



HAL
open science

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

Ekrame Boubtane, Dramane Coulibaly, Christophe Rault

► **To cite this version:**

Ekrame Boubtane, Dramane Coulibaly, Christophe Rault. Immigration, unemployment and GDP in the host country: Bootstrap panel Granger causality analysis on OECD countries. 2013, 31 p. halshs-00800970

HAL Id: halshs-00800970

<https://shs.hal.science/halshs-00800970>

Submitted on 14 Mar 2013

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Documents de Travail du Centre d'Économie de la Sorbonne

C
E
S
W
o
r
k
i
n
g
P
a
p
e
r
s



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

Ekrame BOUBTANE, Dramane COULIBALY, Christophe RAULT

2013.14



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

Ekrame Boubtane

CES-University Paris 1 and CERDI-University of Auvergne

Dramane Coulibaly

EconomiX-CNRS, University of Paris Ouest

Christophe Rault

LEO - University of Orléans and Toulouse Business School, France

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.

*We are very grateful to two anonymous referees for their useful comments and suggestions. This paper was written while the second author was researcher at CEPII. The authors wish to thank Agnès Benassy-Quéré, Agnès Chevallier, Gunther Capelle-Blancard, Christophe Destais, Lionel Fontagné and Lionel Ragot for their many helpful comments on a previous version of this paper. The usual disclaimer applies.

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.

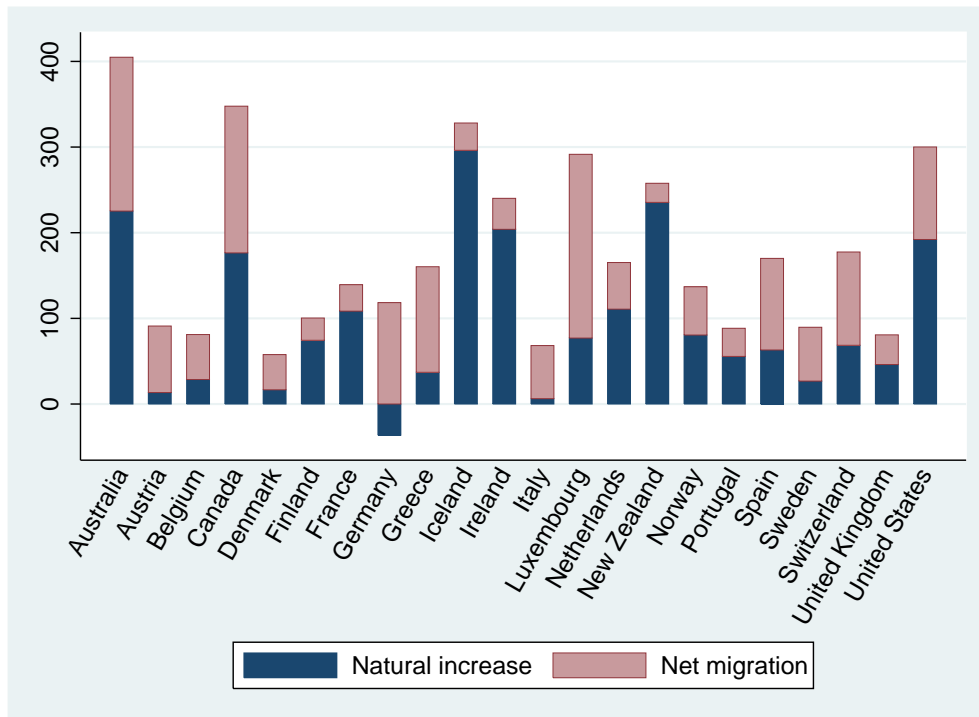


Figure 1: Components of population change, 1980-2005 (Variables are expressed per 1,000 population). Temporary immigration flows are excluded. Source: Authors' calculation, Labour Force Statistics, OECD (2010)

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 outcomes¹ and also how economic

¹See 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 Kõnya (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 Boatlift² 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

