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The effect of intra-European migration on cognitive abilities in later life

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Abstract:

The study raises the question about the long-term effect of intra-European migration on cognitive abilities in later life. In contrast to previous studies, not natives in the destination country but stayers in the origin country are used as reference group for migrants who moved to another European country at some point in life and are now growing old abroad. Using SHARE data and applying an instrumental variable approach in the first and fixed effects models in the second analytical step, the results indicate that migration turns out to have a negative long-term effect on the baseline level of cognitive abilities but that the process of cognitive decline does not differ significantly between migrants and stayers.

Zusammenfassung:

Die vorliegende Studie geht der Frage nach, inwiefern sich intra-Europäische Migration auf die kognitiven Fähigkeiten im späteren Leben auswirkt. Im Gegensatz zu vorherigen Studien werden nicht Personen der Zielländer, sondern Personen der Herkunftsländer als Vergleichsgruppe herangezogen. Unter Nutzung des SHARE Datensatzes und unter Verwendung eines Instrumentalvariablen-Ansatzes im ersten sowie von Fixed Effects Modelle im zweiten Analyseschritt, zeigen die Ergebnisse, dass Migration langfristig einen negativen Effekt auf das Basisniveau der kognitiven Fähigkeiten hat. Hinsichtlich des Prozesses der kognitiven Alterung zeigen sich jedoch keine signifikanten Unterschiede zwischen Migrantinnen und Migranten und den Vergleichspersonen der Herkunftsländer.

Keywords:

Cognition, Intra-European Migration, IV approach, Fixed Effects Growth Curve, SHARE

JEL Classification:

F22, I14

INTRODUCTION

By raising the question whether intra-European migration and the circumstances associated with it influence the cognitive performance of migrants in later life, this study addresses two developments, both with growing importance for Europe. The first one is intra-European migration. In January 2018, 21.8 million people of the more than 500 million inhabitants of the EU member states had been born in a different EU member state than the one in which they were residing (Eurostat 2019). This makes the European Union "(…) *the world's best research laboratory on legal, transnational migration*" (Migration Policy Institute 2017). The second one is cognitive ageing as one fundamental aspect of the ageing process that many European countries are facing. Cognitive ability levels are of growing importance especially in ageing societies as they predict individual productivity better than any other observable individual characteristics (Skirbekk et al. 2012). Schaie (1989) has shown that cognitive functioning is relatively stable until the fifth decade of life and that after this period, the decline in cognitive abilities becomes apparent. However, at all ages there is large variation across individuals in the level of cognitive performance.

Until now, very little is known about the long-term consequences of migration on cognitive abilities. The classical comparison applied by the existing research between immigrants and natives in the destination country allows for observing the relative position of migrants within the host society. However, it does not allow for measuring the effect of migration itself. By using stayers in the European origin countries as reference group for migrants who have moved to another European country and by applying an instrumental variable (IV) approach as well as fixed effects (FE) growth curve models, the empirical strategy of this study allows for measuring the effect of migration on cognitive functioning in later life. The results indicate that intra-European migration turns out to have a negative effect on the level of cognitive abilities. However, for the process of cognitive ageing in later life other factors than having migrated or not seem to be more relevant.

The paper is structured as follows: After giving a brief overview on previous findings and pointing out existing research gaps, theoretical considerations on the influence of migration on cognitive abilities are outlined. The subsequent section contains information on the database and the analytical sample followed by a description of the methods. After presenting the results the paper finishes with a discussion including a section on limitations as well as an outlook for future research.

PREVIOUS FINDINGS AND RESEARCH GAP

The existing research on the consequences of migration for cognitive functioning mainly focuses Latin American immigration to North America. The leading research question in this strand of literature is whether the 'healthy immigrant effect' (HME) extends to indicators of cognitive functioning. To answer this question the cognitive performance of immigrants is compared to US- or Canadian-born natives. The results of the different studies are inconclusive. Some studies suggest that the HME extends to

cognitive abilities for specific migrant groups. Analyzing immigration to Canada, Kopec et al. (2001) find lower rates of cognitive dysfunction for specific immigrant groups. Their results indicate that language plays an important role: an advantage over Canadian-born natives is only detected for non-English speaking Hispanic and African immigrants. Hill et al. (2012a) discover cognitive advantages for those immigrants to the US who migrated in middle-life between the age of 20 and 49 concluding that this reflects the unique cognitive demands of migration during this life phase. In another study, Hill et al. (2012b) test whether the cognition trajectories of older Mexican Americans vary according to nativity status, age at migration, and gender. Their results show that the HME extends to cognition indicators especially among older Mexican American men and confirm that gender is an important conditioning factor in the association between immigrant status and cognitive functioning. Analyzing the rate of cognitive decline, Nguyen et al. (2002) find no apparent difference between Mexican immigrants to the US and US-born natives of Mexican descent. Using the same dataset – the Hispanic Established Populations for the Epidemiologic Study of the Elderly – a variety of subsequent studies do not find cognition differences between immigrants and US-born natives neither (Collins et al. 2009; Miranda et al. 2011; Sachs-Ericsson et al. 2009). In contrast to those findings, the results of Haan et al. (2011) suggest that Mexican immigrants to the US may actually have poorer cognitive functioning than their US-born counterparts.

