

European agriculture under immigration effects: New empirical evidence

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Abstract: European agriculture is widely shaped under the compelling effects of international migration, both economic (labour) immigration and the refugee crisis. This complex endeavour could lead to significant spillover effects also upon the agricultural sectors in neighbouring locations, with different overall economic performances for migrant receiving countries. The research is thus set to assess the outcomes of the European agriculture under the impact of economic and humanitarian migration, focusing on the results achieved by ten EU Member States (most targeted by migrants), during 2000–2016. A balanced panel comprising a complex set of indicators was configured in order to provide accurate credentials for the methodological endeavour that consists of spatial analysis and structural equation modelling (SEM). Estimations show that the agricultural sector will be mainly shaped by economic immigration and less by the humanitarian flows. Major effects are induced through the value added by the agricultural sector, increases in exports of basic foods and agricultural raw materials (spatial analysis). However, a fail to properly manage the EU labour mobility for the following years could lead to a negative downturn on agricultural productivity (SEM).

Keywords: agricultural outcomes; econometric modelling; European Union; immigration flows

The agricultural sector has beneficial contributions to the sustainable economic development since it ensures food supply, jobs, income, a healthy life, environment protection, and, finally, a well-balanced socio-economic structure (FAO 2017a). Jirasek (2017) attested that a refocus on core innovation agricultural strategies in combination with incentives on international trade activity could result in positive “performance feedbacks”. Still, due to its dependence on natural phenomena, agriculture represents the sector with high risks and uncertainties, which determines annual variations of producers’ income, having “unpredictable effects during the whole year” (Jankelova et al. 2017). This situation, in the long term, leads to the migration of farmers, thus inducing compelling effects upon the agricultural sector’s efficiency and overall performance (Aleksneviene et al. 2018). Moreover, a jointly increased effort to support RD (research & development) in agriculture generated

by additional high-skilled labour brought by the immigration process “in a particular region will not only lead to increased agricultural economic output in the state itself, but also in nearby” (Anousheh et al. 2018).

Nowadays Europe faces a major challenge in terms of international migration: (i) increased labour emigration flows from Central and Eastern Europe (CEE) (economic migration); (ii) increasing flows of refugees and asylum seekers, forced by political instability, poverty, and arm assaults to leave their countries and to seek international protection (humanitarian migration); with direct or indirect linkages to the output in various economic sectors, including agriculture. All of these processes embed major social and economic changes both in sending and hosting countries.

However, there are few papers considering the migration impact upon the agricultural sector for Europe. One of them is of McCarthy et al. (2006) who underlined the lack of researches in the migration

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effects upon the agricultural field in Albania and found that “permanent migration also exerts a strong downward pressure on agricultural labour, both total and per capita” (McCarthy et al. 2006). Another study highlighted the negative effects of international migration upon agriculture (resources, income, and technical efficiency) in Albania, a solution being attracting people in rural regions through favourable land and rural development policies (Miluka et al. 2010).

Regarding the international migration effects, the main aspects examined by various authors were predominantly the spillovers induced through international trade, foreign direct investment, labour market implications, innovation (Betz and Simpson 2013; Noja et al. 2018). However, these studies ignore the interlinkages with the agricultural sector. Even more, the studies analysing the impact through the labour market did not consider separately the agricultural component. A large part of the migrants is rural people, “revealed by the fact that around 40% of international remittances are sent to rural areas” (FAO 2017b).

Labour mobility in Europe, especially after the Brexit vote (June 2016), will definitely impact both migrant sending and receiving economies, since it will be re-framed under a new set of migration policies and regulations adopted by EU-27 and the United Kingdom (UK), with important spillovers upon the agricultural sector. A possible reduction in migration flows (especially for the UK) could induce negative effects, particularly in labour-intensive low-salary sectors with jobs occupied mainly by migrants (and possibly refused by natives), such as care work, food processing, manufacturing.

Thus, we found that the implications of migration on the European agricultural sector have not been extensively considered by specialists, as McCarthy et al. (2006) also underlined, “very little is known about its impact”, despite “the potential of migration in fostering, or hindering, the agricultural transformation”. This situation reveals the interest in advanced economies centred for sustainable development of industry sector (Stojanovic-Blab et al. 2016), in detrimental of the agriculture one. Different from any other studies, the general objective of our research is to examine the outcomes of the European agricultural sector under the compelling effects of economic and humanitarian immigration, by considering ten EU countries that are most targeted by migrants (EU-10), namely Germany, France, the UK, Austria, Sweden, Italy, Spain, Belgium, Denmark and Finland. The main motivation for selecting only EU-10 countries resides in the fact

that these countries are mainly targeted by migrants (both economic and humanitarian) and thus have the largest immigration stocks/inflows according to recent data from OECD (2017), Eurostat (European Commission 2018) and UNHCR (2017, 2018). EU-10 countries are therefore confronting with major challenges related to the implications of the immigration process upon their economies, and particularly on the agricultural sector.

We have configured a balanced panel comprising the EU-10 Member States (MS), and a complex set of three categories of indicators analysed through various scenarios during 2000–2016, referring to: (i) agricultural sector; (ii) international migration; (iii) social-economic framework.

Detailed aims of the paper refer to: (i) assessing the impact of immigration upon the valued added in the agricultural field, as well as upon the agricultural sector’s productivity and international performance; (ii) examining the labour market impacts of immigration in the agricultural sector by identifying whether the national agricultural employees are rather substituted than complemented by migrants; (iii) evaluating the final output of governmental RD strategies and associated expenditures deployed within the agricultural sector and testing to see whether this could be an incentive for addition immigration inflows.

