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10 July 2019

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Abstract

This paper provides cross-country evidence on the relationship between immigration-induced diversity and economic performance, as evaluated by the Economic Fitness metric. To address endogeneity concerns, we use gravity-based predictors of migrant diversity as a source of exogenous variation. We show that migration induces a sizable positive effect on the counties' Fitness. These findings appear to stem from migrants into middle-income counties. Our results are robust to the use of data from alternative sources, estimation methods, and an extensive set of contemporaneous and historical controls. Importantly, we establish the validity of the results using a time-varying instrument and conventional panel data regressions.

Keywords: Immigration, Gravity Model, Economic Fitness

1 Introduction

National statistics show that international migration has risen rapidly over the past decades (Özden et al., 2011). As a result, a substantial fraction of the workforce worldwide are immigrants.[1][2] These developments have sparked a wealth of economics literature, mainly exploring the effects of immigrants on the wages of natives (see, among many

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[1] According to the latest available data, foreign-born individuals amount to about 271.5 million (United Nations, 2019).
[2] In the aftermath of the 2007-2009 global recession, mass migration coincided with the electoral success of far-right populist parties. As summarized in Rodrik (2020), a growing number of empirical studies have established a causal linkage between these trends.

others, Altonji and Card, 1991, Borjas, 2003; Ottaviano and Peri, 2012).[3] More recent studies, however, have taken a broader perspective by looking at the interplay between migration and economic performance at the macro level (see e.g., Felbermayr et al. 2010; Ortega and Peri, 2014; Alesina et al., 2016; Bove and Elia, 2017; Bahar et al., 2020). Nevertheless, more research is needed to understand the role of immigrants in shaping the receiving economies.

Theory suggests that cross-border mobility generates substantial income gains due to immigration-induced diversity in skills and ideas (Ortega and Peri, 2014; Alesina et al., 2016). What is more, international migration is considered to promote development by accelerating the diffusion of knowledge (Bosseti et al., 2015; Bahar and Rapoport, 2018). The opposite view is that heterogeneous migrations may hamper development by eroding social trust (Alesina and La Ferrara, 2002; Putnam, 2007). Furthermore, some scholars posit that the effects on host societies may be adverse if migrants undermine institutions, conducive to economic growth (see, e.g., Collier, 2013; Borjas, 2015). Recent evidence, however, indicates that immigration is unlikely to undermine the institutional environment in the receiving economies (see, e.g., Clark et al., 2015; Powell et al., 2017).[4]

In this article, we examine the impact of immigrant diversity on the host countries' economic performance, as proxied by the novel Fitness metric, introduced by Tacchella et al. (2012; 2013). Fitness provides a quantitative measure of an economic system's productive capabilities, based on the concept of economic complexity - the capacity to export diversified and less ubiquitous products - introduced by Hausmann et al. (2007); Hidalgo and Hausmann (2009). As has been consistently shown by these authors and a recent growing empirical literature, export sophistication is among the strongest predictors of economic growth. However, Tacchella et al. (2012; 2013) recognize that the relationship between diversification and ubiquity is not necessarily linear, as has been earlier proposed by Hidalgo and Hausmann (2009), and introduce a non-linear algorithm on the countries'

[3] Edo (2019) provides a summary review of empirical studies on the labor market effects of immigration.

[4] There is, however, some evidence that migration influences political institutions adversely in low-income countries (see, Roupakias and Dimou, 2021)

Fitness and products' complexity.[5] In addition, as can be seen in Figure 2, which depicts cross-country patterns on Economic Fitness, advanced economies in Western Europe and Northern America tend to be more "Fit" as compared to the rest of the world. China and India also display a noteworthy performance. At the same time, the bottom part of this figure suggests that these economies also tend to be more multi-ethnic, as they attract immigrants from a vast array of source countries and cultures. Hence, these preliminary observations imply that it is of particular importance to examine whether migration matters for the comparative Fitness of the destination countries.

[Insert Figure 2 about here]

The most related previous studies to ours are Bahar et al. (2020) and Alesina et al. (2016), who have focused on the cross-country effects of birthplace diversity on Hidalgo and Hausmann's (2009) economic complexity metric and income per person, respectively.[6][7] Both studies have found a positive immigrant contribution to a large cross-section of countries. The main departure of our approach with respect to Bahar et al (2020) is that we consider the Economic Fitness metric that, though not immune to criticism, is probably the best among the complexity indicators (see, e.g., Pietronero et al., 2017; Liao and Vidmer, 2018). In addition, we also recur to conventional panel data estimates, following the method introduced by Feyrer (2019). Our findings also lend support to the evidence reported in Alesina et al. (2016), highlighting the potential role of immigrant diversity on a country's competitiveness and complexity. Our paper is also related to Ortega and Peri (2014), who study the effects of openness to trade and immigration on economic development. Interestingly, they find that the contribution of immigration is

[5] These authors also argue that Economic Fitness even outperforms International Monetary Fund's more sophisticated approach at predicting economic growth.

[6] There is also a growing literature looking at the effects of immigrant diversity at the regional level (e.g., Ottaviano and Peri, 2006; Ager and Brückner, 2013; Trax et al., 2015; Kemeny and Cooke, 2018; Docquier et al., 2020; Fulford, et al., 2020)

[7] A closely related study is Valette (2018) who examines the impact of emigrants from developing countries on the transmission of productive technology back to their homeland. Using the System GMM estimator, this study conveys the message that source countries enjoy large gains in terms of export sophistication.

more significant as compared to trade. The present paper also fits into the literature examining the determinants of cross-border mobility by estimating a pseudo-gravity model of bilateral migrations (e.g., Mayda, 2010; Grogger and Hanson, 2011). We pursue a similar approach, to ease concerns over the validity of our analysis, stemming from the fact that the selection of migrants in the receiving countries is unlikely to be random. Specifically, we apply an instrumental variables approach, using the gravity-based migrations to generate exogenous variation. This identification strategy has recently gained wide acceptance among researchers attempting to isolate causal effects of migration in a cross-sectional setting (see, e.g., Felbermayr et al., 2010; Ortega and Peri, 2014; Alesina et al., 2016; Bahar et al., 2020).

We construct a birthplace diversity measure using data from Özden et al. (2011). We put special care to minimize the risk of omitted variable bias by employing an extensive set of covariates. Following common practice in the literature (see, e.g., Hall and Jones, 1999; Rodriguez and Rodrik, 2000; Acemoglu et al., 2001; Frankel and Romer, 1999; Rodrik et al., 2004), our analysis accounts for the roles of geography, institutions, and openness to trade. Overall, this paper produces robust evidence that immigrant-induced diversity displays a robust positive association with the Fitness of the countries. Our preferred IV estimates suggest that a standard deviation increase in our birthplace diversity indicator causes Fitness to increase by about 0.4 standard deviations. However, we show that there is significant heterogeneity according to the destination countries' level of development. In particular, we find that the contribution of migrants is more pronounced into middle-income countries. Most importantly, we find supportive evidence once we employ a time-varying instrument a la Feyrer (2019) within a panel data setting, using data from United Nations Migrant Stocks.

The rest of the paper unfolds as follows. In Section 2 we discuss the data and the empirical model used to identify the relationship between immigration and economic "fitness". Section 3 presents the findings of the research, focusing on the 2SLS estimates; and performs a battery of robustness checks. Finally, Section 4 draws conclusions.

2 Data and Model

Up until the early 2000s, cross-country analysis of international migrations was bound to be limited due to data availability. However, this has been made possible recently thanks to several research teams and international institutions (such as the United Nations) that have collected and harmonized data from various population records (see, Özden et al., 2011; Artuc et al., 2015). From Özden et al. (2011) we exploit information on bilateral migration for the years 1990 and 2000,[8] to construct an indicator on immigrant heterogeneity, that is derived as follows (see, e.g., Ottaviano and Peri, 2006; Alesina et al, 2016):

$$Div_c = 1 - \sum_{j=\neq c}^{M} (\mathrm{M_{cj}})^2 \quad (1)$$

where M_{cj} stands for the ratio between the number of immigrants born in country j and residing in country c and the total population in country c. The index ranges between 0 and 1, with greater values denoting more diversity among migrants.[9] In addition, we use complementary data from Artuc et al (2015), which y the same token, we also investigate whether the effects of immigrant diversity are skill-specific using data from. As is common in the literature, we simultaneously control for the share of immigrants over the total population. For completeness, we also exploit immigration data from a third source, the United Nations Migrant Stock Data, that enables us to construct a time-varying diversity measure.

