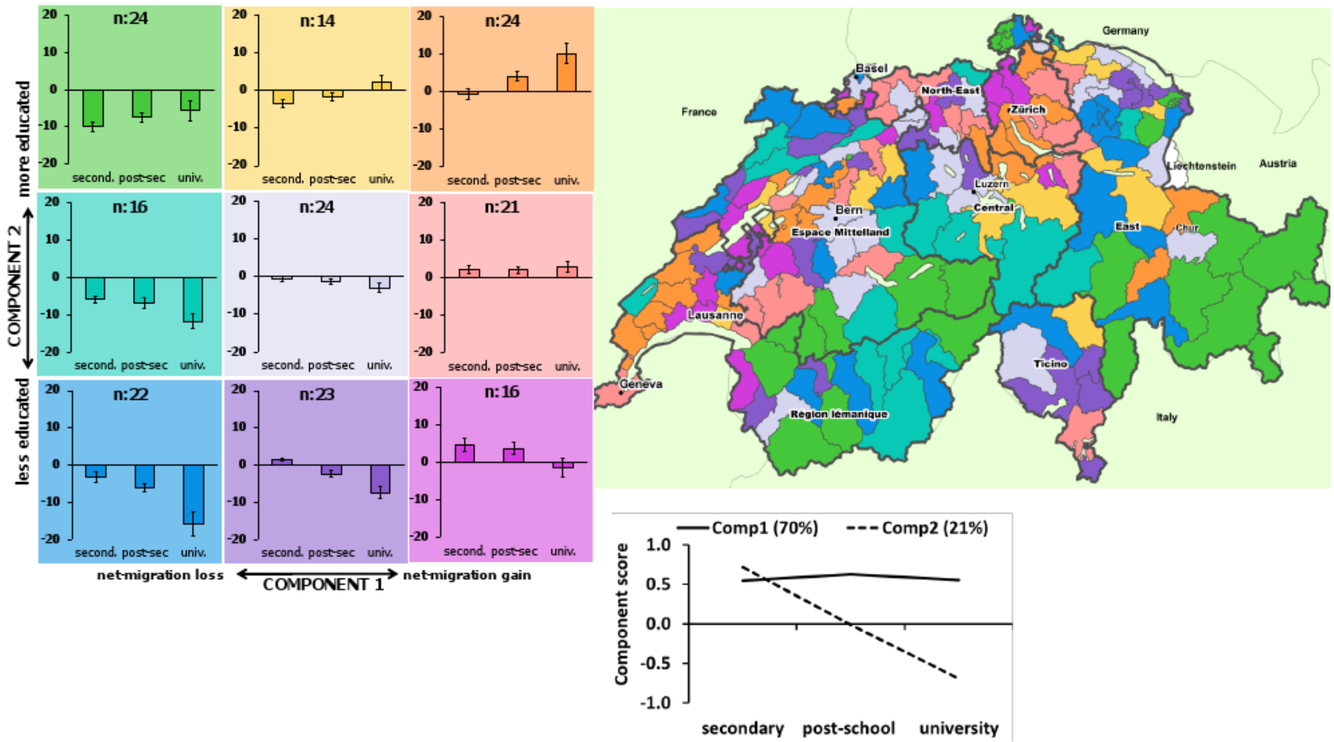


Figure 10: Bicomponent maps of net-migration probabilities, Districts, Switzerland, 1995-2000