DATA AND METHODOLOGY

Data description

For our analysis, we focus on several important dimensions related to the contribution of immigration to the valued added by agriculture in total economic output of EU-10 MS, sector’s productivity and international performance. The variables are analysed during 2000–2016 and grouped into three main categories, as follows:

(i) agricultural indicators: employment in agriculture (thousands persons) (*AGRI_Empl*); employment distribution (employment in agriculture as % of total employment) (*AGRI_ER_D*); value added by kind of economic activity (USD at current prices in millions) (*VA_AGRI*), including agriculture, hunting, forestry, fishing; agricultural factor income per annual work unit (EUR per annual work unit, chain linked volumes) (*AGRI_AWU*); government support to agricultural RD (million EUR) (*GOV_AGRI*) as government budget appropriations or outlays; merchandise trade matrix – food group exports

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(thousands USD) (X_FOOD); merchandise trade matrix – agricultural raw materials exports (thousands USD) (X_AGRI_RM);

(ii) international migration indicators: labour immigrants' flows (number of persons) ($IMIG$); asylum applicants' flows (number of persons) ($ASYL$);

(iii) social-economic framework indicators: at-risk-of-poverty rate (%) (POV_R), annual net earnings of a two-earner married couple with two children (EUR) ($EARN$); life expectancy at birth (years) (LE), reflecting the well-being; educational level reflected through the educational attainment for tertiary education (number of persons) (EDU_Tert), for quality of education; employment rate (%) (ER), unemployment rate of foreign population (%) (UR_F), the active labour market policies (% of GDP) ($ALMPs$) and the passive labour market policies (% of GDP) ($PLMPs$) related to labour market; RD expenditures for the business enterprise sector (% of GDP) ($BERD$), to entail innovation implications; inflows of FDI (foreign direct investments) (FDI_I) and outflows of FDI (FDI_O) (USD at current prices in millions), and KOF index of globalization (KOF_T).

Part of these indicators has been considered as key variables in other studies in the fields of agriculture, especially within the EU (Reiff et al. 2018).

The data were collected from the following databases: Eurostat (European Commission 2018); International Migration Database (OECD 2017); United Nations High Commission for Refugees (UNHCR 2017); World Development Indicators (World Bank 2017); UNCTAD-stat (UNCTAD 2017); ETH Swiss Federal Institute of Technology Zurich (ETH 2017); ILOSTAT (International Labour Organisation (ILO 2017)).

Supplementary Figure S1 (in electronic supplementary material (ESM); for the supplementary material see the electronic version) highlights the results of considered agricultural indicators in 2016 for the EU-10 MS. Thus, within our panel, the highest contributions of agricultural results in 2016 were in France (for VA_AGRI , $AGRI_AWU$, GOV_AGRI , and X_FOOD), Italy (VA_AGRI), Belgium ($AGRI_AWU$), Germany (GOV_AGRI , X_FOOD and X_AGRI_RM), and Sweden (X_AGRI_RM). Most employees in agriculture are in France and Italy ($AGRI_Empl$, thousands persons), and Spain and Austria ($AGRI_ER_D$, %).

Research Hypotheses and Methods applied

In line with the general objective and detailed aims of the paper, we have set the following hypotheses (H):

H₁: The immigration flows (especially $IMIG$) have a positive impact on the value added by the agricultural sector (VA_AGRI);

H₂: National agricultural employees are substituted rather than complemented by migrants;

H₃: The immigration flows (especially $IMIG$) have positive effects upon the agricultural results, measured through $AGRI_AWU$, X_FOOD , and X_AGRI_RM ;

H₄: An increase in government expenditures on RD activities deployed within the agricultural sector leads to significant increases in the immigration inflows;

H₅: The inter-linkages between variables positively impact the EU-10 agricultural outcomes.

Firstly, in order to provide a suitable comparability of data among countries, and to eliminate the variations and associated differences, we have used the standardisation procedure as a first method of analysing the data and thus developed a composite indicator (y_i) for each variable used in the empirical analysis, according to the Equation 1 (OECD 2005):

$$y_i = \frac{x_i - \text{mean}}{sd}, \quad (1)$$

where y_i is the composite indicator developed across the panel to discard country variations, x_i represents the crude value of the indicator, and sd is the standard deviation.

Further, we have taken into account spatial interference in the developed models. Therefore, to see if the observations are grouped together or randomly spread, we have applied numerous spatial analysis models with a general configuration described by Equations 2a–2b (Viton 2010):

Spatial lag models:

$$y = \lambda W y + X \beta + u, \quad (2a)$$

Spatial error models:

$$y = X \beta + u, \quad u = \rho W u + v, \quad (2b)$$

where W is the inverse distance weights matrix, y is the dependent (outcome) variable, X represents the explanatory (independent) variables, λ and ρ are scalars that measure the dependence of y_i on nearby y and the spatial correlation in the errors, u represents the error term (spatially correlated residuals), v captures independent and identically distributed disturbances.

