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A dynamic panel data analysis of the asymmetric impact of labour cost on intra-EU migration

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Abstract. *This paper investigates the main factors influencing migration inflows within the European Union over the 2013-2024 period. Using a dynamic panel data approach based on the Arellano-Bond GMM estimator, it accounts for persistence in migration patterns and potential endogeneity in socio-economic indicators. The research focuses on the differences between high- and low-inflow countries regarding "push" and "pull" migration factors. Primary results show that labour cost increases act as a significant "pull" factor in high-immigration states, whereas in low-immigration countries it loses statistical significance. Notably, the NEET rate emerges as the strongest inhibitor of immigration across the EU-27, having a substantial negative impact in the low-inflow country model. Moreover, the old age dependency ratio behaves like a "push" factor, while GDP per capita growth positively shapes migration dynamics. These findings suggest that EU migration policies should address the asymmetrical influence of labour cost on intra-EU migration through targeted interventions.*

Keywords: labour cost, intra-EU migration, dynamic panel data analysis, high versus low immigration, EU-27 countries.

JEL Classification: F22, C23, J30.

1. Introduction

The context of intra-European labour migration has undergone important transformations in the last three decades regarding proactive integration of labour force. The evolution towards a united labour market was first signalled by the adoption of the Citizens' Right Directive 2004/38/EC (European Parliament & Council of the European Union, 2004) and later by the introduction of the Regulation 492/2011 on Freedom of Movement for Workers within the European Union (EU) (European Parliament & Council of the European Union, 2011). These two constitute the pillars of free movement and residence of people and workers across the European Economic Area (EEA), thus eliminating work permit and residency restrictions and helping promote more migration between the founding countries of the EU and newer member states. However, only on January 1st, 2014, were the last obstacles removed, workers from Romania and Bulgaria receiving full rights (European Commission, 2014), followed by the progressive integration of Croatian labour force through 2020 (European Commission, 2015).

Given the absence of formal barriers between the EU countries, labour force is spatially reallocated mainly through the interaction of "push" and "pull" socio-economic factors, as conceptualized by Lee (1966). Therefore, migrants selectively respond either to factors affecting their country of origin or to those influencing their destination. This behaviour is then explored by Harris and Todaro (1970), treating migrants as rational actors who take into consideration the costs and benefits of their choice of migration, especially regarding the levels of wages and job opportunities. However, their choice of destination could often be shaped by interpersonal income comparisons to their reference group rather than individualistic reasons, as suggested by Stark and Bloom (1985). Thereby, low-income individuals who decide to move may trigger another migration round since the relative income deprivation of those remaining increases, creating a self-perpetuating migration cycle. This dynamic is further on reinforced in the study of Massey et al. (1993), stating that existing migration stocks in the destination countries act like a "pull" factor because the expansion of migrants' networks lowers the risks and costs of newcomers.

Building upon the above-mentioned legislative and theoretical framework, the aim of this paper consists in investigating the main factors that trigger or inhibit migration inflows around the European Union, by considering "pull" factors like GDP per capita growth or labour cost, along with "push" factors like the NEET rate and old age dependency ratio among others. As methodological approach, several Arellano-Bond dynamic panel models were estimated for the period 2013-2024 at the following territorial levels: (1) the EU-27; (2) the European country sub-sample with higher-than-average immigration flows; and (3) the European country sub-sample with lower-than-average immigration flows, respectively. As main research question (RQ), the paper aims to answer the following question:

RQ: Are there any divergences in terms of "pull" and "push" factors on intra-EU migration between the high versus low inflow countries?

The structure of the paper is the following: Section 2 briefly tackles the literature review on the topic of migration factors, while Section 3 is dedicated to the methodology and data

description. Section 4 summarizes the main results and discusses the implications of the main findings, while the last section concludes.

2. Literature review

The landscape of empirical research on European migration has traditionally been dominated by macro-econometric frameworks, primarily gravity-type or "push and pull" models. In these early specifications, bilateral migration flows were typically regressed against a foundational set of variables, including GDP per capita, wage gaps, unemployment differentials, and proxies for migration costs such as geographic distance and colonial ties (Mayda, 2010). Panel data estimations within this tradition consistently identified income levels and labour market conditions as the primary predictors of intra-EU mobility (Afonso et al., 2025).