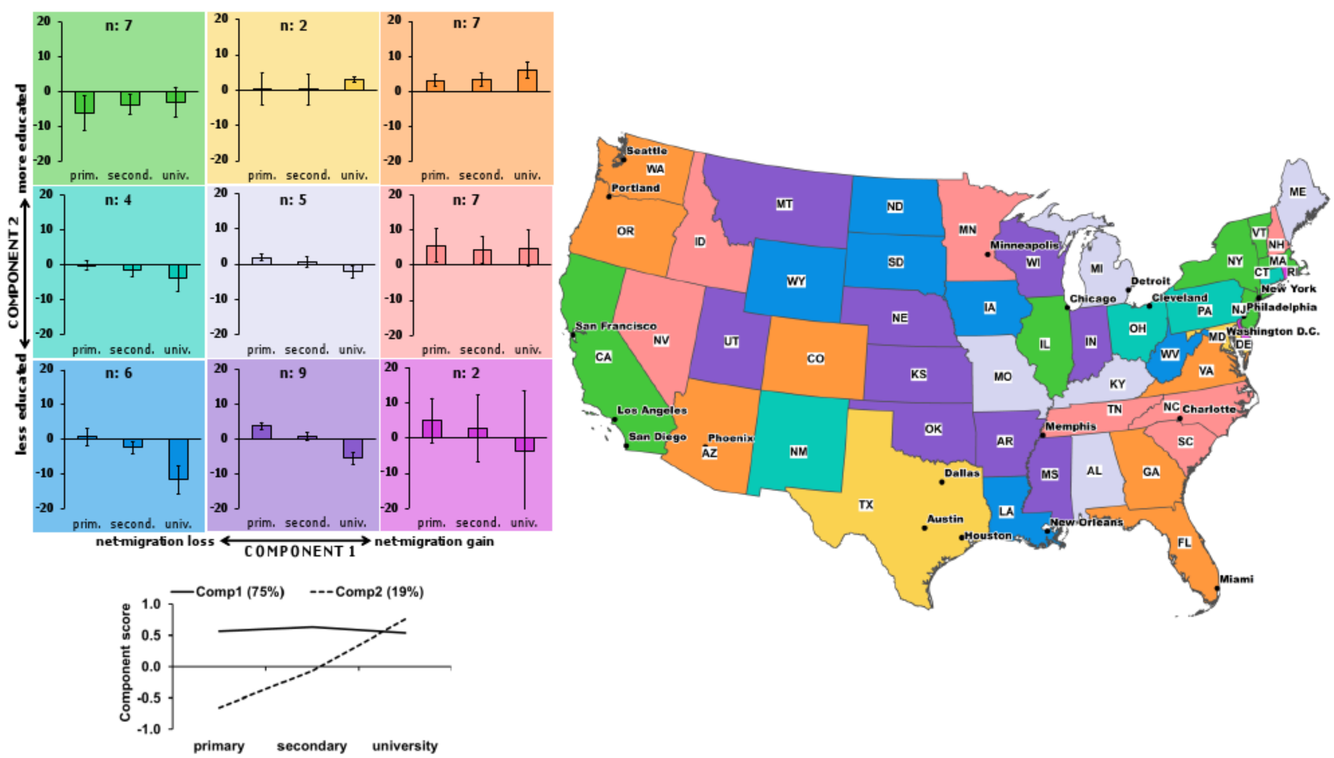


Figure 11: Bicomponent maps of net-migration probabilities, States, United States, 1995-2000 (Alaska and Hawaii excluded)

3.3.1 Migration Impact

It is well established that migration has an impact on the population age structure and size of regions in that it causes redistribution of population in the settlement system (Plane, 1994). Redistribution occurs when the size of the inflows to a given region differs from the size of the outflows. The larger the net balance of migration and the higher the ratio of this net balance to total movement, the higher is the efficiency of migration. This in turn means that the higher the efficiency of redistribution through migration, the higher is the impact on the settlement system.

We use the migration effectiveness index (MEI) and the Aggregate Net Migration Probability (ANMP) as measures of migration impact. The system-wide index MEI can assume values between 0 and 100 and is calculated as the ratio of the sum of the absolute value of each state's net-migration balance to the sum of total movement between all states in the system:

$$MEI = \frac{\sum_i \left| D_i - O_i \right|}{\sum_i (D_i + O_i)} \tag{2}$$

where Di is the total in-migration to state i and Oi is the total out-migration from state i.

The ANMP is a system-wide equivalent of the net-migration probability. It captures the degree of redistribution of population through migration relative to the total population. The ANMP is similar to the MEI in that it is calculated as the ratio of the sum of the absolute value of each region's net-migration balance to the total PAR and is expressed as a percentage.

$$ANMP = \frac{0.5 * \sum_i \left| D_i - O_i \right|}{\sum_i PAR_i} \tag{3}$$

The MEI is generally higher than the ANMP, due to the smaller denominator. The overall picture is one of increasing ANMPs with level of education, except for Brazil (see Table 3 and Figure 12). The correlation is somewhat stronger for the ANMP than for the MEI, suggesting that it it the intensity combined with the effectiveness of migration that differ by education, rather than solely the redistributional effect of the MEI. Across all education groups, the MEI is highest in South Africa and Malaysia, indicating that net-migration in these counties is more efficient as a mechanism for population redistribution than in the other four countries. Somewhat surprising are the small differences by education in the MEI, suggesting that migration among university-graduates is not more efficient than migration among less-education people. Hence net-migration has a smaller than expected impact on regional differences in the education structure of populations. Perhaps it is the strongly selected destination choices of the better educated rather than the redistribution effect of migration itself that causes regions to become brain-rich or brain-poor.