The standard econometric model is defined as a baseline panel regression model, but reconfigured through the spatial procedures (lag, Equation 3a and error, Equation 3b):

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$$VA_AGRI_{it} = \lambda WVVA_AGRI_{it} + \beta_0 + \beta_1 IMIG_{it} + \beta_2 ASYL_{it} + \beta_3 ER_{it} + \beta_4 BERD_{it} + \beta_5 ALMPs_{it} + \beta_6 EDU_Tert_{it} + \beta_7 EARN_{it} + \beta_8 FDI_I_{it} + \beta_9 FDI_O_{it} + u_{it} \tag{3a}$$

$$VA_AGRI_{it} = \beta_0 + \beta_1 IMIG_{it} + \beta_2 ASYL_{it} + \beta_3 ER_{it} + \beta_4 BERD_{it} + \beta_5 ALMPs_{it} + \beta_6 EDU_Tert_{it} + \beta_7 EARN_{it} + \beta_8 FDI_I_{it} + \beta_9 FDI_O_{it} + \rho Wu_{it} + v_{it} \tag{3b}$$

where VA_AGRI_{it} – value added by kind of economic activity, λ is the scalar that measures the dependence of VA_AGRI_{it} on nearby VA_AGRI_{it} , W is the inverse distance weights matrix, β are the regression parameters (coefficients), $IMIG_{it}$ – labour immigrants’ flows, $ASYL_{it}$ – asylum applicants’ flows, ER_{it} – employment rate, $BERD_{it}$ – research & development expenditures for the business enterprise sector, $ALMPs_{it}$ – the active labour market policies, EDU_Tert_{it} – educational level reflected through the educational attainment for tertiary education, $EARN_{it}$ – annual net earnings of a two-earner married couple with two children, FDI_I_{it} – inflows of foreign direct investments, FDI_O_{it} – outflows of foreign direct investments, t is the number of observed time periods, u represents the error term (spatially correlated residuals), ρ is the scalar that measures the spatial correlation in the errors, v captures independent and identically distributed disturbances, $i = 1, \dots, m$. The variables used for our model configuration vary across spatial estimations, depending on the hypothesis tested by each model.

The existence (or absence) of spatial autocorrelation was verified with Patrick Moran (Moran’s I) test, calculated as in Equation 4.

$$I = \frac{R}{\sum_i \sum_j \omega_{ij}} \times \frac{\sum_i \sum_j \omega_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_i (x_i - \bar{x})^2} \tag{4}$$

where ω_{ij} are the elements of the spatial weights matrix W (row standardised), R is the number of regions with associated neighbours (spatial units indexed by i and j), x is the variable of interest, \bar{x} is the mean of x .

Hereinafter, we have used structural equations modelling (SEM) in order to enclose the links between the migration determinants, social-economic indicators and agricultural variables, from an integrated perspective (direct, indirect and total interlinkages). The configuration of the SEM is shown by the Equation 5.

$$\begin{cases} b_{11}y_{1t} + \dots + b_{1m}y_{mt} + c_{11}x_{1t} + \dots + c_{1n}x_{nt} = \varepsilon_{1t} \\ b_{21}y_{1t} + \dots + b_{2m}y_{mt} + c_{21}x_{1t} + \dots + c_{2n}x_{nt} = \varepsilon_{2t} \\ \vdots \\ b_{m1}y_{1t} + \dots + b_{mm}y_{mt} + c_{m1}x_{1t} + \dots + c_{mn}x_{nt} = \varepsilon_{mt} \end{cases} \tag{5}$$

where t is the number of observed periods, b_{ij} represents the y_{ij} endogenous variable’s parameters, c_{ij} are the x_{ij} exogenous variable’s parameters, $i = 1, \dots, m$, $j = 1, \dots, n$; ε is the error term (residuals).

RESULTS AND DISCUSSIONS

Spatial analysis

In line with the first hypothesis, we have assessed the migrants’ contribution to the valued added by agriculture in the overall economic activity (VA_AGRI) by taking into account the performances achieved individually and by neighbours (spatial spillover effects).

Thus, in Table 1, the spatial lag model results control for spatial autocorrelation in the dependent variable (VA_AGRI). The independent variables are, besides immigration indicators ($IMIG$, $ASYL$), those related to: labour market (ER , $ALMPs$), educational quality (EDU_Tert), people well-being ($EARN$), innovation ($BERD$), and investments (FDI_I , FDI_O), as main possible impact vectors, as suggested by previous findings (Betz and Simpson 2013; Jirasek 2017; Anousheh et al. 2018; Noja et al. 2018).

The spatial error model controls for autocorrelation in both the dependent and independent variables, thus being more robust. The Lagrange Multiplier (LM) tests are significant, thus indicating the presence of spatial dependence. Rho reveals the spatial dependence inherent in the sample data, quantifying the average influence on observations by their neighbouring observations. It has a positive effect and is highly significant for the complete sample. At the same time, $lambda$ is positive and statistically significant for the 2000–2016 in spatial-error models thus proving the positive autoregressive influence of explanatory variables on the VA_AGRI . Moreover, the Moran’s I highlights a positive global spatial autocorrelation. Therefore, the agricultural performances achieved by the neighbouring locations under the immigration effects are also essential for impacting migrant EU-10. All the testing parameters procedures have allowed us to reject the null hypothesis that the variables’ coefficients are jointly equal to zero, as an important

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Table 1. Results of spatial models (robust and bootstrap), dependent variable *VA_AGRI_st*, 2000–2016, number of observations = 170