Although the results are pointing to different directions, these previous studies have made significant contributions to the understanding of the cognitive performance of immigrants in relation to their native counterparts. However, the research design of comparing immigrants to the native reference group in the destination country does not allow for measuring the effect of migration itself. The first research gap addressed by this study is therefore to investigate the consequences of migration for the cognitive functioning of migrants by using stayers in the origin country as reference group.

The second research gap is a methodological one. Using individual administrative panel data covering the whole Norwegian male population born in 1932 and 1933, a recent study by Bütikofer and Peri (2016) finds evidence that high levels of cognitive ability are associated with a higher propensity to migrate. Their results indicate that endogeneity is a serious concern that needs to be addressed methodologically when analyzing the effect of migration on cognition. *"The pervasive endogeneity in decisions surrounding migration requires more advanced techniques, e.g. instrumental variables, which deal with this issue explicitly"* (McKenzie and Sasin 2007: 2). A few studies exist that use an instrument for different migration contexts (see McKenzie and Sasin 2007 for an overview). However, for the intra-European migration context there is so far no study applying an IV approach.

A last research gap refers to the consequences of migration for the process of cognitive ageing. This understudied research question is addressed by the second analytical step in which I use the panel structure of the SHARE dataset to apply a fixed effect model (FE) in order to analyze in how far the process of cognitive ageing varies between migrants and stayers.

THEORETICAL FRAMEWORK

A priori it remains unclear whether migration has a positive or negative effect on cognitive abilities in later life. On the one side, migration could have beneficial consequences due to the need to adapt to a new environment. There is evidence that the human brain changes structurally in response to environmental demands (Mechelli et al. 2004). Functioning in another language is one example for such an environmental change. The cognitive demands connected to it might have a positive long-term effect on the cognitive functioning of migrants. Both Bialystok et al. (2004) and Kave et al. (2008) have shown that bilingualism improves cognitive outcomes in later life. In this context, the age of acquisition is a crucial factor as shown by Mechelli et al. (2004). The authors investigate whether there is a relation between brain structure, proficiency in the second language and age at acquisition. Their results indicate that the grey-matter density correlates negatively with the age at acquisition of the second language.

On the other side, acculturative stress associated with migration could lead to reduced cognitive abilities in the long run. Acculturation refers to the changes that groups and individuals undergo when they come into contact with another culture (Williams and Berry 1991). Acculturative stress refers to the stressors that directly result from and have its source in the acculturation process (Berry 1990). It can be a result of minority status, experiences of discrimination and may also follow from 'cultural dissonance' between one's native culture and the destination country's culture (Suarez-Orozco and Qin 2006; Vega and Rumbaut 1991). Over time, the stress associated with difficult immigration and acculturation experiences could undermine cognitive functioning through physiological mechanisms. In this context, primate studies have shown that social hierarchies influence stress hormones and induce hippocampal damage among low status animals (Sapolsky et al. 1990). Chronic psychosocial stress predicts reduced hippocampal cell proliferation – an effect that was greatest in older animals (Simon et al. 2005). This applies to human beings as well. Overexposure to stress hormones has shown to be sufficient to disrupt or even damage the hippocampus, the region of the brain that regulates memory, orientation, and the rate of cognitive decline (McEwen & Sapolsky, 1995; McEwen, 2002).

A possible effect of migration on cognitive abilities in later life is most probably a combination of different factors. Within the framework of this paper, it is not possible to disentangle those factors and mechanisms. The primary purpose is to shed light on whether there is a negative or positive effect.

DATA

Database

This study uses data from release 7.0.0 of the Survey of Health, Aging and Retirement in Europe (SHARE). SHARE is a multidisciplinary and cross-national panel dataset on health, socio-economic status and social and family networks of more than 140,000 individuals aged 50 or older. In the currently released seven waves collected via computer assisted personal interviews (CAPI), the survey covers 27 European countries plus Israel. Compared to other datasets, SHARE has two major advantages. First, it

allows for investigating the long-term effect of migration as the majority of migrants in the dataset have migrated a long time ago (on average more than 30 years). Second, the variety of countries covered by SHARE and the large number of respondents makes it possible to observe both migrants in their new destination country as well as stayers in the respective European origin country in sufficient quantity. This allows not only describing the differences in the cognitive performance between immigrants and the native population of the destination country (as done by previous research), but also measuring the effect of migration itself by using stayers in the origin country as reference group.

On the other hand, one of the main disadvantages of the database is that sufficient language skills are a precondition for participating in the SHARE interview. Fluency in the destination country's language plays a decisive role for the labour market integration of migrants (Rumbaut 1997). Therefore, one would expect that excluding persons with insufficient language skills will particularly affect migrants of low socioeconomic status. Examining data collected in the contact phase of the SHARE survey on persons who did not participate in the SHARE interview due to language barriers, Hunkler et al. (2015) investigate the coverage of the migrant population in SHARE. "*[E]ven though SHARE was not designed to specifically survey migrants, we* [the authors] *conclude that it is a viable dataset for analysing migrants aged 50 and older both within and across countries*" (Hunkler et al. 2015: 202).