However, the last decade has witnessed a significant evolution in both the conceptualization of migration drivers and the analytical toolkit employed by scholars. Methodologically, the field has transitioned from static gravity equations (Belu et al., 2025) toward more sophisticated dynamic panel models and instrumental-variable approaches designed to mitigate endogeneity between migration and economic performance (Åslund, 2005). Theoretically, this shift reflects a move away from viewing migration as a mere response to isolated economic signals, moving instead toward a complex interaction of individual aspirations, capabilities, and structural constraints (de Haas, 2021). This multi-layered perspective is often categorized through the distinction between predisposing, proximate, precipitating, and mediating factors (Van Hear et al., 2012; Manafi & Roman, 2022), allowing for a more nuanced inclusion of institutional variables such as welfare-state generosity and labour market regulations (De Giorgi & Pellizzari, 2009).

Parallel to these theoretical advances, recent literature has increasingly adopted data-driven classification and dimensionality-reduction techniques. Methods like cluster analysis are now frequently used to move beyond simple linear relationships, allowing researchers to identify distinct typologies of migration regimes and multidimensional driver profiles (Kumpikaitė-Valiūnienė et al., 2025; Rosińska, 2024). These approaches are particularly effective at detecting latent patterns within combined economic, demographic, and socio-political factors (Manafi & Roman, 2022).

Despite this broadening, a critical gap persists in capturing the dynamic nature of migration triggers, especially when accounting for the inherent endogeneity and persistence of flows within the EU-27. While previous studies often rely on static frameworks, they frequently overlook the "Nickell bias" and the complex feedback loops between immigration and labour market indicators. This study addresses these shortcomings by employing a dynamic panel data approach based on the Arellano-Bond estimator. By incorporating a lagged dependent variable and transforming regressors through first differencing, we provide a more robust estimation of how factors like GDP growth, labour costs, and NEET rates shape immigration dynamics. Furthermore, we differentiate the analysis by categorizing EU states into high- and low-inflow groups, allowing for a comparative investigation into how these drivers vary across different migratory regimes.

3. Data description and methodology

For this research, yearly data for the period 2013-2024 regarding the EU-27 countries was used. The following indicators collected from the Eurostat database were taken into consideration: intra-EU immigration (*immig*) as dependent variable, GDP per capita growth (*gdp_cap_growth*), labour cost change (*lab_cost_c*), NEET rate (*neet_r*), old age dependency ratio (*old_age_dep*), Gini coefficient (*gini_coef*), net earnings (*net_earn*), corruption perception index (*corrupt_i*), and life expectancy at birth (*life_exp*) as independent variables.

Intra-EU immigration is represented by the number of immigrants whose origin residence country belongs to the EU and destination country is also an EU member state. Immigration flows are aggregated for the EU-28 for the period 2013-2019, and for the EU-27 for the period 2020-2024, after the Brexit, with a missing value for Portugal in 2024.

GDP per capita growth is expressed in chain linked volumes as percentage change on previous period, showing the growth in real terms. Labour cost change represents the percentage change on previous period of nominal unit labour cost based on hours worked. NEET is an abbreviation coming from young persons neither in employment nor in education. Its rate is calculated as the number of youth aged 15-29 in one of the situations previously mentioned in relation to the total number of youth aged 15-29. Old age dependency ratio is expressed as the total population aged 65+ in relation to the total population aged 15-64. A missing value of this indicator exists for Greece in 2024.

Further on, Gini coefficient of equivalised disposable income is measured on a scale from 0 to 100, where 0 means perfect equality, while 100 means maximum inequality. For this indicator, there are missing values in 2013. Net earnings represent the difference between gross earnings and social security contributions and income taxes for a single person without children earning 50% of the average wage, being expressed in purchasing power standard. Missing values were found for Cyprus in 2013, 2015 and 2016. Corruption perception index is a composite indicator highlighting people's perception of how corrupt the public sector is. It can take values between 0 (very high level of corruption) and 100 (very low level of corruption). Finally, life expectancy at birth is the mean number of years expected for a newborn to live, given specific mortality conditions. For comparability reasons, variables expressed in other units of measurement than percentage points or values between 0 to 100 were transformed by applying the logarithm.