Dependent variable	(1)	(2)	(3)	(4)
<i>VA_AGRI_st</i>	spatial_lag (robust)	spatial_lag (bootstrap)	spatial_error (robust)	spatial_error (bootstrap)
<i>IMIG_st</i>	0.107 ^{***} (0.0283)	0.107 (0.0647)	0.125 [*] (0.0522)	0.125 [*] (0.0487)
<i>ASYL_st</i>	-0.0131 (0.0248)	-0.0131 (0.0509)	-0.00642 (0.0304)	-0.00642 (0.0601)
<i>ER_st</i>	0.167 ^{***} (0.0304)	0.167 [*] (0.0722)	0.165 ^{***} (0.0464)	0.165 ^{**} (0.0559)
<i>BERD_st</i>	-0.0295 (0.0218)	-0.0295 (0.0469)	-0.0275 (0.0329)	-0.0275 (0.0435)
<i>ALMPs_st</i>	0.0559 ^{**} (0.0195)	0.0559 (0.0462)	0.0450 (0.0277)	0.0450 (0.0402)
<i>EDU_Tert_st</i>	-0.0433 [*] (0.0196)	-0.0433 (0.0454)	-0.0304 (0.0280)	-0.0304 (0.0368)
<i>EARN_st</i>	0.00980 (0.0263)	0.00980 (0.0556)	-0.00947 (0.0317)	-0.00947 (0.0459)
<i>FDI_I_st</i>	-0.103 ^{***} (0.0209)	-0.103 [*] (0.0524)	-0.0889 ^{***} (0.0264)	-0.0889 (0.0701)
<i>FDI_O_st</i>	0.0888 ^{***} (0.0225)	0.0888 (0.0600)	0.0670 ^{**} (0.0212)	0.0670 (0.0553)
<i>_cons</i>	0.135 ^{***} (0.0170)	0.135 (0.0997)	17.36 (18.22)	17.36 ^{***} (0.0388)
<i>Rho</i>	0.994 ^{***}	0.994 ^{***}	–	–
<i>_cons</i>	(0.00584)	(0.232)	–	–
<i>Sigma</i>	0.230 ^{***}	0.230 ^{***}	0.289 ^{***}	0.289 ^{***}
<i>_cons</i>	(0.0163)	(0.0291)	(0.0190)	(0.0331)
<i>Lambda</i>	–	–	0.994 ^{***}	0.994 ^{***}
<i>_cons</i>	–	–	(0.00555)	(0.298)
<i>Test parameters</i> (<i>p</i> = 0.0000)	chi2 (9) = 204.00	chi2 (9) = 71.87	chi2 (9) = 58.62	chi2 (9) = 76.65
<i>LM</i>	371.096 (0.000)	371.096 (0.000)	320.509 (0.000)	320.509 (0.000)
<i>Wald test</i> <i>of rho/lambda</i>	2.9e+04 (0.000)	2.9e+04 (0.000)	3.2e+04 (0.000)	3.2e+04 (0.000)

Acceptable range for *rho*: $-1.476 < rho < 1.000$; acceptable range for *lambda*: $-1.476 < lambda < 1.000$

Moran's I *IMIG* *I* = 0.5000; *p* = 0.000; *ASYL* *I* = 0.082; *p* = 0.000; *VA_AGRI* = 0.642; *p* = 0.000

Inverse distance weights matrix (row-standardised) features dimension: 170 × 170; 1st quartile distance: 0.4; median distance: 1.7; 3rd quartile distance: 2.3; maximum distance: 5.1; largest minimum distance: 0.92; smallest maximum distance: 2.65

*, **, *** denotes *p* < 0.05, 0.01, 0.001, respectively; standard errors in parentheses; *VA_AGRI_st* – value added by kind of economic activity, standardised; *IMIG_st* – labour immigrants' flows, standardised; *ASYL_st* – asylum applicants' flows, standardised; *ER_st* – employment rate, standardised; *BERD_st* – research & development expenditures for the business enterprise sector, standardised; *ALMPs_st* – active labour market policies, standardised; *EDU_Tert_st* – educational level reflected through educational attainment for tertiary education, standardised; *EARN_st* – annual net earnings of a two-earner married couple with two children, standardised; *FDI_I_st* – inflows of foreign direct investments, standardised; *FDI_O_st* – outflows of foreign direct investments, standardised; *LM* – Lagrange Multiplier

Source: authors' research in Stata

measure of model correct specification. The highly statistically significant estimated coefficients are slightly different in size, but consistent in sign (have not changed their sign throughout different procedures), except for the *EARN* variable (Table 1).

The results obtained highlight that the economic immigration flows (*IMIG*) have a positive impact (the estimated coefficients are positive and significant, 0.107 and 0.125) and lead to an important increase in the *VA_AGRI* (agriculture's contribution to EU-

10 GDP). Thus, **H₁ is fulfilled**. The uncertainty brought by the Brexit ongoing process seems to negatively reflect in terms of *FDI_I* that lead to a slight decrease in the *VA_AGRI*. Negative effects are again registered for the *ALMPs* (education and training policies), and *EDU_Tert*. On the other hand, this could be an incentive for *FDI_O*, with important positive spillovers in the agricultural sector, increasing the *VA_AGRI*. Positive effects are also registered if the labour market performance improves (increases in the total *ER*,

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the coefficients being positive and extremely significant from a statistical point of view).

In this respect, we have continued our empirical research by developing a new model that captures the immigration impact upon the national agricultural employment (*AGRI_Empl*) and employment distribution in agriculture (*AGRI_ER_D*) for the EU-10 MS (H_2). The focus here is to analyse whether national agricultural employees are complemented or substituted by migrants (*IMIG* and *ASYL*). The results obtained are synthesised in Table 2.