Analytical Samples

All regular panel waves of SHARE (waves 1, 2, 4, 5, and 6) enter the analyses. Due to the intra-European focus of this study, Israel is excluded both as origin and destination country. Additionally, the origin countries Luxembourg, Estonia and Ireland are not included in the analytical samples because the number of emigrants from these three origin countries is too low. Overall, the dataset for the first analytical step is composed of 77,969 individuals of whom 74,792 are stayers and 3,177 are migrants (4.1 percent). The sample covers 17 European origin countries: Denmark, Sweden, Germany, Austria, France, Switzerland, the Netherlands, Belgium, the Czech Republic, Poland, Hungary, Slovenia, Croatia, Greece, Italy, Spain, and Portugal. The share of emigrants differs largely between those origin countries. It ranges from 0.6 percent in the Greek sample to 18.0 percent in the Portuguese sample.

The sample for the panel model in the second analytical step is restricted to repeated observations. All respondents for whom only one observation is available are excluded from the analysis. Those respondents cannot contribute to the model as changes over time are analyzed. Additionally, Croatian and Hungarian migrants are dropped even if they have repeated observations. The reason is that Croatia and Hungary participated only in one wave of SHARE so that the reference group of Croatian and Hungarian stayers has only one observation. This leads to a total sample size for the fixed effects model of 48,832 respondents with 129,933 observations. The share of observations from migrants is slightly lower than in the first analytical sample (3.6 percent). This is not necessarily a consequence of higher attrition among migrants as destination and origin countries possibly participated in different waves leading to deviating participation opportunities depending on the origin-destination combination.

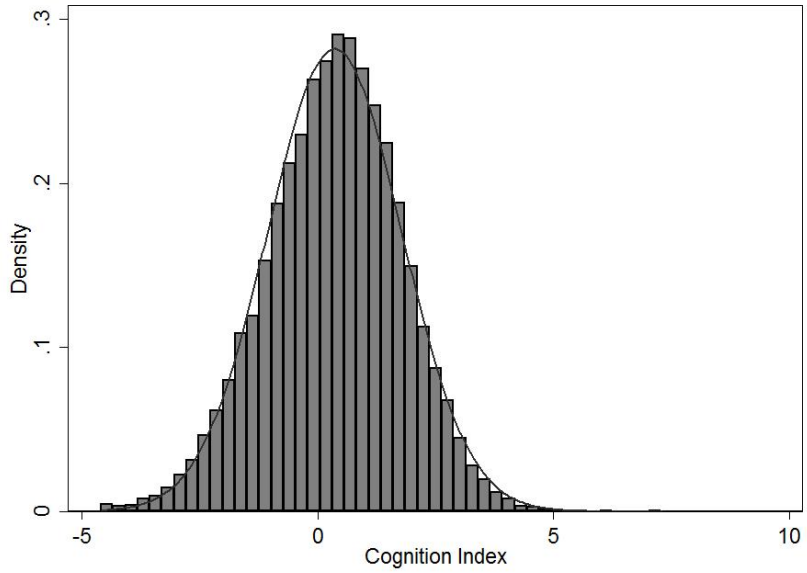
METHODS

Dependent variable

Cognitive functioning in SHARE is measured via four different cognitive tasks (Mehrbrod et al. 2017): (i) Numeracy is assessed by nine items. Five items measure subtraction calculation skills and four items measure percentage calculation skills. The result score contains the number of correct answers and ranges from 0 to 5: the higher the score, the better the respondent's mathematical performance. Episodic memory is tested via verbal registration and recall of a list of ten common words. The respondents listen to that list once and get tested twice, the first time immediately after the encoding phase (ii) and the second time after a delay (iii). The total scores of the two tests range from 0 to 10 and correspond to the number of words the respondent is able to recall. For testing (iv) verbal fluency, respondents have to name as many words as possible from a semantic category (e.g. animals) within 60 seconds. The score measures performance via the total number of correct words with a minimum of 0 and a maximum of 100.

The operationalization of cognition follows the strategy of Bonsang and Dohem (2015) who use SHARE data to analyze the effect of retirement on cognitive functioning. After standardizing the different cognitive measures, principal component analysis is used to generate a normally distributed cognition index that ranges from a minimum of about -5 to a maximum of about +5. Figure 1 illustrates the distribution of the cognition index used as dependent variable (DV).

Figure 1: Distribution of the cognition index



Source: Own calculations based on SHARE release 7.0.0

Instrumental variable approach

The empirical strategy of this study is divided into two analytical steps. The first one investigates whether there is an effect of migration on the level of cognition in later life restricting the sample to the first interview of each respondent. The method applied is an IV approach using the *ivreg2* command (Baum et al. 2007). The analyses are performed with the statistical software Stata 14.

