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Immigration, unemployment and GDP in the host country: Bootstrap panel Granger causality analysis on OECD countries*

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Abstract

This paper examines the causality relationship between immigration, unemployment and economic growth of the host country. We employ the panel Granger causality testing approach of Kónya (2006) that is based on SUR systems and Wald tests with country specific bootstrap critical values. This approach allows to test for Granger-causality on each individual panel member separately by taking into account the contemporaneous correlation across countries. Using annual data over the 1980-2005 period for 22 OECD countries, we find that, only in Portugal, unemployment negatively causes immigration, while in any country, immigration does not cause unemployment. On the other hand, our results show that, in four countries (France, Iceland, Norway and the United Kingdom), growth positively causes immigration, whereas in any country, immigration does not cause growth.

Keywords: Immigration, growth, unemployment, causality.
JEL classification: E20, F22, J61.

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1 Introduction

During the last decades, most OECD countries experienced an increase in international migration. Indeed, the number of immigrants received in OECD countries substantially increased in the last decades, from about 82 millions in the 1990 to 127 million in the 2010 (United Nation, 2009). Immigrants are the main source of population growth in the OECD countries. They contribute more and more to population growth, compared to natural increase (the excess of births over deaths), particularly in European countries during the last years (Figure 1). In the context of the aging population and the shrinking working age population, migration flows are likely to continue at a sustained pace in the next decades.

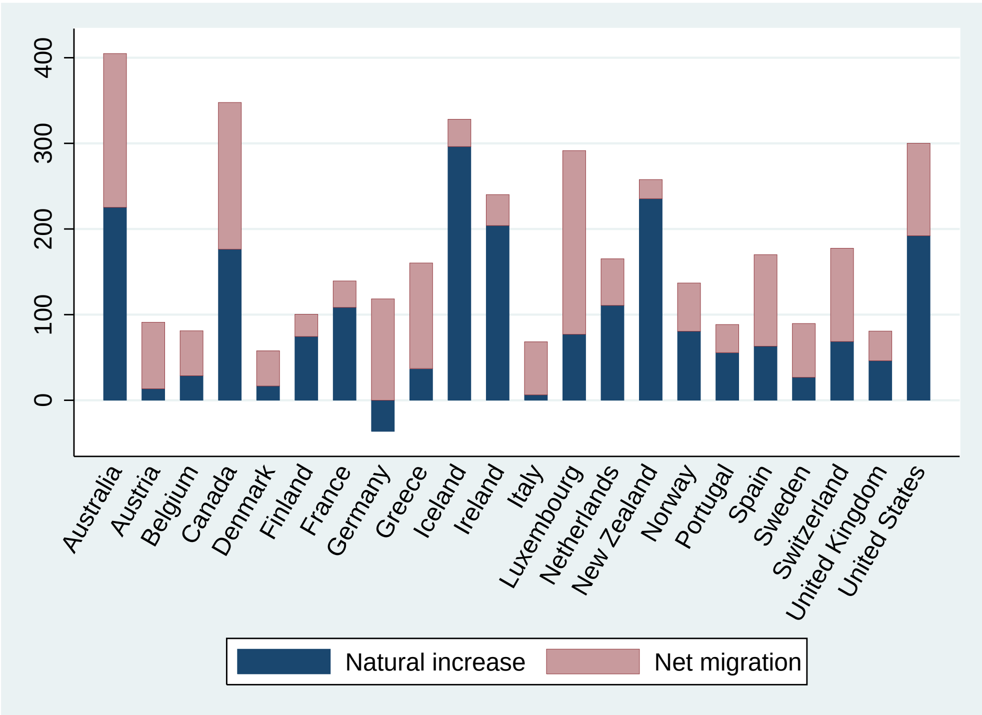

Figure 1: Components of population change, 1980-2005 (Variables are expressed per 1,000 population). Temporary immigration flows are excluded. Source: Authors' calculation, Labour Force Statistics, OECD (2010)

However, there is a public and political concern about the impact of the international migration on economic conditions in the receiving countries. Economists have studied, both theoretically and empirically, the impact of immigration on a variety of host country outcomes[1] and also how economic

[1]See Okkerse (2008) and Keer and Keer (2011) for a review of literature.

conditions in the receiving countries affect migration flows.

Theoretical studies (Johnson, 1980; Grossman, 1982) on the impact of immigration on labour market in host countries show that the effects of immigrants on the employment of residents depend on whether immigrants and natives are substitutes or complements in production. Generally, the empirical studies on the impact of immigration on labour market in host countries conclude that migration flows do not reduce the labour market prospects of natives (Simon et al., 1993; Pischke and Velling, 1997; Dustmann et al., 2005).

Theoretical studies on the effect of immigration on growth show that if migrants are skilled an inflow of migrants will have a less negative effect on growth compared to the natural increase in population (Dolado et al., 1994; Barro and Sala-i-Martin, 1995). This result is corroborated by the findings from the empirical papers (Dolado et al., 1994; Ortega and Peri, 2009).

Some empirical papers have examined the causality between immigration and unemployment and growth on data from different countries (Pope and Withers, 1985; Marr and Siklos, 1994; Islam, 2007; Morley, 2006). The idea is based on the fact that migrants take into account job opportunities in their decision to migrate and the economic conditions are likely to have a significant impact on migrations policies. Generally, the empirical papers on the causal link between immigration and host economic activity find no evidence of migration causing unemployment and growth, but find evidence of causation running in the opposite direction.

This paper contributes to the existing literature on immigration by investigating the causality relationship between immigration and host country economic conditions (unemployment and growth) using the panel Granger causality testing approach recently developed by Kònya (2006) that is based on SUR systems and Wald tests with country specific bootstrap critical values. This approach allows to test for Granger-causality on each individual panel member separately by taking into account the contemporaneous correlation across countries. Therefore, for each country, it allows to test for the causality relationship between immigration and host economic variables depending on immigration policy.

We use annual data over the 1980-2005 period for 22 OECD countries which are the major host countries (Figure 1). Our study provides evidence that immigration does not cause host economic conditions (unemployment and income per capita) and the influence of host economic conditions on immigration depends on the host country. Indeed, on the one hand, our finding suggests that, only in Portugal, unemployment negatively Granger causes immigration inflow, while in any country, immigration inflow does not Grange cause unemployment. On the other, our results indicate that, in four countries (France, Iceland, Norway and the United Kingdom), economic growth positively Granger causes immigration inflow, while in any country, immigration inflow does not Granger cause economic growth. This heterogeneity in the influence of host economic conditions on immigration can be related to the characteristics of host country immigration policies.

The remainder of the paper is organized as follows. The existing literature on the interaction between immigration, unemployment and growth is reviewed in Section 2. Section 3 presents the econometric methodology. Section 4 describes the data and reports the empirical results. Finally, Section 5 offers some concluding remarks.

2 Literature review

Since the early 1980s a considerable literature on immigration has been developed. The main concern is about the effect of immigration on labour market and economic growth in the host country.

Theoretical papers by Johnson (1980), Borjas (1987), Schmidt et al. (1994) and Greenwood and Hunt (1995) show that the effects of immigrants on the employment of residents depend on whether immigrants and natives are substitutes or complements in production. If the labour suppliers of residents and recent immigrants are substitutes, an inflow of immigrants will reduce wages (assuming wage adjustment to clear the labour market) and will increase the total employment. If labour force participation rates are sensitive to real wage rates, part of adjustment will occur through resident employment. So, immigration may cause unemployment among natives who are not willing to work at this lower wages. On the contrary, if residents and immigrant workers are complements in production (immigrants may be particularly adept at some types of jobs) the arrival of new immigrants may increase resident productivity and then raise their wages and their employment opportunities.

