Innovation and Migration in the Mediterranean Region during 1972-2017: A Panel Data Analysis

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Abstract: *This study aims to analyze the relationship between innovation and migration among 15 Mediterranean countries (Algeria, Morocco, Egypt, Tunisia, Syrian, France, Italy, Germany, Spain, Greece, Turkey, United Kingdom, Malta, Portugal, and palestine) during the period 1972 - 2017. Theoretically, this paper presents the connection between Migration and Innovation through the osmosis theory of human migration. Empirically, a Mediterranean data about migration and innovation between the 15 countries during the studied period has been collected. Based on the cointegration and the panel Granger Causality Tests, migration and innovation relationship has been analysed. The results have detected a long run relationship between the two variables. Moreover, the FMOLS and DOLS results have confirmed the existence of a long run relationship between innovation and migration. Furthermore, the Granger Causality Test results have indicated that the causality direction between innovation and migration is sensitive to innovation level within the Mediterranean countries. These findings mean, economically, that innovation is more likely to affect migration in the Mediterranean region during the period 1972 - 2017.*

Keywords: Innovation, International Migration, Mediterranean Countries, FMOLS, DOLS, Cointegration, Granger Causality.

JEL Classification O3 J6 C23

ملخص : تهدف هذه الدراسة إلى تحليل العلاقة بين الابتكار والهجرة بين 15 دولة متوسطية (الجزائر، المغرب، مصر، تونس، سوريا، فرنسا، إيطاليا، ألمانيا، إسبانيا، اليونان، تركيا، المملكة المتحدة، مالطا، البرتغال، وفلسطين) خلال الفترة 1972-2017. نظريًا ، تعرض هذه الورقة العلاقة بين الهجرة والابتكار من خلال نظرية الأسموز للهجرة البشرية. تجريبياً ، تم جمع بيانات حول الهجرة والابتكار ل 15 دولة متوسطية خلال فترة الدراسة. و بالاعتماد على اختبار التكامل المشترك واختبارات السببية غرانجر Granger، تم تحليل علاقة الهجرة والابتكار. أظهرت النتائج المتحصل عليها عن وجود علاقة طويلة المدى بين المتغيرين. علاوة على ذلك ، أكدت نتائج FMOLS و DOLS وجود علاقة طويلة الأمد بين الابتكار والهجرة. كما أشارت نتائج اختبار السببية غرانجرGranger إلى أن الاتجاه السببي بين الابتكار والهجرة حساس لمستوى الابتكار في دول البحر الأبيض المتوسط. وتعني هذه النتائج ، اقتصاديًا، أن الابتكار من المرجح أن يؤثر على الهجرة في منطقة البحر الأبيض المتوسط خلال الفترة 1972-2017.

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الكلمات المفتاحية : الابتكار، الهجرة الدولية، دول البحر الأبيض المتوسط، FMOLS، DOLS، التكامل المشترك ، سببية Granger.

1.Introduction

During the last decades, a growing prosperity in technologies and human development have characterized the world. These rapid advances in technology can have enormous benefits and serious downsides. On the one hand, this high technology is mostly concentrated in the developed countries and on the other, such concentration servs as a magnet that pull the actors that can develop technology in the developing countries. In 2017, the countries with high income have counted 4256 researchers per million inhabitants, whereas the countries with middle income have counted around 262, and only 154 researchers are registered in the low-income countries (United Nations , 2021, p. 47).

In the same vein, the UNCTAD technology and innovation report (2021) attested that despite the speedy progress in the high technology added value for some emerging countries such as China, Vietnam and India during the period 2000 – 2016, the gap between the developed and the developing countries is the same. Furthermore, the less developed countries have registered a 17-9 % decrease in their share. Recently, the Global Innovation Index (GII) revealed that several African countries have achieved great progress in terms of innovation. Morocco, for example, has made a big step towards the top to 77th. In addition, eight economies in the Mediterranean region moved up, notably Algeria 120th and Egypt 94th. (Global innovation index, 2021, p. 4)

The Mediterranean region is characterized by a large gap of disparities. The North Mediterranean countries are, in general, highly developed and very advanced in technology and innovation, while the countries of the South still struggling with the fundamental economic problems such as employment, inflation, poverty, health and education.

