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Health differentials between citizens and immigrants in Europe: A heterogeneous convergence

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Ethics approval

Our study is based on data from SHARE Waves 1, 2, 3 (SHARELIFE), 4 and 5 (DOIs: 10.6103/SHARE.w1.500, 10.6103/SHARE.w2.500, 10.6103/SHARE.w3.500, 10.6103/SHARE.w4.500, 10.6103/SHARE.w5.500). The SHARE study is subject to continuous ethics review. During Waves 1 to 4, SHARE was reviewed and approved by the Ethics Committee of the University of Mannheim. Wave 4 of SHARE and the continuation of the project were reviewed and approved by the Ethics Council of the Max Planck Society.

Highlights:

- We investigate differences in health patterns between immigrants and citizens in Europe.
- We use panel data on more than 100,000 older adults.
- Results show a reversal of health differentials between citizens and immigrants.
- There is also substantial heterogeneity across immigrant groups.
- The importance is stressed on the wealth of the country of origin.

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4 **Health differentials between citizens and immigrants in Europe:**
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6 **A heterogeneous convergence**
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11 **Abstract**
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14 The literature on immigration and health has provided mixed evidence on
15 the health differentials between immigrants and citizens, while a growing body
16 of evidence alludes to the unhealthy assimilation of immigrants. Relying on
17 five different health measures, the present paper investigates the heterogeneity
18 in health patterns between immigrants and citizens, and also between immi-
19 grants depending on their country of origin. We use panel data on more than
20 100,000 older adults living in nineteen European countries. Our panel data
21 methodology allows for unobserved heterogeneity. We document the existence
22 of a healthy immigrant effect, of an unhealthy convergence, and of a rever-
23 sal of the health differentials between citizens and immigrants over time. We
24 are able to estimate the time threshold after which immigrants' health be-
25 comes worse than that of citizens. We further document some heterogeneity
26 in the convergence of health differentials between immigrants and citizens in
27 Europe. Namely, the unhealthy convergence is more pronounced in terms of
28 chronic conditions for immigrants from low-HDI countries, and in terms of
29 self-assessed health and body-mass index for immigrants from medium- and
30 high-HDI countries.
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50 **Keywords:** Healthy immigrant effect · Europe · Health differentials · Health
51 convergence · Immigration · Health economics.
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55 **JEL classification:** F22 · I14 · J15.
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4 **1. Introduction**
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7 The literature on immigration and health has provided mixed evidence on the
8 health differentials between citizens and immigrants in developed countries. While
9 some studies report that immigrants are in better health than citizens [1, 2, 3, 4, 5] -
10 providing support for the so-called *healthy immigrant effect* - others find the opposite
11 [6, 7]. A growing body of evidence further shows that immigrants' health deteriorates
12 with the length of residence in the host country [8, 9, 10, 11]. This phenomenon,
13 sometimes called *unhealthy assimilation*, implies that the healthy immigrant effect,
14 if any, is transitory. Describing and explaining the evolution of immigrants' health is
15 of particular importance from a research and policy perspective. Once settled in the
16 host country, immigrants would tend to have different health trajectories, not only
17 relative to their native counterparts, but also among subgroups of immigrants.
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30 The present paper attempts to assess whether the healthy immigrant effect, if
31 any, is followed by a convergence of immigrants' health status toward that of citizens
32 in Europe. We use panel data on more than 100,000 older adults living in nineteen
33 European countries. The panel data methodology employed allows for unobserved
34 heterogeneity. We document the existence of a healthy immigrant effect, of an un-
35 healthy convergence, and of a reversal of the health differentials between citizens and
36 immigrants over time. We are able to estimate the time threshold after which immi-
37 grant's health becomes worse than that of citizens. We further show that the effect
38 on health of the immigrants' length of residence in the host country differs depending
39 on the wealth of the country of origin and on the health measure considered. The
40 present paper fits in the literature investigating the heterogeneity in health patterns
41 across immigrant groups, with a focus on the wealth of the immigrants' country
42 of origin. Once settled in the European countries, immigrants from poor countries
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4 tend to work in the so-called 3D jobs (dirty, dangerous and demeaning) [12]. In this
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6 regard, the positive health selection (the healthy immigrant effect) would be higher
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8 for immigrants from poorer countries because of the physically demanding nature of
9
10 their work [13]. This would also be a factor of faster health deterioration.
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12 As we investigate the effect on health of the immigrants' length of stay in Europe,
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14 we focus on older immigrants. In North-West European countries, the three decades
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16 after 1945 were characterized by large-scale labour immigration. Immigration into
17
18 southern European destinations became significant from the 1970s [14]. We are
19
20 now able to investigate the evolution of immigrants' health over a long time span,
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22 which explains the recent development of studies on older immigrants in Europe
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24 [14, 8, 9, 7, 15].
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27 The remaining of the paper is organized as follows. Section 2 reviews the liter-
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29 ature on immigrants' health in developed countries. The data and the econometric
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31 methodology are detailed in Sections 3 and 4, respectively. Section 5 presents the
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33 results, and Section 6 discusses the implications of the findings and concludes.
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36 **2. Literature review: immigrant's health in developed countries**

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40 In developed countries, health differentials between natives and immigrants and
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42 their evolution have been linked to the interplay of several factors. These include
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44 socio-economic conditions, individual factors (immigrants' behavior, health-related
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46 selection), and characteristics of both the country of origin (social norms, wealth)
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48 and of destination (social norms, integration policies towards immigrants). These
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50 health differentials are often mirrored by differences in access to health care.
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53 McDonald and Kennedy [1] document a healthy immigrant effect and an un-
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55 healthy convergence in Canada regarding chronic conditions, but not self-assessed
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4 health, indicating that this phenomenon would be more pronounced in terms of
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6 physical health than health perceptions. Also in Canada, while showing the exist-
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8 tence of a healthy immigrant effect in the case of depression, Wu and Schimmele [2]
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10 find that depression among immigrants increases with their length of stay.
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12 In the United States, immigrants are less likely to have health insurance coverage
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14 and have lower health care use and spending than their native counterparts [16, 17,
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16 18, 19, 20]. Observed differences in the access to health insurance and health care
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18 have been seen as one of the interplaying factors behind citizen-immigrant health
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20 differentials. Antecol and Bedard [3] show that immigrants have a lower body-
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22 mass index (BMI) upon arrival, but that they converge to that of the Americans
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24 as the length of stay increases. This relationship between BMI and duration of
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26 residence varies by gender and ethnicity [21], and by arrival cohorts, with more recent
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28 immigrant cohorts being more likely to be obese upon arrival and to experience
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30 a faster unhealthy convergence [22]. Other recent studies show that social norms
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32 in both the host country and the country of origin influence immigrants' health
33
34 behaviors. Focusing on smoking behaviors, Leung [23] finds that assimilation in
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36 the United States is positively (negatively) associated with the likelihood of being a
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38 smoker for immigrants from low-smoking (high-smoking) countries.
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41 Analyses of the relationship between immigrants' health and duration of residence
42
43 in Europe have yielded mixed and sometimes conflicting evidence. Lindert et al. [24]
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45 report disparities across migrant groups in the prevalence of mental disorders and in
46
47 the access and utilization of mental health services. Solé-Auró et al. [7] investigate the
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49 differences in health care utilization between older natives and immigrants. They find
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51 that older immigrants, particularly those who arrived recently, have a higher use of
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53 health care services (physician visits and hospital stays), due to differences in health,
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55 health behaviors, socio-economic status or countries' health system characteristics.
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4 Moullan and Jusot [25] show the existence of a North-South gradient in immigrants'
5 health status, with immigrants in Italy and Spain having a better health status than
6 in Belgium and France. Using three different health measures (self-reported health
7 status, limiting long-standing illnesses, and self-reported chronic illness), Giannoni
8 et al. [5] show that non-European immigrants tend to have better health in countries
9 with pro-immigrant integration policies.

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16 Using Swedish data, Pudaric et al. [26] show that, compared with Swedish-born
17 individuals, country of birth is associated with poor health status (for immigrants
18 from Southern Europe, Eastern Europe and Finland) and impaired instrumental ac-
19 tivities of daily living (for Southern Europeans, Finns and refugees from developing
20 countries). The authors also provide a theoretical framework for the link between
21 immigrants' health deterioration and acculturation. They argue that poorly ac-
22 culturated immigrants are exposed to long-term stress reactions due to a series of
23 individual, structural and cultural factors, which may in turn harm their health.
24 Bengtsson and Scott [27] highlight a gap in sickness benefit consumption between
25 Swedish natives and immigrants, and also between immigrants depending on the
26 country of birth. The authors show that while western immigrants and natives dis-
27 play similar patterns, immigrants from labor-sending countries, whose occupations
28 are more physically demanding, have a higher average number of sick days.
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44 In Spain, Malmusi et al. [8] document large migration-related health inequalities,
45 with immigrants from poor areas being the worse-off group, which can be related
46 to immigrants' socio-economic deprivation compared with natives. Evidence that
47 immigrants' health deteriorates over time at a faster rate for immigrants working in
48 high-risk jobs have been found in Spain [28] and in Germany [11].
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54 In France, Vignier et al. [29] report that individuals in threat-related exile have
55 a lower probability of accessing health care. Furthermore, it has been shown that
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4 undocumented immigrants experience great difficulty in exercising their rights to
5 health care and tend to underutilize the *State Medical Assistance* [30]. The settlement
6 process of recently arrived immigrants from sub-Saharan Africa has been shown to
7 be long and precarious [31]. This long period of insecurity is mirrored by a lower
8 health care utilization of recently arrived immigrants compared to the French-born
9 population with equivalent health needs. This is reported in Berchet and Jusot
10 [32], who also indicate that the healthy immigrant effect was mainly observed for
11 immigrants who settled in France before the economic crisis of the mid-1970s. And
12 even for these first- and second-generations immigrants, studies show that they suffer
13 from premature dependency in old age [33], and, more generally, that their health
14 became worse than that of the French-born population from the mid-2000s [34, 35].
15 Such health disparities are mainly due to differences in social capital, income and
16 occupation status [36], and vary depending on the region of origin [37].
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32 **3. Data**