Generally, empirical studies on the impact of immigration on labour market in host countries conclude that migration flows do not reduce the labour market prospects of natives. For example, the empirical studies based on the spatial correlation approach (Simon et al., 1993 for the U.S; Pischke and Velling, 1997 for Germany; Dustmann et al., 2005 for the U.K.) find no adverse effects of immigration on native unemployment. This result is corroborated by findings from the studies based on natural experiments, i.e., immigration caused by political rather than economic factors (Card, 1990 for the Mariel Boatlift[2] and Hunt, 1992 for the return of "pieds-noirs" in France after the independence of Algeria). Contrary to the studies mentioned above that are conducted at the country level, Angrist and Kugler (2003) use a panel of 18 European countries from 1983 to 1999 and find a slightly negative impact of immigrants on native labour market employment. Jean

[2]In 1980, Fidel Castro permitted any any person wished to leave Cuba free access to depart from the port of Mariel. Approximately, 125000 Cubans, mostly unskilled workers, migrated to Miami. As a result, Miami's labour force increased by 7 percent.

and Jimenez (2007) evaluate the unemployment impact of immigration (and its link with output and labour market policies) in 18 OECD countries over the period 1984 to 2003, and they do not find any permanent effect of immigration.

Some theoretical works (Dolado et al., 1994; Barro and Sala-i-Martin, 1995) use a Solow growth model augmented by human capital to analyze the effects of immigrants on growth. They conclude that the effects of migration on economic growth depend on the skill composition of immigrants. The more migrants are educated, the more immigration has a positive effect on the economic growth in the host country.

Estimating an augmented Solow model on data from OECD economies during the 1960-1985 period, Dolado et al. (1994) find empirical evidence that corroborates its theoretical result. Their empirical result shows that because of their human capital content, migration inflows have less than half the negative impact of comparable natural population increases. However, more recently, Ortega and Peri (2009) estimate a pseudo-gravity model on 14 OECD countries over the period 1980 to 2005 and find that immigration does not affect income per capita.

A number of studies evaluate the fiscal impacts of immigration to examine whether immigration burdens the host country's social welfare systems more than is covered by the taxes paid by the immigrants (Auerbach and Oreopoulos, 1999; Borjas, 1995, 2001; Passel and Clark, 1994). These studies generally conclude that the total economic impact on the host country is relatively small.

Since migrants take into account job opportunities in their decision to migrate and because the economic conditions in host countries are likely to have a significant impact on migration policies, some empirical papers examine whether the migration flows respond to host country economic conditions. Particularly, some previous papers examine the Granger causality links between immigration and unemployment using data on individual country (Pope and Withers, 1985 for Australia; Marr and Siklos, 1994 and Islam, 2007 for Canada). They find no evidence of migration causing higher average rates of unemployment, but find evidence of causation running in the opposite direction. However, Shan et al. (1999) find no Granger-causality between immigration and unemployment, using data from Australia and New Zealand. Morley (2006) finds evidence of a long-run Granger causality running from per capita GDP to immigration on data for Australia, Canada and the USA.

Contrary to these previous empirical papers that examine the Granger causality between immigration and unemployment and growth using data on individual country, we employ here panel Granger causality techniques for a panel of OECD countries. We use the panel Granger causality testing approach of Kònya (2006) that is based on SUR systems and Wald tests with country specific bootstrap critical values. Firstly, since country specific bootstrap critical values are generated, this approach allows to test for Granger-causality on each individual panel member separately by taking into account the possible contemporaneous correlation across countries. Generating country specific bootstrap critical values allows not to implement pretesting for unit roots and cointegration. Finally, bootstrapping provides a way to account for the distortions caused by small samples.

3 Econometric methodology

Three approaches can be implemented to test for Granger-causality in a panel framework. The first one is based on the Generalized Method of Moments (GMM) that estimates (homogeneous) panel model by eliminating the fixed effect. However, it does not account for neither heterogeneity nor cross-sectional dependence[3]. A second approach that deals with heterogeneity was proposed by Hurlin (2008), but its main drawback is that the possible cross-sectional dependence is not taken into account. The third approach developed by Kònya (2006) allows to account for both cross-sectional dependence and heterogeneity. It is based on Seemingly Unrelated Regression (SUR) systems and Wald tests with country specific bootstrap critical values and enables to test for Granger-causality on each individual panel member separately, by taking into account the possible contemporaneous correlation across countries. Given its generality, we will implement this last approach in this paper.

The panel causality approach by Kònya (2006) that examines the relationship between Y and X can be studied using the following bivariate finite-order vector autoregressive (VAR) model:

$$\begin{cases} y_{i,t} = \alpha_{1,i} + \sum\limits_{s=1}^{ly_1} \beta_{1,i,s} y_{i,t-s} + \sum\limits_{s=1}^{lx_1} \gamma_{1,i,s} x_{i,t-s} + \varepsilon_{1,i,t} \\ x_{i,t} = \alpha_{2,i} + \sum\limits_{s=1}^{ly_2} \beta_{2,i,s} y_{i,t-s} + \sum\limits_{s=1}^{lx_2} \gamma_{2,i,s} x_{i,t-s} + \varepsilon_{2,i,t} \end{cases} \tag{1}$$

where the index i ($i = 1, ..., N$) denotes the country, the index t ($t = 1, ..., T$) the period, s the lag, and ly_1, lx_1, ly_2 and lx_2 indicate lag lengths. The error terms, $\varepsilon_{1,i,t}$ and $\varepsilon_{2,i,t}$ are supposed to be white-noises (i.e. they have zero means, constant variances and are individually serially uncorrelated) and may be correlated with each other for a given country. Moreover, it is assumed that Y and X are stationary or cointegrated so, depending on the time-series properties of the data, they might denote the level, the first difference or some higher difference.

[3]Moreover, as shown by Pesaran et al. (1999) the GMM estimators can lead to inconsistent and misleading estimated parameters unless the slope coefficients are in fact identical.

We consider two bivariate systems. In the former system $System\ 1:$ $(Y = U, X = M)$ where U and M denote unemployment rate and net migration rate, respectively. In the latter $System\ 2:$ $(Y = LGDP, X = M)$, where $LGDP$ denotes the natural logarithm of per capita real GDP (or real income).[4]

With respect to system (1) for instance, in country i there is one-way Granger-causality running from X to Y if in the first equation not all $\gamma_{1,i}$'s are zero but in the second all $\beta_{2,i}$'s are zero; there is one-way Granger-causality from Y to X if in the first equation all $\gamma_{1,i}$'s are zero but in the second not all $\beta_{2,i}$'s are zero; there is two-way Granger-causality between Y and X if neither all $\beta_{2,i}$'s nor all $\gamma_{1,i}$'s are zero; and there is no Granger-causality between Y and X if all $\beta_{2,i}$'s and $\gamma_{1,i}$'s are zero.