For long time, these human and economic imbalances have led to enlarge the economic gap between the two coasts of the Mediterranean the fact that has fostered migration pressures. Despite this gap between the countries of the southern and those of the northern shore of the Mediterranean, proximity has strengthened interactions between these countries in terms of trade and production factors movements.

Innovation is defined as the process by which, firms create new products, process, services, technologies, or new ideas. It can also be defined as the knowledge production function, in which the factors represent the spent capitals on R&D combined with, both the appropriate capital and the skilled workforce (OZGen, et al., 2011).

Regarding the relationship between innovation and migration. Theoretically, on the one hand, innovation can be considered as a factor of attraction of migration (pull) from the countries of the southern shore of the Mediterranean. On the other hand, this same migration can contribute to the increase of innovation in the countries of the northern shore and translated into a push factor.

This research focus on the relationship between innovation and migration in the Mediterranean countries over the period 1972 - 2017. in this context, we have question to answer: is there a relationship between innovation and migration within the Mediterranean countries?

In practice, the objective is to check the hypothesis that innovation is a cause of migration or migration boost the innovation in the Mediterranean countries.

In this paper, the causality between innovation and migration will be examined. To do so, the first section will present a review of literature about the relationship between migration and innovation. Then, the new logic of the osmosis theory of human migration will be presented and considered as the theoretical basis of this study. The second section will overview the existing empirical studies about migration and innovation, with a focus on the innovative new researches. The third section will provide an explanation of the methodology and data, in addition to the Panel Cointegration and Granger Causality estimations. In section four, the main finding of this study will be concluded, and the statistical and economic interpretation of the econometric results will be discussed.

2. Theoretical background

Despite the importance of the migration/innovation nexus in the economic debate of both the origin and the host countries, there is a scarce literature that have combined these two dimensions. For a long time, the neoclassical theories of international migration have considered the individual migration decision as an act based on wage differentials and the probability of finding a job (Lewis (1954), Harris et Todaro (1970)). However, the economists view of the causes and consequences of labor migration has changed with the emergence of the new economics of labor migration (NELM). According to Stark and Bloom's (1985) People choose to move for less deprivation, which means a higher absolute income. According to the authors, when the hypothesis of heterogeneous workers is linked to the imperfect information of qualifications, the qualification level (skills level) plays an important role in migration motivation.

Recently, the osmosis theory has reconciled the different disciplines and proposed a unifying model that explains the root drivers of human migration (Djelti, 2017, p. 52). According to this theory, migration pressure is the engine of migration and border permeability is the regulator. The degree of permeability is defined by networks and control policies, while migration pressure is calculated based on the natural determinants of human migration. More precisely, water, climate, security, and population density represent the natural determinants of human migration. After the great transformation, the natural determinants have evolved into several sub determinants. Among the sub determinants we have innovation as an important factor that serves to increase the pressure in the countries where it is concentrated. Innovation affects the attraction of labor from the underdeveloped countries.

For long time, labor mobility has not been considered in the economic theory, especially in the international trade theories. In this logic, we have framed our literature review linking international migration to innovation. Put it differently, the economic effects of migration on host countries, in the context of the mobility of the factors of production will be considered as our main focus.

Economists have investigated the impact of migration on competitiveness, complementarity, public spending, and social protection in the receiving countries. In this context, Borjas studies have shown that migration has negative effects on the economies of the receiving countries. Theoretically, migration influences innovation directly through the contributions of immigrants to research and indirectly through spillover effects on individual researchers, the formation of specialized research groups, and the provision of complementary skills such as management and entrepreneurship
(Hunt & Gauthier, 2009).

In the same vein, migration has dynamic beneficial effects on the economies of the host countries through new investments, knowledge exchange, product variety, and consumption externalities associated with the ethnic variety of the population (Ottaviano and Peri (2012), Bellini et al (2008)).

Migration can also positively affect innovation in the host countries through increasing population size, population density, and local demand. Mazzolari and Neumark (2009) suggest that this demand can be met by additional imports but also by a large level and variety of local production (Hunt & Gauthier, 2009), which can be interpreted by a need for additional creativity that boosts innovation in these host countrie.