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35 We use data from the SHARE survey [38], which primarily aims at investigat-
36 ing ageing issues in Europe. The SHARE survey has also been used to investigate
37 the relationship between immigration and health [9, 7, 15]. Our analysis is based
38 on four waves conducted in 2004-2005, 2006-2007, 2010-2012 and 2013, respectively.
39 These waves share the same methodology. The survey samples individuals over 50
40 years old in European countries. Individuals of the same household are also sur-
41 veyed, regardless of their age. The 19 countries in the sample are Austria, Belgium,
42 Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland,
43 Italy, Luxembourg, the Netherlands, Poland, Portugal, Slovenia, Spain, Sweden,
44 and Switzerland.
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4 Individuals' citizenship status (citizen or immigrant) is the main variable of in-
5 terest. Among the alternative definitions of "immigrant", that are based on country
6 of birth, nationality or length of stay in the host country [39], we have opted for the
7 definition based on nationality, as the focus is on individuals who are legal residents,
8 either permanent, temporary or refugees, and who represent a distinct category of
9 the population. A study including three different categories - immigrants born for-
10 eigners in a foreign country, naturalized citizens and native citizens - would have
11 been of great interest, but we cannot identify naturalized citizens in our data.
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21 When individuals are surveyed for the first time, major life events are collected
22 retrospectively. Thus, we know the immigrants' year of arrival, allowing us to com-
23 pute the length of stay in the host country. As it is likely to be highly correlated
24 with age, we divide the length of stay by the age. This measures the immigrants'
25 share of lifetime in the host country. Immigrants in the sample arrived in the host
26 country between 1916 and 2013. Immigrants' year of arrival distribution is shown in
27 Figure 1.
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36 *[Figure 1 about here]*
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40 We also have information on the immigrants' country of origin, from which we
41 construct a categorical variable based on the wealth of the country of origin. We
42 use the UN's Human Development Index (HDI) as a measure of wealth. The HDI
43 index doesn't measure economic growth alone but also considers individuals and their
44 capabilities. GDP is a particular measure of wealth focusing only on this part of
45 wealth which is measurable by a monetary value. By using HDI we intend to move
46 beyond GDP and account a broader societal dimension of wealth and well-being.
47 Based on their HDI value in 2015, countries of origin are classified as low human
48 development ($HDI < 0.700$), medium ($0.700 \geq HDI < 0.836$) and high human
49 development ($HDI \geq 0.836$).
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4 development (HDI \geq 0.836). The 0.700 cut-off is commonly used to distinguish
5 low- from medium-HDI countries, and the 0.836 cut-off represents the lowest HDI
6 value among European Union countries (Hungary), as performed by Malmusi et al.
7 [8]. Although immigrants in the sample arrived in the host country between 1916
8 and 2013, we only use the 2015 HDI of the country of origin, as more than 83%
9 of the immigrants left their country of origin before the oldest year for which HDI
10 data is available. The wealth of the country of origin should be interpreted with an
11 appropriate degree of caution related to the fact that, although HDI data exhibit a
12 strong path-dependency, some countries may be categorized in a given HDI category
13 which was not the same at the time of migration.
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25 Detailed definitions of the variables used are given in Table 1. Five different health
26 measures are used as dependent variables: (1) SAH (whether the individual reports a
27 less than very good health), as is common in the literature (see for instance Antecol
28 and Bedard 3 or Malmusi et al. 8), (2) the body-mass index (whether the individual
29 is overweight or obese), (3) chronic conditions (the number of chronic diseases), (4)
30 mental health (whether the individual is depressed), and (5) physical limitations
31 (whether the individual has one or more limitations with activities of daily living
32 [ADL]). An extended discussion on the relevance of the health measures considered
33 is provided in Appendix A1 of the electronic supplementary material. Descriptive
34 statistics of the variables used in the analyses are given in Table A1 of the electronic
35 supplementary material. Individuals in the sample are aged 22 to 103. Citizens'
36 and immigrants' age distributions are relatively similar, as shown in Table A2 of
37 the electronic supplementary material. Table A3 of the electronic supplementary
38 material displays the percentage of immigrants by region of origin. The majority of
39 immigrants come from the European Union or other European countries (48.09% and
40 30.48%, respectively). Stateless persons represent 8.07% of the sample of immigrants,
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4 and immigrants coming from Africa represent 7.74%. Immigrants from the Americas
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6 or Asia and Oceania represent slightly less than 3%, respectively.
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9 *[Table 1 about here]*
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11 12 13 **4. Econometric methodology** 14

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16 We use a Mundlak [40] panel probit model for all binary dependent variables
17 (Equation 1), and a Mundlak [40] panel Poisson model for the discrete positive de-
18 pendent variable, that is, the number of chronic diseases (Equation 2). The Mundlak
19 [40] specification is a fixed effect for all time-varying variables and a random effect
20 for all time-constant variables. With a usual fixed effect model we would not be able
21 to estimate a parameter for time-constant variables. With a random specification
22 we would impose a certain specification to time-varying and time-constant variables.
23 The Mundlak specification allows us to take the best of the two specification by
24 transforming a random effect statistical routine in a fixed effect model for the time-
25 varying variables if and only if the intra individuals means of these variables are
26 included [41]. For individual i ($i = 1, \dots, n$) in survey year t ($t = 1, \dots, T$):
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$$42 \quad P(y_{it} = 1|x_{it}) = \Phi(x_{it}\beta + c_i) \quad (1)$$

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44 where Φ is the standard normal cumulative distribution function.
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$$48 \quad P(Y_{it} = y_{it}|x_{it}) = F(y_{it}, x_{it}\beta + c_i) \quad (2)$$

49
50 where $F(x, z) = P(X = x)$. X is Poisson distributed with mean $\exp(z)$.
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53 Equation 1 and Equation 2 are estimated using maximum likelihood. In both
54 models, x_{it} is the vector of explanatory variables (some of these variables are con-
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4 stant over time) and c_i is the time-invariant unobservable. We include the within-
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6 individual means of the time-varying regressors, \bar{x}_i , to allow for the possibility that
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8 the unobserved time-invariant individual effect and the regressors are correlated (see
9
10 Wooldridge 42 for further methodological details):

$$11 \quad c_i = \bar{x}_i\theta + \nu_i \quad \text{and} \quad E(c_i|x_i) = \bar{x}_i\theta \quad (3)$$

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17 where \bar{x}_i is the panel-level mean of x_{it} , and ν_i is a time-invariant unobservable that
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19 is uncorrelated to the regressors.
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22 We include both age and period (survey wave) effects in the model. Cohort effects
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24 are not included due to the age-period-cohort identification problem and the impossi-
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26 bility to disentangle these three effects, as they are mathematically confounded [43].
27
28 Period effects are likely to capture unobserved factors common to all individuals in
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30 the sample. Country fixed effects are also included in the model to control for unob-
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32 served country-specific characteristics. Robust standard errors are computed at the
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34 household level to account for intra-household correlation. By using the Mundlak
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36 specification, the model accounts for the correlation between time-varying regres-
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38 sors and individual effects. We nonetheless acknowledge the potential presence of
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40 time-varying sources of endogeneity (for instance an income shock affecting both the
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42 access to health care and health outcomes).
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46 Finally, we calculate average partial effects (APEs) to discuss the results in terms
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48 of magnitude. APEs are computed by averaging the partial effects across the popu-
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50 lation distribution of individual effects, which integrates out the unobserved hetero-
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52 geneity [42].

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54 As we focus on older immigrants, we cannot rule out the potential presence of a
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56 so-called *salmon bias* in our analysis. The literature on the salmon bias - immigrants
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4 who suffer from a long-term illness returning to their country of origin - has recently
5
6 been reviewed in a study by Wallace and Kulu [44], reporting mixed evidence. More
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8 importantly, when there is evidence of a salmon bias, studies show that the mortality
9
10 of those who return to their country of origin should have been unrealistically high
11
12 in order to offset the migrant mortality advantage [45, 44]. From an econometric
13
14 standpoint, the salmon bias would imply that there is measurement error in the
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16 dependent variable due to the fact that health of some immigrants would not be
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18 accounted for. The measurement error would thus be positively associated with the
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20 dummy variable for being an immigrant. In a similar manner, the immigrants' length
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22 of stay in the host country would be positively associated with the measurement error,
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24 in the sense that the parameter on length of stay would have been larger without
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26 the presence of a salmon bias, if any.
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30 **5. Results**