A common assumption of the regression framework is that the error term is uncorrelated with the explanatory variable or that $COV(x_i, \varepsilon_i) = 0$. An OLS estimator is unbiased and consistent when this assumption holds. Endogeneity leads to the violation of this assumption (Bollen 2012). The causes of endogeneity are omitted variables, selection and reverse causality. Bütikofer and Peri (2016) show that high cognitive ability levels are associated with a higher propensity to migrate. Migrants seem to be positively selected along with cognition leading to a violation of the assumption so that $COV(x_i, \varepsilon_i) \neq 0$.

The IV approach provides a way to nonetheless obtain consistent parameter estimates (Cameron and Trivedi 2005). Two primary conditions have to be fulfilled for applying IV. The first one is the *conditional independence assumption*. Variable *Z* can be used as an instrument for regressor *x* in $y = \beta x + \varepsilon$ if (1) *Z* is correlated with *x* and (2) uncorrelated with the error ε. Implicit in (2) is that *Z* has no direct effect on the outcome *y* (Bollen 2012). This means that the instrument has to be correlated with migration (having migrated or not), and may not be correlated with individual cognitive abilities in later life. The second assumption is the *relevance assumption*. It requires that there is sufficient association between the instrumental variable and the regressor being instrumented (Cameron and Trivedi 2005). While the relevance assumption can be tested empirically, the conditional independence assumption has to be justified argumentatively.

The proposed instrument for intra-European migration is the country-specific share of emigrants at a certain time. I argue that the share of emigrants (*migshare*) influences the individual probability to migrate – the higher the share of emigrants at a certain time the higher should be the individual probability to migrate – but that it is uncorrelated with individual cognitive abilities in later life (conditional independence assumption). To test whether the instrument is associated sufficiently with migration (relevance assumption), the first stage of the IV model regresses the instrumental variable on the binary variable M_i flagging migrants and stayers. The equation of the first stage regression testing the relevance of the instrument can be written as:

$$M_i = \alpha_1 \mathrm{I}\,(migshare_{ct}) + \alpha_2\, X_i + \mu_c + \tau_t + \gamma \qquad (1)$$

If the instrument turns out to be relevant in the first stage, the second stage of the IV model uses the instrumented migration variable $\widehat{M}_i$ to test whether migration has an effect on cognitive functioning in later life. The second stage can be written as:

$$COG_i = \beta_1 + \beta_2\, \widehat{M}_i + \beta_3\, X_i + \mu_c + \tau_t + \gamma \qquad (2)$$

The control variables X_i included in the model are gender, age and years of education. Only pre-treatment characteristics can be included which restricts the number of possible controls to those few variables. μ_c in equations 1 and 2 represents origin country fixed effects and τ_t wave fixed effects. It is important to include wave fixed effects because the baseline interview can have taken place in any of the five SHARE panel waves between 2004 and 2015.

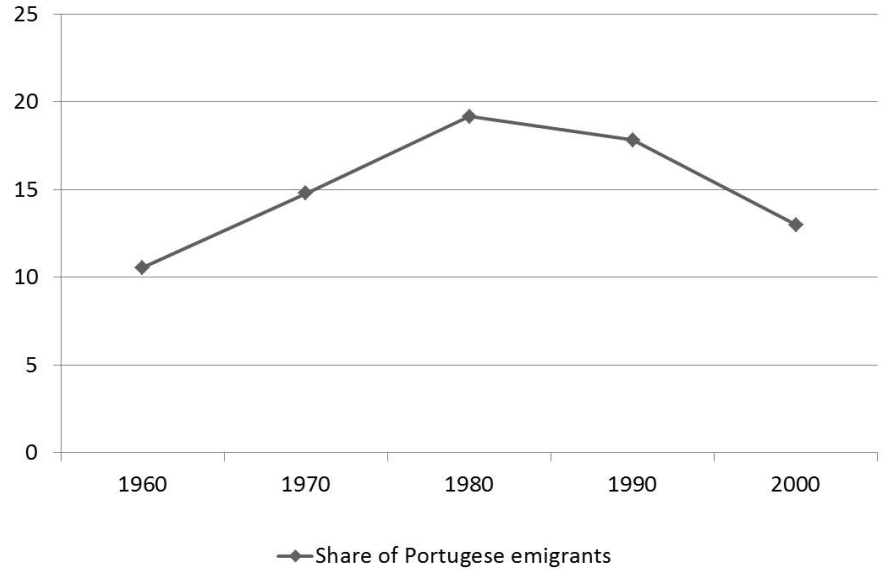
Dataset used for generating the instrument

The dataset used for generating the instrument is the *Global Bilateral Migration Database* provided by the World Bank (Özden et al. 2011). It contains global matrices of bilateral migrant in- and outflows for 226 countries spanning from 1960 to 2000 (decennial data). The primary data source is the *United Nations Populations Division's Global Migration Database*, a data repository that comprises around 3,500 census and population register records (United Nations 2008).