Table 3: Migration Effectiveness Index (MEI) by education and age

Age	Education	Australia	Brazil	Malaysia	South Africa	Switzerland	United States
20-29	less than primary	-	35.92	-	38.9	18.39	-
	primary completed	11.62	31.71	-	51.0	14.89	19.85
	secondary completed	18.08	22.37	-	55.3	19.84	12.64
	university completed	18.16	21.64	-	40.5	20.00	17.27
30-49	less than primary	-	14.81	-	23.3	16.31	-
	primary completed	15.62	14.30	-	26.4	10.63	19.64
	secondary completed	18.21	12.31	-	25.3	10.61	13.35
	university completed	15.12	16.37	-	24.2	12.82	10.07
20-49	less than primary	-	23.35	31.8	28.8	17.35	-
	primary completed	13.62	20.07	31.4	40.3	12.76	19.26
	secondary completed	18.15	13.50	35.5	44.3	15.23	12.64
	university completed	16.64	15.46	30.6	31.2	16.41	11.91

4 Migration Connectivity

The Coefficient of Variation (CV) as a measure of migration connectivity reveals the strength of the links between regions in the migration system by testing equality in size of place-to-place flows (Bell et al., 2002; Plane and Mulligan, 1997; Rogers and Sweeney, 1998). The index value is low if regions are well connected and all flows in the system are equal in size. A high spatial focus is indicative of a concentration of migrants in a small number of flows, so that the degree of connectivity between regions is low. The CV measures the spread or dispersion of a set of flows as a proportion of the mean flow size. High CV values indicate strong dispersion relative to the mean flow size. The CV is calculated as the ratio of the standard deviation to the mean of observed migrant counts in the origin-destination matrix (Allison, 1978):

$$CV = \frac{\sqrt{\left\{\sum_i \sum_{j \neq \mathrm{i}} (M_{il} - \overline{M})^2 / n(n-1)\right\}}}{\overline{M}} \tag{4}$$

The above equation was used to calculate CVs separately for in- and out-migration by state. Each in- and out-migration CV was then weighted by the state's share of total in- and out-migration respectively (Rogers and Sweeney, 1998). The system-wide CV was then derived by summing all weighted in- and out-migration CV values.

The overall picture is one of little differences by educational attainment for both age groups. A weak correlation between the ACV and level of education is apparent for Australia, where migration connectivity is lower (the spatial focus is higher) for flows among university-graduates than for flows among primary and secondary educated. Australian graduates tend to concentrate in flows between the capital cities, the coastal destinations, and the mining areas, although differences in connectivity by education are small.

Table 4: System-wide index of the migration-weighted coefficients of variation (CV) by education and age

Age	Education	Australia	Brazil	Malaysia	South Africa	Switzerland	United States
20-29	less than primary	-	4.10	-	2.2	10.57	-
	primary completed	4.56	3.86	-	7.5	8.39	3.49
	secondary completed	4.91	3.39	-	9.3	7.61	2.81
	university completed	5.36	3.60	-	1.6	8.30	2.88
30-49	less than primary	-	3.92	-	3.4	10.51	-
	primary completed	4.61	3.66	-	4.6	9.39	3.63
	secondary completed	4.72	3.03	-	4.1	8.76	2.96
	university completed	5.08	3.03	-	2.1	7.92	2.72
20-49	less than primary	-	3.98	2.4	2.2	10.54	-
	primary completed	4.58	3.74	9.3	5.1	8.89	3.52
	secondary completed	4.81	3.19	2.0	5.6	8.18	2.86
	university completed	5.22	3.13	6.7	1.6	8.11	2.73