31 32 33 **5.1 Baseline model**

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37 Maximum likelihood estimates of the model (Equation 1 and Equation 2) and
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39 APEs are reported in Table A4 of the electronic supplementary material. The es-
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41 timates show that immigrants are more likely to be in better health than citizens.
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43 This is true for all dependent variables except mental health, for which there is no
44
45 significant difference between citizens and immigrants. The APE of being an im-
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47 migrant ranges from -0.029 (for ADL limitations) to -0.067 (for chronic conditions).
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49 The probability of reporting poor SAH is 4.2%-points lower for immigrants than for
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51 citizens. As reported in the introduction, such healthy immigrant effect has been
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53 highlighted previously. Nevertheless, the results reveal that the immigrants' length
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55 of stay - measured as the share of lifetime in the host country - is significantly and
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4 negatively associated with their health for all five health measures. A 10% increase
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6 in the share of lifetime in the host country increases the probability of reporting poor
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8 SAH by 1.13%-points. Immigrants who spent most of their lives in the host country
9
10 have a 11.3% higher probability of reporting poor health than those who arrived
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12 very recently. This is illustrated in Figure 2, which shows the estimated relation-
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14 ship between the immigrants' length of stay and their health for the five dependent
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16 variables.
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20 *[Figure 2 about here]*
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23 The estimated health of citizens is included for comparison. We can see that the
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25 healthy immigrant effect holds only for immigrants who arrived recently in the host
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27 country. For all five health measures, health worsens with the share of lifetime in
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29 the host country. Another important result is that, when the share of lifetime in
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31 the host country increases, immigrants' health eventually becomes poorer than that
32
33 of citizens, as illustrated in Figure 2. Immigrants' self assessed and mental health
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35 reach the level of citizens when they have spent around 30 to 35% of their life in the
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37 host country (corresponding to, on average, approximately 18 to 21 years spent in
38
39 the host country). For obesity and overweight, immigrants reach the level of citizens
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41 after having spent 45% of their life in the host country (on average approximately
42
43 27 years). This figure rises to 50% for chronic conditions (on average approximately
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45 30 years) and 80% for ADL limitations (on average approximately 52 years).
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48 We now interpret the coefficients for the other variables, which are common to
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50 all individuals in the sample. Compared to men, women are less likely to report
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52 poor health, to be overweight or obese, or to have physical limitations, but are
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54 more likely to have poor mental health. No significant gender difference is found
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56 for chronic conditions. Formal education is negatively associated with poor health
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4 status, with evidence of an education gradient. Current job situation is found to have
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6 different effects depending on the health measure considered. Note that the variable
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8 on current job situation has a specific category for permanently sick individuals,
9
10 because their job situation is necessarily determined by their condition. This allows
11
12 to appropriately capture the effect of being unemployed. In the case of SAH and
13
14 mental health, being retired is associated with better health compared to all other
15
16 categories (employed or self-employed, unemployed and homemaker or permanently
17
18 sick). Being employed or self employed is associated with better health compared
19
20 to all other categories in the case of BMI and chronic conditions. Regarding ADL
21
22 limitations, being unemployed, homemaker or permanently sick is associated with
23
24 poor health, while no significant association is found for the other categories. Marital
25
26 status is found to have no effect on chronic conditions and ADL limitations. The
27
28 likelihood of having poor mental health is 9%-points higher for widowed than for
29
30 individuals who are married or in a registered partnership (the reference category),
31
32 while no significant association is found for the other categories (never married and
33
34 divorced). Being divorced is positively associated with being overweight or obese.
35
36 Never married and widowed individuals are more likely to have poor SAH. Drinking
37
38 is positively associated with being overweight or obese, negatively associated with
39
40 having poor mental health, and has no significant association with SAH, chronic
41
42 conditions and ADL limitations. Physical inactivity increases the probability of
43
44 having poor health for all health measures except BMI, for which it is negatively
45
46 associated with being overweight or obese. Having children is associated with better
47
48 mental and SAH, fewer chronic conditions, a higher likelihood of being overweight or
49
50 obese and appears to be not associated with ADL limitations. Having grandchildren
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52 is associated with a higher likelihood of being overweight or obese, more chronic
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54 conditions, poor SAH (for three grandchildren or more) and is not associated with
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4 mental health and ADL limitations. For all health measures except BMI, the number
5
6 of medical consultations is strongly associated with poor health, with a marked
7
8 gradient. In the same way, the number of nights in hospital is linearly associated
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10 with poor health except for BMI, for which individuals who spent six or more nights
11
12 in hospital in the year preceding the survey are less likely to be overweight or obese.
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14 Households' ability to make ends meet is associated with a higher likelihood of being
15
16 overweight or obese. For all other health measures, the ability to make ends meet
17
18 is associated with better health, with evidence of a socio-economic gradient in the
19
20 case of self-assessed and mental health. The analysis of period (survey wave) effects
21
22 indicates that the likelihood of being overweight or obese, of developing chronic
23
24 diseases and of having poor mental health increased over time (from 2004-2005 to
25
26 2013). Almost no significant period effects are found for self-assessed health and
27
28 ADL limitations. Finally, age is positively associated with poor health in the case
29
30 of SAH and ADL limitations, and negatively associated with poor health in the
31
32 case of BMI, chronic conditions and mental health. The unexpected negative effect
33
34 of age for chronic conditions and mental health might due to the fact that, for an
35
36 undocumented reason, the average number of chronic conditions and mental health
37
38 are slightly decreasing between each individual's first and second interview (which
39
40 may be distinct from the first and second wave, as some individuals entered the
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42 SHARE survey after the first survey-wave).
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47 **5.2. Wealth of the country of origin**

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50 To gain more understanding about the effects of being immigrant on health, we
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52 also investigate whether the effects highlighted previously change depending on the
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54 wealth of the country of origin. To do so, the immigrant status variable of the
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4 previous model is allowed to take on several values based on the level of human
5 development of the country of origin. This variable is also interacted with the im-
6 migrants' share of lifetime in the host country. Maximum likelihood estimates and
7 APEs are presented in Table A5 of the electronic supplementary material. Note
8 that all the other results remain qualitatively the same, in terms of sign, magnitude,
9 and statistical significance. Figure 3 shows the estimated relationship between the
10 immigrants' length of stay and their probability of having poor health depending on
11 the wealth of the country of origin. This is done for the five health measures.
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22 *[Figure 3 about here]*
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25 The results reveal that the effect of being an immigrant on health, and also that
26 of the length of stay in the host country, varies depending on the wealth of the coun-
27 try of origin and the health measure considered. When arriving in the host country,
28 immigrants from high HDI-countries are less likely to have poor SAH than citizens,
29 while no significant association is found for the other categories. Nevertheless, when
30 the share of lifetime in the host country increases, immigrants from medium- and
31 high-HDI countries have poorer SAH, as illustrated in Figure 3a. The length of stay
32 does not appear to change the SAH of stateless persons or immigrants from low-HDI
33 countries. In the case of BMI, we found previously that immigrants are less likely
34 to be overweight or obese than natives, but that this likelihood increases with the
35 share of lifetime in the country. This result seems to hold mainly for immigrants
36 from high-HDI countries. Although their likelihood of being overweight or obese is
37 10.3%-points lower than that of citizens, immigrants from high-HDI countries who
38 spent most of their lives in the host country are 21.4% more likely to be overweight
39 or obese than those who arrived very recently, as shown in Figure 3b. The results
40 regarding chronic conditions reveal a marked socio-economic gradient in the effect
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4 of being an immigrant and in that of their length of stay in the host country. Im-
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6 migrants have a lower likelihood of developing chronic diseases, as shown previously.
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8 Compared to citizens, the likelihood of developing a chronic disease is 20.1%-points
9
10 lower for immigrants from low-HDI countries, while this figure falls to 8.4% and 3%
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12 for immigrants from medium- and high-HDI countries, respectively. We showed ear-
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14 lier that, among immigrant, the likelihood of developing chronic diseases increases
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16 with the share of lifetime in the country. We now show that, although immigrants
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18 from low-HDI countries have the lowest likelihood of having chronic conditions, they
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20 have the highest rate of health deterioration. There is a 28.2% difference between
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22 immigrants from low-HDI countries who arrived very recently and those who spent
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24 most of their lives in the host country. This figure falls to 14.4% and 7.7% for immi-
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26 grants from medium- and high-HDI countries, respectively. The poorer the country
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28 of origin, the higher the deterioration of health with increasing share of lifetime in
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30 the host country. This is illustrated in Figure 3c. In the case of mental health, it
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32 seems that stateless persons have a lower likelihood of being depressed, while no
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34 significant association is found for the other groups. The results also indicate that
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36 immigrants from medium-HDI countries and stateless persons experience a mental
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38 health deterioration with the length of stay in the host country. Finally, the results
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40 show that the results found previously regarding ADL limitations hold mainly for
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42 immigrants from medium-HDI countries. They have a lower likelihood of having one
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44 or more ADL limitations, but this likelihood increases with the length of stay in the
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46 host country.
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51 **6. Conclusion**

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55 The question of whether there are significant health differentials between citizens
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4 and immigrants has extensively been addressed in the literature. Nonetheless, less is
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6 known about the evolution of immigrants' health over time. This paper attempted
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8 therefore to explore the dynamics of citizen-immigrant health differentials as well
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10 as the determinants of these dynamics. It employed panel models that allow for
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12 unobserved heterogeneity amongst more than 100,000 older persons living in nine-
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14 teen European countries. Unlike previous studies that only focused on one or two
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16 measures of health, the present analysis has considered five different indicators of
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18 health status. This allowed to account for the multidimensionality of health and its
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20 evolution over time. Assessing the impact of the length of stay on immigrant health
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22 requires adjusting for the effect of age. The latter has been accounted for by using
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24 an age-adjusted measure of the length of stay in the host country.
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27 Our paper highlighted large health differentials (1) between citizens and immi-
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29 grants, (2) between immigrants depending on their length of stay in the host country,
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31 and (3) between immigrants depending on the wealth of their country of origin. These
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33 differentials are found to vary depending on the health measure considered. Some
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35 interesting results emerging from our analysis are worth discussing. First, our study
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37 generally, corroborates previous evidence on the healthy immigrant effect – according
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39 to which immigrants are initially more likely to be in better health as compared to
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41 citizens [1, 2, 3, 4, 5]. Secondly, our study also corroborates previous findings on the
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43 unhealthy assimilation of immigrants in developed countries [8, 9, 10, 11]. For all
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45 health measures considered, we found that, on average, immigrants' health deterio-
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47 rates over time. In contrast to previous studies, our results not only shed light on
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49 the convergence of immigrants' health towards that of citizens. Interestingly, using
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51 an age-adjusted measure of the length of stay in the host country, we were able to
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53 show that this unhealthy convergence is such that the health of immigrants eventu-
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55 ally becomes poorer than that of citizens. Thirdly, our results clearly revealed the
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4 presence of substantial heterogeneity in the observed unhealthy convergence, with
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6 respect to both the wealth of the country of origin and the health measured con-
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8 sidered. For instance, in terms of chronic conditions, the health of immigrants from
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10 low-HDI countries tends to deteriorate faster than that of immigrants from richer
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12 countries. This is not surprising given that immigrants from low-HDI countries tend
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14 to work in the so-called 3D jobs (dirty, dangerous and demeaning) once settled in
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16 the European countries [12]. By contrast, the unhealthy convergence with respect
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18 to SAH seems to hold mainly for immigrants from medium- and high-HDI coun-
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20 tries. In this case, the convergence of SAH towards that of citizens may well be a
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22 result of peer effects. Self-assessments of health have been shown to be influenced
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24 by social comparisons within age groups, especially among older people [46]. Thus,
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26 immigrants from medium- and high-HDI countries may tend to rate their health as
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28 similar to that of their native peers, which are more likely to belong to the same
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30 socio-economic group.
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33 Altogether, such heterogeneity in the convergence of health differentials between
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35 immigrants and citizens in Europe seems to indicate that the unhealthy convergence
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37 is more pronounced in terms of chronic conditions for immigrants from low-HDI
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39 countries, and in terms of SAH and BMI for immigrants from medium- and high-
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41 HDI countries. Future research shall attempt to identify the underlying factors of
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43 such heterogeneous convergence.
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Table 1: Definitions of the dependent and independent variables