Since for a given country the two equations in (1) contain the same predetermined, i.e. lagged exogenous and endogenous variables, the OLS estimators of the parameters are consistent and asymptotically efficient. This suggests that the 2N equations in the system can be estimated one-by-one, in any preferred order. Then, instead of N VAR systems in (1), we can consider the following two sets of equations:

$$\begin{cases} y_{1,t} = \alpha_{1,1} + \sum_{s=1}^{ly_1} \beta_{1,1,s} y_{1,t-s} + \sum_{s=1}^{lx_1} \gamma_{1,1,s} x_{1,t-s} + \varepsilon_{1,1,t} \\ y_{2,t} = \alpha_{1,2} + \sum_{s=1}^{ly_1} \beta_{1,2,s} y_{2,t-s} + \sum_{s=1}^{lx_1} \gamma_{1,2,s} x_{2,t-s} + \varepsilon_{1,2,t} \\ \vdots \\ y_{N,t} = \alpha_{1,2} + \sum_{s=1}^{ly_1} \beta_{1,N,s} y_{N,t-s} + \sum_{s=1}^{lx_1} \gamma_{1,N,s} x_{N,t-s} + \varepsilon_{1,N,t} \end{cases} \tag{2}$$

and

$$\begin{cases} x_{1,t} = \alpha_{2,1} + \sum_{s=1}^{ly_2} \beta_{2,1,s} y_{1,t-s} + \sum_{s=1}^{lx_2} \gamma_{2,1,s} x_{1,t-s} + \varepsilon_{2,1,t} \\ x_{2,t} = \alpha_{2,2} + \sum_{s=1}^{ly_2} \beta_{2,2,s} y_{2,t-s} + \sum_{s=1}^{lx_2} \gamma_{2,2,s} x_{2,t-s} + \varepsilon_{2,2,t} \\ \vdots \\ x_{N,t} = \alpha_{2,N} + \sum_{s=1}^{ly_2} \beta_{2,N,s} y_{2,t-s} + \sum_{s=1}^{lx_2} \gamma_{2,N,s} x_{N,t-s} + \varepsilon_{2,N,t} \end{cases} \tag{3}$$

Compared to (1), each equation in (2), and also in (3), has different predetermined variables. The only possible link among individual regressions is contemporaneous correlation within the systems. Therefore, system 2 and 3 must be estimated by (SUR) procedure to take into account contemporaneous correlation within the systems (in presence of contemporaneous

[4]Since per capita real GDP grows exponentially, it is taken in logarithm.

correlation the SUR estimator is more efficient than the OLS one). Following Kònya (2006), we use country specific bootstrap Wald critical values to implement Granger causality[5]. Generating bootstrap Wald critical allows Y and X not to be necessary stationary, they can denote the level, the first difference or some higher difference.

This procedure has several advantages. Firstly, it does not assume that the panel is homogeneous, so it is possible to test for Granger-causality on each individual panel member separately by taking into account the possible contemporaneous correlation across countries. Therefore, for each country, it allows to test the causality relationship between immigration and host economic variables depending on immigration policy. Secondly, this approach which extends the framework by Phillips (1995) by generating country specific bootstrap critical values does not require pretesting for unit roots and cointegration. This is an important feature since unit-root and cointegration tests in general suffer from low power, and different tests often lead to contradictory results. Finally, bootstrapping provides a way to account for the distortions caused by small samples.

To check the robustness of our results, we consider two trivariate specifications. However, our focus will remain on the bivariate, one-period-ahead relationship between migration and unemployment or per capita GDP, so we will not consider the possibility of two variables jointly causing the third one. In the former $System\ 3$: $(Y = U, X = M, Z = LGDP)$, when testing for the causality between migration and unemployment, GDP per capita is treated as an auxiliary variable; whereas in the latter $System\ 4$: $(Y = LGDP, X = M, Z = U)$ when testing for the causality between migration and GDP per capita, unemployment is treated as an auxiliary variable. Therefore, the trivariate specifications allows to test for the causality between migration and unemployment, or GDP per capita by taking into account the correlation between unemployment and economic growth. For the trivariate systems, the corresponding augmented variants of (2) and (3) are

$$\begin{cases} y_{1,t} = \alpha_{1,1} + \sum_{s=1}^{ly_1} \beta_{1,1,s} y_{1,t-s} + \sum_{s=1}^{lx_1} \gamma_{1,1,s} x_{1,t-s} + \sum_{s=1}^{lz_1} \lambda_{1,1,s} z_{1,t-s} + \varepsilon_{1,1,t} \\ y_{2,t} = \alpha_{1,2} + \sum_{s=1}^{ly_1} \beta_{1,2,s} y_{2,t-s} + \sum_{s=1}^{lx_1} \gamma_{1,2,s} x_{2,t-s} + \sum_{s=1}^{lz_1} \lambda_{1,2,s} z_{2,t-s} + \varepsilon_{1,2,t} \\ \vdots \\ y_{N,t} = \alpha_{1,N} + \sum_{s=1}^{ly_1} \beta_{1,N,s} y_{N,t-s} + \sum_{s=1}^{lx_1} \gamma_{1,N,s} x_{N,t-s} + \sum_{s=1}^{lz_1} \lambda_{1,N,s} z_{N,t-s} + \varepsilon_{1,N,t} \end{cases} \tag{4}$$

and

[5]See Appendix for the procedure regarding how bootstrap samples are generated for each country.

$$
\begin{cases}
x_{1,t} = \alpha_{2,1} + \sum_{s=1}^{ly_2} \beta_{2,1,s} y_{1,t-1} + \sum_{s=1}^{lx_2} \gamma_{2,1,s} x_{1,t-s} + \sum_{s=1}^{lz_2} \lambda_{2,1,s} z_{1,t-s} + \varepsilon_{2,1,t} \\
x_{2,t} = \alpha_{2,2} + \sum_{s=1}^{ly_2} \beta_{2,2,s} y_{2,t-1} + \sum_{s=1}^{lx_2} \gamma_{2,2,s} x_{2,t-s} + \sum_{s=1}^{lz_2} \lambda_{2,2,s} z_{2,t-s} + \varepsilon_{2,2,t} \\
\vdots \\
x_{N,t} = \alpha_{2,N} + \sum_{s=1}^{ly_2} \beta_{2,N,s} y_{2,t-1} + \sum_{s=1}^{lx_2} \gamma_{2,N,s} x_{N,t-s} + \sum_{s=1}^{lz_2} \lambda_{2,N,s} z_{N,t-s} + \varepsilon_{2,N,t}
\end{cases}
\tag{5}
$$

4 Data and Econometric investigation

We use annual data over the period 1980 to 2005 for 22 OECD countries[6] which are the major host countries. We use net migration, because, as mentioned by OECD, the main sources of information on migration vary across countries. This may pose problem for the comparability of available data on inflows and outflows. Since the comparability problem is generally caused by short-term movements, as argued by OECD (2009), taking net migration tends to eliminate these movements that are the main source of non-comparability. Besides, compared to data on inflows and outflows, for the countries that we consider, there are long available series on data on net migration. Net migration rate is measured as total annual arrivals less total departures, divided by the total population. Net migration data include immigrants from OECD countries and do not make a distinction between nationals and foreigners. Entries of persons admitted on a temporary basis are not included in this statistic. Only permanent and long-term movements are considered[7]. Real GDP (in 2000 Purchasing Power Parities) per capita is used to measure real income. The unemployment rate is the ratio of the labour force that actively seeks work but is unable to find work. All variables are taken from OECD Databases. Table 1 reports summary statistics of variables. The figures in Table 1 show that, on average, immigration rate increased from 0.92 per thousand during the period 1980-1984 to 4.57 per thousand during the 2000-2005 period. At the same time, GDP per capita increased, whereas it is difficult to point out a decrease or an increase in unemployment rate.