As already discussed in the introduction, our main proxy for economic development is the indicator from proposed by Tacchela et al. (2012) (available at: https://datacatalog.worldbank.org/dataset/economic-fitness).[10] Their approach is based on Hausmann et al. (2007) and Hidalgo and Hausmann (2009), who argue that the number of

[8] The data are available at: https://datacatalog.worldbank.org/dataset/global-bilateral-migration-database.
[9] The countries with the highest value of diversity are, Denmark, Canada and Norway. At the other end of the spectrum, we find countries such as Sri Lanka, Bangladesh and Nepal.
[10] For further technical details on the construction of "fitness", we refer the interest reader to Tacchela et al. (2012).

exported products (diversity) and the number of countries exporting each product (ubiquity) convey important information about a country's productive capabilities. However, Tachella et al. (2012; 2013) recognize that diversification may be misleading in identifying export sophistication in a linear way, and introduce an indicator for countries' fitness, *F*, and products' complexity, *Q*, that can be summarized according to the following iterative approach:

$$\begin{cases} \tilde{F}_c^{(n)} = \sum_p M_{cp} Q_p^{(n-1)} \\ \tilde{Q}_c^{(n)} = \dfrac{1}{\sum_p M_{cp}\left(\dfrac{1}{F_p^{(n-1)}}\right)} \end{cases} \rightarrow \begin{cases} F_c^{(n)} = \dfrac{\tilde{F}_c^{(n)}}{\langle \tilde{F}_c^{(n)} \rangle_c} \\ Q_p^{(n)} = \dfrac{\tilde{Q}_p^{(n)}}{\langle \tilde{Q}_p^{(n)} \rangle_c} \end{cases} \quad (2)$$

where the initial conditions are $Q_p^{(0)} = 0 \; \forall p$ and $F_c^{(0)} = 0 \; \forall c$, and *M* is a binary country-product that reports whether a country is a net exporter of a product according to Balassa's (1965) criterion of revealed comparative advantage. Within this context, Fitness captures the ability of countries to export a diversified basket of complex products, where non-complex products are those exported by underdeveloped countries.[11]

As a check of robustness, we use data from Archibugi and Coco (2004), who propose an alternative indicator of technological capabilities, measured along three dimensions: the creation of technology, the technological infrastructures, and the development of human skills.

In line with the relevant literature, we also employ an extensive set of control variables to reduce concerns on omitted variables bias (see, e.g., Ortega and Peri, 2014; Alesina et al., 2016). Specifically, we introduce covariates that capture the level of economic development (GDP per capita), country size (population), openness to trade (sum of imports and exports normalized by GDP), and resource-richness (a dummy indicating

[11] To gain further insights on the relationship between Economic Fitness and economic development, we run a lowess nonparametric regression of Fitness on income per person. As it is evident in Appendix Figure A1, there is a non-monotonic relationship that is mainly driven by energy rich countries, which appear to be less 'Fit' f.

whether a country is a net exporter of oil or gas).[12] Information on income and trade openness is drawn from the Penn World Table (PWT)[13]. Data on population are from the World Development Indicators. The oil dummy is computed using data from the latest Quality of Government Standard Dataset (QoG).

We also introduce time-invariant variables, that are similar to those used in several mainstream studies (e.g., Hall and Jones, 1999; Rodriguez and Rodrik, 2000; Acemoglu et al., 2001; Sachs, 2003) to account for the roles of geographic characteristics (distance from the equator, dummy for being landlocked, distance to the nearest coastline, the percentage of land area in tropics, land area in sq. km), disease and climate environment (malaria and yellow fever indicators, mean temperature and precipitation over the 1960-1990 period), dummy indicators for former European colonies, and continent/year fixed effects to capture unobserved heterogeneity. Notice, that, as in Ortega and Peri (2014), the variable distance from the equator serves as an exogenous proxy for a country's institutional development. This choice is motivated by Hall and Jones (1999) who argue that as Europeans in the 1500s tended to settle in areas farther from the equator, contemporary institutional performance must be related to this geographic characteristic due to persistence.

[Insert Table 1 about here]

Hence, to identify the effects of diversity on economic fitness, we estimate the following empirical model:

$$Ecfit_{c,t} = a + \beta Diversity_{c,t-5} + \gamma \boldsymbol{X}_{c,t} + \gamma_i + \varphi_t + u_{c,t} \tag{3}$$

where the dependent variable Ecfit is an indicator of productive capabilities in country c; Diversity is our main independent variable of interest that captures birthplace diversity among immigrants, and $\boldsymbol{X}$ is a vector of the explanatory variables that were described above. Except for the migrant diversity and the immigrant share, all variables are measured

[12] See Table 1 for a detailed description of data and sources.
[13] In particular, we use variables rgdpl and openc from Penn World Tables (7.0)

in years 1995 and 2005. To quantify the association between migration and the Fitness of countries, we standardize the dependent variable as well as the main independent variables (i.e., the migrant diversity and the immigrant share). In robustness checks, we further expand the set of controls by including average years of schooling from the Wittgenstein Centre Human Capital Data Explorer, institutions (Polity IV's polity2 index, and the average value of the World Governance Indicators), real trade openness in the spirit of Alcalá and Ciccone, 2004), the KOF globalization index, and population density in 1500CE.

However, the OLS estimate of β in equation (3) would be spurious either due to reverse causality issues or due to unobserved confounding, i.e., co-determinants of Fitness and diversity. It might also be the case of noisy data if (undocumented) migrants are underreported in population records. To mitigate these endogeneity and measurement error concerns, we use predicted diversity as a source of exogenous variation, generated by a gravity approach, quite similar to Ortega and Peri (2014); Alesina et al (2016). The underlying identification assumption is that the gravity predictors represent the supply-driven component of migration. The first step to predict diversity involves relating bilateral migrant stocks between destination and source countries (M_{cj}) to bilateral distance ($dist_{cj}$), the size of destination and source countries ($Pop_c, Pop_j,\ Area_c, Area_j$), the number of landlocked countries in each country pair ($Landlocked_c$), dummy indicators for common ethnic and official languages, common border and past colonial ties dummies ($ComLang1_{cj}, ComLang2_{cj}, Border_{cj}$), time zone differences ($Timezone_{cj}$), as well as interactions between the border dummy and the controls for distance, size, and being landlocked:[14]

[14] We compile our gravity dataset by merging data from CEPII (available at: http://www.cepii.fr) and the bilateral matrices of migrant stocks from Özden et al. (2011).

$$\ln(M_{cj}) = \gamma_1 dist_{cj} + \gamma_2 Pop_c + \gamma_3 Pop_j + \gamma_4 Area_c + \gamma_5 Area_j$$
$$+\gamma_6 Landlocked_c + \gamma_7 Border_{cj} + \gamma_8 ComLang1_{cj} + \gamma_9 ComoLang2_{cj}$$
$$+\gamma_{10} dist_{cj} * Border_{cj} + \gamma_{11} Pop_c * Border_{cj} + \gamma_{12} Pop_j * Border_{cj}$$
$$+\gamma_{13} Area_c * Border_{cj} + \gamma_{14} Area_j * Border_{cj}$$
$$+\gamma_{15} Landlocked_c * Border_{cj} + \gamma_{16} Colony_{cj} + \gamma_{17} Timezone_{cj} + u_{cj} \quad (4)$$

where u_{cj} is the error term. We estimate the model with OLS as well as with the Poisson pseudo-maximum likelihood estimators (PPML), as in Silva and Tenreyro (2006). However, given the limitations of the OLS approach when a dataset contains numerous zero value observations, as in our case, our preferred estimator is the PPML.[15]

The second step entails imputing the predicted stock of immigrants by source country at the destination country level.[16] We, then, calculate the predicted birthplace diversity using the predicted stocks according to the formula (1). A preliminary inspection of the unconditional correlation between predicted and actual diversity indicates that the instrument is strong (see Figure 2). Following Alesina et al. (2016), Figure 2 also plots the relationship between the difference in predicted and actual diversity against income per person. A negative correlation between these variables would signify a valid research design in terms of endogeneity. Reassuringly, we see that our approach predicts lower migrant diversity toward high-income countries than toward low-income countries.