Variable	Type	Definition
Health measures (dependent variables)		
Self-assessed health	Binary	1 if the individual i reports a less than very good health in survey wave t ; 0 otherwise
BMI	Binary	1 if the individual i is overweight or obese in survey wave t ; 0 otherwise
Chronic conditions	Discrete	Individual i 's number of chronic diseases in survey wave t
Mental health	Binary	1 if the individual i is depressed in survey wave t ; 0 otherwise
ADL limitations	Binary	1 if the individual i has one or more limitations with activities of daily living in survey wave t ; 0 otherwise
Citizenship status	Binary	Citizen (=base category); Immigrant (legal residents, either permanent, temporary or refugee)
Immigrant's share of lifetime in the host country	Continuous	Immigrant i 's length of stay in the host country divided by his/her age
Wealth of the country of origin	Categorical	Citizen (=base category); Low HDI (<0.700); Medium HDI (0.700>=HDI<0.836); High HDI (>=0.836); Stateless
Gender	Binary	Male (=base category); Female
Formal education	Categorical	None or Primary (=base category); Secondary; Tertiary
Current job situation	Categorical	Retired (=base category); Employed or Self-employed; Unemployed; Homemaker or Permanently sick [in survey wave t]
Marital status	Categorical	Married or Registered partnership (=base category); Never married; Divorced; Widowed [in survey wave t]
Drinking	Binary	1 if the individual i was drinking more than 2 glasses of alcohol almost everyday in survey wave t ; 0 otherwise
Physical inactivity	Binary	1 if the individual i was physically inactive in survey wave t ; 0 otherwise
Number of children	Categorical	0 (=base category); 1; 2; 3 or more [in survey wave t]
Number of grandchildren	Categorical	0 (=base category); 1; 2; 3 or more [in survey wave t]
Doctor consultations	Categorical	Number of doctor consultations: 1st quartile (=base category); 2nd; 3rd; 4th [in survey wave t]
Nights in hospital	Categorical	0 (=base category); Between 1 and 5; 6 or more [in survey wave t]
Household able to make ends meet	Categorical	With great difficulty (=base category); With some difficulty; Fairly easily; Easily [in survey wave t]
Country	Categorical	Austria (=base category); Belgium; Czech Republic; Denmark; Estonia; France; Germany; Greece; Hungary; Ireland; Italy; Luxembourg; the Netherlands; Poland; Portugal; Slovenia; Spain; Sweden; Switzerland
Survey wave	Categorical	2004-2005 (=base category); 2006-2007; 2010-2012; 2013
Age	Continuous	In years

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Figure 1: Immigrants' year of arrival distribution

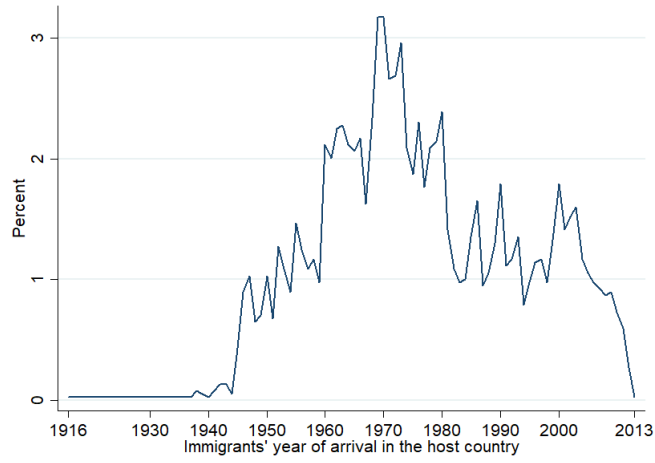
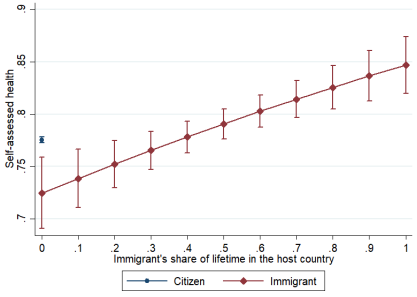
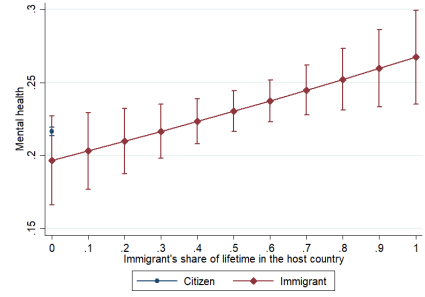


Figure 2: Effect of the immigrants' share of lifetime in the host country on health

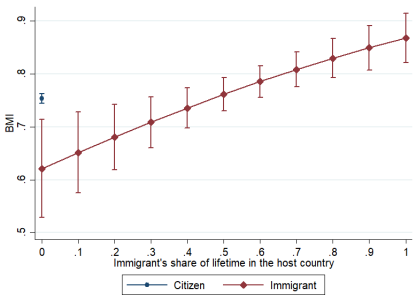
(a) Self-assessed health



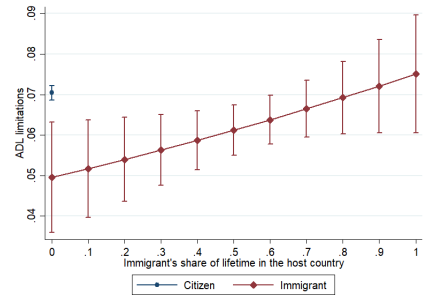
(d) Mental health



(b) BMI



(e) ADL limitations



(c) Chronic conditions

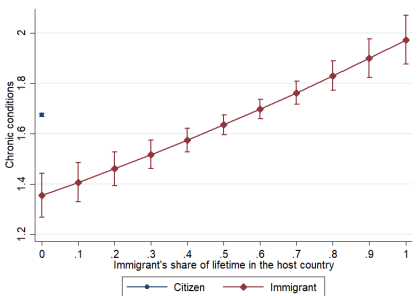
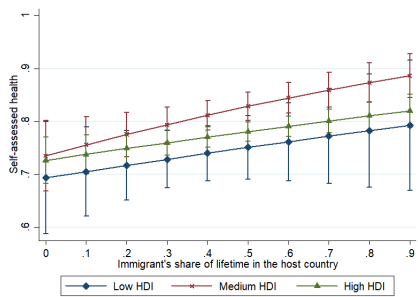
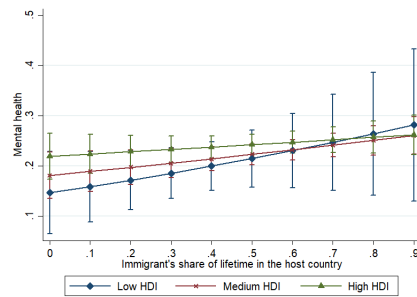


Figure 3: Effect of the immigrants' share of lifetime in the host country on health given the wealth of the country of origin

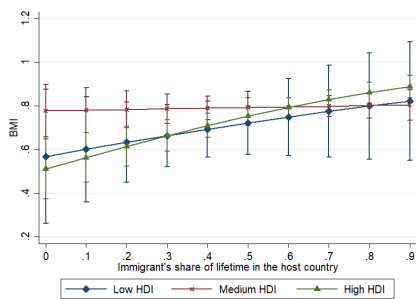
(a) Self-assessed health



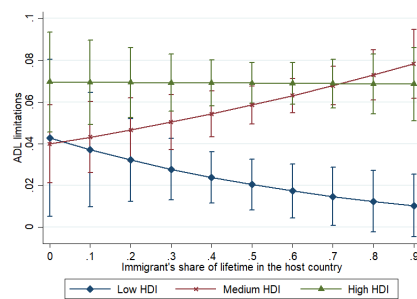
(d) Mental health



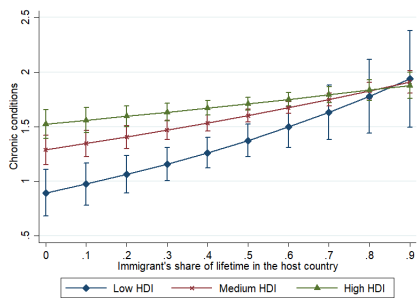
(b) BMI



(e) ADL limitations



(c) Chronic conditions



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4 **Health differentials between citizens and immigrants in Europe:**
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6 **A heterogeneous convergence**
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10
11 **Abstract**
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14 The literature on immigration and health has provided mixed evidence on
15 the health differentials between immigrants and citizens, while a growing body
16 of evidence alludes to the unhealthy assimilation of immigrants. Relying on five
17 different health measures, the present paper investigates the heterogeneity in
18 health patterns between immigrants and citizens, and also between immigrants
19 depending on their country of origin. We use ~~representative~~ panel data on
20 more than 100,000 older adults living in nineteen European countries. Our
21 panel data methodology allows for unobserved heterogeneity. We document
22 the existence of a healthy immigrant effect, of an unhealthy convergence, and of
23 a reversal of the health differentials between citizens and immigrants over time.
24 We are able to estimate the time threshold after which immigrants' health
25 becomes worse than that of citizens. We further document some heterogeneity
26 in the convergence of health differentials between immigrants and citizens in
27 Europe. Namely, the unhealthy convergence is more pronounced in terms of
28 ~~objective health~~ **chronic conditions** for immigrants from low-HDI countries,
29 and in terms of ~~subjective health~~ **self-assessed health and body-mass index** for
30 immigrants from medium- and high-HDI countries.
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50 **Keywords:** Healthy immigrant effect · Europe · Health differentials · Health
51 convergence · Immigration · Health economics.
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54 **JEL classification:** F22 · I14 · J15.
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4 **1. Introduction**
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7 The literature on immigration and health has provided mixed evidence on the
8 health differentials between citizens and immigrants in developed countries. While
9 some studies report that immigrants are in better health than citizens [1, 2, 3, 4, 5] -
10 providing support for the so-called *healthy immigrant effect* - others find the opposite
11 [6, 7]. A growing body of evidence further shows that immigrants' health deteriorates
12 with the length of residence in the host country [8, 9, 10, 11]. This phenomenon,
13 sometimes called *unhealthy assimilation*, implies that the healthy immigrant effect,
14 if any, is transitory. Describing and explaining the evolution of immigrants' health is
15 of particular importance from a research and policy perspective. Once settled in the
16 host country, immigrants would tend to have different health trajectories, not only
17 relative to their native counterparts, but also among subgroups of immigrants.
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30 The present paper attempts to assess whether the healthy immigrant effect, if
31 any, is followed by a convergence of immigrants' health status toward that of citizens
32 in Europe. We use **representative** panel data on more than 100,000 older adults living
33 in nineteen European countries. The panel data methodology employed allows for
34 unobserved heterogeneity. We document the existence of a healthy immigrant effect,
35 of an unhealthy convergence, and of a reversal of the health differentials between
36 citizens and immigrants over time. We are able to estimate the time threshold after
37 which immigrant's health becomes worse than that of citizens. We further show
38 that the effect on health of the immigrants' length of residence in the host country
39 differs depending on the wealth of the country of origin and on the health measure
40 considered. The present paper fits in the literature investigating the heterogeneity
41 in health patterns across immigrant groups, with a focus on the wealth of the im-
42 migrants' country of origin. **Once settled in the European countries, immigrants**
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4 from poor countries tend to work in the so-called 3D jobs (dirty, dangerous and de-
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6 meaning) [12]. In this regard, the positive health selection (the healthy immigrant
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8 effect) would be higher for immigrants from poorer countries because of the phys-
9
10 ically demanding nature of their work [13]. This would also be a factor of faster
11
12 health deterioration.