Based on the *Global Bilateral Migration Database* and the *World Population Prospects* containing country- and time-specific population numbers (World Bank 2017), the share of emigrants is calculated for each of the 17 SHARE origin countries for the five years corresponding to the five census rounds of the Bilateral Migration Database between 1960 and 2000. Linear interpolation is applied to fill up the unobserved years between the census rounds and to increase the variation across time. Figure 2 illustrates this for the example of Portugal, the country in the sample with the highest share of emigrants.

The country-specific mean age at migration is used for the assignment of values because it is regarded as the time for 'being at risk' for migrating. It ranges between 18 years for Spanish emigrants and 36 years for Swiss emigrants. In the example of Portugal, the mean age at migration in the sample is 25. Thus, to each Portuguese respondent the share of Portuguese emigrants of the year in which the respondent was 25 years old is assigned.

Figure 2: Share of emigrants used as IV by the example of Portugal 1960 - 2000



Source: Own calculations based on World Bank data (2017)

Fixed effects model

Apart from selection and reverse causality, unobserved components that might simultaneously affect cognition and the tendency to migrate are another source of endogeneity. Typical examples of such characteristics are genetics or individual preferences that remain unobserved in many surveys. To investigate whether the process of cognitive ageing differs between migrants and stayers and to resolve unobserved heterogeneity, I take advantage of the available panel data structure in SHARE in the second analytical step and apply a fixed effects model (FE). FE models rule out time-constant unobserved heterogeneity between individuals by measuring the changes within individuals (Brüderl and Ludwig 2014). The model can be written as:

$$\gamma_{it} - \bar{\gamma}_i = (x_{it} - \bar{x}_i)\,\beta + (\varepsilon_{it} - \bar{\varepsilon}_i) \qquad (3)$$

γ_{it} represents the value of the cognition index observed for individual *i* at time *t*, x_{it} the time-variant independent variables observed for individual *i* at time *t*, and ε the error term. As migration is observed before the survey period and is therefore a time-invariant characteristic, an interaction of migration and age is used. x_{it} includes the number of chronic diseases in order to control for health, a variable measuring subjecting well-being, a dummy variable for being retired, an imputed measure of the yearly household net income, as well as the wave of observation. The results are displayed as growth curves over age for migrants and stayers separately.

RESULTS

Results of the IV model

On the descriptive level, migrants and stayers in the IV sample are very similar regarding the control variables. As displayed in Table 1, the share of females, age structure and years of education are almost identical in the two groups. The mean values of the different components of the cognition index are quite similar between migrants and stayers, too. Stayers perform slightly better in the first recall test, while migrants' performance is slightly better in the delayed recall test. However, a t-test shows that the differences are not significant. The numeracy score is identical in both groups. The only remarkable and statistically significant difference between migrants and stayers on the descriptive level can be observed for the verbal fluency test. Here, the performance of migrants is significantly lower than the performance of stayers ($p < 0.001$). However, language barriers might influence the lower performance of migrants in verbal fluency because for many migrants the interview language is not their mother tongue. For this reason, models excluding verbal fluency from the cognition index (henceforth referred to as 'reduced cognition index') are calculated, too.

Table 1: Summary statistics for the IV sample

	Stayers (n= 74,792)		**Migrants** (n= 3,177)	
	Mean	**SD**	**Mean**	**SD**
Female	0.54	0.50	0.55	0.50
Age	61.6	7.7	62.0	7.8
Years of education	11.0	4.1	11.0	4.9
First recall test [0; 10]	5.4	1.7	5.3	1.7
Delayed recall test [0; 10]	3.9	2.0	4.0	2.1
Numeracy [0; 5]	3.5	1.0	3.5	1.1
Verbal fluency [0; 100]	20.5	7.5	19.5	7.0

Source: Own calculations based on SHARE release 7.0.0

The result of the first stage regression presented in Table 2 indicates that the country- and time-specific share of emigrants is a relevant instrument for intra-European migration. It has a highly significant positive effect on having migrated. The tests for weak identification and underidentification indicate that having migrated is influenced sufficiently by the country- and time-specific share of emigrants.

Table 2: First stage regression of the IV model; DV: having migrated

Share of emigrants	0.0073*** (0.0007)
Female	0.0029** (0.0014)
Age	-0.0002 (0.0001)
Years of education	0.0010*** (0.0002)
N	77,969
R-squared (centered)	0.041
Anderson underidentification test Chi-sq(1)	97.87***
Weak identification test (Wald F-statistic)	97.96***
Weak-instrument-robust inference	15.22***

Note: Standard errors in parentheses; birth country FE and wave FE included;
*** p<0.01, ** p<0.05, * p<0.1
Source: Own calculations based on SHARE release 7.0.0

The second stage of the IV model tests whether instrumented intra-European migration has an effect on the level of cognition. The first column in Table 3 contains the result of the OLS regression. The result shows a positive coefficient for (non-instrumented) migration. With reference to the results of Bütikofer and Peri (2016), positive selection might be the reason for this result. Indeed, the IV model in the second column shows that migration turns out to have a large and highly significant negative effect of -2.5 on cognitive abilities in later life as soon as endogeneity is accounted for. Regarding the coefficients of the control variables, the direction is in accordance with expectations based on the existing literature. Women are performing significantly better than men, cognitive abilities decrease with age and increase with additional years of education.