[Insert Figure 2 about here]

3 Results

In this section, we explore the effects of immigrant diversity on the amount of productive knowledge and capabilities, as measured by the Economic Fitness index from Tacchela et al. (2012), We also assess the robustness of the main findings along the following lines: (i) using different estimation techniques, (ii) using alternative measures for the level of host

[15] Notice, that we refrain from introducing destination fixed effects in the gravity equation, to avoid a potential violation of the exclusion restriction assumption.

[16] In particular, letting Z and $\hat{\beta}$ to denote the vectors of right-hand-side regressors and the coefficients in equation (4), the linear (OLS) gravity predictor is given by: $\widehat{Gravity\ instrument} = \frac{\left(\sum_{i\neq j} \exp\left(\ln\left(Z_{ij}\widehat{\beta}\right)\right)\right)}{\sum_{i\neq j} \exp\left(\ln\left(Z_{ij}\widehat{\beta}\right)+ Natives_i\right)}$.

countries' complexity, institutional quality, and openness to trade, (iii) introducing further contemporaneous and historical controls, (iv) performing heterogeneity tests.

3.1 OLS estimates

Table 2 contains our OLS estimates using equation (3) and standard errors clustered at the country level. We add controls gradually, as in Alesina et al. (2016), beginning in column (1) with a parsimonious regression of Fitness on migrant diversity and the immigrant share. Next, column (2) introduces continent and year dummies to account for area-specific heterogeneity and common temporal-specific shocks. Specification (3) includes only exogenous and semi-exogenous variables, related to geography and the disease/climate environment. In column (4) we add potential confounders that may explain simultaneously the trends in Economic Fitness and immigrant diversity, namely income per capita, openness to trade, total population, and an indicator for energy net exporters. Specification (5) introduces dummies for former British and French colonies to account for the influence of European colonization on comparative Economic Fitness, whereas the last column displays the results from the full specification. Importantly, the additional controls in columns improve the fit of the model substantially, as the R^2 increases from 0.048 to 0.675 between the columns (1) and (6). We find, through specifications, that immigrant diversity has a positive and significant effect on Economic Fitness at the one percent significance level. By contrast, the coefficient on the immigrant share variable is smaller in magnitude and usually statistically insignificant. Notably, these estimates are very close to the ones reported in Bahar et al. (2020). Notice, also, that GDP per capita and population are strongly positively correlated with the Fitness, metric, whereas, being an energy-rich country reduces economic performance.

[Insert Table 2 about here]

3.2 2SLS estimates

Nevertheless, as discussed earlier, migrants tend to sort into regions that offer better opportunities, and thus the estimates displayed above might not be interpreted as causal. If complex economies attract migrants from all over the world, we would expect the OLS estimate of immigrant diversity to be upwardly biased. We cannot also rule out the possibility of attenuation bias due to measurement errors. To address these concerns, we re-estimate equation (3) using an instrumental variables approach. However, before we proceed to the second-stage findings, it is important to briefly discuss the results obtained from the pseudo-gravity equation (4), which are then used to generate predicted immigrant diversity. We use both the OLS and the PPML estimator, clustering the standard errors at the country pair level. The results are generally quite consistent between specifications, though the fit of the PPML regression is higher. Most of the findings are significant and compatible with our expectations. Specifically, bilateral distance, country size, common language, and past colonial ties are positively correlated with migration. Based on this evidence, as well as on the predictive power of the resulting instrumental variables in the first-stage regressions, we opt to build our instrument, relying on the PPML specification.[17] According to the first-stage results (not reported for brevity available through request), the gravity-based instrument appears to be strongly correlated with the actual immigrant diversity. What is more, the Kleibergen–Paap first-stage statistics, which are reported at the bottom of the remaining Tables, suggest that the estimated parameters of interest are unlikely to suffer from weak identification issues.

[Insert Table 3 about here]

Table 4 presents the second-stage estimates, along with the associated cluster-robust standard errors. We start with our baseline IV specification which reveals that an increase in immigrant diversity is associated with higher levels of productive capabilities. Notice, however, that the coefficient on immigrant diversity is much larger in magnitude as compared to the full specification estimate in Table 3. Specifically, a standard deviation

[17] When using the gravity-based linear predictors as instruments, the second-stage coefficients on the immigrant diversity variable remain qualitatively similar to the ones shown in the main text but are less precisely estimated.

increase in migrant diversity increases Economic Fitness by about 0.4 standard deviations. Next, we pay attention to potential endogeneity issues concerning the immigrant share variable. A natural solution would have been to use the linear gravity-based predictors as an instrumental variable in our 2SLS estimation strategy. However, it was not possible from the data available to generate a strong instrument for the fraction of migrants. We, therefore, adopt an alternative approach, by employing a standard Bartik (1991) shift-share instrument. To that aim, we interact the share of migrants from country j in country c (in the base year 1980) with the total number of migrants from country *j* (in years 2000 and 2010).[18] Instrumenting the immigrant share variable with shift-share predicted migration, but not immigrant diversity with the gravity-predictor, we, once again, find that the effect of the immigrant share is statistically insignificant. Lastly, column (3) instruments both the immigrant diversity and the fraction of migrants. The statistical patterns that emerge from this empirical exercise reinforce our prior conclusion that it is migrant diversity that matters for economic complexity, rather than the size of the immigrant population.

[Insert Table 4 about here]

3.3 Robustness

In Figure 3, we deal with concerns related to influential observations, based on a leverage-versus-squared-residual plot. The upper part of this figure suggests that countries 11, 12, 175, 176 have larger-than-average residuals. We also observe that country 59 has higher-than-average leverage. We, therefore, remove these from the sample and re-estimate our baseline IV model. The bottom part of Figure 3 plots the second-stage estimate after this amendment. Notably, we once again observe a quite strong effect of diversity on Economic

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[18] Specifically, we apply the following formula: $\widehat{Bartik}_{cjt} = \frac{\phi_{cj,1980} \times immigrants_{,jt}}{Population_{ct}}$, where $\phi_{cj,1980}$ is the 1980 share of immigrant population from country *j* in country *c*, and $immigrants_{,jt}$ is the total number of immigrants from country *c* and year t. We aggregate immigrants into 22 broad origin groups, namely Australia and New Zealand, Caribbean, Central America, Central Asia, Eastern Africa, Eastern Asia, Melanesia, Eastern Europe, Micronesia, Middle Africa, Northern Africa, Northern America, Northern Europe, Polynesia, South America, South-Eastern, Asia Southern, Africa, Southern Asia, Southern Europe, Western Africa, Western Asia, Western Europe.

Fitness. The correlation coefficient is about 0.45 whereas the associated t-statistic indicates significance at the one percent level.

[Insert Figure 3 about here]

Thus far, we have controlled for the influence of institutions implicitly through exogenous geographic indicators such as distance from the equator. We have also used trade openness from the World Development Indicators database of the World Bank. In Table 5 we employ an alternative approach to verify our prior results, by controlling directly for the effects of institutional environment on comparative Fitness as well as by considering alternative measures for openness. In particular, we use the revised combined polity2 scores from the Polity IV project and the average value of the six indicators of governance from WGI as direct measures of institutions. The polity2 index captures the level of democracy and lies within the range of -10 to +10. The Worldwide Governance Indicators take values between -2.7 and 2.1 with higher values indicating better institutional performance.[19] Notably, the regressions reported in columns (1) and (2) suggest that the correlation between Fitness and migrant diversity remains positive and statistically significant despite these modifications. Specification (3) adds average years of schooling in population above 25 years old. In Column (4) we consider "real openness" as suggested by Alcalá and Ciccone, (2004), calculated by normalizing the sum of imports and exports by the PPP GDP, using data from PWT.[20] Column (5) measures openness by the KOF globalization indicator, whereas column (6) takes account of early development by using population density in 1500CE as a proxy for it. As we observe, the results remain qualitatively similar to the ones we found in Table 3.