²In 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 Konya (2006) that is based on SUR systems and Wald tests with country specific bootstrap critical values. Firstly, since country spe-

cific 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 dependence³. 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:

$$\begin{cases} y_{i,t} = \alpha_{1,i} + \sum_{s=1}^{ly_1} \beta_{1,i,s} y_{i,t-s} + \sum_{s=1}^{lx_1} \gamma_{1,i,s} x_{i,t-s} + \varepsilon_{1,i,t} \\ x_{i,t} = \alpha_{2,i} + \sum_{s=1}^{ly_2} \beta_{2,i,s} y_{i,t-s} + \sum_{s=1}^{lx_2} \gamma_{2,i,s} x_{i,t-s} + \varepsilon_{2,i,t} \end{cases} \quad (1)$$

where the index i ($i = 1, \dots, N$) denotes the country, the index t ($t = 1, \dots, T$) 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.

³Moreover, 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:

$$\left\{ \begin{array}{l} y_{1,t} = \alpha_{1,1} + \sum_{s=1}^{ly_1} \beta_{1,1,s} y_{1,t-s} + \sum_{s=1}^{lx_1} \gamma_{1,1,s} x_{1,t-s} + \varepsilon_{1,1,t} \\ y_{2,t} = \alpha_{1,2} + \sum_{s=1}^{ly_1} \beta_{1,2,s} y_{2,t-s} + \sum_{s=1}^{lx_1} \gamma_{1,2,s} x_{2,t-s} + \varepsilon_{1,2,t} \\ \vdots \\ y_{N,t} = \alpha_{1,N} + \sum_{s=1}^{ly_1} \beta_{1,N,s} y_{N,t-s} + \sum_{s=1}^{lx_1} \gamma_{1,N,s} x_{N,t-s} + \varepsilon_{1,N,t} \end{array} \right. \quad (2)$$

and

$$\left\{ \begin{array}{l} x_{1,t} = \alpha_{2,1} + \sum_{s=1}^{ly_2} \beta_{2,1,s} y_{1,t-s} + \sum_{s=1}^{lx_2} \gamma_{2,1,s} x_{1,t-s} + \varepsilon_{2,1,t} \\ x_{2,t} = \alpha_{2,2} + \sum_{s=1}^{ly_2} \beta_{2,2,s} y_{2,t-s} + \sum_{s=1}^{lx_2} \gamma_{2,2,s} x_{2,t-s} + \varepsilon_{2,2,t} \\ \vdots \\ x_{N,t} = \alpha_{2,N} + \sum_{s=1}^{ly_2} \beta_{2,N,s} y_{N,t-s} + \sum_{s=1}^{lx_2} \gamma_{2,N,s} x_{N,t-s} + \varepsilon_{2,N,t} \end{array} \right. \quad (3)$$

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

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

correlation the SUR estimator is more efficient than the OLS one). Following Konya (2006), we use country specific bootstrap Wald critical values to implement Granger causality⁵. 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

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

and

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

$$\left\{ \begin{array}{l} x_{1,t} = \alpha_{2,1} + \sum_{s=1}^{ly_2} \beta_{2,1,s} y_{1,t-s} + \sum_{s=1}^{lx_2} \gamma_{2,1,s} x_{1,t-s} + \sum_{s=1}^{lz_2} \lambda_{2,1,s} z_{1,t-s} + \varepsilon_{2,1,t} \\ x_{2,t} = \alpha_{2,2} + \sum_{s=1}^{ly_2} \beta_{2,2,s} y_{2,t-s} + \sum_{s=1}^{lx_2} \gamma_{2,2,s} x_{2,t-s} + \sum_{s=1}^{lz_2} \lambda_{2,2,s} z_{2,t-s} + \varepsilon_{2,2,t} \\ \vdots \\ x_{N,t} = \alpha_{2,N} + \sum_{s=1}^{ly_2} \beta_{2,N,s} y_{N,t-s} + \sum_{s=1}^{lx_2} \gamma_{2,N,s} x_{N,t-s} + \sum_{s=1}^{lz_2} \lambda_{2,N,s} z_{N,t-s} + \varepsilon_{2,N,t} \end{array} \right. \quad (5)$$

4 Data and Econometric investigation

We use annual data over the period 1980 to 2005 for 22 OECD countries⁶ 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 considered⁷. 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

⁶The 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.