Since the results from the causality test may be sensitive to lag structure, determining optimal lag length(s) is crucial for the robustness of findings. For a relatively large panel, equation- and variable-varying lag structure

[6]The sample includes: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Iceland, Italy, Luxembourg, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, Portugal, United Kingdom and United States.

[7]Unauthorized migrants are not taken into account at the time of arrival. They may be included when they are regularized and obtain a long-term status in the country.

Table 1: Descriptive statistics of 22 OECD countries

Period	Immigration rate (in thousand)	Unemployment rate (in percent)	GDP per capita (2000 PPP)
1980-1984	0.9251	6.81	18589
1985-1989	1.4407	7.22	20946
1990-1994	3.4877	8.17	22868
1995-1999	2.8396	7.95	25460
2000-2005	4.5671	6.05	29288

would lead to an increase in the computational burden substantially. To overcome this problem, following Kònya (2006) we allow maximal lags to differ across variables, but to be the same across equations. We estimate the system for each possible pair of ly_1, lx_1, ly_2, and lx_2 respectively by assuming from 1 to 4 lags and then choose the combinations minimizing the Akaike Information Criterion (AIC). The AIC selects the following lags: in the first bivariate system $ly_1 = 2$, $lx_1 = 1$, $ly_2 = 1$, and $lx_2 = 1$; and in the second one $ly_1 = 2$, $lx_1 = 1$, $ly_2 = 1$ and $lx_2 = 2$. In the first trivariate system, we take $ly_1 = 2$, $lx_1 = 1$, $lz_1 = 1$, $ly_2 = 1$, $lx_2 = 1$ and $lz_2 = 1$; and in the second one $ly_1 = 2$, $lx_1 = 1$, $lz_1 = 1$, $ly_2 = 1$, $lx_2 = 2$ and $lz_2 = 1$.

As mentioned above, testing for the cross-sectional dependence in a panel causality study is crucial for selecting the appropriate estimator. Following Kònya (2006) and Kar et al. (2010), to investigate the existence of cross-sectional dependence we employ three different tests: Lagrange multiplier test statistic of Breusch and Pagan (1980) for cross-sectional dependence and two cross-sectional dependence tests statistic of Pesaran (2004), one based on Lagrange multiplier and the other based on the pair-wise correlation coefficients.

The Lagrange multiplier test statistic for cross-sectional dependence of Breusch and Pagan (1980) is given by:

$$CD_{BP} = T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}^2 \tag{6}$$

where $\hat{\rho}_{ij}$ is the estimated correlation coefficient among the residuals obtained from individual OLS estimations. Under the null hypothesis of no cross-sectional dependence with a fixed N and large T, CD_{BP} asymptotically follows a chi-squared distribution with $N(N-1)/2$ degrees of freedom (Greene (2003), p.350).

Since, BP test has a drawback **(indiquer lequel ?Dramane)** when N is large, Pesaran (2004) proposes another Lagrange multiplier (CD_{LM}) statistic for cross-sectional dependence that does nor suffer from this problem. The CD_{LM} statistic is given as follows:

Table 2: Results for cross-sectional dependence tests

Bivariate system			
Model	CD_{BP}	CD_{LM}	CD
System 1 (U)	450.7726***	10.2246***	83.1740***
	(0.000)	(0.000)	(0.000)
System 1 (M)	280.7111**	2.3128**	35.8008***
	(0.014)	(0.021)	(0.000)
System 2 (LGDP)	709.8659***	22.2789***	131.8569***
	(0.000)	(0.000)	(0.000)
System 2 (M)	308.4733**	3.6044***	12.2688***
	(0.000)	(0.000)	(0.000)

Trivariate system			
Model	CD_{BP}	CD_{LM}	CD
System 3 (U)	449.2574***	10.1543***	89.0142***
	(0.000)	(0.000)	(0.000)
System 3 (M)	308.1410	3.5889	3510
	(0.001)	(0.000)	(0.000)
System 4 (LGDP)	634.9612***	18.7940***	120.2349***
	(0.000)	(0.000)	(0.000)
System 4 (M)	326.7683**	4.4556***	6.1835***
	(0.000)	(0.000)	(0.000)

U, M and $LGDP$ denote unemployment rate, net migration rate and natural logarithm of per capita real GDP, respectively. CD_{BP}, CD_{LM} and CD denote respectively the test statistic of Breusch and Pagan Lagrange multiplier statistic for cross-sectional dependence, Pesaran Lagrange multiplier statistic for cross-sectional dependence, and Pesaran cross-sectional dependence statistic based on the pair-wise correlation coefficients. Under the null hypothesis of no cross-sectional dependence, CD_{BP} follows a chi-square distribution with $N(N-1)/2$ degrees of freedom, CD_{LM} and CD follow standard normal distribution . ***, ** and * indicate rejection of the null hypothesis at 1 and 5 and 10 percent level of significance, respectively.

$$CD_{LM} = \sqrt{\frac{1}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} (T\hat{\rho}_{ij}^2 - 1) \tag{7}$$

Under the null hypothesis of no cross-sectional dependence with the first $T \to \infty$ and then $N \to \infty$, CD_{LM} asymptotically follows a normal distribution. However, this test is likely to exhibit substantial size distortions when N is large relative to T. To tackle this issue, Pesaran (2004) proposes a new test for cross-sectional dependence (CD) that can be used where N is large and T is small. This test is based on the pair-wise correlation coefficients rather than their squares used in the LM test. The CD statistic is given by:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \tag{8}$$

Under the null hypothesis of no cross-sectional dependence with the $T \rightarrow \infty$ and then $N \rightarrow \infty$ in any order, CD asymptotically follows a normal distribution. Pesaran (2004) show that the CD test is likely to have good small sample properties (for both N and T small).

Tables 2 reports the results of these cross-sectional dependence tests. The results in 2 show that, for bivarriate and trivariate systems, all the three tests reject the null of no cross-sectional dependence across the members of the panel at 5% level of significance, implying that the SUR method is appropriate rather than a country-by-country OLS estimation. Cross-sectional dependence tests confirm that strong economic links exist between OECD countries members.

5 Results and Discussion

Tables 3-6 report the results of Granger causality. Notice that the bootstrap critical values are substantially higher than the chi-square critical ones usually applied with the Wald test, and that they vary considerably from a country to another and across tables[8]. This reflects **Christophe propose de supprimer (the stationary property of the series and) Dramane confirmation?** the cross-section dependance.

The results of causality tests from immigration to unemployment and from unemployment to immigration are displayed in Table 3 and Table 4, respectively. The results of causality from immigration to per capita GDP and from GDP per capita to immigration are displayed in Table 5 and Table 6, respectively. In tables 3-6, the column 'estimated coefficient' represents the estimated coefficient of x_{t-1} (y_{t-1}) in the equation testing from Granger causality from X to Y (Y to X). Since, in each case, in testing from Granger causality from X to Y (Y to X), we have only one lag for X (Y), this estimated coefficient represent both the short run and the long impact.