The econometric analysis was mainly based on dynamic panel data estimations, using R and RStudio, consisting of Arellano-Bond models. Developed by Arellano and Bond (1991), this type of model employs a generalized method of moments (GMM) estimator, focusing on individual effects, a lagged dependent variable and no strictly exogenous variables. The general equation of the standard dynamic specification follows the form:

$$y_{it} = \propto y_{i,t-1} + \beta x'_{it} + \eta_i + \epsilon_{it}$$

where y_{it} is the dependent variable, $y_{i,t-1}$ represents the first-order lag of the dependent variable, x'_{it} comprises the explanatory factors, while η_i and ϵ_{it} account for the unobserved effects, respectively the individual fixed effect and the idiosyncratic error.

The Arellano-Bond model was designed to address the dynamic panel bias, also known as the "Nickell bias", which appears when the correlation between the lagged dependent variable and the unobserved effects exists, resulting in inconsistent estimations (Nickell, 1981; Bond, 2002). Thus, all model regressors are usually first differenced to eliminate the fixed effect (Anderson & Hsiao, 1981), building a GMM system composed of the standard dynamic panel equation and the transformed one. Apart from this, instruments are introduced by using the lags of the dependent and independent variables to control for endogeneity. However, it should be noted that the Arellano-Bond model ought to be applied to datasets in which the number of cross-sectional units (N) is larger than the number of time periods (T), and that the number of instruments used should be limited because it tends to increase depending on T (Roodman, 2009).

To validate the Arellano-Bond estimations, a suite of diagnostic tests can be used. The Wald test adapted for the GMM estimation checks the joint significance of explanatory factors, whereas the Sargan test indicates the validity of the instruments introduced in the model (Sargan, 1958). Other important tests include the ones for the presence of autocorrelation: AR(1) test which looks for first-order serial correlation in the differenced error term, and AR(2) test which checks the exogeneity of instruments. The expected results of these two tests should indicate first-order serial correlation in differenced residuals, with exogenous instruments, along with no second-order serial correlation of errors.