The results obtained highlight that even though the immigrants increase the national labour force stock in the agricultural sector of EU-10 MS (positive estimated coefficients for *AGRI_Empl* both for *ASYL*, and especially for *IMIG* in model 1 and 3, Table 2), they tend to substitute national agricultural employees rather than complementing them, since the employment rate in agriculture (*AGRI_ER_D*) decreases under the immigration effects (negative estimated coefficients

associated with *IMIG* and *ASYL* for model 2 and 4, Table 2). Thus, **H_2 is fulfilled.**

Furthermore, to better capture the immigration effects upon the EU-10 agricultural sector, we have expanded our empirical analysis (Table 3) by considering as dependent variables *AGRI_AWU* (model 1), *X_FOOD* (model 2), and *X_AGRI_RM* (model 3).

The results obtained highlight important positive effects induced by economic immigration (*IMIG*) upon the EU-10 agricultural sector during 2000–2016. This is reflected particularly through a significant increase in *X_FOOD* (for *IMIG*) and *X_AGRI_RM*, as attested by the positive and extremely statistically significant estimated coefficients (0.235 for *X_FOOD*, and 0.389 for *X_AGRI_RM* associated with *IMIG*). Therefore, there is evidence to attest that additional labour immigration flows positively reflect upon the international trade performance of the agricultural sector, by significantly increasing basic food and agricultural raw materials exports. The impacts of immi-

Table 2. Results of spatial models (robust), dependent variables *AGRI_Empl_st* and *AGRI_ER_D*, 2000–2016, number of observations = 170

	(1) <i>AGRI_Empl</i> (spatial lag)	(2) <i>AGRI_ER_D</i> (spatial lag)	(3) <i>AGRI_Empl</i> (spatial error)	(4) <i>AGRI_ER_D</i> (spatial error)
<i>IMIG_st</i>	0.171*** (0.0240)	-0.110 (0.0630)	0.256*** (0.0441)	-0.193** (0.0749)
<i>ASYL_st</i>	0.00679 (0.0223)	-0.0959° (0.0461)	0.0175 (0.0323)	-0.000154 (0.0475)
<i>BERD_st</i>	-0.109*** (0.0264)	-0.160° (0.0641)	-0.163*** (0.0422)	-0.400*** (0.0919)
<i>ALMPs_st</i>	0.130*** (0.0300)	-0.00848 (0.0477)	0.198*** (0.0471)	0.0828 (0.0595)
<i>EDU_Tert_st</i>	-0.0801** (0.0244)	-0.0977 (0.0798)	-0.101*** (0.0282)	-0.0917 (0.0837)
<i>EARN_st</i>	-0.221*** (0.0225)	-0.336*** (0.0711)	-0.234** (0.0292)	-0.377*** (0.0744)
<i>FDI_I_st</i>	-0.0416 (0.0259)	-0.164° (0.0777)	-0.0574 (0.0347)	-0.203** (0.0780)
<i>FDI_O_st</i>	0.0469° (0.0226)	-0.0480 (0.0686)	0.0467° (0.0237)	0.0270 (0.0587)
<i>_cons</i>	0.180*** (0.0189)	0.0222 (0.0520)	14.81 (16.29)	-0.294 (1.076)
<i>Rho</i>	0.988***	0.813***	-	-
<i>_cons</i>	(0.0115)	(0.140)	-	-
<i>Sigma</i>	0.244***	0.659***	0.297***	0.636***
<i>_cons</i>	(0.0138)	(0.0375)	(0.0175)	(0.0369)
<i>Lambda</i>	-	-	0.993***	0.948***
<i>_cons</i>	-	-	(0.00690)	(0.0611)

*, **, *** denotes $p < 0.05, 0.01, 0.001$, respectively; standard errors in parentheses; *AGRI_Empl_st* – employment in agriculture, standardised; *AGRI_ER_D* – employment distribution; *IMIG_st* – labour immigrants’ flows, standardised; *ASYL_st* – asylum applicants’ flows, standardised; *BERD_st* – research & development expenditures for the business enterprise sector, standardised; *ALMPs_st* – active labour market policies, standardised; *EDU_Tert_st* – educational level reflected through the educational attainment for tertiary education, standardised; *EARN_st* – annual net earnings of a two-earner married couple with two children, standardised; *FDI_I_st* – inflows of foreign direct investments, standardised; *FDI_O_st* – outflows of foreign direct investments, standardised

Source: authors’ research in Stata

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Table 3. Results of spatial lag models (robust), various agricultural indicators used as dependent variables, number of observations = 170

	(1) <i>AGRI_AWU_st</i>	(2) <i>X_FOOD_st</i>	(3) <i>X_AGRI_RM_st</i>
<i>IMIG_st</i>	0.0529 (0.0333)	0.235*** (0.0694)	0.389*** (0.0849)
<i>ASYL_st</i>	-0.0622** (0.0227)	0.108* (0.0476)	0.0284 (0.0536)
<i>ER_st</i>	-0.156*** (0.0455)	-0.341*** (0.0733)	-0.435*** (0.0760)
<i>BERD_st</i>	0.00651 (0.0344)	0.186* (0.0769)	0.840*** (0.105)
<i>ALMPs_st</i>	0.0995* (0.0416)	0.0846 (0.0551)	-0.0894 (0.0637)
<i>EDU_Tert_st</i>	0.0653* (0.0295)	0.0568 (0.0544)	-0.0941 (0.0495)
<i>EARN_st</i>	0.163** (0.0557)	0.201** (0.0620)	0.305*** (0.0776)
<i>FDI_I_st</i>	-0.0539 (0.0318)	-0.143* (0.0609)	-0.0882 (0.0642)
<i>FDI_O_st</i>	0.0532 (0.0315)	0.190** (0.0686)	0.200* (0.0805)
<i>_cons</i>	0.0555 (0.0427)	0.0577 (0.0475)	0.0372 (0.0493)
<i>Rho</i>	0.616**	0.924***	0.542*
<i>_cons</i>	(0.200)	(0.0721)	(0.218)
<i>Sigma</i>	0.311***	0.565***	0.616***
<i>_cons</i>	(0.0246)	(0.0374)	(0.0525)