[Insert Table 5 about here]

In Table 6 we report a set of additional estimates by using data for immigration from

[19] More precisely, our WGI metric is the average value of the following subindices: voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption

[20] However, Rodrik et al. (2004) dispute whether real openness is superior to the conventional measure of trade.

Artuc al. (2015). These authors have compiled migration data disaggregated by skill for the the years 1990 and 2000. Hence, this permits us to study whether the effects of immigration are skill-specific. As discussed in Borjas (2019) and Docquier et al. (2020), highly educated migrant flows may generate more complementarities and greater economic gains than their less-educated counterparts. Column (1) uses the diversity among all immigrants from these data, whereas columns (2) and (3) use diversity indicators for college and non-college migrants, respectively. Each of these specifications also uses skill-specific migrant shares. Unfortunately, data limitations prevent us from instrumenting the immigrant share with the shift-share predictor. Hence, the coefficients on the immigrant share variable must be interpreted with caution. Importantly, we find that the estimate on general migrant diversity is qualitatively similar (though slightly stronger) to the results we found in Table 4. On the other hand, similar to Bahar et al. (2020), but unlike Docquier et al. (2020), the estimated coefficients on the skill-specific indicators are quite similar, indicating that migrants help economic performance irrespective of their level of education.

[Insert Table 6 about here]

Next, we re-estimate our empirical model by using the ArCo index of technological progress from Archibugi and Cooco (2004) as the dependent variable, instead of the Fitness metric. This measure captures information on patents, scientific articles, internet penetration, electricity consumption, tertiary science and engineering enrollment, average years of schooling and literacy rates. The first column in Table 7 uses general migrant diversity from Özden et al. (2011) whereas in the remaining regressions we employ data from Artuc et al. (2015). Interestingly, the coefficient on migrant diversity remains positive across specifications, though we lose significance in specifications (1) and (3). Overall, the estimates from Table 7 confirm that migrants influence a country's productive structure even when we use an alternative proxy for it.

[Insert Table 7 about here]

3.4 Heterogeneous effects

Before concluding this paper, we perform a heterogeneity test in order to understand whether the level of development in the receiving economies matters in explaining the relationship between migration and Fitness. Hence, we divide the sample into three equally sized groups according to the level of income per person in 1995. Following the standard practice in the literature, we do so by introducing interaction terms between diversity and dummy variables indicating the level of development. We also interact the PPML instrument with these indicators. Figure 3 plots the second-stage estimates along with the 95 percent intervals from this empirical exercise. Interestingly, we find that the impact of birthplace diversity is stronger and statistically significant for middle-income countries. In contrast, no significant effects can be identified for the remaining groups of countries. Similar results are also found by Bahar et al. (2020) where economies at the middle tercile of economic complexity appear to gain more by diversity.

[Insert Figure 4 about here]

3.5 Panel data, 2SLS evidence

Despite our main cross-sectional analysis is based on a rich set of explanatory variables, there is still room for omitted confounding that might render the inference invalid. In this section, we re-estimate our empirical model using the latest United Nations Migrant Stock Data[21] over the period 1990-2010, which are available in 5-year intervals. We also use predicted diversity as a source of exogenous variation, obtained from a gravity model in the spirit of Feyrer (2019) that is suitable for panel settings. The essence of Feyrer's approach lies in the use of interactions between distance and year dummies, in order to generate gravity predictors that vary with time.[22] The interaction terms are intended to

[21] We have downloaded the data using the package untools in *R*, available at: https://dante-sttr.gitlab.io/un-tools/index.html
[22] This method was originally proposed to estimate the causal effects of trade on income. For some applications with time-varying gravity instruments within the migration context, see, Valette (2018); Docquier et al. (2020).

capture the effects of country-specific transportation costs on cross-border movements. Keeping these issues in mind, we estimate a panel gravity equation which is identical to the one used in Valette (2018). In particular, bilateral migrant stocks are regressed on distance, common language and past colonial ties indicators, and distance by year interactions. Our model also includes year and country of origin fixed effects. The "zero-stage" results, are shown in the Appendix Table A.

Table 8 presents two sets of empirical estimates, based on the specification which considers interactions between migrant diversity and income terciles, similar to the ones we reported in Figure 4, using a cross-section design. The estimated equations include only time-varying controls, namely gdp per capita, average years of schooling, trade openness, and total population. The top part considers OLS regressions that include year and country fixed effects. Importantly, accounting for time-invariant unobserved heterogeneity yields quite robust results that are consistent with those we found earlier, with one exception. Specifically, migrant diversity enhances economic performance into middle income host countries. There is, however, a strong negative effect on low-income countries.

The bottom part of Table 8 presents the second-stage estimates from this important empirical exercise. The general pattern that emerges from panel B is that, once again, migrant diversity mostly affects countries at the middle tercile. The estimated effects, however, appear to be weaker in terms of statistical significance. On the other hand, the impact on countries that belong to the lowest income tercile ceases to be significant and also becomes positive once we control for population, trade openness and schooling.

[Insert Table 8 about here]

4. Conclusions

Recent studies have shown that economic complexity is a key factor for economic development. This article considers the question of whether migrants influence complexity, as measured by the Economic Fitness indicator from Tacchela et al. (2012).

Using a cross-section of developed and developing countries, and gravity predictors of bilateral migrations to address the usual endogeneity and measurement error concerns, we have shown that higher migrant diversity is correlated with higher levels of Fitness. Encouragingly, this finding appears to be robust in a series of sensitivity tests, including, among others, immigration data from external sources, an alternative dependent variable from Archibugi and Coco (2004), and an extensive set of controls. Interestingly, however, this pattern appears to differ according to the host country's level of development. In particular, we find that immigration generates gains for middle-income countries whereas the effects on rich and poor economies appear to be negligible.

The current findings add to the growing body of cross-sectional studies on the nexus between immigration and economic performance. This paper has focused on the Fitness of countries, providing pieces of evidence in support of earlier findings, and in particular, those reported in Alesina et al. (2016) and Bahar et al. (2020).

Nevertheless, we improve on previous studies by using conventional panel data methods to account for time-invariant unobserved heterogeneity. We consistently detect qualitatively similar results once we replicate the main analysis, combining the approach introduced by Feyrer (2019), to generate a time-varying instrument, with data in 5-year intervals over the period 1990-2010 from the United Nations Migrant Stocks. We establish that migrant diversity mostly enhances economic performance into middle-income states.

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Table 1 Summary statistics of the main variables

Variable	Obs	Mean	Std.Dev.	Min	Max	Source
Economic Fitness	258	1.083	1.682	0	10.273	World Bank, Tacchela et al. (2012)
ArCo	258	.312	.189	.017	.867	Archibugi and Coco (2004)
Birthplace diversity	258	.726	.196	.03	.965	Own calculations, World Bank, Özden et al. (2011)
PPML instrument	258	.871	.126	.226	.98	Own calculations, Özden et al. (2011), BACI dataset
Immigrant share	258	7.611	12.171	.036	77.616	World Bank, Özden et al. (2011)
Bartik instrument	258	5.674	9.059	.006	76.811	Own calculations, World Bank, Özden et al. (2011)
Distance from equator	258	27.762	18.116	.422	67.47	Ortega and Peri (2014)
Landlocked	258	.24	.428	0	1	Ortega and Peri (2014)
Distance to nearest coast	258	.4	.438	.003	2.206	Nunn and Puga (2012)
Pct. tropic land	258	31.743	41.514	0	100	Nunn and Puga (2012)
Malaria indicator	258	.29	.4	0	.95	Ortega and Peri (2014)
Yellow fever indicator	258	.434	.497	0	1	Ortega and Peri (2014)
Average temperature	258	17.687	8.724	-7.929	28.639	Ashraf and Galor (2013)
Average precipitation	258	84.713	59.355	2.911	241.718	Ashraf and Galor (2013)
Land area	258	967000	2280000	646	1.71e+07	Nunn and Puga (2012)
GDP/capita, PPP	258	10757.57	13233.63	169.098	87399.84	PWT
Trade openness	258	80.464	49.173	2.008	442.475	PWT
Population	258	4.48e+07	1.47e+08	267000	1.30e+09	World Development Indicators
Oil/gas exporter	258	.341	.475	0	1	The QoG Institute, University of Gothenburg
Polity2	254	2.937	6.697	-10	10	Polity IV Project
WGI instq	258	-.089	.957	-2.1	1.894	World Governance Indicators
Average years of schooling	250	6.765	3.52	.11	12.86	Wittgenstein Centre Human Capital Data Explorer
Real openness	258	49.031	41.962	.889	326.267	PWT
KOF Globalization index	258	54.47	16.556	21.552	88.022	KOF Swiss Economic Institute
Population density in 1500	256	6.26	8.957	.022	46.639	Ashraf and Galor (2013)
Former British colony	258	.248	.433	0	1	Nunn and Puga (2012)
Former French colony	258	.163	.37	0	1	Nunn and Puga (2012)