14 As we investigate the effect on health of the immigrants' length of stay in Eu-
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16 rope, we focus on older immigrants. ~~In the 1950s, post-war Europe has relied on~~
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18 ~~immigration to sustain its economic growth.~~ In North-West European countries, the
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20 three decades after 1945 were characterized by large-scale labour immigration. Immi-
21
22 gration into southern European destinations became significant from the 1970s [14].
23
24 We are now able to investigate the evolution of immigrants' health over a long time
25
26 span, which explains the recent development of studies on ~~elderly~~ older immigrants
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28 in Europe [14, 8, 9, 7, 15].

31 The remaining of the paper is organized as follows. Section 2 reviews the literature
32
33 on immigrants' health in developed countries ~~and discusses the relevance of the health~~
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35 ~~measures used in this study.~~ The data and the econometric methodology are detailed
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37 in Sections 3 and 4, respectively. Section 5 presents the results, and Section 6
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39 discusses the implications of the findings and concludes.
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42 **2. Literature review: immigrant's health in developed countries**

43 ~~2.1 Immigrant's health in developed countries~~

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50 In developed countries, health differentials between natives and immigrants and
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52 their evolution have been linked to the interplay of several factors. These include
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54 socio-economic conditions, individual factors (immigrants' behavior, health-related
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56 selection), and characteristics of both the country of origin (social norms, wealth)
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4 and of destination (social norms, integration policies towards immigrants). These
5 health differentials are often mirrored by differences in access to health care.
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8 McDonald and Kennedy [1] document a healthy immigrant effect and an un-
9 healthy convergence in Canada regarding chronic conditions, but not self-assessed
10 health, indicating that this phenomenon would be more pronounced in terms of
11 physical health than health perceptions. Also in Canada, while showing the exist-
12 tence of a healthy immigrant effect in the case of depression, Wu and Schimmele [2]
13 find that depression among immigrants increases with their length of stay.
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20 In the United States, immigrants are less likely to have health insurance coverage
21 and have lower health care use and spending than their native counterparts [16, 17,
22 18, 19, 20]. [Observed differences in the access to health insurance and health care](#)
23 [have been seen as one of the interplaying factors behind citizen-immigrant health](#)
24 [differentials.](#) Antecol and Bedard [3] show that immigrants have a lower body-
25 mass index (BMI) upon arrival, but that they converge to that of the Americans
26 as the length of stay increases. This relationship between BMI and duration of
27 residence varies by gender and ethnicity [21], and by arrival cohorts, with more recent
28 immigrant cohorts being more likely to be obese upon arrival and to experience
29 a faster unhealthy convergence [22]. Other recent studies show that social norms
30 in both the host country and the country of origin influence immigrants' health
31 behaviors. Focusing on smoking behaviors, Leung [23] finds that assimilation in
32 the United States is positively (negatively) associated with the likelihood of being a
33 smoker for immigrants from low-smoking (high-smoking) countries.
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50 Analyses of the relationship between immigrants' health and duration of residence
51 in Europe have yielded mixed and sometimes conflicting evidence. Lindert et al. [24]
52 ~~show disparities across host countries and immigrant groups in the prevalence of~~
53 ~~mental disorders and in the access and utilization of mental health services~~ report
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4 disparities across migrant groups in the prevalence of mental disorders and in the
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6 access and utilization of mental health services. Solé-Auró et al. [7] investigate the
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8 differences in health care utilization between ~~elderly~~ older natives and immigrants.
9
10 They find that ~~elderly~~ older immigrants, particularly those who arrived recently,
11
12 have a higher use of health care services (physician visits and hospital stays), due
13
14 to differences in health, health behaviors, socio-economic status or countries' health
15
16 system characteristics. Moullan and Jusot [25] show the existence of a North-South
17
18 gradient in immigrants' health status, with immigrants in Italy and Spain having a
19
20 better health status than in Belgium and France. Using three different health mea-
21
22 sures (self-reported health status, limiting long-standing illnesses, and self-reported
23
24 chronic illness), Giannoni et al. [5] show that non-European immigrants tend to have
25
26 better health in countries with pro-immigrant integration policies.
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29 Using Swedish data, Pudaric et al. [26] ~~show that country of birth is associated~~
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31 ~~with poor health status and impaired instrumental activities of daily living (IADL)~~
32
33 show that, compared with Swedish-born individuals, country of birth is associated
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35 with poor health status (for immigrants from Southern Europe, Eastern Europe
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37 and Finland) and impaired instrumental activities of daily living (for Southern Eu-
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39 ropeans, Finns and refugees from developing countries). The authors also provide
40
41 a theoretical framework for the link between immigrants' health deterioration and
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43 acculturation. They argue that poorly acculturated immigrants are exposed to long-
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45 term stress reactions due to a series of individual, structural and cultural factors,
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47 which may in turn harm their health. Bengtsson and Scott [27] highlight a gap in
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49 sickness benefit consumption between Swedish natives and immigrants, and also be-
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51 tween immigrants depending on the country of birth. The authors show that while
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53 western immigrants and natives display similar patterns, immigrants from labor-
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55 sending countries, whose occupations are more physically demanding, have a higher
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4 average number of sick days.

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6 In Spain, Malmusi et al. [8] document large migration-related health inequalities,
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8 with immigrants from poor areas being the worse-off group, which can be related
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10 to immigrants' socio-economic deprivation compared with natives. Evidence that
11
12 immigrants' health deteriorates over time at a faster rate for immigrants working in
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14 high-risk jobs have been found in Spain [28] and in Germany [11].

15
16 In France, Vignier et al. [29] report that individuals in threat-related exile have
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18 a lower probability of accessing health care. Furthermore, it has been shown that
19
20 undocumented immigrants experience great difficulty in exercising their rights to
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22 health care and tend to underutilize the *State Medical Assistance* [30]. The settlement
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24 process of recently arrived immigrants from sub-Saharan Africa has been shown to
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26 be long and precarious [31]. This long period of insecurity is mirrored by a lower
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28 health care utilization of recently arrived immigrants compared to the French-born
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30 population with equivalent health needs. This is reported in Berchet and Jusot
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32 [32], who also indicate that the healthy immigrant effect was mainly observed for
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34 immigrants who settled in France before the economic crisis of the mid-1970s. And
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36 even for these first- and second-generations immigrants, studies show that they suffer
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38 from premature dependency in old age [33], and, more generally, that their health
39
40 became worse than that of the French-born population from the mid-2000s [34, 35].
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42 Such health disparities are mainly due to differences in social capital, income and
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44 occupation status [36], and vary depending on the region of origin [37].
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49 ~~2.2 Relevance of the health measures considered~~

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53 ~~The analysis is based on five health indicators, allowing us to test whether health~~
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55 ~~differentials across citizenship status and over time vary depending on the health~~
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4 measure considered. These measures are: self-assessed health (SAH), the body mass
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6 index (BMI), chronic conditions, mental health, and physical limitations.

7
8 SAH has long been revealed to be a powerful predictor of mortality and morbid-
9
10 ity [38, 39, 40, 41] ,even though it has less predictive power than objective health
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12 measures [41]. Studies nonetheless indicate that health reporting differs by income
13
14 and education level, reporting heterogeneity in SAH by socio-economic status, which
15
16 may also be the case by citizenship status. For instance, higher educated older Eu-
17
18 ropeans have been shown to be more critical of a given health state [42]. Thus, the
19
20 predictive power of SAH for mortality might also differ by education level [43] . And
21
22 if there is no significant difference between ethnic groups in the association of SAH
23
24 with more objective measures of morbidity [44, 45], such association is nonetheless
25
26 sensitive to cross-country heterogeneity in response styles [46]. Altogether, SAH has
27
28 been widely used in cross-country health studies [47] and in studies on immigration
29
30 and health [37, 8, 5]. Although the relationship between BMI and mortality have been
31
32 extensively studied and debated [48], the recent study by the Global BMI Mortality
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34 Collaboration [49], involving more than ten million participants in four continents,
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36 indicates that overweight and obesity are associated with higher all-cause mortality.
37
38 BMI has been used in influential studies on the migration-health relationship [3, 50].
39
40 Chronic conditions have obvious deleterious effects on functioning and well-being
41
42 [51], and mental health has been shown to be associated with morbidity and mortal-
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44 ity [52]. Finally, a large body of evidence indicates that impairment in activities of
45
46 daily living (ADL) is a strong predictor of mortality in the elderly [53, 54].
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50 Altogether, it is worth noting that the associations among these five different
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52 health measures might differ by age, gender, or other socio-demographic character-
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54 isties. For instance, Imai et al. [55] show that the association of BMI with functional
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56 health status and SAH is sensitive to gender and age. This motivates the use of
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4 ~~different health measures to compare their relationship with the variables of interest.~~

5 6 7 **3. Data**

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10 We use data from the SHARE survey [56], which primarily aims at investigat-
11 ing ageing issues in Europe. The SHARE survey has also been used to investigate
12 the relationship between immigration and health [9, 7, 15]. Our analysis is based
13 on four waves conducted in 2004-2005, 2006-2007, 2010-2012 and 2013, respectively.
14 These waves share the same methodology. The survey samples individuals over 50
15 years old in European countries. Individuals of the same household are also sur-
16 veyed, *regardless of their age*. The 19 countries in the sample are Austria, Belgium,
17 Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland,
18 Italy, Luxembourg, the Netherlands, Poland, Portugal, Slovenia, Spain, Sweden,
19 and Switzerland.
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Individuals' citizenship status (citizen or immigrant) is the main variable of in-
terest. ~~An immigrant is defined as an individual who is or intend to be settled in
the host country~~ [57]. Among the alternative definitions of "immigrant", that are
based on country of birth, nationality or length of stay in the host country [57], we
have opted for the definition based on nationality, as the focus is on individuals who
are legal residents, either permanent, temporary or refugees, and who represent a
distinct category of the population. A study including three different categories -
immigrants born foreigners in a foreign country, naturalized citizens and native citi-
zens - would have been of great interest, but we cannot identify naturalized citizens
in our data.