3.Empirical Studies

Like the theoretical studies, there are little empirical studies that have investigated the relationship between migration and innovation. Zucker and Darby (2006), have studied the geographic movements of scientists in the US and the other countries with higher technology level. The results have revealed a strong link relating the geographical movement of star scientists and the countries with high concentration of technological level. In general, the study results have shown that the scientists prefer to move to the high-tech areas, in order to obtain support and take advantages from the existing opportunities.

Based on the variations in the annual changes in the H-1B visa system, Kerr and Lincoln (2010), have shown that the increase in this type of immigration boosts innovation through immigration rather then the other factors. Likewise, using a 1940–2000 international panel, Hunt and Gauthier Loiselle (2009) have examined the impact of skilled immigrants on innovation. The results have shown that highly skilled migrant affect positively the number of patents in the USA.

Ozgen et al., (2011) have estimated the effect of the number, qualification, and immigration diversity on innovation in the host countries using a panel data of 170 regions in Europe during the periods 1991-1995 and 2001-2005. In this study, innovation is measured by the number of patents per million inhabitants. The results have revealed that innovation is, clearly, a function of regional accessibility, industrial structure, human capital, and GDP growth. In addition, patent applications are positively affected by the diversity of the immigrant community at a minimum level. More precisely, the results have shown that an increase of 0.1 in the divisional index of regions increases the number of patent applications by 0.5 per million inhabitants, which represents around 2%. Moreover, the results have revealed that although the average skill level of immigrants affects patents, a higher number of foreigners in the population is not necessarily an increase in the number of patents.

Some other studies, such as Peri et al., (2013) have demonstrated the positive effect linking migration and innovation. According to them, at the regional level, the expansion of the H-1B program, in specific localities, increases productivity in the entire region. Based on these results, the economists have tried to explain the existence of differences between their results and the other studies. According to the authors, the effect of migration on innovation is more likely to be important locally.

Another study established by Kerr et al., (2014) has demonstrated that migration is a very important driver of innovation in the high-tech countries, especially in the United States. According to the authors, the analysis has shown that the presence of migrants in the fields of science, technology, engineering, and mathematics (STEM), and the considerable number of migrants who have become superstars are evident.

Bahar et al., (2018) have examined the relationship between international migration flows and innovation dynamics in the origin and the destination countries. Using a gravity model, the authors have estimated the stock of migration, and have reduced the possible endogeneity issues. The results have shown that 3.5% are more likely to become technology producers for each 100% increase in the stock of immigrants (around 30,000 people) from countries ranked in the same technology level. The authors have highlighted the robustness of the results for skilled migrants, driven entirely by international migration than by trade or investment. The results have revealed that those migrants facilitate the diffusion of knowledge between countries.

Claudio Fassioa et al., (2019) have studied the effects of skilled migration on innovation in the European industries (UK, Germany and France) during the period 1994 – 2005. The study has concluded that the Highly educated migrants affect positively innovation. However, these effects differ across industries. Put it simply, the industries with low levels of overeducation, high levels of FDI and Trade openness are, strangely, affected in addition to the industries with higher ethnic diversity. Moreover, the effect of a single skilled immigrant represents about one-third than the one of the skilled natives.

Bratti and Conti (2018) have studied the effect of immigration on innovation in Italy with a focus on the effect of skilled migrants on innovation. The results have demonstrated a positive and significant correlation between the share of immigrants and the patent applications that emerge. Furthermore, the model estimation of medium, high, and low skilled migrants have showed that a 1% increase in high and medium skilled migrants in the population increased patenting per capita by 12%.

In a new study, Pudryk et al., (2021) have examined the following hypothesis: net migration is it negatively/positively influenced by the decreasing/increasing level of innovation and government efficiency in some European countries (Bulgaria, Croatia, Lithuania, Latvia, Poland, and Romania) during the period 2011-2018. The results have revealed that migration rate is significantly affected by innovation development and governance effectiveness (political stability and the absence of violence or terrorism, regulatory quality, voice, and accountability).