*, **, *** denotes $p < 0.05, 0.01, 0.001$, respectively; standard errors in parentheses; *AGRI_AWU_st* – agricultural factor income per annual work unit, standardised; *X_FOOD_st* – merchandise trade matrix – food group exports, standardised; *X_AGRI_RM_st* – merchandise trade matrix – agricultural raw materials exports, standardised; *IMIG_st* – labour immigrants' flows, standardised; *ASYL_st* – asylum applicants' flows, standardised; *ER_st* – employment rate, standardised; *BERD_st* – research & development expenditures for the business enterprise sector, standardised; *ALMPs_st* – active labour market policies, standardised; *EDU_Tert_st* – educational level reflected through the educational attainment for tertiary education, standardised; *EARN_st* – annual net earnings of a two-earner married couple with two children, standardised; *FDI_I_st* – inflows of foreign direct investments, standardised; *FDI_O_st* – outflows of foreign direct investments, standardised

Source: authors' research in Stata

gration on *AGRI_AWU* are also positive for *IMIG* and negative for *ASYL*. In the case of *ASYL*, the negative coefficients, pointing that an increase in asylum seekers into EU-10 would lead to a reduction in *AGRI_AWU*, reveal the importance of accurate strategies, policies and specific measures that have to be adopted by the major receiving countries to cope with increased humanitarian immigration so that the potential negative effects on agricultural outcomes to be rooted out. Thus, **H₃ is fulfilled**.

A jointly increased effort is made by the EU-10 to support RD in agriculture (*BERD*) generated by additional high-skilled labour brought by the immigration process (*EDU_Tert*), which is in line with previous findings in the literature (Anousheh et al. 2018). Furthermore, spatial estimations reveal the importance of *BERD* in increasing the *X_FOOD* and *X_AGRI_RM* (the estimated coefficients are positive and extremely significant from a statistical point of view), aspects also underlined by Jirasek (2017).

In line with these results, we have developed a new model that enables a preliminary analysis of whether countries which are spending more for the agricultural sector in terms of RD support are rather open to accept immigrants and therefore to lead to an increase in the immigration inflows into these countries (**H₄**). The results obtained are detailed in Table 4.

The **H₄** hypothesis is verified by the results obtained since the estimated coefficients associated with the *GOV_AGRI* variable are positive and extremely statistically significant (0.608*** and 0.755**), thus revealing that an increase in the government expenditures on RD activities deployed within the agricultural sector leads to significant increases in the immigration inflows into EU-10 MS, suggesting that these countries are continuously open to accept immigrants (**H₄ is fulfilled**). The coefficients associated with the *BERD* variable are also positive (even though with a lower degree of statistical significance), pointing to the same previous conclusion. Another incentive

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Table 4. Results of spatial models – effects of government support for agricultural RD activities upon immigration flows, number of observations = 170

Dependent variable	(1)	(2)	(3)	(4)
	spatial lag robust	spatial lag bootstrap	spatial error robust	spatial error bootstrap
<i>IMIG_st</i>				
<i>GOV_AGRI_st</i>	0.608*** (0.142)	0.608*** (0.118)	0.755*** (0.160)	0.755*** (0.119)
<i>BERD_st</i>	0.0626 (0.0486)	0.0626 (0.0562)	0.0203 (0.0558)	0.0203 (0.0663)
<i>ALMPs_st</i>	-0.0142 (0.0294)	-0.0142 (0.0396)	-0.0833 (0.0431)	-0.0833* (0.0400)
<i>AGRI_Empl_st</i>	-0.00188 (0.0702)	-0.00188 (0.100)	0.519*** (0.0956)	0.519*** (0.0721)
<i>EDU_Tert_st</i>	-0.0554 (0.0472)	-0.0554 (0.0452)	0.0135 (0.0478)	0.0135 (0.0508)
<i>EARN_st</i>	0.0368 (0.0456)	0.0368 (0.0499)	0.110* (0.0502)	0.110* (0.0551)
<i>FDI_I_st</i>	0.0711 (0.0388)	0.0711v (0.0777)	0.0684 (0.0421)	0.0684 (0.0568)
<i>FDI_O_st</i>	-0.0271 (0.0468)	-0.0271 (0.0722)	-0.0169 (0.0405)	-0.0169 (0.0646)
<i>_cons</i>	0.268*** (0.0399)	0.268*** (0.0605)	1.263 (1.454)	1.263*** (0.0432)
<i>Rho</i>	0.973**	0.973***	–	–
<i>_cons</i>	(0.0286)	(0.276)	–	–
<i>Sigma</i>	0.393***	0.393***	0.400***	0.400***
<i>_cons</i>	(0.0387)	(0.0355)	(0.0357)	(0.0389)
<i>Lambda</i>	–	–	0.978***	0.978**
<i>_cons</i>	–	–	(0.0225)	(0.348)

*, **, *** denotes $p < 0.05, 0.01, 0.001$, respectively; standard errors in parentheses; RD – research & development; *IMIG_st* – labour immigrants’ flows, standardised; *GOV_AGRI_st* – government support to agricultural RD, standardised; *BERD_st* – RD expenditures for the business enterprise sector, standardised; *ALMPs_st* – active labour market policies, standardised; *AGRI_Empl_st* – employment in agriculture, standardised; *EDU_Tert_st* – educational level reflected through the educational attainment for tertiary education, standardised; *EARN_st* – annual net earnings of a two-earner married couple with two children, standardised; *FDI_I_st* – inflows of foreign direct investments, standardised; *FDI_O_st* – outflows of foreign direct investments, standardised

Source: authors’ research in Stata

for attracting migrants into this sector is an improvement in the level of earnings (*EARN*) along with additional agricultural employment (*AGRI_empl* only in the presence of statistical significance) which could reflect a networking effect (migrant networks) and a feature of stability and growth of this sector.