When individuals are surveyed for the first time, major life events are collected
retrospectively. Thus, we know the immigrants' year of arrival, allowing us to com-

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4 pute the length of stay in the host country. As it is likely to be highly correlated
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6 with age, we divide the length of stay by the age. This measures the immigrants'
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8 share of lifetime in the host country. Immigrants in the sample arrived in the host
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10 country between 1916 and 2013. Immigrants' year of arrival distribution is shown in
11
12 Figure 1.
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14
15 *[Figure 1 about here]*
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18
19 We also have information on the immigrants' country of origin, from which we
20
21 construct a categorical variable based on the wealth of the country of origin. We
22
23 use the UN's Human Development Index (HDI) as a measure of wealth. [The HDI](#)
24
25 [index doesn't measure economic growth alone but also considers individuals and their](#)
26
27 [capabilities. GDP is a particular measure of wealth focusing only on this part of](#)
28
29 [wealth which is measurable by a monetary value. By using HDI we intend to move](#)
30
31 [beyond GDP and account a broader societal dimension of wealth and well-being.](#)
32
33 Based on their HDI value in 2015, countries of origin are classified as low human
34
35 development ($\text{HDI} < 0.700$), medium ($0.700 \leq \text{HDI} < 0.836$) and high human
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37 development ($\text{HDI} \geq 0.836$). The 0.700 cut-off is commonly used to distinguish
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39 low- from medium-HDI countries, and the 0.836 cut-off represents the lowest HDI
40
41 value among European Union countries (Hungary), as performed by Malmusi et al.
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43 [8]. Although immigrants in the sample arrived in the host country between 1916
44
45 and 2013, we only use the 2015 HDI of the country of origin ~~due to data availability,~~
46
47 [as more than 83% of the immigrants left their country of origin before the oldest](#)
48
49 [year for which HDI data is available. The wealth of the country of origin should be](#)
50
51 [interpreted with an appropriate degree of caution related to the fact that, although](#)
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53 [HDI data exhibit a strong path-dependency, some countries may be categorized in a](#)
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55 [given HDI category which was not the same at the time of migration.](#)
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4 Detailed definitions of the variables used are given in Table 1. Five different health
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6 measures are used as dependent variables: (1) SAH (whether the individual reports a
7
8 less than very good health), as is common in the literature (see for instance Antecol
9
10 and Bedard 3 or Malmusi et al. 8), (2) the body-mass index (whether the individual
11
12 is overweight or obese), (3) chronic conditions (the number of chronic diseases), (4)
13
14 mental health (whether the individual is depressed), and (5) physical limitations
15
16 (whether the individual has one or more limitations with activities of daily living
17
18 [ADL]). An extended discussion on the relevance of the health measures considered
19
20 is provided in Appendix A1 of the electronic supplementary material. Descriptive
21
22 statistics of the variables used in the analyses are given in Table A1 of the electronic
23
24 supplementary material. Individuals in the sample are aged 22 to 103. Citizens'
25
26 and immigrants' age distributions are relatively similar, as shown in Table A2 of
27
28 the electronic supplementary material. Table A3 of the electronic supplementary
29
30 material displays the percentage of immigrants by region of origin. The majority of
31
32 immigrants come from the European Union or other European countries (48.09% and
33
34 30.48%, respectively). Stateless persons represent 8.07% of the sample of immigrants,
35
36 and immigrants coming from Africa represent 7.74%. Immigrants from the Americas
37
38 or Asia and Oceania represent slightly less than 3%, respectively.
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43 *[Table 1 about here]*
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47 **4. Econometric methodology**

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50 ~~We use a random effects panel probit model for all binary dependent variables~~
51 ~~(Equation 1), and a random effects panel Poisson model for the discrete positive~~
52 ~~dependent variable, that is, the number of chronic diseases (Equation 2).~~ We use
53
54 a Mundlak [58] panel probit model for all binary dependent variables (Equation
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1), and a Mundlak [58] panel Poisson model for the discrete positive dependent variable, that is, the number of chronic diseases (Equation 2). The Mundlak [58] specification is a fixed effect for all time-varying variables and a random effect for all time-constant variables. With a usual fixed effect model we would not be able to estimate a parameter for time-constant variables. With a random specification we would impose a certain specification to time-varying and time-constant variables. The Mundlak specification allows us to take the best of the two specification by transforming a random effect statistical routine in a fixed effect model for the time-varying variables if and only if the intra individuals means of these variables are included [59]. For individual i ($i = 1, \dots, n$) in survey year t ($t = 1, \dots, T$):

$$P(y_{it} = 1|x_{it}) = \Phi(x_{it}\beta + c_i) \quad (1)$$

where Φ is the standard normal cumulative distribution function.

$$P(Y_{it} = y_{it}|x_{it}) = F(y_{it}, x_{it}\beta + c_i) \quad (2)$$

where $F(x, z) = P(X = x)$. X is Poisson distributed with mean $\exp(z)$.

Equation 1 and Equation 2 are estimated using maximum likelihood. In both models, x_{it} is the vector of explanatory variables (some of these variables are constant over time) and c_i is the time-invariant unobservable. We include the within-individual means of the time-varying regressors, \bar{x}_i , to allow for the possibility that the unobserved time-invariant individual effect and the regressors are correlated (see Wooldridge 60 for further methodological details):

$$c_i = \bar{x}_i\theta + \nu_i \quad \text{and} \quad E(c_i|x_i) = \bar{x}_i\theta \quad (3)$$

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4 where \bar{x}_i is the panel-level mean of x_{it} , and ν_i is a time-invariant unobservable that
5 is uncorrelated to the regressors.
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8 We include both age and period (survey wave) effects in the model. Cohort effects
9 are not included due to the age-period-cohort identification problem and the impossi-
10 bility to disentangle these three effects, as they are mathematically confounded [61].
11 Period effects are likely to capture unobserved factors common to all individuals in
12 the sample. Country fixed effects are also included in the model to control for unob-
13 served country-specific characteristics. Robust standard errors are computed at the
14 household level to account for intra-household correlation. [By using the Mundlak](#)
15 [specification, the model accounts for the correlation between time-varying regres-](#)
16 [sors and individual effects. We nonetheless acknowledge the potential presence of](#)
17 [time-varying sources of endogeneity \(for instance an income shock affecting both the](#)
18 [access to health care and health outcomes\).](#)
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31 Finally, we calculate average partial effects (APEs) to discuss the results in terms
32 of magnitude ~~(see [60] for details on the calculation of APEs in the presence of un-~~
33 ~~observed heterogeneity).~~ APEs are computed by averaging the partial effects across
34 the population distribution of individual effects, which integrates out the unobserved
35 heterogeneity [60].
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41 As we focus on older immigrants, we cannot rule out the potential presence of a
42 so-called *salmon bias* in our analysis. The literature on the salmon bias - immigrants
43 who suffer from a long-term illness returning to their country of origin - has recently
44 been reviewed in a study by Wallace and Kulu [62], reporting mixed evidence. More
45 importantly, when there is evidence of a salmon bias, studies show that the mortality
46 of those who return to their country of origin should have been unrealistically high
47 in order to offset the migrant mortality advantage [63, 62]. From an econometric
48 standpoint, the salmon bias would imply that there is measurement error in the
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4 dependent variable due to the fact that health of some immigrants would not be
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6 accounted for. The measurement error would thus be positively associated with the
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8 dummy variable for being an immigrant. In a similar manner, the immigrants' length
9
10 of stay in the host country would be positively associated with the measurement error,
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12 in the sense that the parameter on length of stay would have been larger without
13
14 the presence of a salmon bias, if any.
15