The results of Hill et al. (2012b) point to gender differences in the consequences of migration for cognition. Therefore, Table 3 additionally contains separate models for men and women. The results show effect heterogeneity: the negative effect of migration on cognition is considerably larger for women than it is for men. Following the reasoning of Hill et al. (2012b) this gender difference might be related to gender-specific stress associated with migration. The process of migration and acculturation might be especially stressful for women inter alia as result of a lack of control over the migration decision.

Table 3: OLS regression and second stage regression of the IV model; DV: cognition index

	OLS	**IV**		
	Total	Total	Male	Female
Migration	0.0666**	-2.4655***	-1.9985***	-3.1194**
	(0.0224)	(0.6819)	(0.6910)	(1.4557)
Female	0.0782***	0.0859***		
	(0. 0087)	(0.0097)		
Age	-0.0449***	-0.0442***	-0.0412***	-0.0465***
	(0.0006)	(0.0007)	(0.0009)	(0.0009)
Years of education	0.1050***	0.1132***	0.1065***	0.1189***
	(0.0011)	(0.0014)	(0.0018)	(0.0023)
N	77,969	77,969	35,933	42,036
R-squared (centered)	0.2818	0.1641	0.1696	0.1286

Note: Standard errors in parentheses; birth country FE and wave FE included;
*** p<0.01, ** p<0.05, * p<0.1
Source: Own calculations based on SHARE release 7.0.0

To test whether the negative effect of migration is potentially caused by migrants having to perform the verbal fluency test in another language than their mother tongue, the subsequent models exclude the verbal fluency test from the cognition index and use the 'reduced cognition index' as DV. The results presented in Table 4 show again a positive and even larger coefficient of migration in the OLS regression. However, the effect in the IV model is considerably smaller using the reduced cognition

index as DV. This suggests that the large effect of migration found in the first model might indeed be connected to migrants not being native speakers in the interview language. When excluding verbal fluency from the index, the effect of migration on cognition decreases by half to -1.2. A comparison of the R-squared values indicates that using the reduced cognition index explains more variance. Furthermore, the difference in the effect size between men and women decreases considerably in the models based on the reduced cognition index. The effect of migration for women is no longer significant. This suggests that the effect heterogeneity found in the models including verbal fluency might rather be a consequence of different language barriers for male and female migrants than the consequence of gender-specific stress associated with migration.

Table 4: Second stage regression of the IV model**;** DV: reduced cognition index

	OLS	**IV**		
	Total	Total	Male	Female
Migration	0.0862***	-1.2263**	-1.0699*	-1.3942
	(0.0210)	(0.6069)	(0.6235)	(1.2578)
Female	0.0885***	0.0924***		
	(0. 0082)	(0.0086)		
Age	-0.0383***	-0.0379***	-0.0354***	-0.0399***
	(0.0006)	(0.0006)	(0.0008)	(0.0008)
Years of education	0.0977***	0.0991***	0.0942***	0.1030***
	(0.0011)	(0.0013)	(0.0017)	(0.0019)
N	77,969	77,969	35,933	42,036
R-squared	0.2367	0.1987	0.1845	0.2105

Note: Standard errors in parentheses; birth country FE and wave FE included;
*** p<0.01, ** p<0.05, * p<0.1
Source: Own calculations based on SHARE release 7.0.0

The literature points to the importance of age at migration. Age at migration might not only matter due to the age of acquisition of the foreign language (Mechelli et al. 2004). In addition, the pre- and post-migration experiences, the connectedness to and the identification with cultural habits and norms might differ between persons who migrated in early childhood as opposed to persons who migrated later in life. One further aspect is that the performance in cognitive tasks is likely to be influenced by educational standards. According to Anstey and Christensen (2000) education is the social exposure mostly linked to cognitive abilities in later life. The effect of migration might differ between people who migrated after finishing school in the origin country as opposed to migrants who at least partly visited school in the new destination country. Therefore, the last set of models test whether age at migration plays a role for the effect size. The first model excludes all migrants who migrated before age 10, which leads to a reduction of the sample size by 750 migrants. The second model excludes all respondents who migrated before age 16 reducing the sample additionally by 256 respondents. Both models use the reduced cognition index without verbal fluency as DV. The results show that the negative effect of migration is

stronger when excluding persons who migrated before age 10 and even stronger when restricting the sample to those who migrated after age 16. These results suggest that age at migration seems to be a decisive factor for migrants' cognitive abilities in later life.

Table 5: Second stage regression of the IV model; DV: reduced cognition index; excluding migrants who migrated before age 10 and before age 16

	Migration after age 10	**Migration after age 16**
Migration	-1.6908** (0.7805)	-3.0199** (1.4394)
Female	0.0948*** (0.0089)	0.0984*** (0.0102)
Age	-0.0381*** (0.0006)	-0.0382*** (0.0006)
Years of education	0.0992*** (0.0012)	0.1002*** (0.0016)
N	77,219	76,963
R-squared (centered)	0.1830	0.0863

Note: Standard errors in parentheses; birth country FE and wave FE included;
*** p<0.01, ** p<0.05, * p<0.1
Source: Own calculations based on SHARE release 7.0.0

These results turned out to be robust against using the country-specific median age at migration instead of the mean age at migration for the assignment of values of the time- and country-specific share of emigrants.