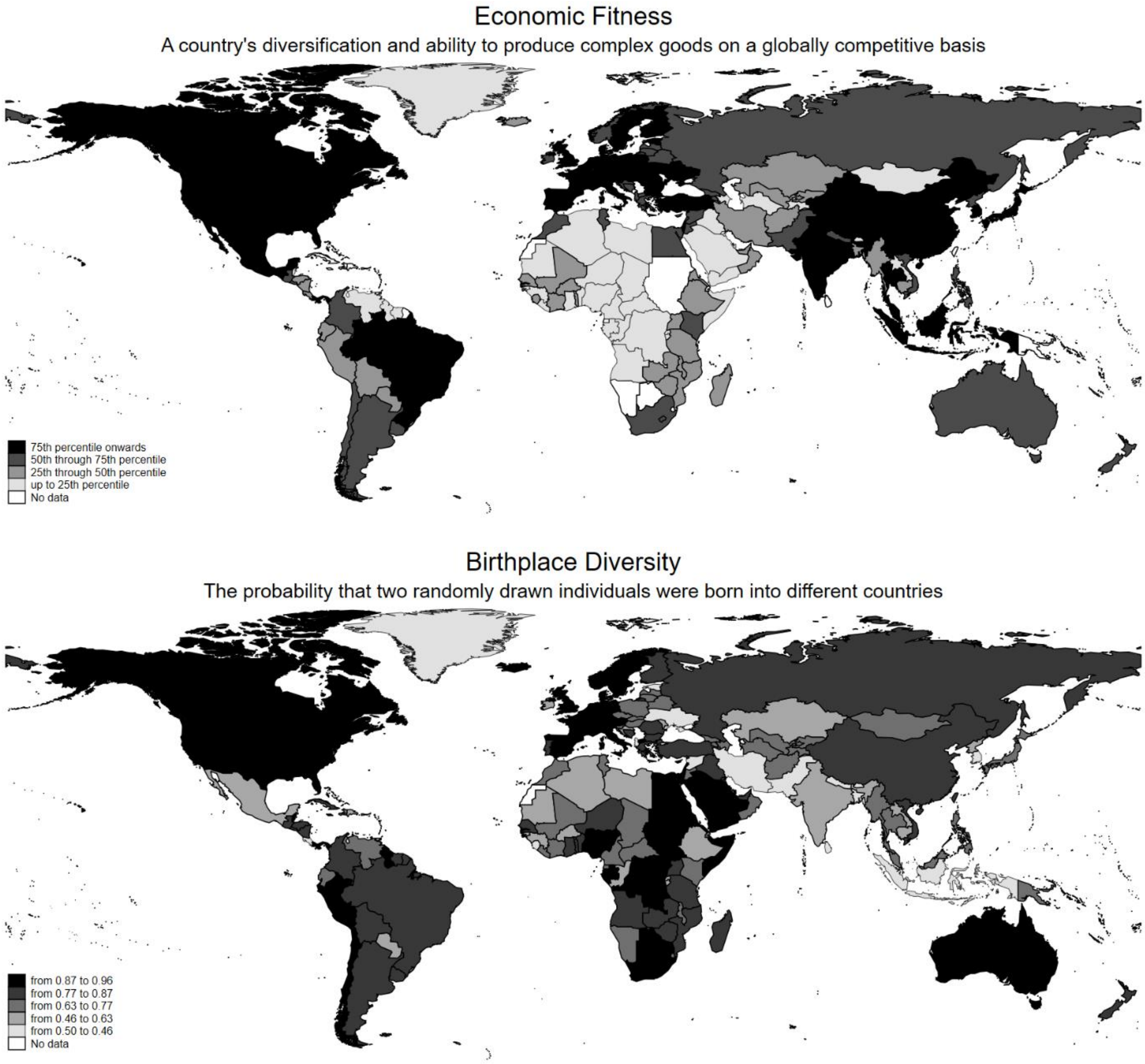

Figure 1 Economic Fitness and birthplace diversity among immigrants. Authors' elaborations on Tacchela et al. (2012) and Özden et al. (2011) data.

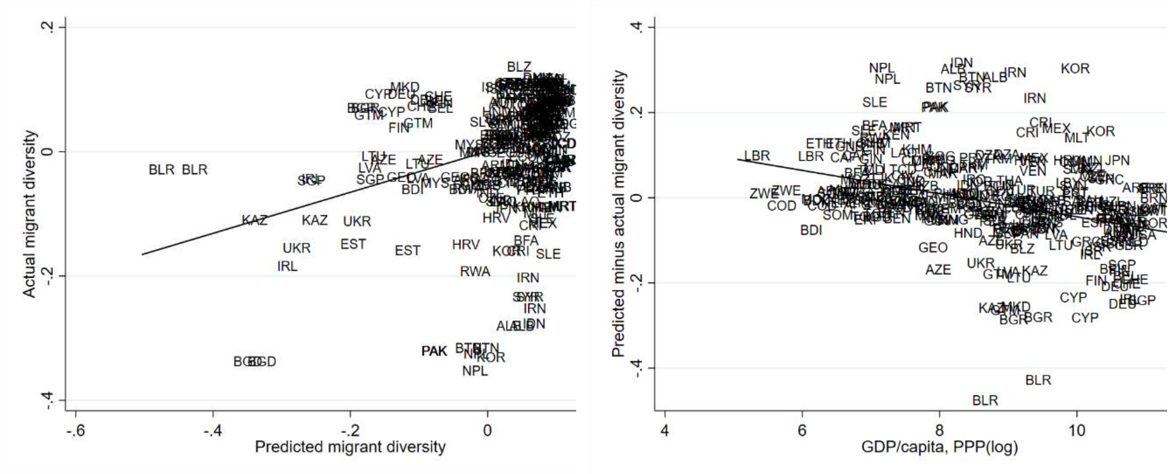

Figure 2 Unconditional correlations: actual migrant diversity versus gravity-predicted instrument (left), gravity-based predicted migrant diversity minus actual migrant diversity versus GDP per capita (right)

Table 2 Gravity Estimates of Bilateral Migrations ("Zero-stage")

	(1)	(2)
Dependent variable: Bilateral migrant stock	OLS	PPML
Distance	-1.401***	-1.586***
	(0.140)	(0.120)
Population, destination	0.311***	0.319**
	(0.0879)	(0.146)
Population, origin	0.123	0.548***
	(0.134)	(0.101)
Area, destination	0.111	0.424***
	(0.0840)	(0.143)
Area, origin	0.0768*	0.161*
	(0.0390)	(0.0843)
Sum landlocked	-0.483*	-0.622**
	(0.260)	(0.259)
Border	4.442	-2.983**
	(3.653)	(1.498)
Border * Population, destination	-0.198	0.395***
	(0.247)	(0.144)
Border * Population, origin	0.181	-0.260**
	(0.165)	(0.110)
Border * Area, destination	0.308	-0.451**
	(0.190)	(0.197)
Border * Area, origin	0.185	0.276*
	(0.166)	(0.147)
Border * Distance	-1.250***	0.475
	(0.478)	(0.418)
Border * landlocked	0.372	0.472**
	(0.323)	(0.204)
Common language	0.948***	1.554***
	(0.248)	(0.492)
Common official language	0.304*	0.0210
	(0.158)	(0.467)
Colonial relationship	2.445***	1.568***
	(0.212)	(0.242)
Time zone differences	0.244*	0.148***
	(0.129)	(0.0301)
Origin by year FE	YES	YES
Year FE	YES	YES
Observations	34,120	88,620
R-squared	0.363	0.580