More Recently, Djelti (2021) has studied the relationship between migration and innovation. The study is based on a new theoretical logic and a panel data for 13 Mediterranean countries during the period 1962-2012. The results have argued that innovation is strongly correlated with migration at the long term, with the existence of causal relationship from innovation to migration at short term. Moreover, the highest level of innovation in the countries of the northern shore of the Mediterranean attract emigration from the southern shore of the Mediterranean.

In general, these studies have shown that migrant play an important and positive role on innovation level of destinations countries (Zucker and Darby (2006); Djelti (2021);

Pudryk et al (2021)). For example. Zucker and Darby (2006), has found that the scientists prefer to move to the high-tech areas, in order to obtain support and take advantages from the existing opportunities. More recently, Djelti (2021)., looked at the relationship between migration and innovation differently. According to him, innovation is an important driver of migration in the Mediterranean region. Other studies have shown that migration has positive and significant effects on innovation level of destination countries (Hunt and Gauthier Loiselle (2009); Ozgen et al (2011) (2011); Peri et al (2013); Kerr et al (2014); Bahar et al (2018); Claudio Fassioa et al (2019); Bratti et conti (2018)). For example, Kerr et al (2014), have found that an important number of migrants who have become superstars in the US, thanks to the presence of migrants in the fields of science, technology, engineering, and mathematics (STEM).

4.Data and Methodology

In this article, the relationship between Migration and innovation using the net migrants and the innovation by number of patents will be estimated. In practice, the used data will be combined based on the world bank database. The estimated panel data considers 15 Mediterranean countries (Algeria, Morocco, Egypt, Tunisia, Syrian, France, Italy, Germany, Spain, Greece, Turkey, United Kingdom, Malta, Portugal,and Palestine) for the period of 1972 to 2017.

In order to address the relationship between innovation and migration in the long term, The Angel and Granger cointegration approach will be used. The estimation will be divided in tow steps: in the first one, the integrated order of the variables based on a panel will be identifies. In the second step, the unit root panel will be tested. According to Engel and Granger (1987) if the results show that the considered series are integrated in the same order, so it is possible to say that there is some long run relationship (Cointegration).

Based on the panel granger analysis. The panel causal relationship between innovation and migration will be tested in order to define the direction of causality between the variables.

5.Empirical results

The proposed model is presented in the following general equation:

$$LOGMIG_{it} = a_{0i} + b_i LOGINNOV_{it} + e_{it}$$

Where:

LOGMIG: represents net migration

t: is the period

i: is the country

a: is a constant

LOGINNOV: represents innovation the innovation level

5.3 The optimal lag selection

For this analysis, it is necessary to determine the optimal delays.

Table (1): The optimal lag selection

LAG	LOGL	LR	FPE	AIC	SC	HQ
0	-211.5470	NA	0.394450	4.745490	4.801041	4.767891
1	-91.82157	231.4692	0.030140	2.173813	2.340467	2.241017
2	-81.21526	20.03414*	0.026030*	2.027006*	2.304762*	2.139014*
3	-79.98365	2.271640	0.027692	2.088526	2.477385	2.245336
4	-79.13155	1.533783	0.029720	2.158479	2.658441	2.360093

Note: * indicates the delay order

Source: (EViews12)

Table 01 shows that based on the LR, FPE, and AIC criteria, the optimal number of lags is 2. In general, three out of five tests show that the optimal number of lags is 2. Economically speaking, this means that this year's migration is influenced by two periods ahead (t-2).

5.4 Unit root tests

In practice, the LLC, IPS, BRT and MW panel unit root test are used for the identification of series integration order. The results are presented in the following table.