Results of the FE model

The second analytical step uses the available panel data structure of SHARE and tests whether the process of cognitive decline over time differs between migrants and stayers. Again, the summary statistics presented in Table 6 show that stayers and migrants are similar regarding the covariates. The share of female respondents, age structure, years of education, the share of retired respondents and the number of chronic diseases are almost identical in both groups. The only statistically significant differences ($p < 0.001$) are observed for yearly household income and subjective well-being with migrants showing higher values in both control variables. In the longitudinal sample, migrants' performance regarding first and delayed recall is slightly better than the performance of stayers. The difference in the delayed recall test is even statistically significant ($p < 0.001$). The performance of both groups is identical in the numeracy test and like in the cross-sectional sample for the IV model, migrants show a significantly worse performance of in the verbal fluency test ($p < 0.001$). As outlined previously, latter might be connected to the interview language being potentially different from the migrants' mother tongue. Therefore, once again I run two separate models, one based on the index including all cognitive tests and one based on the reduced cognition index excluding verbal fluency.

Table 6: Summary statistics for the FE sample

	Stayers (n= 125,316)		**Migrants** (n= 4,617)	
	Mean	**SD**	**Mean**	**SD**
Female	0.55	0.50	0.56	0.50
Age	64.3	7.7	64.4	8.0
Years of education	11.1	4.2	11.0	4.9
Retired	0.54	0.50	0.53	0.50
Yearly hh income in €	35,689	60,235	45,432	45,980
Number of chronic diseases	1.1	1.2	1.1	1.2
Well-being (CASP)	38.3	6.0	38.6	5.9
First recall test [0; 10]	5.5	1.6	5.6	1.7
Delayed recall test [0; 10]	4.2	2.1	4.4	2.1
Numeracy [0; 5]	4.0	1.2	4.0	1.2
Verbal fluency [0; 100]	21.1	7.5	20.3	7.1

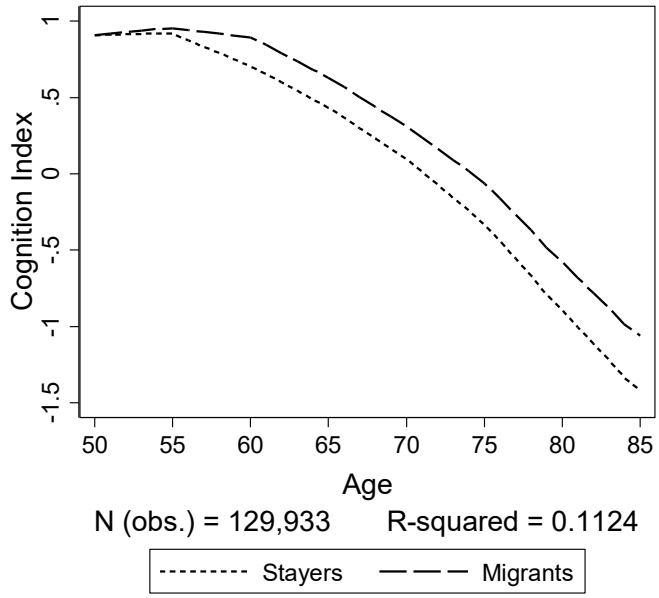
Source: Own calculations based on SHARE release 7.0.0

The fixed effects growth curves based on the cognition index including verbal fluency are presented in Figure 3. The difference between migrants and stayers regarding the process of cognitive ageing is modeled via an interaction between migrant status (0 = stayer; 1 = migrant) and age splines. The differences in the level of cognitive abilities are leveled out at age 50. Important is that only the slopes and not the position of the two curves can be interpreted. Figure 3 shows that the two growth curves are almost parallel. There is no significant difference regarding the process of cognitive ageing when using the cognition index including all tasks as dependent variable.

Using the reduced cognition index as dependent variable, the slope of the curves for stayers and migrants is slightly different between the age of 50 and 65. However, the difference is not significant. From age 65 onwards, the slopes of the two growth curves are almost identical. A test of statistical significance for the overall curve shows that the difference between migrants and stayers is insignificant once again (Prob > F = 0.25).