This table presents OLS and PPML estimates using data for the years 1990 and 2000, obtained from the World Bank's Global Bilateral Migration Database and CEPII. *** p<0.01, ** p<0.05, * p<0.1

Table 3. Immigration and economic performance, OLS estimates

Dependent variable:EF	(1) Parsimonious	(2) Continent/ Year FE	(3) Geography and disease environment	(4) GDP/capita, trade, population, oil	(5) Colonial history	(6) Full specification
Birthplace diversity	0.235***	0.209***	0.232***	0.122***	0.203***	0.171***
	(0.077)	(0.063)	(0.065)	(0.047)	(0.063)	(0.047)
Immigrant share	-0.004	-0.105*	0.017	-0.094	-0.132**	-0.068
	(0.064)	(0.060)	(0.068)	(0.063)	(0.059)	(0.056)
Distance to equator			-0.004			0.004
			(0.012)			(0.009)
Landlocked			0.077			0.265
			(0.217)			(0.170)
Distance to coast			-0.494*			-0.042
			(0.261)			(0.200)
Pct. tropic land			-0.007**			-0.005**
			(0.003)			(0.003)
Malaria			-0.555***			0.484**
			(0.188)			(0.213)
Yellow fever			0.369			0.278*
			(0.291)			(0.167)
Mean temperature			-0.022			-0.016
			(0.017)			(0.014)
Mean precipitation			0.006**			0.003*
			(0.002)			(0.002)
Area (Log)			0.153**			-0.168***
			(0.061)			(0.049)
GDP/capita, PPP (Log)				0.416***		0.471***
				(0.084)		(0.079)
Trade openness				-0.023		-0.028
				(0.077)		(0.081)
Population (Log)				0.285***		0.425***
				(0.055)		(0.068)
Oil/gas exporter				-0.525***		-0.321***
				(0.125)		(0.119)
Former British colony					0.209	-0.064
					(0.237)	(0.142)
Former French colony					0.043	0.068
					(0.161)	(0.151)
Continent FE	No	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	Yes	Yes
Observations	258	258	258	258	258	258
# Countries	129	129	129	129	129	129
Adjusted R^2	0.048	0.337	0.408	0.627	0.337	0.675

This table presents pooled OLS estimates using data for the years 1990 and 2000. Except otherwise specified, each specification includes broad region dummies, namely, Europe, Americas, Asia, and Oceania (omitted category: Africa). Robust standard errors, clustered by country. *** p<0.01, ** p<0.05, * p<0.1

Table 4. Immigration and economic performance, Second-stage estimates

Dependent variable: economic fitness	(1)	(2)	(3)
Birthplace Diversity	0.396**	0.172***	0.388**
	(0.187)	(0.048)	(0.178)
Immigrant share	-0.076	-0.097	-0.114
	(0.060)	(0.114)	(0.130)
Distance to equator	0.007	0.004	0.006
	(0.011)	(0.009)	(0.011)
Landlocked	0.219	0.261	0.214
	(0.188)	(0.171)	(0.188)
Distance to coast	0.060	-0.029	0.074
	(0.240)	(0.202)	(0.243)
Pct. tropic land	-0.007**	-0.005*	-0.007**
	(0.003)	(0.003)	(0.003)
Malaria indicator	0.290	0.480**	0.293
	(0.287)	(0.215)	(0.285)
Yellow fever indicator	0.388*	0.285*	0.393*
	(0.208)	(0.169)	(0.209)
Mean temperature	-0.011	-0.015	-0.011
	(0.016)	(0.014)	(0.016)
Mean precipitation	0.005*	0.002	0.004*
	(0.002)	(0.002)	(0.002)
Area (Log)	-0.192***	-0.173***	-0.197***
	(0.054)	(0.049)	(0.055)
GDP/capita, PPP (Log)	0.406***	0.485***	0.428***
	(0.098)	(0.090)	(0.104)
Trade openness	-0.048	-0.030	-0.050
	(0.090)	(0.082)	(0.091)
Population (Log)	0.424***	0.420***	0.418***
	(0.072)	(0.071)	(0.075)
Oil/gas exporter	-0.317**	-0.322***	-0.318**
	(0.134)	(0.120)	(0.134)
Former British colony	-0.085	-0.049	-0.065
	(0.155)	(0.150)	(0.163)
Former French colony	0.116	0.070	0.118
	(0.189)	(0.151)	(0.187)
Continent FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	258	258	258
# Countries	129	129	129
Adjusted R-squared	0.638	0.675	0.641
Instruments:	PPML		PPML
		Bartik	Bartik
Kleibergen-Paap F-Test	14.08	18.38	7.543

This table presents 2SLS estimates using data for the years 1990 and 2000. Except otherwise specified, each specification includes broad region dummies, namely, Europe, Americas, Asia, and Oceania (omitted category: Africa). Robust standard errors, clustered by country. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

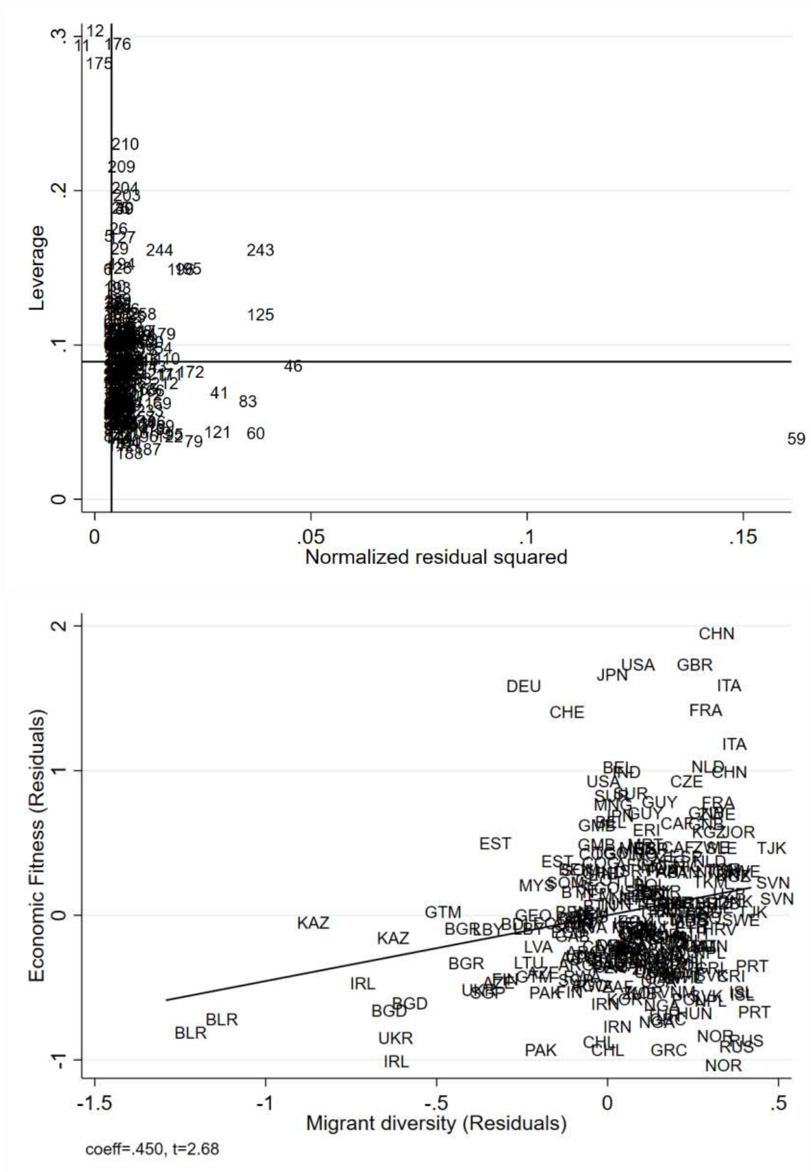

Figure 3 Leverage-residual plot and Second-stage estimates without influential observations.