The results in Table 3 show that, in any country, there is no causality from immigration to unemployment. Table 4 shows that, for only Portugal, there is a significant (at the 10% level of significance) negative causality running from unemployment to immigration, whereas for the other countries there is no significant causality running from unemployment to immigration.

The results in Table 5 suggest that, in any country, there is no significant causality running from immigration to GDP. Table 6 shows that in four countries (France, Iceland, Norway and the United Kingdom) there is a

[8]The chi-square critical values for one degree of freedom, i.e. for Wald tests with one restriction, are 6.6349, 3.8415, 2.7055 for 1%, 5% and 10%, respectively.

Table 3: Granger causality tests from immigration to unemployment - bivariate model

Country	Estimated coefficient	Test Stat.	Bootstrap critical values 1%	5%	10%
Australia	0.1938	13.0198	287.7363	138.7766	90.6493
Austria	0.0234	5.6799	286.6355	125.8565	80.5467
Belgium	-0.1245	3.6805	175.4215	77.6084	50.1208
Canada	0.0059	0.0140	274.5667	139.4946	91.9954
Denmark	-0.2288	5.7721	337.5072	140.8359	90.8154
Finland	1.2062	52.9716	316.3091	150.2173	96.7384
France	-0.0292	0.0222	173.9483	81.8138	52.8704
Germany	0.0173	1.9601	295.8401	139.7354	93.7130
Greece	0.0821	9.0246	230.2833	109.3694	72.4079
Iceland	0.0610	15.7417	286.9114	132.6577	86.1520
Ireland	-0.1138	23.1385	342.9583	154.8923	103.2070
Italy	-0.0583	11.3306	207.7941	85.4204	54.6998
Luxembourg	0.0072	2.4710	331.8680	159.0345	106.0899
Netherlands	0.1967	11.7020	230.3935	99.0387	62.2805
New Zealand	-0.0130	0.4398	248.4385	112.1155	75.7471
Norway	0.2627	58.7593	303.4181	134.9851	85.3963
Portugal	0.0218	0.6693	156.7490	75.7666	49.2947
Spain	-0.2794	57.3525	241.2615	110.0584	72.6988
Sweden	0.0373	1.2791	404.1338	196.2905	125.7544
Switzerland	0.0767	35.3416	296.1276	143.5848	92.3061
United Kingdom	-0.1357	3.8144	263.5924	119.9834	77.9560
United States	-0.1908	7.7114	284.1708	132.2164	83.6499

Note: H_0 : immigration does not cause unemployment. The column "Estimated coefficient" denotes the estimated coefficient of the lag of immigration rate in the equation testing for Granger causality from immigration to unemployment rate. Column "Test Stat." represents the Wald test statistic for Granger causality from immigration to unemployment rate. ***, **, and * indicate the rejection of the null hypothesis at the 1, 5, and 10 percent levels of significance, respectively.

Table 4: Granger causality tests from unemployment to immigration - bivariate model

Country	Estimated coefficient	Test Stat.	Bootstrap critical values 1%	5%	10%
Australia	-0.3315	8.2290	306.8964	143.4189	93.5239
Austria	0.0892	0.0347	326.9468	141.4868	90.3277
Belgium	-0.0858	13.4350	206.6685	90.3308	58.6337
Canada	-0.2170	6.5177	292.1500	125.6811	80.9669
Denmark	0.1012	4.8414	350.6973	150.9016	100.5670
Finland	-0.0378	9.5450	273.6004	130.8957	85.1077
France	-0.0540	16.1243	290.4957	147.3383	99.4058
Germany	-0.0490	0.1187	294.3776	144.2217	95.1106
Greece	-0.0161	0.0375	341.1858	171.5095	111.4617
Iceland	-0.2756	1.1717	218.2504	100.4272	64.8144
Ireland	-0.3785	5.1142	244.2332	107.9090	69.3826
Italy	-0.1845	1.7309	369.5746	169.3226	113.8005
Luxembourg	1.4298	5.7080	207.6518	99.2973	64.7285
Netherlands	0.1746	16.5221	236.9243	124.0193	81.6781
New Zealand	0.2662	1.7910	290.4320	134.6834	85.8611
Norway	0.0597	0.3610	264.9229	119.5181	74.3819
Portugal	-0.6033	122.3191*	334.0911	146.9617	97.5169
Spain	-0.1282	6.1913	132.1068	59.5167	38.1426
Sweden	-0.0153	0.1089	232.5700	108.9333	69.3073
Switzerland	-0.5030	14.4276	241.6980	116.7093	76.3445
United Kingdom	-0.0364	0.6224	221.8538	102.3553	66.4853
United States	-0.0649	4.0023	314.9698	153.4151	100.2002

Note: H_0 : unemployment does not cause immigration. Column "Estimated coefficient" denotes the estimated coefficient of the lag of unemployment rate in the equation testing for Granger causality from unemployment to immigration. Column "Test Stat." represents the Wald test statistic for Granger causality from unemployment to immigration. ***, **, and * indicate the rejection of the null hypothesis at the 1, 5, and 10 percent levels of significance, respectively.

Table 5: Granger causality tests from immigration to per capita GDP - bivariate model

Country	Estimated coefficient	Test Stat.	Bootstrap critical values 1%	5%	10%
Australia	-0.0062	145.2363	642.1363	300.2588	184.0594
Austria	-0.0014	20.1850	509.7105	216.5362	133.1134
Belgium	-0.0030	18.2444	681.2106	284.3846	186.9683
Canada	-0.0071	107.2464	908.8519	393.7506	258.2969
Denmark	-0.0000	0.0018	651.5292	255.4873	155.2668
Finland	-0.0223	136.2913	603.1720	268.2465	169.2409
France	-0.0207	103.0732	585.3197	304.6188	206.4012
Germany	0.0004	7.8763	558.5621	269.2568	182.6525
Greece	-0.0007	0.6512	185.0076	83.9402	53.1138
Iceland	-0.0041	25.0658	528.0840	232.1546	141.7218
Ireland	-0.0016	23.6291	531.9374	223.8201	144.6197
Italy	-0.0004	1.1934	524.0714	244.2464	159.6062
Luxembourg	0.0001	0.0160	475.9581	197.6779	119.3652
Netherlands	-0.0028	24.4681	609.2427	270.3311	176.1551
New Zealand	-0.0005	1.9322	528.0105	229.6578	144.5666
Norway	-0.0036	38.4940	883.3209	343.9916	215.0718
Portugal	-0.0010	1.0132	472.0737	216.6576	137.7028
Spain	-0.0000	0.0004	517.1960	249.8073	168.2989
Sweden	-0.0021	7.7808	704.4112	310.1129	197.6469
Switzerland	-0.0026	28.3606	491.3078	230.0392	150.7396
United Kingdom	-0.0039	24.8869	770.9085	344.2256	229.1871
United States	-0.0016	1.4538	638.4730	305.0717	199.0662

Note: H_0 : immigration does not cause per capita GDP. Column "Estimated coefficient" denotes the estimated coefficient of the lag of immigration rate in the equation testing for Granger causality from immigration rate to log (per capita GDP). Column "Test Stat." represents the Wald test statistic for Granger causality from immigration rate to log(per capita GDP). ***, **, and * indicate the rejection of the null hypothesis at the 1, 5, and 10 percent levels of significance, respectively.