SEM models

The immigration impact upon the EU-10 agricultural sector cannot be captured only through direct relationships but requires an integrated framework that takes into account both the major determinants of the immigration inflows (economic and humanitarian), the mediated factors (social-economic framework) and final output (*VA_AGRI*, *AGRI_AWU*, *X_FOOD* and *X_AGRI_RM*). In this respect, we have configured a new complex model based on simultaneous equations modelling that was processed through the Maximum Likelihood Estimator (MLE).

We have accounted for SEM through MLE also because panel regression estimates by Ordinary Least Squares (OLS)/Generalised Least Squares (GLS) might not be consistent since the unit-root tests applied gave contradictory results (Levin-Lin-Chu and Im-Pesaran-Shin tests had p -values close to 1). In the case of SEM models, we have applied specific Wald tests for equations, compared Likelihood Ratios (LR) results (LR test for model versus saturated and baseline versus saturated) and Information Criteria (Akaike’s, Bayesian) for each estimated model, along with other baseline comparison. Thus, we were able to select and store four models (*VA_AGRI*, *AGRI_AWU*, *X_FOOD* and *X_AGRI_RM*). The variables considered generally measure people’s well-being (*POV_R*, *EARN*, *LE*), educational quality (*EDU_tert*), changes in the labour force stock in agriculture due to immigration and associated labour market policies (*UR_F*, *ALMPs*, *PLMPs*, *AGRI_Empl*, *IMIG*, *ASYL*), and the impact of globalization (*KOF_T*).

Our estimations (Figure 1) highlight that the immigration inflows (both *IMIG* and *ASYL*) are mainly shaped by the labour market performances of other migrants already residing in EU-10 (*UR_F*) and low poverty risks (*POV_R*). A reduction in these credentials leads to a major reduction of the immigration flows. At the same time, the immigration effects upon *AGRI_Empl* are significant mainly in the case of *IMIG*, a major role in these positive outcomes being played

by *PLMPs* (unemployment benefits and earlier retirement facilities of elder workers with decreased possibilities in finding a job). Instead, the *ALMPs* act like a disincentive to labour market participation in agriculture. *KOF_T* has a negative impact both for *IMIG*, and for *ASYL*, thus showing that international migration becomes a major frontier of globalization. Furthermore, these inter-linkages positively impact the EU-10 agricultural sector in terms of a signifi-