Table 5. Immigration and economic performance, institutions, human capital and

alternative measures of openness, Second-stage estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: economic fitness						
Birthplace diversity	0.443**	0.340*	0.429**	0.389**	0.412*	0.397**
	(0.203)	(0.194)	(0.208)	(0.188)	(0.236)	(0.156)
Immigrant share	-0.157	-0.092	-0.098	-0.110	-0.116	0.072
	(0.147)	(0.127)	(0.132)	(0.126)	(0.137)	(0.118)
Polity2	-0.005					
	(0.013)					
WGI Instq		0.143				
		(0.132)				
Schooling (years)			-0.064			
			(0.126)			
Real trade openness				0.035		
				(0.083)		
KOF globalization					-0.004	
					(0.012)	
Pop density in 1500						0.050***
						(0.007)
Geography, disease controls	Yes	Yes	Yes	Yes	Yes	Yes
GDP, Trade, Population, Oil	Yes	Yes	Yes	Yes	Yes	Yes
Continent FE, colonial history	Yes	Yes	Yes	Yes	Yes	Yes
Observations	254	258	250	258	258	256
# Countries	127	129	125	129	129	128
Adjusted R-squared	0.625	0.656	0.631	0.640	0.633	0.740
Instruments:	PPML	PPML	PPML	PPML	PPML	PPML
	Bartik	Bartik	Bartik	Bartik	Bartik	Bartik
Kleibergen-Paap F-Test	5.135	5.976	6.601	6.965	3.730	8.055

This table presents 2SLS estimates using data for the years 1990 and 2000. Except otherwise specified, each specification includes broad region dummies, namely, Europe, Americas, Asia, and Oceania (omitted category: Africa). Robust standard errors, clustered by country. *** p<0.01, ** p<0.05, * p<0.1

Table 6. Immigration and economic performance, Second-stage estimates by skill level

	(1)	(2)	(3)
Dependent variable: economic fitness			
Birthplace diversity (all immigrants)	0.411***		
	(0.142)		
Immigrant share (all immigrants)	0.014		
	(0.064)		
Birthplace diversity (skilled immigrants)		0.381*	
		(0.195)	
Immigrant share (skilled immigrants)		0.005	
		(0.076)	
Birthplace diversity (unskilled immigrants)			0.344**
			(0.135)
Immigrant share (unskilled immigrants)			0.007
			(0.055)
Geography and disease controls	YES	YES	YES
GDP/capita Trade Population Oil	YES	YES	YES
Continent FE colonial history	YES	YES	YES
Observations	258	258	258
# Countries	129	129	129
Adjusted R-squared	0.623	0.652	0.639
Instruments:	PPML	PPML	PPML
Kleibergen-Paap F-Test	17.99	13.45	16.30

This table presents 2SLS estimates using data for the years 1990 and 2000. Immigration data disaggregated by skill level are obtained from Artuc et al. (2015). Except otherwise specified, each specification includes broad region dummies, namely, Europe, Americas, Asia, and Oceania (omitted category: Africa). Robust standard errors, clustered by country. *** p<0.01, ** p<0.05, * p<0.1

Table 7. Alternative measure of economic complexity , 2SLS estimates

	(1)	(2)	(3)	(4)
Dependent variable: Arco Technological Capabilities				
Birthplace diversity (all immigrants)	0.107	0.174**		
	(0.097)	(0.070)		
Immigrant share (all immigrants)	0.002	0.050		
	(0.004)	(0.047)		
Birthplace diversity (skilled immigrants)			0.100	
			(0.098)	
Immigrant share (skilled immigrants)			0.109**	
			(0.055)	
Birthplace diversity (unskilled immigrants)				0.166**
				(0.070)
Immigrant share (unskilled immigrants)				0.030
				(0.043)
Observations	258	258	258	258
Adjusted R-squared	0.878	0.886	0.883	0.883
Geography and disease controls	Yes	Yes	Yes	Yes
GDP/capita Trade Population Oil	Yes	Yes	Yes	Yes
Continent FE colonial history	Yes	Yes	Yes	Yes
Kleibergen-Paap F-Test	14.08	17.99	13.45	16.30

This table presents 2SLS estimates using data for the years 1990 and 2000. The first column uses immigration data obtained from Özden et al. (2011). Columns 2 to 4 use immigration data obtained from Artuc et al. (2015). Except otherwise specified, each specification includes broad region dummies, namely, Europe, Americas, Asia, and Oceania (omitted category: Africa). Robust standard errors, clustered by country. *** p<0.01, ** p<0.05, * p<0.1

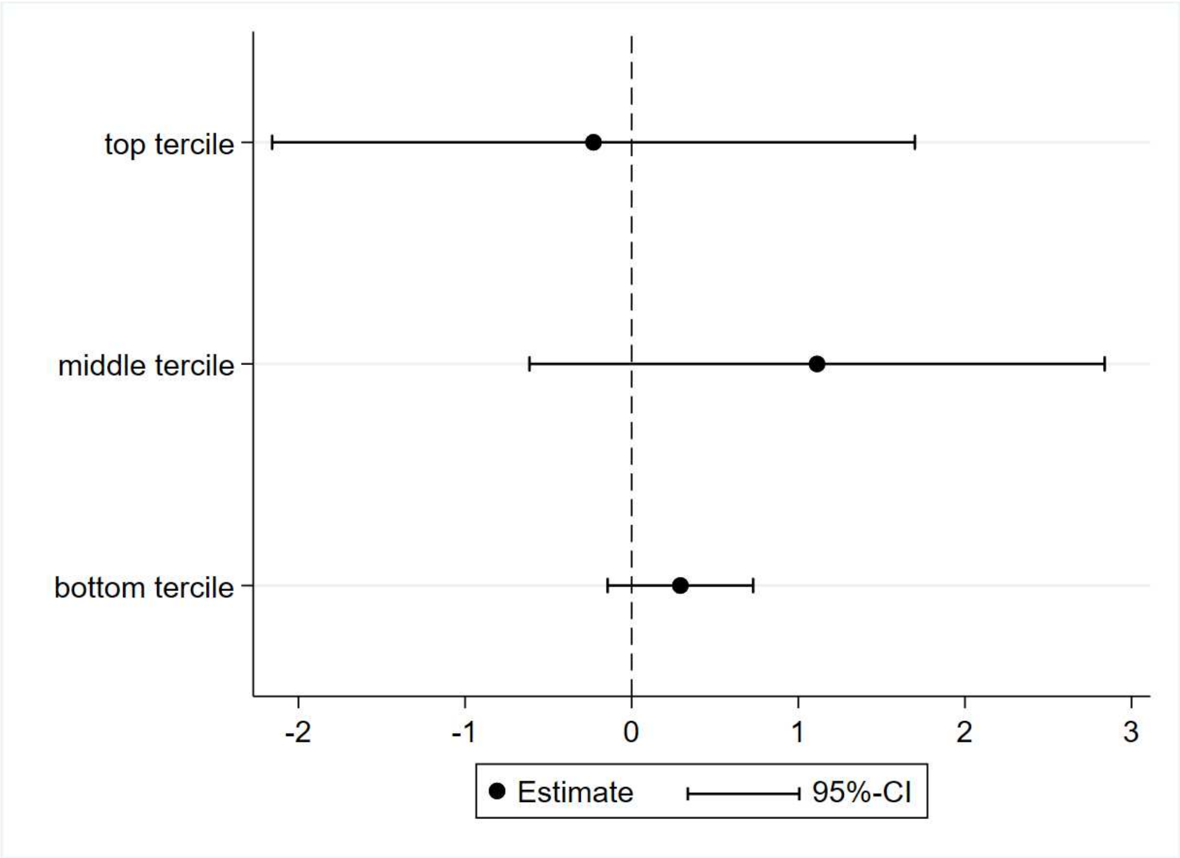

Figure 4 Second-stage estimates on the effect of migrant diversity on Economic Fitness according to the receiving countries' level of economic development.