Table 6: Granger causality tests from GDP per capita to immigration - bivariate model

Country	Estimated coefficient	Test Stat.	Bootstrap critical values 1%	5%	10%
Australia	0.5966	0.2133	44.1132	21.2758	14.2802
Austria	4.1763	3.0485	69.4796	31.4398	19.9934
Belgium	2.2344	7.9633	165.3051	81.3064	53.7078
Canada	4.7688	16.5011	67.4497	31.3532	20.3437
Denmark	0.9893	0.5960	64.1267	29.2654	19.2426
Finland	0.7857	4.5312	96.3905	45.0952	28.9216
France	0.3803	14.5200*	38.4159	19.2248	12.9537
Germany	-1.9891	0.5180	103.0069	50.1292	32.2102
Greece	-1.6919	1.8655	190.9693	90.9634	60.1493
Iceland	19.4588	72.6350**	78.6381	34.7857	21.7824
Ireland	12.0384	37.9026	229.9758	104.5681	68.5805
Italy	5.5991	7.6469	42.8646	21.7309	14.0878
Luxembourg	2.1905	1.8097	77.9690	36.2650	22.8619
Netherlands	-1.3450	2.8127	57.4609	25.3127	16.4470
New Zealand	14.6758	8.0079	70.7573	32.1478	20.4502
Norway	4.9385	43.0513***	42.8830	21.1842	13.4986
Portugal	3.2272	19.6184	175.9970	80.2091	51.6689
Spain	4.7815	13.5030	243.5550	128.0488	89.6999
Sweden	1.4345	0.9856	66.7698	29.7692	19.2975
Switzerland	3.9219	1.3726	93.4584	43.4481	27.4950
United Kingdom	3.9982	34.5706**	66.1783	29.5176	18.6249
United States	0.3443	0.4280	93.8299	42.5891	27.7797

Note: H_0 : per capita GDP does not cause immigration. Column "Estimated coefficient" denotes the estimated coefficient of the lag of log (per capita GDP) in the equation testing for Granger causality from log(per capita GDP) to immigration rate. Column "Test Stat." represents the Wald test statistic for Granger causality from log(per capita GDP) to immigration rate. ***, **, and * indicate the rejection of the null hypothesis at the 1, 5, and 10 percent levels of significance, respectively.

positive significant causality running from GDP to immigration; while in the other countries there is no significant causality running from GDP to immigration. There is a positive causality running from GDP to immigration at 1 percent level of significance for Norway, 5 percent level of significance for Iceland and the United Kingdom Norway and 10 percent level of significance for France.

Table 7: Granger causality tests from immigration to unemployment - trivariate model

Country	Estimated coefficient	Test Stat.	Bootstrap critical values 1%	5%	10%
Australia	-0.0236	0.2616	334.7989	149.5224	96.9316
Austria	0.0000	0.0000	217.9372	95.8341	67.7080
Belgium	0.2315	7.8663	239.4201	127.4790	88.2908
Canada	0.0332	1.6553	301.0002	151.0504	94.8809
Denmark	-0.1222	2.1206	245.3595	118.8353	81.0714
Finland	1.1832	60.0880	281.9510	159.2575	95.2094
France	0.4630	2.9252	209.0307	98.4185	70.4652
Germany	-0.0683	21.2939	239.9914	124.7901	84.8816
Greece	0.0730	6.5802	221.2246	99.5950	67.9572
Iceland	0.0601	18.4297	173.9361	79.5713	52.5650
Ireland	-0.0140	0.1830	340.5097	174.8992	122.6541
Italy	-0.0338	1.7075	269.7529	118.0978	68.6167
Luxembourg	-0.0109	7.2257	323.5371	141.3815	98.4819
Netherlands	-0.1284	3.6164	234.9126	129.9640	83.6289
New Zealand	0.0025	0.0227	216.0790	100.3512	67.0414
Norway	0.2228	27.7386	198.0062	104.7487	65.6404
Portugal	0.1705	38.8816	178.8365	88.6373	54.7418
Spain	-0.3758	40.2969	355.6600	159.9856	107.8534
Sweden	-0.0597	5.3803	271.3265	148.3409	101.0271
Switzerland	0.0461	6.9727	284.6761	166.0940	113.5712
United Kingdom	0.1884	13.7985	299.0586	177.7895	124.2034
United States	-0.1235	4.0838	185.7634	94.4119	60.1460

Note: H_0 : immigration does not cause unemployment. The column "Estimated coefficient" denotes the estimated coefficient of lag of immigration rate in the equation testing for Granger causality from immigration to unemployment rate. Column "Test Stat." represents the Wald test statistic for Granger causality from immigration to unemployment rate. ***, **, and * indicate the rejection of the null hypothesis at the 1, 5, and 10 percent levels of significance, respectively.

Table 8: Granger causality tests from unemployment to immigration - trivariate model

Country	Estimated coefficient	Test Stat.	Bootstrap critical values 1%	5%	10%
Australia	-0.3544	7.4992	279.1272	112.9311	72.3312
Austria	-1.1704	4.7155	298.8886	129.4893	84.5797
Belgium	-0.0346	1.4860	242.8462	119.6951	89.1278
Canada	-0.0754	0.4910	188.0826	91.5665	61.4262
Denmark	0.2585	32.4278	188.2056	118.6136	80.7883
Finland	-0.0561	22.5583	138.6604	72.7321	51.4282
France	-0.1242	64.9696	300.9184	155.5800	99.3673
Germany	0.4609	4.6375	203.8046	109.3860	76.4460
Greece	0.2199	4.5983	185.7841	97.2281	64.1550
Iceland	-0.9214	13.8203	107.5253	60.1570	38.9982
Ireland	-0.1921	2.1211	224.5771	110.0444	64.4107
Italy	-0.8811	41.1152	243.3718	132.7531	89.5198
Luxembourg	1.1127	2.3414	177.9395	106.4410	71.6757
Netherlands	0.6740	63.0093	189.7809	105.0316	75.0042
New Zealand	0.5082	6.5117	191.1896	91.0532	61.8064
Norway	-0.2136	6.7821	159.1635	85.6986	56.1403
Portugal	-0.3488	19.2426*	258.8398	107.6579	13.2983
Spain	-0.3087	38.6889	249.8439	126.8201	82.2173
Sweden	-0.0442	0.6697	128.9744	75.5884	52.1674
Switzerland	-1.1771	82.4006	175.6078	102.6137	94.8856
United Kingdom	0.0972	2.6250	205.7940	100.9149	66.4243
United States	-0.1923	14.9663	227.6817	118.0697	76.5009

Note: H_0 : unemployment does not cause immigration. Column "Estimated coefficient" denotes the estimated coefficient of the lag of unemployment rate in the equation testing for Granger causality from unemployment to immigration. Column "Test Stat." represents the Wald test statistic for Granger causality from unemployment to immigration. ***, **, and * indicate the rejection of the null hypothesis at the 1, 5, and 10 percent levels of significance, respectively.