⁷Unauthorized 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:

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

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 not 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*** (0.000) | 10.2246*** (0.000) | 83.1740*** (0.000) |
| System 1 (M) | 280.7111** (0.014) | 2.3128** (0.021) | 35.8008*** (0.000) |
| System 2 (LGDP) | 709.8659*** (0.000) | 22.2789*** (0.000) | 131.8569*** (0.000) |
| System 2 (M) | 308.4733** (0.000) | 3.6044*** (0.000) | 12.2688*** (0.000) |
| Trivariate system | | | |
| Model | CD_{BP} | CD_{LM} | CD |
| System 3 (U) | 449.2574*** (0.000) | 10.1543*** (0.000) | 89.0142*** (0.000) |
| System 3 (M) | 308.1410 (0.001) | 3.5889 (0.000) | 3510 (0.000) |
| System 4 (LGDP) | 634.9612*** (0.000) | 18.7940*** (0.000) | 120.2349*** (0.000) |
| System 4 (M) | 326.7683** (0.000) | 4.4556*** (0.000) | 6.1835*** (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.

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

Under the null hypothesis of no cross-sectional dependence with the first $T \rightarrow \infty$ and then $N \rightarrow \infty$, 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:

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

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 bivariate 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 tables⁸. This reflects **Christophe propose de supprimer (the stationary property of the series and) Dramane confirmation?** the cross-section dependence.

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

⁸The 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 - bi-variate 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 - bi-variate 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 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 lead 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

⁹The 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 $[e_{H_0,i,t}^*]$ where $t = 1, \dots, T^*$ 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 $\varepsilon_{i,t}$,

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

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.

References

- Angrist, J.D. and Kugler, A.D. (2003). Protective or counter-productive? Labour market institutions and the effect of immigration on EU natives? *Economic Journal*, 113(488), 302-331.
- Auerbach A. and Oreopoulos P. (1999). Analyzing the Fiscal Impact of U.S. Immigration. *The American Economic Review*, 89(2), 176-180.
- Barro, R. and Sala-i-Martin, X. (1995). Economic Growth. *McGraw-Hill*. New York
- Breusch, T., Pagan, A. (1980). The LM test and its applications to model specification in econometrics. *Review of Economic Studies*, 47, 239-254.
- Borjas, G. (1987). Immigrants, minorities, and labor market competition. *Industrial and Labor Relations Review*, 40(3), 382-92.
- Borjas, G. (1995). The economic benefits from immigration. *Journal of Economic Perspectives*, 9(2), 3-22.
- Borjas G. (2001). Does immigration grease the wheels of the labor market? *Brookings Papers on Economic Activity*, 1, 69-134.
- Card, D. (1990) The impact of the Mariel boatlift on the Miami labor market. *Industrial and Labor Relations Review*, 43(2), 245-257.
- Card, D. (2001) Immigrant inflows, native outflows and the local labor market impacts of higher immigration. *Journal of Labor Economics*, 19(1), 22-64.
- Dolado, J., Goria, A. and Ichino, A. (1994). Immigration, human capital and growth in the host country: evidence from pooled country Data. *Journal of Population Economics*, 7(2), 193-215.
- Dustmann, C., F. Fabbri and I. Preston. (2005). The Impact of Immigration on the British Labour Market. *The Economic Journal*, 115(507), 324-341.
- Greene, W.H., (2003). Econometric Analysis. 2nd ed. *Prentice-Hall*.
- Greenwood, M.J and Hunt G.L (1995). Economic effects of immigrants on native and foreign-born workers: Complementarity, substitutability, and other channels of influence. *Southern Economic Journal* 61(4), 1076-1097.
- Grossman, J.B (1982) The Substitutability of Natives and Immigrants in Production, *Review of Economics and Statistics* 64(4), 596-603.
- Hunt, J. (1992) The impact of the 1962 repatriates from Algeria on the French labor market. *Industrial and Labor Relations Review* 45(3), 556-572.
- Hurlin, C. (2008), 'Testing for Granger Non Causality in Heterogeneous Panels' *Mimeo, Department of Economics: University of Orleans*.
- Im, K., Pesaran, H., and Shin, Y. (2003). Testing for Unit Roots in Heterogeneous Panels. *Journal of Econometrics* 115(1), 53-74.