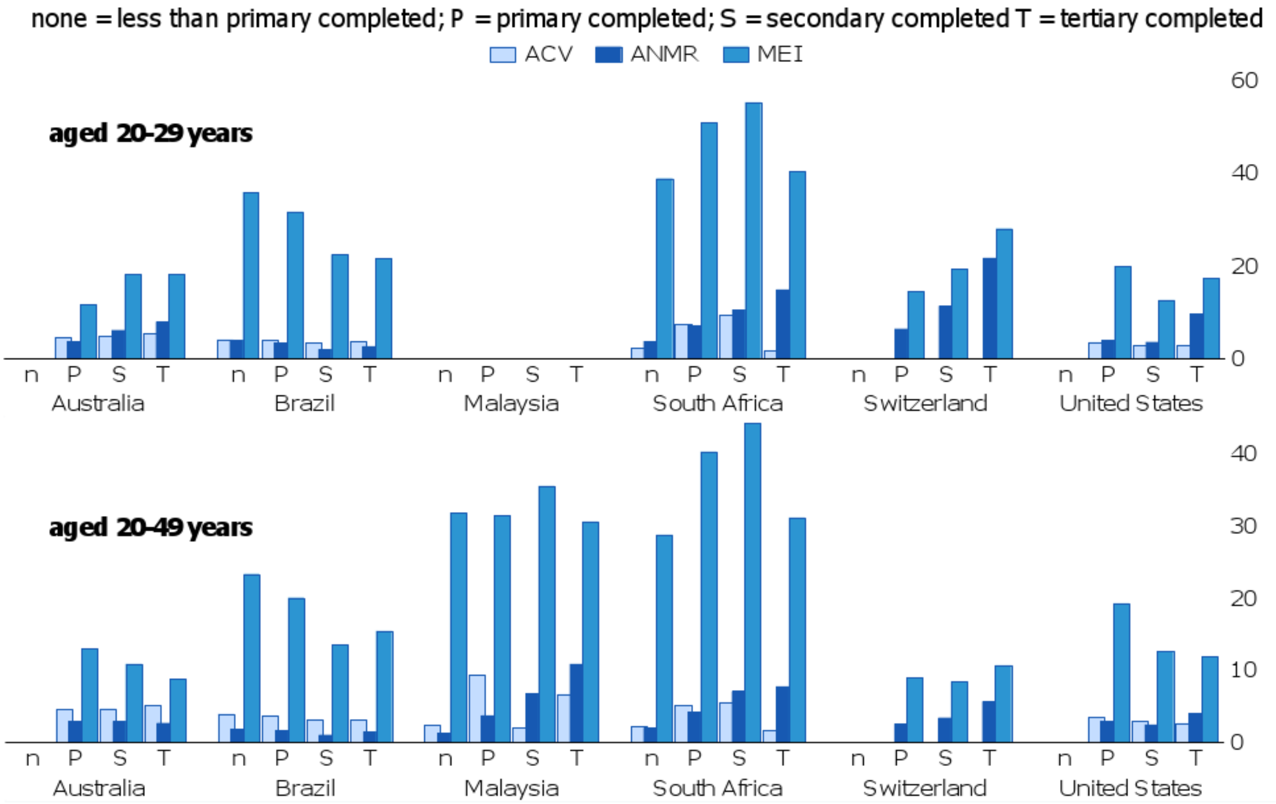


Figure 12: Migration Connectivity (ACV) and Impact (MEI, ANMR), by age group

5 Migration Distance

While there is general consensus that distance has a deterring effect on migration (Lee, 1966), the relatively high occurrence of interstate moves among the highly-skilled to urban destinations points to the better educated being less deterred by distance than the less educated.

We use spatial interaction models to determine how much the system of interstate migration flows is deterred by distance and whether the distance-decay effect varies by education. The model assumes that the size of a migration flow between states is proportional to the population size of the origin and destination regions and the distance between the two places (Boyle, 1995; Flowerdew and Lovett, 1988). The unconstrained spatial interaction model based on the Poisson distribution has the form (see Boyle, 1995):

$$M_{ij} = exp(\beta_0 + \beta_1 lnP_i + \beta_2 lnP_j + \beta_3 lnd_{ij} + \beta_4) + \varepsilon_i \quad (5)$$

where Mij is the predicted count of migrants moving between states i and j; Pi, Pj, and dij are the independent variables of origin population size, destination population size and distance with corresponding regression coefficients $\beta 1$ to $\beta 4$ and ϵi is the error term. The total PAR of migrating at the beginning of the period was used to calculate population size.

Table 5 sets out the results from the Poisson models for the United States to identify differences by education in the effects of distance-decay and population size. The coefficients show that the distance-decay effect on interstate migration decreased across education groups from -0.9 for primary educated to -0.69 for university-graduates, indicating that the highly skilled were more likely to move over longer distances than the less educated. The effects of population size at the origin and destination were strongly positive for all population groups. Among university-graduates, the size of the destination population (with the same education level) is more important than the population at the origin. For all other groups, the origin population has a stronger effect. This finding underlines the selective destination choices of the highly skilled. As this is work in progress, results for the other five countries were not yet available.