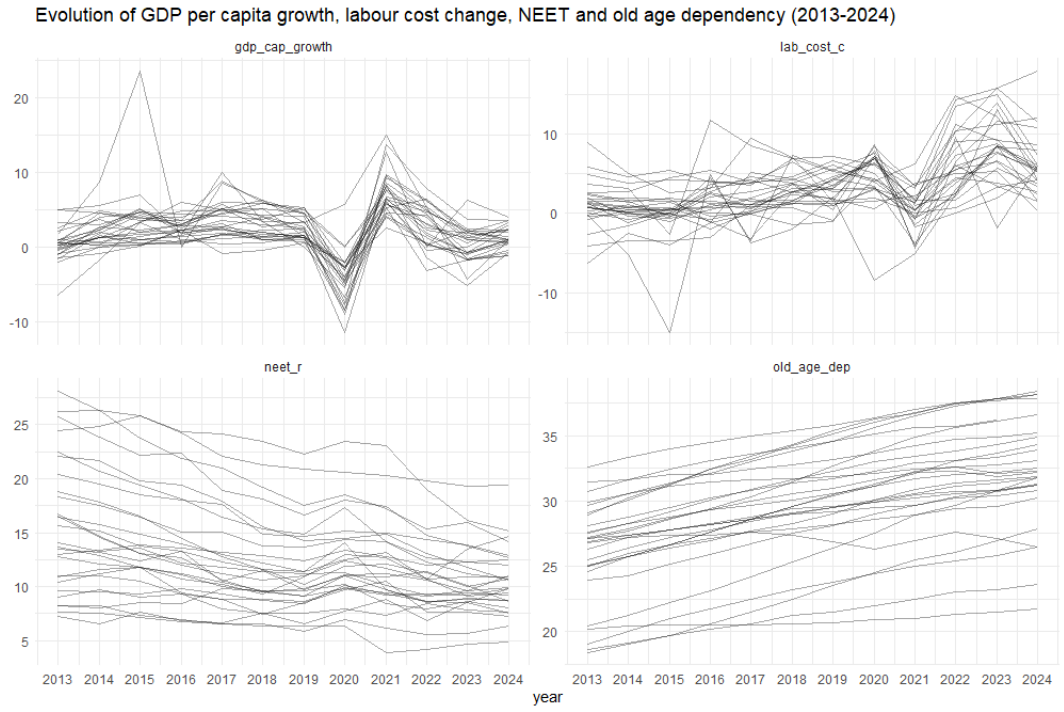
4. Results and discussion

Based on the initial dataset, the Arellano-Bond model was estimated by also incorporating the first lag of intra-EU immigration into the model. The estimations showed that the Gini coefficient, net earnings, corruption perception index and life expectancy at birth were statistically insignificant, while GDP per capita growth, labour cost change, NEET rate and old age dependency ratio significantly shaped immigration. Moreover, as expected, the first lag of immigration was influential, emphasizing the importance of previous year immigration flow in explaining its dynamic.

Figure 1 illustrates the evolution of the significant independent variables for the period 2013-2024. GDP per capita recorded visible volatility throughout the chosen time interval, showing relative moderate growth in the pre-pandemic years, followed by a sharp contraction in 2020 caused by the COVID-19 crisis. This decline was then succeeded by a notable recovery in 2021, and a stabilization afterwards. In the case of labour cost changes, the fluctuations were moderate, presenting an upward trend in the later years of the period, which may reflect wage adjustments during the post-pandemic economic rebound.

In contrast, the NEET rate presented a general downward trend across most EU-27 states, highlighting improvements in the youth integration regarding labour market and education. However, there was a temporary increase concerning the year 2020, indicating a disruption caused by the pandemic. By the end of the period, the rates were considerably lower than at the beginning of it. Finally, old age dependency ratio had a consistent upward trajectory across almost all countries, emphasizing a long-term structural demographic ageing.