Table 9: Granger causality tests from immigration to GDP per capita - trivariate model

Country	Estimated coefficient	Test Stat.	Bootstrap critical values 1%	5%	10%
Australia	-0.0019	2.7210	263.0225	145.8187	95.8702
Austria	-0.0016	52.1135	176.8970	98.1363	70.2374
Belgium	-0.0013	1.4123	201.3232	113.9322	80.0250
Canada	-0.0036	49.2108	426.2160	207.6525	143.1817
Denmark	-0.0005	0.3593	236.7658	103.3482	69.9353
Finland	-0.0151	148.9112	354.1961	250.0251	165.7849
France	-0.0104	21.8196	217.7683	125.9724	84.1495
Germany	0.0018	109.6546	359.8191	196.2351	117.6784
Greece	-0.0022	12.2776	84.4463	43.1847	30.1339
Iceland	-0.0037	55.9620	258.6184	108.5395	71.9754
Ireland	0.0004	0.2885	314.5068	123.1126	84.9670
Italy	0.0020	22.0193	247.4185	125.6980	78.8425
Luxembourg	0.0004	0.2612	271.3135	102.4394	66.6438
Netherlands	0.0002	0.0469	302.4367	138.8919	97.4181
New Zealand	-0.0012	7.2373	212.6498	97.5138	63.3307
Norway	-0.0007	0.8258	248.7915	131.7521	83.3682
Portugal	-0.0026	4.8777	252.3874	136.2109	89.8816
Spain	0.0022	51.7245	360.7482	177.4140	113.8133
Sweden	-0.0005	0.3652	331.6734	166.9935	113.4156
Switzerland	-0.0021	38.1448	203.7382	104.0096	72.0211
United Kingdom	-0.0032	14.1634	390.5799	165.6081	106.3365
United States	0.0038	5.1356	223.9490	123.8660	73.3980

Note: H_0 : immigration does not cause per capita GDP. Column "Estimated coefficient" denotes the estimated coefficient of the lag of immigration rate in the equation testing for Granger causality from immigration rate to log(per capita GDP). Column "Test Stat." represents the Wald test statistic for Granger causality from immigration rate to log(per capita GDP). ***, **, and * indicate the rejection of the null hypothesis at the 1, 5, and 10 percent levels of significance, respectively.

Table 10: Granger causality tests from GDP per capita to immigration - trivariate model

Country	Estimated coefficient	Test Stat.	Bootstrap critical values 1%	5%	10%
Australia	-0.1911	0.0193	33.1207	15.8983	10.5450
Austria	4.7758	3.2613	57.7751	24.6857	17.7721
Belgium	1.9504	4.6028	132.3694	54.3006	35.0875
Canada	5.1178	14.6852	41.5492	20.1348	14.7413
Denmark	3.4962	5.0764	59.8428	33.2786	21.2082
Finland	1.0496	6.4777	52.4382	27.2489	16.6740
France	0.5871	33.3279**	50.1890	20.1720	12.6587
Germany	2.5736	0.5161	74.3589	36.0617	23.8127
Greece	1.1091	0.6373	163.6991	73.3959	49.7018
Iceland	24.8554	95.9432***	36.1925	19.7481	13.4029
Ireland	10.8065	29.0963	75.1909	35.3527	29.7500
Italy	13.9791	100.5827	349.7739	220.4192	115.0919
Luxembourg	3.7774	2.9931	63.2546	33.8113	20.9812
Netherlands	4.3278	3.2520	84.4697	43.4926	29.1752
New Zealand	15.9942	11.6162	38.2584	19.3498	12.3952
Norway	5.6071	59.6025***	31.2682	16.1885	10.7985
Portugal	0.1791	0.0395	104.1727	42.8774	27.2084
Spain	7.5361	31.3371	237.2832	96.6455	65.7927
Sweden	2.0523	1.8519	58.4588	25.7216	17.3191
Switzerland	29.7581	158.6569	397.1388	249.7637	162.9928
United Kingdom	3.3460	8.5492*	28.8443	8.8169	4.8859
United States	-0.8556	1.3413	76.4092	32.2444	19.1393

Note: H_0 : GDP does not cause immigration. Column "Estimated coefficient" denotes the estimated coefficient of the lag of log (per capita GDP) in the equation testing for Granger causality from log(per capita GDP) to immigration rate. Column "Test Stat." represents the Wald test statistic for Granger causality from log(per capita GDP) to immigration rate. ***, **, and * indicate the rejection of the null hypothesis at the 1, 5, and 10 percent levels of significance, respectively.

To check the robustness of our findings, Tables 7-10 report the results using a trivariate specification. In the trivariate specifications, the focus will remain on the bivariate, one-period-ahead relationship between migration and and unemployment or GDP per capita, so we will not study the possibility of two variables jointly causing the third one. The results in Tables 7-10 corroborate the findings from the bivariate specifications (except for the significance level in some cases).

Our finding that immigration does not impact host economic variables supports the results from some previous studies (Simon et al., 1993; Dolado et al., 1994; Marr and Siklos, 1994; Pischke and Velling, 1997; Dustmann et al., 2005 Ortega and Peri, 2009).

The result that immigration does not impact host GDP per capita can be explained by the human capital content of migration inflow (Dolado et al., 1994). On the one hand, due to reduction in the capital/labour ratio in the host economy, increase in immigration (population) would leads to a decrease in output per capita. On the other hand, the more migrants are educated, the more immigration has a positive effect on the economic growth of the host country. If immigrants have little human capital, the negative impact caused by the reduction in the capital/labour ratio will dominate. If immigrant human capital levels are higher than natives' by a sufficient amount, immigration will increase output per capita. Therefore, our results suggest that, the human capital content of the migration inflow is high in order to compensate the negative effect caused by reduction in the capital/labour ratio. As a result there will be no negative impact of immigration on growth and employment.

The result that immigration does not cause resident unemployment can be explained as follows. According to theoretical models, the effects of immigration on wages and employment of host country residents, depend on the extent to which migrants are substitutes or complements to those of existing workers (Borjas, 1995). If migrants and residents are substitutes, immigration will decrease wages by increasing competition in the labour market. The extent to which declining wages increases unemployment or inactivity among host country residents depends on the willingness of existing workers to accept lower wages. If, on the other hand, migrants are complementary to host country residents, the arrival of new immigrants may increase resident productivity and then raise their wages and their employment opportunities. Thus, our finding that immigration does not cause resident unemployment reflects the fact there may be a coexistence of substitutability and complementarity between migrants and residents. As mentioned by Orrenius and Zavodny (2007), the degree of substitution between immigrants and natives is likely to vary across skill levels and over time. In fact, substitution can occur in industries with less skilled workers because employees are more interchangeable and training costs are lower than in industries with skilled workers. Moreover, the differences in the quality and relevance of education and experience acquired abroad make skilled immigrants less substitutable for skilled natives.

For some countries, the particular findings of causality from immigration to host economic variables can be related to their immigration policies. In the case of Portugal, the negative influence of unemployment on immigration can be explained by the fact that the needs of Portuguese employers play a significant role in the recruitment process of the newly arrived immigrants. Moreover, both Portuguese nationals and foreigners are more likely to immigrate to a third European country when the labour market situation is less favorable in Portugal.

In France, family component is the main channel of entry for long-term immigrants. The positive influence of the economic growth on migration flows may be related to family reunification requirements. In order to bring their families, immigrants have to satisfy a minimum level of income. During a period of higher growth, immigrants have great possibility to satisfy this minimum level of income criteria. Moreover, economic migration to France mainly includes immigrants from European countries (such as Portugal) that are attracted by better economic prospects.

Norway and Iceland are two small countries with high incomes and high demand for labour. So, the main attraction for immigrants to these two countries is the high standard of living. A large percentage of labour immigration is from Nordic neighbours and OECD countries. The booming economy and the increased demand of labour in Norway and Iceland led authorities to allow the entry of labour migrants over the last years.