Table 5: Spatial interaction model parameters, United States, 20-49 year olds, by education (all parameter estimates are significant at 1% level)

	total		primary		secondary		university	
Variable	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
ln(Origin population)	0.943	0.00	1.114	0.00	0.956	0.00	0.864	0.00
ln(Destination population)	0.850	0.00	0.747	0.00	0.800	0.00	0.929	0.00
ln(Distance in km)	-0.757	0.00	-0.904	0.00	-0.758	0.00	-0.691	0.00
Constant	-12.256	0.01	-10.673	0.02	-11.546	0.01	-11.194	0.01
Deviance	5,758,136		611,267		4,042,604		1,770,863	
No. of observations	2,352		2,352		2,352		2,352	
Residual df	2,348		2,348		2,348		2,348	
McFadden's Adj R2	0.77		0.74		0.72		0.82	

6 Conclusion

This paper presented the first cross-national comparison of the spatial structure of internal migration by education. Indexes capturing four important dimensions of the spatial structure of migration were calculated for each country. The analysis revealed enduring regularities in differences across education groups in the intensity, age pattern and spatial pattern of internal migration in the six countries under study. We have highlighted differences by education in migration intensities and distance, and similarities in migration connectivity and impact. In line with findings in Australia, the US and Europe (Castorina et al., 2010; Florida, 2002; Hansen and Niedomysl, 2009; Waldorf, 2009; Whisler et al. 2008), we find that the better educated show a strong centralisation trend in the migration system.

The findings will inform the making of plausible assumptions about the likely future intensities of migration between the provinces of India and China for the upcoming round of IIASA/Wittgenstein Centre human capital projections. Given the dearth of adequate data on migration flows by level of education in India and China, we assume that the empirical regularities identified in the cross-national comparison of migration in Australia, Brazil, Malaysia, South Africa, Switzerland and the United States presented in this paper also hold in the Chinese and Indian context.

7 References

Basker, E. (2002) Education, job search and migration. University of Missour-Columbia Working Paper.

Bell, M. and Muhidin, S. (2009) Cross-National Comparison of Internal Migration United Nations Development Program Human Development Reports Research Paper 2009/30.

Bell, M., Blake, M., Boyle, P., Duke-Williams, O., Rees, P., Stillwell, J., et al. (2002) Cross-national comparison of internal migration: issues and measures. Journal of the Royal Statistical Society: Series A (Statistics in Society), 165(3), 435-464.

Boyle, P. (1995). Rural in-migration in England and Wales 1980-1981. Journal of Rural Studies, 11(1), 65-78.

Castorina, Diana, Stoeckl, N., and Welters, Riccardo (2010) Internal migration in Australia: does it exacerbate or mitigate regional skills disparities? Proceedings of 12th Path to Full Employment Conference In: 12th Path to Full Employment Conference, 2 - 3 December 2010, Newcastle. NSW, Australia.

Florida, R. (2002) Bohemia and economic geography. J Econ Geogr, 2,55-71.

Flowerdew, R., and Lovett, A. (1988). Fitting Constrained Poisson Regression Models to Interurban Migration Flows. Geographical Analysis, 20, 297–307.

Hansen, H.K. & Niedomysl, T. (2009) Migration of the creative class: evidence from Sweden. J Econ Geogr, 9, 191-206.

Lee, E. S. (1966). A Theory of Migration. Demography, 3(1), 47-57.

Long, L. (1991) Residential Mobility Differences among Developed Countries. International Regional Science Review, 14(2), 133-147.

Long, L.H., Tucker, C.J. and Urton, W.L. (1988) Migration distances, an international comparison. Demography, 25, 633-40.

Openshaw, S. (1984). The Modifiable Areal Unit Problem. Norwich: GeoBooks.

Plane, D. A. (1994). The wax and wane of interstate migration patterns in the USA in the 1980s: a demographic effectiveness field perspective. Environment and Planning A, 26(10), 1545-1561.

Plane, D. A., and G. F. Mulligan (1997) Measuring Spatial Focusing in a Migration System. Demography, 34(2), 251-262.

Rees, P., Bell, M., Duke-Williams, O., and Blake, M. (2000). Problems and solutions in the measurement of migration intensities: Australia and Britain compared. Population Studies, 54(2), 207 - 222.

Ritsila, J. and M. Haapanen (2003). Where Do the Highly Educated Migrate? Micro-Level Evidence from Finland. International Review of Applied Economics Vol. 17(4), 437-448.

Rogers, A., Raquillet, R., and Castro, L. J. (1978) Model migration schedules and their applications. Environment and Planning A, 10(5), 475-502.

Rogers, A., and Sweeney, S. (1998). Measuring the Spatial Focus of Migration Patterns. The Professional Geographer, 50(2), 232 - 242.

Schroeder, J. P. (2009). Visualizing patterns in U.S. Urban population trends. Unpublished PhD Thesis, University of Minnesota.

Waldorf, B. (2009) Is human capital accumulation a self-propelling process? Comparing educational attainment levels of movers and stayers. The Annals of Regional Science, 43, 323-344.

Whisler, R. L., B. S.Waldorf, G. F. Mulligan, & D.A. Plane. (2008) Quality of life and the migration of the college educated: A life-course approach. Growth and Change 39:59–94.