Figure 1. *Evolution of significant independent variables (2013-2024)*

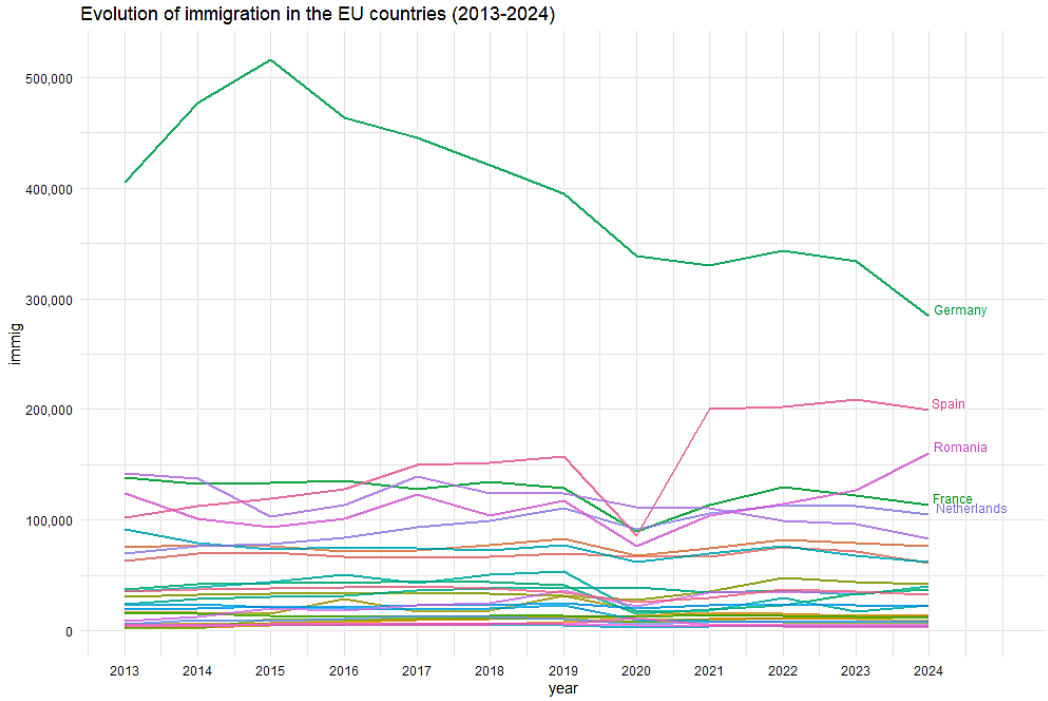


Source: authors' own computation in RStudio.

Figure 2 presents the evolution of the number of intra-EU immigrants across the EU-27 states between 2013 and 2024, highlighting a substantial cross-country heterogeneity in both the level and dynamics of the phenomenon. Germany represented the primary destination state throughout the entire period, reaching a peak of more than 500,000 immigrants in 2015, being mostly associated with the European migration crisis. Even though the flows gradually decreased afterwards, this country continued to receive the highest number of immigrants, remaining above 250,000 in 2024. Being the second major destination country with around 200,000 immigrants in 2024, Spain recorded an increase in immigration until 2019, followed by a sudden drop in 2020, then a strong recovery and a stabilization from 2021 on. In contrast, Romania showed an upward trend in recent years after presenting moderate inflows. In 2024, this country placed on the third position, with around 160,000 immigrants. Compared to Germany and Spain, France and Netherlands exhibited more stable levels of immigration throughout the period. The remaining EU states had lower numbers of immigrants, with temporary declines at the beginning of pandemic across most of them.

Overall, the figure emphasizes noticeable and persistent differences between the EU-27 states regarding intra-EU immigration. Structural factors, such as economic development, labour market conditions, youth integration and demographic pressure, are likely to contribute to these cross-country disparities, thus the need of including individual effects in the empirical model.

Figure 2. *Evolution of immigration in the EU-27 member states (2013-2024)*



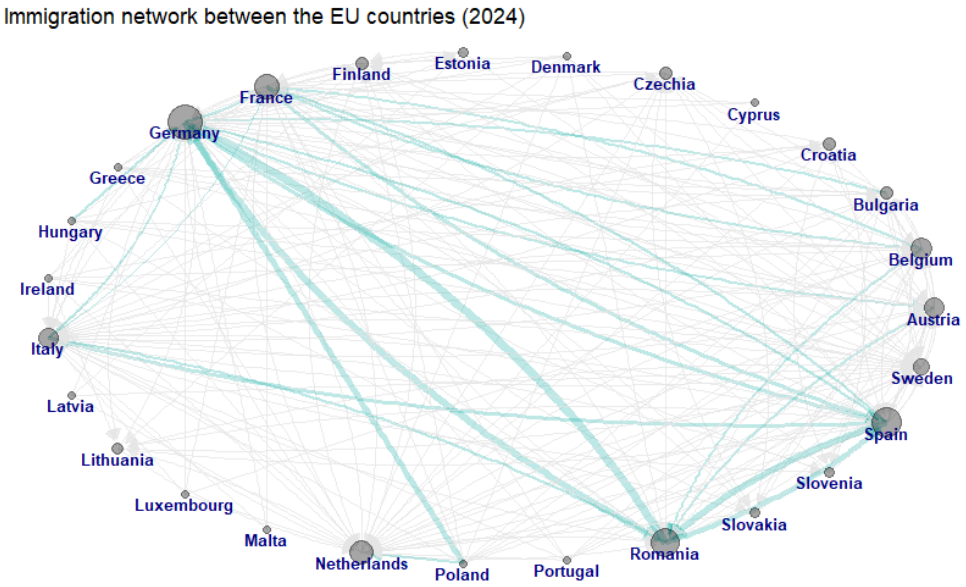
Source: authors' own computation in RStudio.