- Islam, A. (2007). Immigration and Unemployment Relationship: Evidence from Canada. *Australian Economic Papers*, 46(1), 52-66.
- Jean, S. and Jimenez, M. (2007). The Unemployment Impact of Immigration in OECD Countries. *OECD Economics Department Working Paper*, No. 563.
- Johnson, G.E. (1980) The labor market effects of immigration *Industrial and Labor Relations Review*, 33(3), 331-341.
- Kar, M., Nazlođluc, S., and Ađr, H. (2010). Financial development and economic growth nexus in the MENA countries: Bootstrap panel granger causality analysis. *Economic Modelling*.
- Keer S.P., Keer, W.R. (2011). Economic Impacts of Immigration: A Survey. *NBER Working Paper* No. 16736.
- Konya, L. 2006. Exports and growth: Granger causality analysis on OECD Countries with a panel data approach. *Economic Modelling* 23, 978-992.
- Marr, W. and Siklos, P. (1994). The Link between Immigration and Unemployment in Canada. *Journal of Policy Modeling*, 16(1), 1-26.
- Morley, B. (2006). Causality between economic growth and immigration: An ARDL bounds testing approach. *Economics Letters*, 90(1), 72-76.
- OECD,(2009). Recent Trends in International Migration, International Migration Outlook. Paris.
- OECD (2010). Labour Force Statistics 2010. *OECD Publishing*.
- Office for National Statistics (2008). Long-term international migration estimates from the International Passenger Survey (IPS): 1975-1990.
- (2009). Long-term international migration from International Passenger Survey (IPS) tables: 1991-latest.
- Okkerse, L. (2008). How to measure labour market effects of immigration: A review. *Journal of Economic Surveys*, 22(1), 1-30.
- Orrenius, P.M. and Zavodny, M. (2007). Does immigration affect wages? A look at occupation-level evidence. *Labour Economics*, 14(5), 757-773
- Ortega, F., and Peri, G. (2009). The Causes and Effects of International Migrations: Evidence from OECD Countries 1980-2005. *NBER Working Paper* No. 14833.
- Passel J. and Clark R. (1994). How much do immigrants really cost? A reappraisal of Huddle.s .The cost of immigrants. *Urban Institute Working Paper*.
- Pesaran, M.H., (2004). General Diagnostic Tests for Cross Section Dependence in Panels. *CESifo Working Paper 1229; IZA Discussion Paper 1240*.
- Pesaran, M.H., Shin, Y., Smith, R.J. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels *Journal of the American Statistical Association*, Vol. 94, No. 446, pp. 621-634.

- Pischke, J. and Velling, J. (1997). Employment effects of immigration to Germany: an analysis based on local labor markets. *Review of Economics and Statistics* 79(4), 594-604.
- Phillips, P.C.B. (1995). Fully modified least squares and vector autoregression. *Econometrica*, 63, 1023-1078.
- Pope, D. and Withers, G. (1985). Immigration and Unemployment. *Economic Record* 61(2), 554-563.
- Schmidt, M., Stilz, A. and Zimmermann, K. (1994). Mass migration, unions, and government intervention, *Journal of Public Economics* 55(2), 185-201.
- Shan, J, Morris, A. and Sun, F. (1999). Immigration and Unemployment: New evidence from Australia and New Zealand. *International Review of Applied Economics* 13(2), 253-258.
- Simon, J.L., Moore, S. and Sullivan, R. (1993). The effect of immigration on aggregate native unemployment: an across-city estimation. *Journal of Labor Research*, 14(3), 299-316.
- Wooldridge JM. 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.
- Zellner, A. (1962). An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *Journal of the American Statistical Association* 57, 348-368.