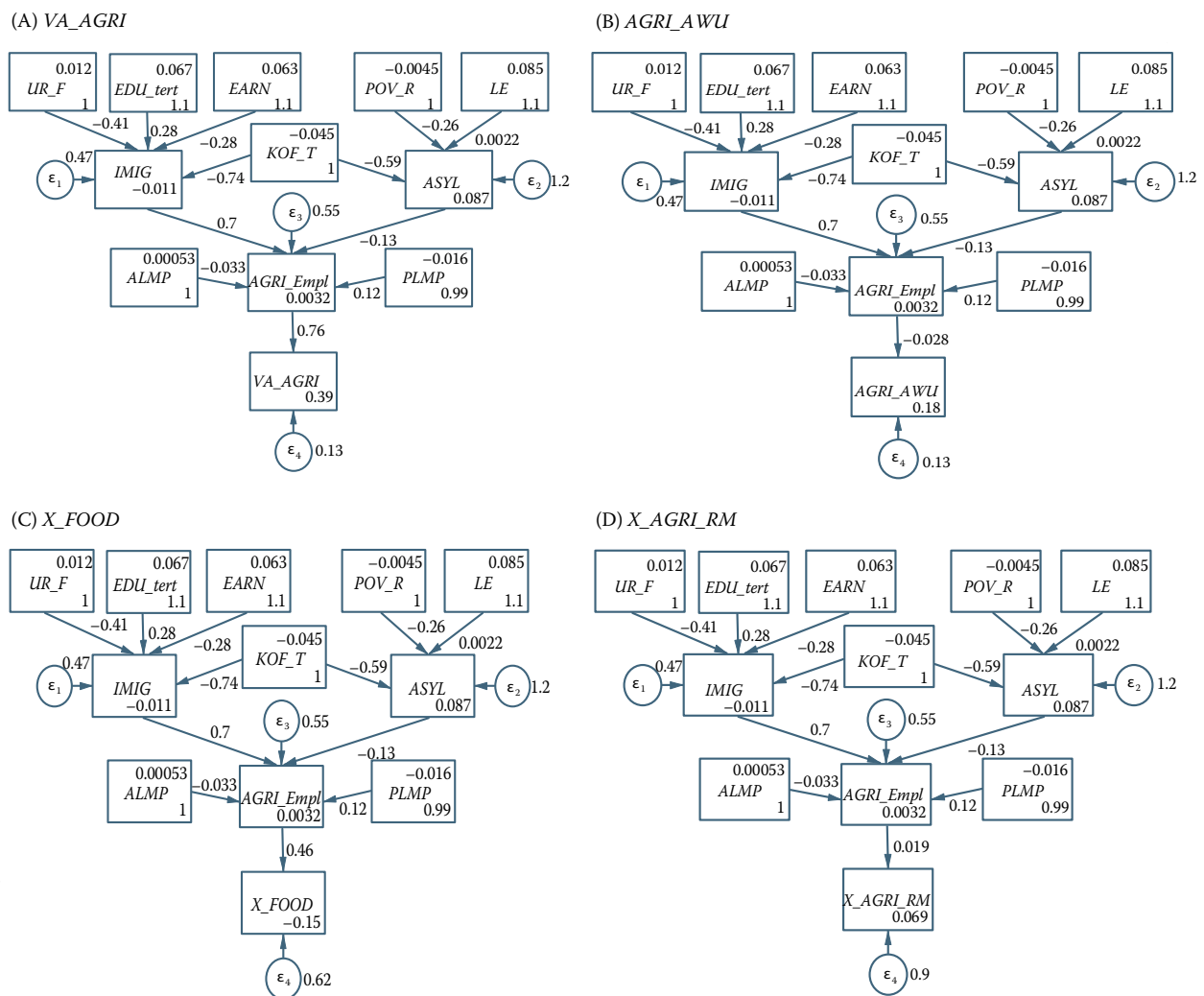


Figure 1. Structural equation modelling (SEM) results for 2000–2016 in EU-10 Member States

VA_AGRI – value added by kind of economic activity; *AGRI_AWU* – agricultural factor income per annual work unit; *X_FOOD* – merchandise trade matrix – food group exports; *X_AGRI_RM* – merchandise trade matrix – agricultural raw materials exports; *UR_F* – unemployment rate of foreign population; *EDU_Tert* – educational level reflected through the educational attainment for tertiary education; *EARN* – annual net earnings of a two-earner married couple with two children; *IMIG* – labour immigrants’ flows; *KOF* – index of the degree of globalization; *ASYL* – asylum applicants’ flows; *POV_R* – at-risk-of-poverty rate; *LE* – life expectancy at birth; *ALMPs_st* – active labour market policies; *PLMPs* – passive labour market policies; *AGRI_Empl* – employment in agriculture

Source: own process in Stata

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cant increase in VA_AGRI (the estimated coefficient is 0.76^{***}), as well as in X_FOOD (the estimated coefficient is 0.46^{***}) and X_AGRI_RM (the estimated coefficient is 0.019^{*} significant at 5% level). However, immigration negatively reverberates through an important decrease in $AGRI_AWU$ (productivity) (quite low in magnitude since the estimated coefficient is close to zero, -0.028, significant at 10% level). Thus, **H₅ is partially fulfilled.**

CONCLUSION

Based on the importance of the sustainability agricultural development (FAO 2017a), and the large amplitude of international migration in Europe, our research aimed to assess the impact of people free movement upon the European agricultural sector. As we have mentioned in the introduction, the implications of migration on the European agricultural sector have not been extensively considered by specialists. To this respect, we have designed five scenarios (hypotheses) that focus on the agricultural results achieved by migrant most targeted EU-10 MS under the impact of international migration flows, based on 2000–2016.

We considered three categories of indicators referring to: agricultural sector, international migration, social-economic framework, that are supposing to influence European agriculture. By applying two sets of econometric methods, spatial analysis and structural equation modelling, we were able to capture some of the most important ways in which the agricultural sector can be influenced, both positively and negatively, by the immigration process.

Overall, we can say that the agricultural sector will be mainly shaped by the economic immigration and less by the humanitarian flows, in the presence of spatial dependency that considers the performances also achieved by neighbouring locations (results of spatial models). Thus, major positive effects are induced by economic immigration through the value added by the agricultural sector (H₁). Even though the immigrants increase the labour force stock in the agricultural sector of EU-10 MS, they tend to substitute national agricultural employees rather than complementing them (H₂). Important aggregated positive effects are induced by economic immigration also upon the agricultural sector's productivity and international performance (basic food and agricultural raw materials exports) (H₃). Moreover, an increase in the government expenditures on RD

activities deployed within the agricultural sector leads to significant increases in the immigration inflows into EU-10 MS (H₄). However, SEM results reveal that there are numerous mechanisms that influence the final agricultural achievements, the interlinkages between variables positively impact the EU-10 agricultural outcomes, only for the value added by the agricultural sector, basic food and agricultural raw materials exports (less for productivity) (H₅). These integrative results reveal that a fail to coordinate the EU labour mobility for the following years could lead to a reduction in agricultural productivity.

A key to sustaining benefits through international migration is “to build countries' capacities to address migration through rural development policies” (FAO 2017a). Agriculture has to serve the citizens' concerns about sustaining food, environment protection and afford farmers to get their living earnings from their work, as main social implications, but also about sustaining the competitiveness (Nowak and Kaminska 2017). Moreover, there are numerous implications highlighted by the research results related to the fact that native residents' reluctance towards migrants might increase because of their association with increased labour market pressures since we have attested that immigrants tend to rather substitute national agricultural employees than complementing them. However, in most of the EU-10 comprised in the panel, life satisfaction and living standard satisfaction as key perceptions of social processes and subjective wellbeing is relatively high and with a positive sequence during the last decade.

Overall, the research performed is not without limitations. Therefore, we intend to expand our dataset by including additional agricultural indicators and more countries, in order to analyse the implications both for migrant-sending, and receiving economies.

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