Further on, the EU-27 states were divided into two groups regarding the number of immigrants registered in 2024: states with higher-than-average immigration flows (Austria, Belgium, France, Germany, Italy, Netherlands, Poland, Romania, Spain) and states with lower-than-average immigration flows. Figure 3 shows the social network of immigrants between the EU countries in 2024, where the states are the nodes, while migration flows are depicted as directed edges. The magnitude of the flows is given by the thickness of links, whereas the node size signifies the in-strength of a country, represented by the total incoming volume of migrants. For clarity, only the top 50% of flows are displayed, the strongest ones being highlighted.

Concerning the states with higher-than-average immigration flows, the in-strength of Poland is underrepresented due to missing data. Apart from this, the network reveals a highly concentrated migration system, with a few countries being important immigration destinations. Germany emerges as the central node, attracting migrants from many EU states, but the most dominant edges come from Romania (22.6% of total volume), Poland (15.6%), Italy (8.2%) and Bulgaria (8%). Spain is another crucial destination, receiving migrants especially from Romania (19.3%), France (15.7%), Italy (15.6%) and Germany (14.1%). Romania represents not only an important source of immigration towards Western and Southern Europe, but also an attractive destination for migrants from Germany (36%), Spain (29.3%), Austria (9.8%) and Belgium (9.6%). France and Netherlands occupy an

intermediate position, with fewer migrants absorbed. In this case, among the origin countries are Belgium, Spain, Germany, Poland and Italy.

Figure 3. *Immigration network between the EU-27 member states (2024)*



Source: authors' own computation in RStudio.

Next, two more distinct Arellano-Bond models were built at the following territorial levels: (1) the high immigration flow countries; and (2) the low immigration flow countries, respectively. Together with the general UE-27 model, the validity of the joint significance of explanatory factors was checked for all three models by applying the Wald test, with p-value being under the 1% threshold. The autocorrelation tests confirmed the presence of the first-order autocorrelation and the absence of the second-order one, while the Sargan test indicated that the instruments used were appropriate.

For the EU-27 model, the coefficient of the first lag of immigration was positive, suggesting that a 1% increase in the previous period immigration would lead to a 0.58% increase in the current period. Also, GDP per capita growth presented a positive influence on the flows of immigrants, a one-percentage-point rise in the independent variable conducting to a 2.39% surge in immigration. Labour cost exerted a positive impact on the number of immigrants, a one-percentage-point higher labour cost producing a 1.02% higher immigration. Unlike the rest, the NEET rate and old age dependency ratio presented a negative effect on attracting immigrants. A one-percentage-point increase in NEET rate would inflict a 5.39% decrease in immigration, the strongest impact of all independent variables, while a one-percentage-point surge in old age dependency ratio would have a 5.33% decline in the number of immigrants.

Comparing high-immigration country model with the low-immigration country one, labour cost change was considerably significant in the first model, but insignificant in the second one. Regarding the previous period immigration, both models have a lower impact on the

current dynamics of immigrants, with weaker significance in the high immigration flow model. The effect of the GDP per capita growth is strongest in the high immigration flow model specification, emphasizing that migrants better responded to economic expansion in preferred destination countries. In the case of labour cost change, its influence gained importance in the model with countries with high immigration, a one-percentage-point increase in this variable determining a 1.35% decrease in the number of immigrants. As an exception, NEET rate was kept in the high-immigration model, having a p-value of 0.15. In comparison with the EU-27 model, this indicator presented a higher impact in the low-immigration model, becoming its strongest factor. Finally, old age dependency ratio had a significant influence on both models but lost a part of its significance. However, this indicator exerted the most substantial effect on immigration in the high-immigration model, a one-percentage-point surge in old age dependency ratio leading to a 3.77% decline in the number of immigrants.