Finally, the explanation of the result for the United-Kingdom is as follows. Immigrants to the United Kingdom are more attracted by the prospect of higher wages produced by the greater economic growth. In the United Kingdom, labour migration represents a sizable percentage of total inflows (44 percent in 2005)[9]. If family members accompanying workers are taken into account, the percentage of economic migration is around 60 percent in 2005. The inflow of labour migration increased from 124 thousands on average per year in the 1980s to 200 thousands in the 1990s. From 2000 to 2005, labour migration inflows reached 333 thousand per year on average.

6 Concluding Remarks

This paper has examined the causality between immigration and the economic conditions of host countries (unemployment and growth). We have employed the panel Granger causality testing approach recently developed

[9] The work category combines two reasons for migration in the International Passenger Survey: "definite job" and "looking for work". Authors' calculation is based on Office for National Statistics (2008); Office for National Statistics (2009).

by Kònya (2006) that is based on SUR systems and Wald tests with country specific bootstrap critical values. We have used annual data over the 1980-2005 period for 22 OECD countries which are the major host countries.

Our study has provided evidence that immigration does not cause host economic conditions (unemployment and income per capita) and the influence of host economic conditions on immigration depends on the host country. Indeed, on the one hand, our finding suggests that, only in Portugal, unemployment negatively Granger causes immigration inflow, while in any country, immigration inflow does not Granger cause unemployment. On the other hand, our results indicate that, in four countries (France, Iceland, Norway and United Kingdom), economic growth positively Granger causes immigration inflow, whereas in any country, immigration inflow does not Granger cause economic growth. This heterogeneity in the influence of host economic conditions on immigration can be related to the characteristics of host country immigration policies.

In order to tackle the problem of ageing population, many OECD countries see immigration as a potential solution to compensate for labour shortage. Our results have revealed that immigration flows do not harm the employment prospects of residents.

Appendix

A-1 The bootstrap procedure

The procedure to generate bootstrap samples and country specific critical values (in the test of no causality from X to Y) consists of the following five steps (Kònya, 2006)

1st step: Implement an estimation of (2) under the null hypothesis of no-causality from X to Y by (i.e. imposing $\gamma_{1,i,s} = 0$ the for all i and s) and get the corresponding residuals:

$$e_{H_0,i,t} = y_{i,t} - \hat{\alpha}_{i,1} + \sum_{s=1}^{ly_1} \hat{\beta}_{1,i,s} y_{i,t-s}$$

From these residuals, build the $N \times T$ $[e_{H_0,i,t}]$ matrix.

2nd step: In order to preserve the contemporaneous dependence between error terms in (2), randomly select a full column from $[e_{H_0,i,t}]$ matrix at a time (i.e do not draw the residuals for each country one-by-one); and denote the selected bootstrap residuals as $\left[e^*_{H_0,i,t}\right]$ where $t = 1, ..., T^*$ and T^* can be greater than T.

3rd step: Build the bootstrap sample of Y under the hypothesis of no-causality from X to Y, i.e. using the following formula:

$$y^*_{i,t} = \hat{\alpha}_{i,1} + \sum_{s=1}^{ly_1} \hat{\beta}_{1,i,s} y^*_{i,t-s} + e^*_{H_0,i,t}$$

4th step: Replace $y_{i,t}$ by $y^*_{i,t}$, estimate (2) without any parameter restrictions and then implement the Wald test for each country to test for the no-causality null hypothesis.

5th step: Develop the empirical distributions of the Wald test statistics by repeating (10,000 replications) the steps 2-4 many times and build the bootstrap critical values.

A-2 Test for serial correlation in residual

Since each system (2) and (3) is estimated separately by accounting for contemporaneous correlated within the system(Kònya, 2006), for each system we implement separately a panel test for serial correlation (for each country error is assumed to be a white noise).

We employ a test for serial correlation in residual based on the approach proposed by Wooldridge (2002), p. 282-283. Let $\varepsilon_{i,t}$ be the residuals that are assumed to be white noises (i.e. with zero means, constant variances and are individually serially uncorrelated) and contemporaneous correlated across countries: $var(\varepsilon_{i,t}) = \sigma_i^2$, $cov(\varepsilon_{i,t}, \varepsilon_{i,s}) = 0 \ for \ t \neq s$, $cov(\varepsilon_{i,t}, \varepsilon_{j,t}) = \sigma_{ij}^2, \ for \ i \neq j$.
Let consider the errors $u_{it} = \Delta\varepsilon_{i,t}$. Under the assumptions on $\varepsilon_{i,t}$,

$$Corr(u_{it}, u_{i,t-1}) = \frac{cov(u_{i,t}, u_{i,t-1})}{\sqrt{var(u_{i,t})var(u_{i,t-1})}} = \frac{-\sigma_i^2}{\sqrt{(2\sigma_i^2)(2\sigma_i^2)}} = -0.5$$

To test for serial correlation in $\varepsilon_{i,t}$, Wooldridge (2002) propose to test $\rho = Corr(u_{it}, u_{i,t-1}) = -0.5$ in the following regression of $u_{i,t}$ on $u_{i,t-1}$

$$u_{i,t} = \rho u_{i,t-1} + \eta_{i,t}$$

The errors $\eta_{i,t}$ are heteroskedastic (because $var(\varepsilon_{i,t}) = \sigma_i^2$), and contrary to Wooldridge (2002), in our case, the errors $\eta_{i,t}$ are cross-sectional correlated (because $cov(\varepsilon_{i,t}, \varepsilon_{j,t}) \neq 0$). Then, we implement the regression of $u_{i,t}$ on $u_{i,t-1}$ using Feasible Generalized Least Squares (FGLS) estimation that allows for heteroskedastic error structure with cross-sectional correlation. To test for $\rho = -0.5$, we use the Wald test statistic that follows, under the null hypothesis, a chi-squared distribution with 1 degree of freedom.

The results of serial correlation test are reported in Table A-1.

Table A-1: Test for serial correlation in residual

Bivariate system		
System	Lag Length	Test Statistic
$(Y = U, X = M)$	$(ly_1, lx_1) = (2, 1)$	0.22(0.639)
	$(ly_2, lx_2) = (1, 1)$	0.38(0.536)
$(Y = LGDP, X = M)$	$(ly_1, lx_1) = (2, 1)$	0.40(0.529)
	$(ly_2, lx_2) = (1, 2)$	0.43(0.511)
Trivariate system		
System	Lag Length	Test Statistic
$(Y = U, X = M, Z = LGDP)$	$(ly_1, lx_1, lz_1) = (2, 1, 1)$	0.03(0.868)
	$(ly_2, lx_2, lz_2) = (1, 2, 1)$	0.93(0.334)
$(Y = LGDP, X = M, Z = U)$	$(ly_1, lx_1, lz_1) = (2, 1, 1)$	0.00(0.962)
	$(ly_2, lx_2, lz_2) = (1, 2, 1)$	0.55(0.459)

U, M and $LGDP$ denote unemployment rate, net migration rate and natural logarithm of per capita real GDP, respectively. The lag length are selected by Akaike Information Criterion and Schwarz Bayesian Criterion. The test for serial correlation is based on the approach proposed by Wooldridge (2002). H_0: no first-order autocorrelation. The test statistic is the Wald test statistic that follows, under the null hypothesis, a chi-squared distribution with 1 degree of freedom. P-values are in parentheses.

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