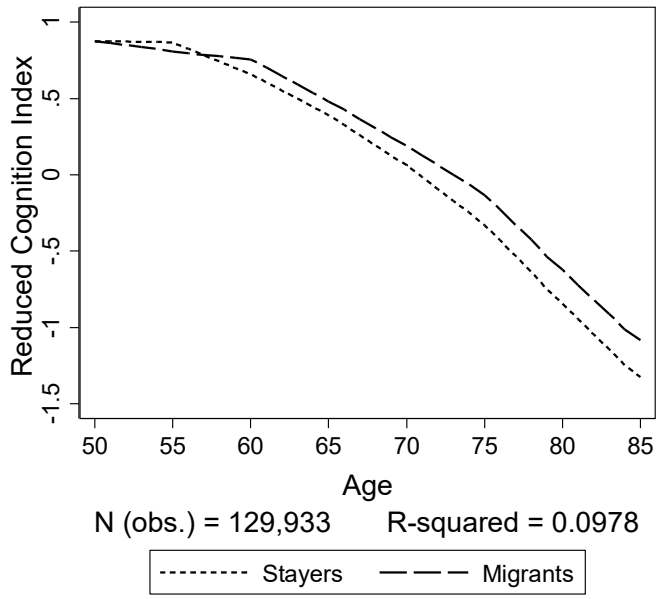
Running separate models for men and women (results available upon request) does not show significant differences for neither of the two groups. Although the Hausman test suggests preferring the fixed effects model over the random effects model, another robustness check showed that the results of the FE models also hold for group specific growth curves based on a random effects model specification. The finding that cognitive abilities of migrants and stayers decrease in a similar manner turns out to be a stable pattern that holds for various model specifications.

Figure 3: Cognitive decline over age; FE growth curves for migrants and stayers; DV: cognition index



Source: Own calculations based on SHARE release 7.0.0

Figure 4: Cognitive decline over age; FE growth curves for migrants and stayers; DV: reduced cognition index



Source: Own calculations based on SHARE release 7.0.0

DISCUSSION

Using the SHARE dataset, this study compares intra-European migrants aged 50 and above who migrated at some point in life and are now growing old abroad to stayers in the respective origin country. The variation in the share of emigrants between countries and across time is used as instrument for migration in the first analytical step which makes this study the first one investigating a possible causal effect of intra-European migration on cognition in later life. I analyze the process of cognitive ageing in the second step by applying fixed effect growth curve models. Before summarizing the main results and drawing concluding remarks, the first part of this discussion section outlines some limitations of the empirical approach.

Many studies in the research field that links migration to cognition use the Mini-Mental State Examination (MMSE) as introduced by Folstein et al. (1975) as measure for cognitive functioning. One limitation of this study is that not all areas tested by the MMSE are part of the cognition measurement. Nevertheless, the combination of mathematical, memory and verbal fluency tests as available in SHARE can be considered as a reliable measurement of cognitive abilities that has been used by various previous studies, e.g. for investigating the effect of retirement on cognition (Bonsang and Dohem 2015; Mazzonna and Peracchi 2017). An additional limitation is that re-migration remains unobserved. This is a potential source of bias. The role of re-migration should be further investigated by future research as migrants might re-migrate selectively not only with regard to physical health (as outlined by the literature on the HME) but also with regard to acculturative stress and cognitive functioning. Furthermore, the findings might be specific for the intra-European migration context and for older migrant generations who are now growing old abroad. Research on other migration contexts and other migrant cohorts might bring out different results. Lastly, the research design applied in this paper does not allow for identifying the mechanisms behind the effect of migration on cognition. More research is needed in order to investigate whether the hypothesis of acculturative stress being the cause of the negative effect can be confirmed or – if not – what other possible mechanisms cause the effect. As outlined by Haan et al. (2011), the socioeconomic status might play a crucial role. Migration may modify the socioeconomic lifetime trajectory and lead to heterogeneity of cognitive functioning in later life. Additional possible mediators mentioned in the literature are health and health behavior as well as cognitive engagement (Glymour and Manly 2008).

Despite these limitations, the results constitute a significant contribution to the understanding of the consequences of migration on cognitive abilities in later live. The IV models of the first analytical step indicate that intra-European migration turns out to have a negative long-term effect on the level of cognitive abilities. The negative effect gets weaker but remains significant when excluding the language sensitive verbal fluency test from the analysis. Separate models for men and women show that effect heterogeneity vanishes after excluding verbal fluency from the analyses pointing to deviating language barriers for male and female migrants. Therefore, these results do not support the hypothesis that the

negative effect may be stronger for women due to gender specific stress associated with the migration process. Furthermore, the findings of the IV models indicate that age at migration is an important factor. Excluding migrants who arrived in the destination country in their early childhood/youth leads to a notable increase of the negative effect. Persons who migrate early in life and visit the school in the destination country seem to be less affected in later life by the negative consequences of migration for cognition. Based on this finding, political implications from the perspective of host societies are that investments into the education of children with migration background pay off in later life and that the linguistic and cultural encouragement of migrants arriving later in life should be given more attention.

Regarding the process of cognitive decline, fixed effects growth curve models applied in the second analytical step do not show significant differences between migrants and stayers. Cognitive decline in later life seems to be determined by other factors. In this context, previous research has identified mental and physical health conditions like depression, diabetes and stroke as the main risk factors for cognitive decline (Nguyen et al. 2002; Hill et al 2012b).

Cognitive ability levels are of increasing relevance for the ageing societies of Europe. Learning more about the long-term consequences of central life decisions – such as migration – for cognitive functioning in later life is therefore a central task for future research.

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