Table 1. *Results of Arellano-Bond models*

Variable	EU-27 model	High immigration flow model	Low immigration flow model
lag (log_immig, 1)	0.5875*** (0.1207)	0.3798* (0.2276)	0.4999*** (0.118)
gdp_cap_growth	0.0239*** (0.0056)	0.0289*** (0.0059)	0.014** (0.0059)
lab_cost_c	0.0102** (0.004)	0.0135** (0.0041)	
neet_r	-0.0539*** (0.0177)	-0.0305 (0.0216)	-0.075*** (0.0213)
old_age_dep	-0.0533*** (0.0186)	-0.0377* (0.0214)	-0.0595** (0.0273)
Sargan test p-value	0.153	0.437	0.159
Autocorrelation test (1) p-value	0.014	0.041	0.042
Autocorrelation test (2) p-value	0.546	0.4	0.804
Wald test p-value	0.000	0.000	0.000
Number of observations	268	90	178
Number of countries	27	9	18
Number of years	12	12	12

Note: *** significant at a threshold of 1%, ** significant at a threshold of 5%, * significant at a threshold of 10%.
Source: authors' own computation in RStudio.

The most notable finding of this study consists in the asymmetric impact of labour cost changes on intra-EU migration between the high versus low inflow countries. Based on the two comparative models, we found that for countries with high immigration flows, labour cost plays as a significant driver in the EU-27, while it becomes statistically irrelevant for the low-immigration group. On the one hand, the positive elasticity in high-immigration flow model might seem counter-intuitive from a firm's perspective, but could suggest that from a migrant's perspective, rising labour costs act as a "pull" factor, as it signals prosperity and better compensation packages in the destination countries. This is particularly the case of Germany or Spain, which dominate the immigration network and where the upward trend in labour costs in the post-pandemic rebound reflects attractive wage adjustments for migrant EU workers.

On the other hand, in the low-immigration flow model, labour cost changes were found to be insignificant, suggesting that for these countries, the migrant's decision is governed by

structural barriers rather than marginal cost or wage changes. Specifically, the high negative impact of the NEET rate and old age dependency in this group indicates that labour market rigidity and demographic decline are far more critical factors for potential immigrants than the nominal labour cost dynamic.

5. Conclusions

Through this paper we intended to investigate the main factors that trigger or inhibit migration inflows around the European Union using Arellano-Bond dynamic panel models. Our findings highlight as the main significant "pull" factor the GDP per capita growth and labour cost changes, while as "push" factors the NEET rate and old age dependency ratio.

As main research question of the paper we were particularly interested in finding out the presence of any divergences in terms of "pull" and "push" factors on intra-EU migration between the high versus low inflow countries. Our findings underscore that the factors attracting migrants are not uniform across the Union. The most striking finding of this divergence lies in the role of labour cost changes. In high-immigration countries, rising labour costs act as a significant "pull" factor, as it might positively signal wage growth and market vitality in the destination countries. Conversely, in low-immigration countries, this factor loses its significance, suggesting that markets in this group of countries are governed by more rigid structural barriers.

Moreover, the research highlights the network persistence, as the presence of the lagged dependent variable across models underscores the path-driven phenomenon of migration, where previous flows facilitate future ones through already established social and economic networks. In terms of economic context, GDP per capita growth remains a universal "pull" factor, with its strongest influence observed in preferred destination countries. Finally, in terms of structural inhibitors, the NEET rate and old age dependency ratio act as powerful negative factors to immigration. The particularly high negative impact of the NEET rate in low-immigration states suggests that poor youth integration and demographic ageing create a "push" effect that nominal economic gains cannot easily offset.

In conclusion, EU migration policy should address the asymmetric impact of labour costs on intra-EU migration through targeted interventions: high-inflow states must manage the integration challenges of rapid growth, while low-inflow states should focus on domestic structural reforms aiming to reduce NEET rates and to improve their overall attractiveness and labour market resilience.

The main limitations of the study are twofold. First, there is the issue of data availability and the methodological restrictions of the Arellano-Bond model to use only a limited number of instruments in the analysis. Second, dynamic panel data estimators are highly sensitive to the specific model specification and the choice of instruments, leading us to a trade-off between having a panel model with higher explanatory power by including the lagged dependent variable in the explanatory list, and dealing with the "Nickell bias" on samples with relatively balanced panels in terms of cross-units and time periods.

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