16 17 18 **5. Results**

19 20 21 **5.1 Baseline model**

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24 Maximum likelihood estimates of the model (Equation 1 and Equation 2) and
25
26 APEs are reported in Table A3A4 of the electronic supplementary material. The
27
28 estimates show that immigrants are more likely to be in better health than citizens.
29
30 This is true for all dependent variables except mental health, for which there is
31
32 no significant difference between citizens and immigrants. The APE of being an
33
34 immigrant ranges from -0.029 (for ADL limitations) to -0.067 (for chronic conditions).
35
36 The probability of reporting poor SAH is 4.2%-points lower for immigrants than for
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38 citizens. As reported in the introduction, such healthy immigrant effect has been
39
40 highlighted previously. Nevertheless, the results reveal that the immigrants' length
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42 of stay - measured as the share of lifetime in the host country - is significantly and
43
44 negatively associated with their health for all five health measures. A 10% increase
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46 in the share of lifetime in the host country increases the probability of reporting
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48 poor SAH by 1.13%-points. Immigrants who spent most of their lives in the host
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50 country have a 11.3% higher probability of reporting poor health than those who
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52 arrived very recently. This is illustrated in Figure 2, which shows the estimated
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54 relationship between the immigrants' length of stay and their health for the five
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4 dependent variables.
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7 *[Figure 2 about here]*
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10 The estimated health of citizens is included for comparison. We can see that the
11 healthy immigrant effect holds only for immigrants who arrived recently in the host
12 country. For all five health measures, health worsens with the share of lifetime in
13 the host country. Another important result is that, when the share of lifetime in
14 the host country increases, immigrants' health eventually becomes poorer than that
15 of citizens, as illustrated in Figure 2. ~~Immigrants' self-assessed and mental health~~
16 ~~reach the level of majority group when they have spent around 30 to 35% of their life~~
17 ~~in host country. For obesity and overweight, immigrants get to majority group level~~
18 ~~after spending 45% of their life in host country. Chronic conditions after 50% of their~~
19 ~~life while for ADL immigrants need to have spent 80% of their life in host country to~~
20 ~~reach health status of majority group.~~ Immigrants' self assessed and mental health
21 reach the level of citizens when they have spent around 30 to 35% of their life in the
22 host country (corresponding to, on average, approximately 18 to 21 years spent in
23 the host country). For obesity and overweight, immigrants reach the level of citizens
24 after having spent 45% of their life in the host country (on average approximately
25 27 years). This figure rises to 50% for chronic conditions (on average approximately
26 30 years) and 80% for ADL limitations (on average approximately 52 years).
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46 We now interpret the coefficients for the other variables, which are common to
47 all individuals in the sample. Compared to men, women are less likely to report
48 poor health, to be overweight or obese, or to have physical limitations, but are
49 more likely to have poor mental health. No significant gender difference is found
50 for chronic conditions. Formal education is negatively associated with poor health
51 status, with evidence of an education gradient. Current job situation is found to have
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4 different effects depending on the health measure considered. Note that the variable
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6 on current job situation has a specific category for permanently sick individuals,
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8 because their job situation is necessarily determined by their condition. This allows
9
10 to appropriately capture the effect of being unemployed. In the case of SAH and
11
12 mental health, being retired is associated with better health compared to all other
13
14 categories (employed or self-employed, unemployed and homemaker or permanently
15
16 sick). Being employed or self employed is associated with better health compared
17
18 to all other categories in the case of BMI and chronic conditions. Regarding ADL
19
20 limitations, being unemployed, homemaker or permanently sick is associated with
21
22 poor health, while no significant association is found for the other categories. Marital
23
24 status is found to have no effect on chronic conditions and ADL limitations. The
25
26 likelihood of having poor mental health is 9%-points higher for widowed than for
27
28 individuals who are married or in a registered partnership (the reference category),
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30 while no significant association is found for the other categories (never married and
31
32 divorced). Being divorced is positively associated with being overweight or obese.
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34 Never married and widowed individuals are more likely to have poor SAH. Drinking
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36 is positively associated with being overweight or obese, negatively associated with
37
38 having poor mental health, and has no significant association with SAH, chronic
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40 conditions and ADL limitations. Physical inactivity increases the probability of
41
42 having poor health for all health measures except BMI, for which it is negatively
43
44 associated with being overweight or obese. Having children is associated with better
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46 mental and SAH, fewer chronic conditions, a higher likelihood of being overweight or
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48 obese and appears to be not associated with ADL limitations. Having grandchildren
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50 is associated with a higher likelihood of being overweight or obese, more chronic
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52 conditions, poor SAH (for three grandchildren or more) and is not associated with
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54 mental health and ADL limitations. For all health measures except BMI, the number
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4 of medical consultations is strongly associated with poor health, with a marked
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6 gradient. In the same way, the number of nights in hospital is linearly associated
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8 with poor health except for BMI, for which individuals who spent six or more nights
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10 in hospital in the year preceding the survey are less likely to be overweight or obese.
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12 Households' ability to make ends meet is associated with a higher likelihood of being
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14 overweight or obese. For all other health measures, the ability to make ends meet
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16 is associated with better health, with evidence of a socio-economic gradient in the
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18 case of self-assessed and mental health. The analysis of period (survey wave) effects
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20 indicates that the likelihood of being overweight or obese, of developing chronic
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22 diseases and of having poor mental health increased over time (from 2004-2005 to
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24 2013). Almost no significant period effects are found for self-assessed health and
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26 ADL limitations. Finally, age is positively associated with poor health in the case
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28 of SAH and ADL limitations, and negatively associated with poor health in the
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30 case of BMI, chronic conditions and mental health. [The unexpected negative effect](#)
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32 [of age for chronic conditions and mental health might due to the fact that, for an](#)
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34 [undocumented reason, the average number of chronic conditions and mental health](#)
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36 [are slightly decreasing between each individual's first and second interview \(which](#)
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38 [may be distinct from the first and second wave, as some individuals entered the](#)
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40 [SHARE survey after the first survey-wave\).](#)
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45 **5.2. Wealth of the country of origin**

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48 To gain more understanding about the effects of being immigrant on health, we
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50 also investigate whether the effects highlighted previously change depending on the
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52 wealth of the country of origin. To do so, the immigrant status variable of the
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54 previous model is allowed to take on several values based on the level of human
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4 development of the country of origin. This variable is also interacted with the im-
5 migrants' share of lifetime in the host country. Maximum likelihood estimates and
6 APEs are presented in Table A4A5 of the electronic supplementary material. Note
7 that all the other results remain qualitatively the same, in terms of sign, magnitude,
8 and statistical significance. Figure 3 shows the estimated relationship between the
9 immigrants' length of stay and their probability of having poor health depending on
10 the wealth of the country of origin. This is done for the five health measures.
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19 *[Figure 3 about here]*
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23 The results reveal that the effect of being an immigrant on health, and also that
24 of the length of stay in the host country, varies depending on the wealth of the coun-
25 try of origin and the health measure considered. When arriving in the host country,
26 immigrants from high HDI-countries are less likely to have poor SAH than citizens,
27 while no significant association is found for the other categories. Nevertheless, when
28 the share of lifetime in the host country increases, immigrants from medium- and
29 high-HDI countries have poorer SAH, as illustrated in Figure 3a. The length of stay
30 does not appear to change the SAH of stateless persons or immigrants from low-HDI
31 countries. In the case of BMI, we found previously that immigrants are less likely
32 to be overweight or obese than natives, but that this likelihood increases with the
33 share of lifetime in the country. This result seems to hold mainly for immigrants
34 from high-HDI countries. Although their likelihood of being overweight or obese is
35 10.3%-points lower than that of citizens, immigrants from high-HDI countries who
36 spent most of their lives in the host country are 21.4% more likely to be overweight
37 or obese than those who arrived very recently, as shown in Figure 3b. The results
38 regarding chronic conditions reveal a marked socio-economic gradient in the effect
39 of being an immigrant and in that of their length of stay in the host country. Im-
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migrants have a lower likelihood of developing chronic diseases, as shown previously. Compared to citizens, the likelihood of developing a chronic disease is 20.1%-points lower for immigrants from low-HDI countries, while this figure falls to 8.4% and 3% for immigrants from medium- and high-HDI countries, respectively. We showed earlier that, among immigrant, the likelihood of developing chronic diseases increases with the share of lifetime in the country. We now show that, although immigrants from low-HDI countries have the lowest likelihood of having chronic conditions, they have the highest rate of health deterioration. There is a 28.2% difference between immigrants from low-HDI countries who arrived very recently and those who spent most of their lives in the host country. This figure falls to 14.4% and 7.7% for immigrants from medium- and high-HDI countries, respectively. The poorer the country of origin, the higher the deterioration of health with increasing share of lifetime in the host country. This is illustrated in Figure 3c. In the case of mental health, it seems that stateless persons have a lower likelihood of being depressed, while no significant association is found for the other groups. The results also indicate that immigrants from medium-HDI countries and stateless persons experience a mental health deterioration with the length of stay in the host country. Finally, the results show that the results found previously regarding ADL limitations hold mainly for immigrants from medium-HDI countries. They have a lower likelihood of having one or more ADL limitations, but this likelihood increases with the length of stay in the host country.

6. Conclusion

The question of whether there are significant health differentials between citizens and immigrants has extensively been addressed in the literature. Nonetheless, less is

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4 known about the evolution of immigrants' health over time. This paper attempted
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6 therefore to explore the dynamics of citizen-immigrant health differentials as well as
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8 the determinants of these dynamics. It employed ~~random-effects~~ panel models that
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10 allow for unobserved heterogeneity amongst more than 100,000 ~~elderly~~ older persons
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12 living in nineteen European countries. Unlike previous studies that only focused
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14 on one or two measures of health, the present analysis has considered five different
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16 ~~(subjective and objective)~~ indicators of health status. This allowed to account for
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18 the multidimensionality of health and its evolution over time. Assessing the impact
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20 of the length of stay on immigrant health requires adjusting for the effect of age.
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22 The latter has been accounted for by using an age-adjusted measure of the length of
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24 stay in the host country.
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27 Our paper highlighted large health differentials (1) between citizens and immi-
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29 grants, (2) between immigrants depending on their length of stay in the host country,
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31 and (3) between immigrants depending on the wealth of their country of origin. These
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33 differentials are found to vary depending on the health measure considered. Some
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35 interesting results emerging from our analysis are worth discussing. First, our study
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37 generally, corroborates previous evidence on the healthy immigrant effect – according
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39 to which immigrants are initially more likely to be in better health as compared to
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41 citizens [1, 2, 3, 4, 5]. Secondly, our study also corroborates previous findings on the
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43 unhealthy assimilation of immigrants in developed countries [8, 9, 10, 11]. For all
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45 health measures considered, we found that, on average, immigrants' health deterio-
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47 rates over time. In contrast to previous studies, our results not only shed light on
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49 the convergence of immigrants' health towards that of citizens. Interestingly, using
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51 an age-adjusted measure of the length of stay in the host country, we were able to
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53 show that this unhealthy convergence is such that the health of immigrants eventu-
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55 ally becomes poorer than that of citizens. Thirdly, our results clearly revealed the
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4 presence of substantial heterogeneity in the observed unhealthy convergence, with
5 respect to both the wealth of the country of origin and the health measured con-
6 sidered. For instance, in terms of chronic conditions, the health of immigrants from
7 low-HDI countries tends to deteriorate faster than that of immigrants from richer
8 countries. This is not surprising given that immigrants from low-HDI countries tend
9 to work in the so-called 3D jobs (dirty, dangerous and demeaning) once settled in
10 the European countries [12]. By contrast, the unhealthy convergence with respect
11 to SAH seems to hold mainly for immigrants from medium- and high-HDI coun-
12 tries. In this case, the convergence of SAH towards that of citizens may well be a
13 result of peer effects. Self-assessments of health have been shown to be influenced
14 by social comparisons within age groups, especially among older people [64]. Thus,
15 immigrants from medium- and high-HDI countries may tend to rate their health as
16 similar to that of their native peers, which are more likely to belong to the same
17 socio-economic group.
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33 Altogether, such heterogeneity in the convergence of health differentials between
34 immigrants and citizens in Europe seems to indicate that the unhealthy convergence
35 is more pronounced in terms of ~~objective health~~ chronic conditions for immigrants
36 from low-HDI countries, and in terms of ~~subjective health~~ SAH and BMI for im-
37 migrants from medium- and high-HDI countries. Future research shall attempt to
38 identify the underlying factors of such heterogeneous convergence.
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Table 1: Definitions of the dependent and independent variables