Table 8. Immigration and economic performance, panel data estimates

	(1)	(2)	(3)	(4)	(5)
[A] OLS estimates					
Birthplace Diversity * bottom tercile	-0.200***	-0.279***	-0.227***	-0.236***	-0.226***
	(0.068)	(0.070)	(0.072)	(0.075)	(0.077)
Birthplace Diversity * middle tercile	0.057**	0.065***	0.058***	0.060***	0.064***
	(0.022)	(0.020)	(0.020)	(0.020)	(0.020)
Birthplace Diversity * top tercile	0.029	0.044	0.044	0.038	0.061
	(0.049)	(0.038)	(0.040)	(0.037)	(0.042)
Immigrant share	-0.017**	-0.015**	-0.018**	-0.018**	-0.015**
	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
GDP/capita, PPP (Log)		0.381*	0.408*	0.409*	0.422*
		(0.220)	(0.221)	(0.220)	(0.225)
Population (Log)			0.319**	0.324**	0.215
			(0.144)	(0.143)	(0.133)
Trade openness				0.084*	0.087
				(0.049)	(0.055)
Schooling (years)					0.234
					(0.146)
Observations	642	630	630	630	611
# Countries	129	129	129	129	125
[B] 2SLS estimates					
Birthplace Diversity * bottom tercile	-0.071	-0.200	0.084	0.113	0.109
	(0.160)	(0.250)	(0.332)	(0.327)	(0.317)
Birthplace Diversity * middle tercile	0.054	0.099**	0.108	0.112	0.195*
	(0.078)	(0.047)	(0.072)	(0.076)	(0.109)
Birthplace Diversity * top tercile	-0.016	-0.108	0.013	0.016	0.433
	(0.074)	(0.120)	(0.103)	(0.100)	(0.351)
Immigrant share	-0.018**	-0.020**	-0.019**	-0.020**	-0.001
	(0.008)	(0.009)	(0.008)	(0.008)	(0.013)
GDP/capita, PPP (Log)		0.363	0.383*	0.381*	0.425*
		(0.232)	(0.230)	(0.229)	(0.223)
Population (Log)			0.426*	0.443**	0.195
			(0.226)	(0.220)	(0.179)
Trade openness				0.065	0.006
				(0.065)	(0.100)
Schooling (years)					0.473*
					(0.283)
Observations	642	630	630	630	611
# Countries	129	129	129	129	125

This table presents OLS and 2SLS estimates using panel data for the period 1990-2010. Immigration data are obtained from United Nations Migrant Stocks. Robust standard errors, clustered by country. *** p<0.01, ** p<0.05, * p<0.1

Appendix

Table A1 List of Countries

Afghanistan	Ghana	Oman
Algeria	Greece	Pakistan
Angola	Guatemala	Panama
Argentina	Guinea	Paraguay
Armenia	Guinea-Bissau	Peru
Australia	Guyana	Philippines
Austria	Honduras	Poland
Azerbaijan	Hungary	Portugal
Bangladesh	Iceland	Qatar
Belarus	India	Russia
Belgium	Indonesia	Rwanda
Benin	Iran	Saudi Arabia
Bhutan	Iraq	Senegal
Bolivia	Ireland	Sierra Leone
Brazil	Israel	Singapore
Bulgaria	Italy	Slovakia
Burkina Faso	Japan	Slovenia
Burundi	Jordan	Somalia
Cameroon	Kazakhstan	South Africa
Canada	Kenya	Spain
Central African Republic	Korea, South	Suriname
Chad	Kuwait	Sweden
Chile	Kyrgyzstan	Switzerland
China	Laos	Syria
Colombia	Latvia	Tajikistan
Congo	Libya	Tanzania
Costa Rica	Lithuania	Thailand
Cote d'Ivoire	Madagascar	Togo
Croatia	Malawi	Tunisia
Czech Republic	Malaysia	Turkey
Denmark	Mali	Turkmenistan
Ecuador	Mauritania	Uganda
Egypt	Mexico	Ukraine
El Salvador	Mongolia	United Arab Emirates
Eritrea	Morocco	United Kingdom
Estonia	Mozambique	United States
Ethiopia	Nepal	Uruguay
Finland	Netherlands	Uzbekistan
France	New Zealand	Venezuela
Gabon	Nicaragua	Vietnam
Gambia	Niger	Yemen
Georgia	Nigeria	Zambia
Germany	Norway	Zimbabwe

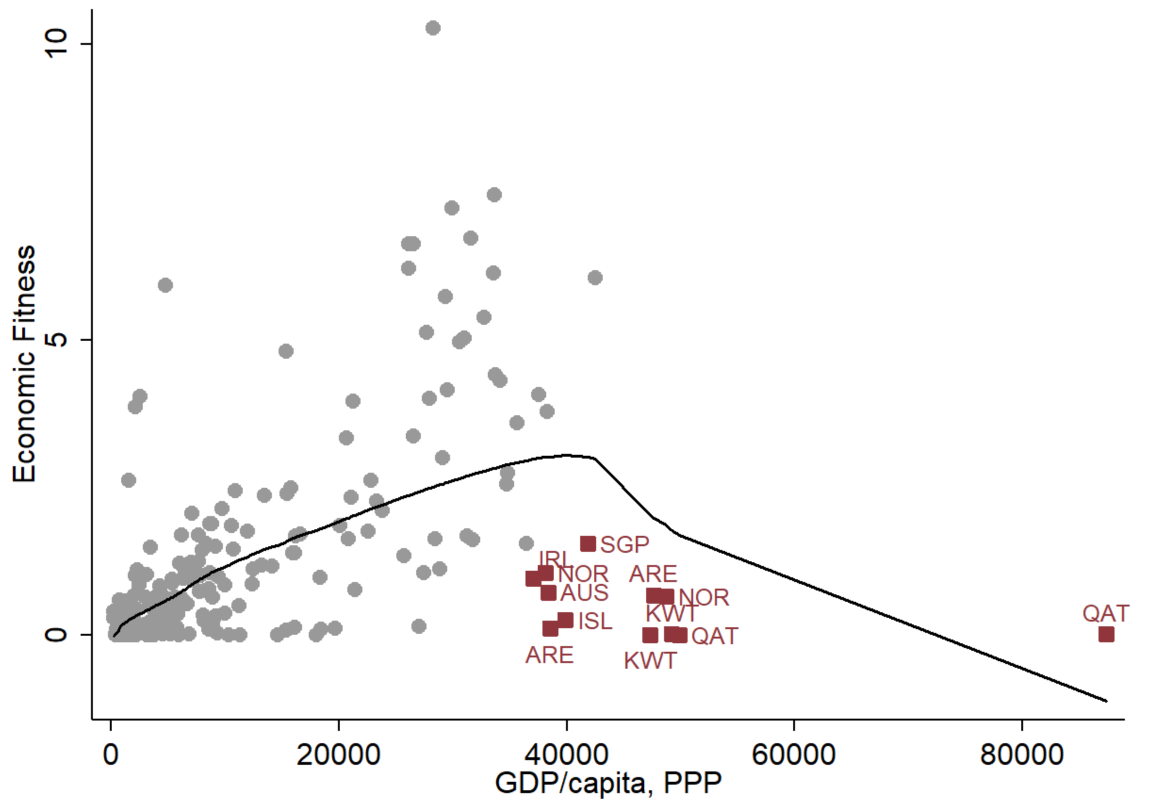

Figure A1 Nonparametric relationship between Economic Fitness and income per person. Authors' elaborations on Tacchela et al. (2012) and PWT data.

Table A2. Gravity estimates, 1990-2010

Dependent variable: Bilateral Migrant Stocks	(1)
Border	2.247***
	(0.213)
Common language	0.956**
	(0.388)
Common official language	0.455*
	(0.275)
Colonial relationship	2.359***
	(0.437)
Distance * I(1990)	-0.703***
	(0.162)
Distance * I(1995)	-0.732***
	(0.163)
Distance * I(2000)	-0.700***
	(0.164)
Distance * I(2005)	-0.706***
	(0.166)
Distance * I(2010)	-0.707***
Observations	51,127
R-squared	0.350

This table presents OLS estimates using panel data for the period 1990-2010. Immigration data are obtained from United Nations Migrant Stocks. Robust standard errors, clustered by country. *** p<0.01, ** p<0.05, * p<0.1