Variable	Type	Definition
Health measures (dependent variables)		
Self-assessed health	Binary	1 if the individual i reports a less than very good health in survey wave t ; 0 otherwise
BMI	Binary	1 if the individual i is overweight or obese in survey wave t ; 0 otherwise
Chronic conditions	Discrete	Individual i 's number of chronic diseases in survey wave t
Mental health	Binary	1 if the individual i is depressed in survey wave t ; 0 otherwise
ADL limitations	Binary	1 if the individual i has one or more limitations with activities of daily living in survey wave t ; 0 otherwise
Citizenship status	Binary	Citizen (=base category); Immigrant (legal residents, either permanent, temporary or refugee)
Immigrant's share of lifetime in the host country	Continuous	Immigrant i 's length of stay in the host country divided by his/her age
Wealth of the country of origin	Categorical	Citizen (=base category); Low HDI (<0.700); Medium HDI (0.700>=HDI<0.836); High HDI (>=0.836); Stateless
Gender	Binary	Male (=base category); Female
Formal education	Categorical	None or Primary (=base category); Secondary; Tertiary
Current job situation	Categorical	Retired (=base category); Employed or Self-employed; Unemployed; Homemaker or Permanently sick [in survey wave t]
Marital status	Categorical	Married or Registered partnership (=base category); Never married; Divorced; Widowed [in survey wave t]
Drinking	Binary	1 if the individual i was drinking more than 2 glasses of alcohol almost everyday in survey wave t ; 0 otherwise
Physical inactivity	Binary	1 if the individual i was physically inactive in survey wave t ; 0 otherwise
Number of children	Categorical	0 (=base category); 1; 2; 3 or more [in survey wave t]
Number of grandchildren	Categorical	0 (=base category); 1; 2; 3 or more [in survey wave t]
Doctor consultations	Categorical	Number of doctor consultations: 1st quartile (=base category); 2nd; 3rd; 4th [in survey wave t]
Nights in hospital	Categorical	0 (=base category); Between 1 and 5; 6 or more [in survey wave t]
Household able to make ends meet	Categorical	With great difficulty (=base category); With some difficulty; Fairly easily; Easily [in survey wave t]
Country	Categorical	Austria (=base category); Belgium; Czech Republic; Denmark; Estonia; France; Germany; Greece; Hungary; Ireland; Italy; Luxembourg; the Netherlands; Poland; Portugal; Slovenia; Spain; Sweden; Switzerland
Survey wave	Categorical	2004-2005 (=base category); 2006-2007; 2010-2012; 2013
Age	Continuous	In years

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Figure 1: Immigrants' year of arrival distribution

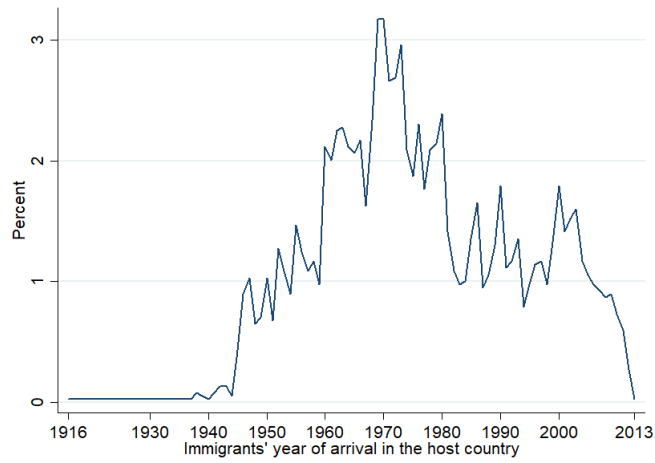
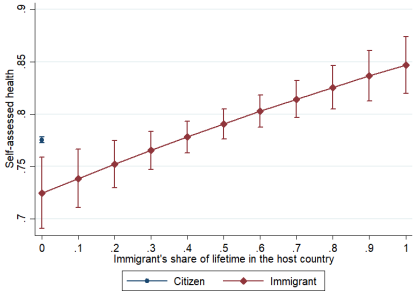
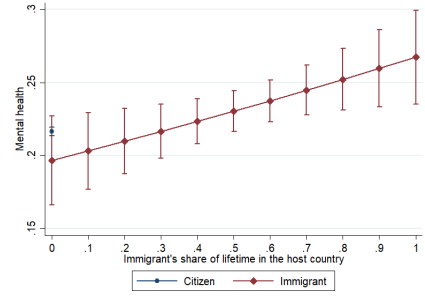


Figure 2: Effect of the immigrants' share of lifetime in the host country on health

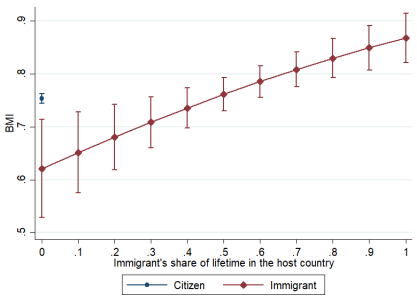
(a) Self-assessed health



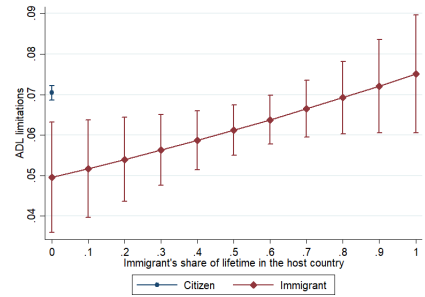
(d) Mental health



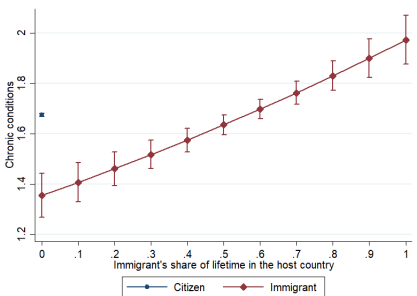
(b) BMI



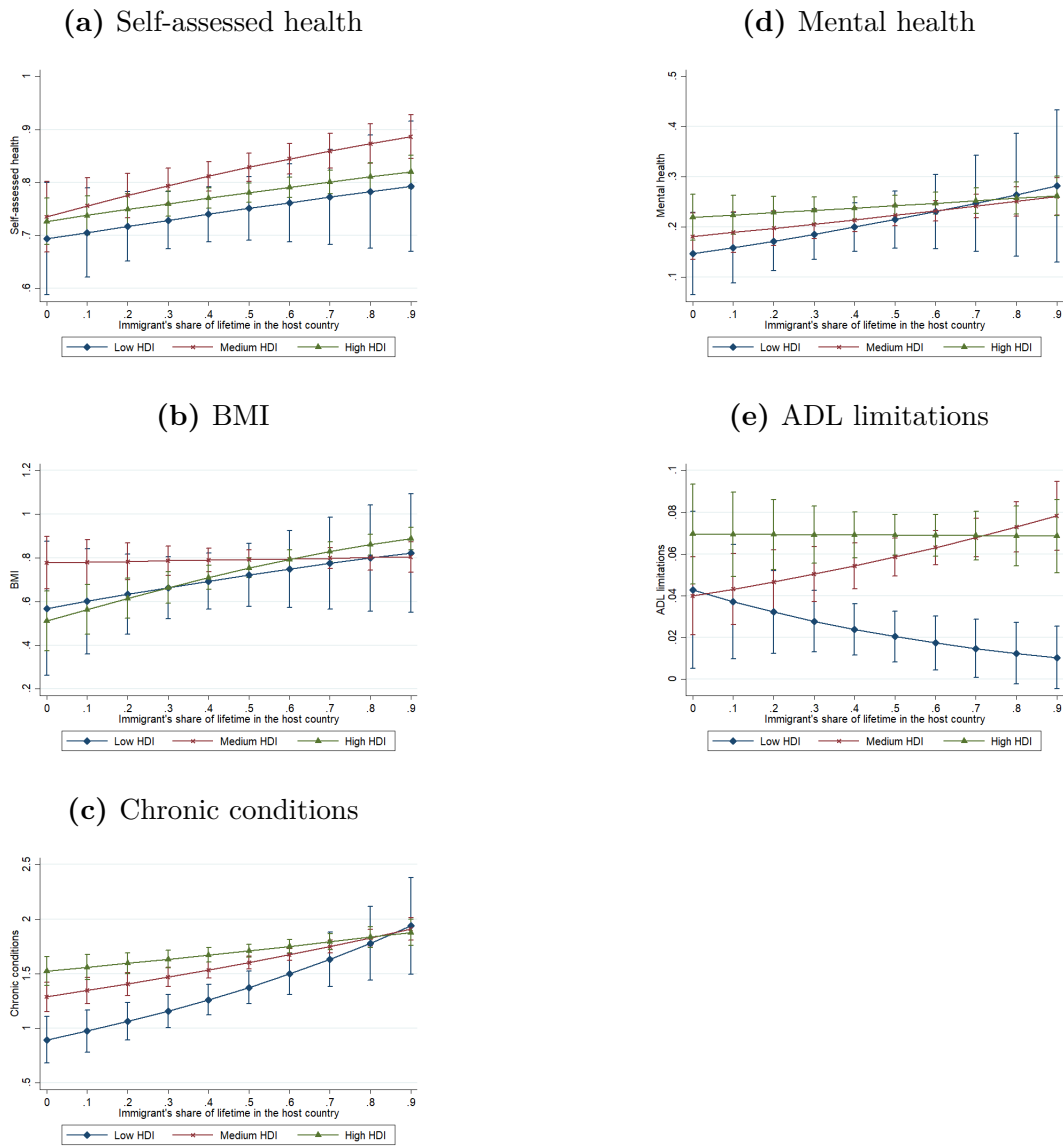
(e) ADL limitations



(c) Chronic conditions



1
2
3 **Figure 3:** Effect of the immigrants' share of lifetime in the host country on health given the wealth of the country
4 of origin



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