Methods	ADF – Fisher Chi-square	PP – Fisher Chi-square	Im, Pesaran and Shin W-stat	Breitung t-stat	Levin, Lin & Chu t*	Hadri Z-stat	Heteroscedastic Consistent Z-stat
LOGINNOV			**Level**				
None	10.9185 (0.9994)	12.7247 (0.9976)	-	-	3.42612 (0.9997)	-	-
Individual intercept	16.2860 (0.9802)	39.5532 (0.1138)	2.75158 (0.9970)	-	-0.85424 (0.1965)	6.47451 (0.0000)	6.29884* (0.0000)
Individual intercept and trend	47.5122* (0.0222)	50.1780* (0.0119)	-0.66238 (0.2539)	6.07087 (1.0000)	-9.21453* (0.0000)	7.06582 (0.0000)	9.35807* (0.0000)
			1st difference				
None	104.442* (0.0000)	102.880* (0.0000)	-	-	-7.86962* (0.0000)	-	-
Individual intercept	73.0301* (0.0000)	77.3675* (0.0000)	-3.74331* (0.0001)	-	-8.28062* (0.0000)	5.62043 (0.0000)	3.52607* (0.0002)
Individual intercept and trend	42.1578 (0.0694)	77.0971* (0.0000)	-0.38679 (0.3495)	3.58189 (0.9998)	-13.3749* (0.0000)	31.4211 (0.0000)	26.0764* (0.0000)
LOGMIG			**Level**				
None	17.4592 (0.9666)	20.9021 (0.8909)	-	-	0.80502 (0.7896)	-	-

Individual intercept	44.2223* (0.0455)	42.7474 (0.0617)	-1.32840 (0.0920)	-	-4.38635* (0.0000)	1.99319 (0.0231)	3.79845* (0.0001)
Individual intercept and trend	41.7579 (0.0751)	36.8572 (0.1813)	-0.25015 (0.4012)	2.05374 (0.9800)	-6.96029* (0.0000)	39.1823 (0.0000)	19.1701* (0.0000)
			1st difference				
None	151.499* (0.0000)	146.412* (0.0000)	-	-	-12.4993* (0.0000)	-	-
Individual intercept	77.4973* (0.0000)	81.0606* (0.0000)	-3.75073* (0.0001)	-	-9.06809* (0.0000)	8.62279 (0.0000)	5.39063* (0.0000)
Individual intercept and trend	39.6076 (0.1127)	69.9600* (0.0000)	-0.30321 (0.3809)	4.10081 (1.0000)	-4.45704* (0.0000)	40.0206 (0.0000)	29.2248* (0.0000)

Table (2): Unit root test for variables in 15 Mediterranean countries.

Note: * denote the null hypothesis of unit root is rejected at 5% level.

Source: (Our elaboration based on the EViews12 outputs)

5.5 Co-integration test

Based on the unit root tests results, the panel co-integration test is elaborated. The results are presented in the following table.

Table (3): Co-integration tests for the 15 Mediterranean countries.

Method	***Common AR coefs*** *(Within-dimension)*			***Individual AR coefs*** *(Between-dimension)*		
LOGMIG LOGINNOV	Test	Statistic	Prob.	Test	Statistic	*Prob.*
Pedroni 1999	Panel v-Statistic	1.982680	0.0237*	Group rho-Statistic	0.142410	*0.5566*
	Panel rho-Statistic	-3.103619	0.0010*	Group PP-Statistic	-4.822358	*0.0000**
	Panel PP-Statistic	-4.122376	0.0000*	Group ADF-Statistic	-3.107148	*0.0009**
	Panel ADF-Statistic	-2.160966	0.0153*			
Pedroni 2004	Panel v-Statistic	0.117670	*0.4532*			
	Panel rho-Statistic	-1.723805	*0.0424*			
	Panel PP-Statistic	-3.656709	*0.0001**			
	Panel ADF-Statistic	-2.660872	*0.0039**			

Significance at *1%

Source: (EViews12)

Regarding the within-dimension relationship, table 4 shows the results of eight Pedroni cointegration statistical tests. The probability result reveals that Six values are less than 5% (Panel PP-Statistic, Panel ADF-Statistic, and Panel PP-Statistic). This indicates the existence of inter-variable cointegration. In other words, for the between-dimension tests, two probability values are less than 5% (Group PP-Statistic and Group ADF-Statistic), which demonstrates the existence of an intra-variable cointegration relationship in the model. Therefore, the results obtained shows the importance and the strength of the panel cointegration tests, compared to the time series tests.

For the next steep, we move to the estimation of the pooling relationship, in the long run. Based on Pedroni ((1999); (2001)) and Mark and Sul (1954), the FMOLS and DOLS estimators give Multiple results. It is worth noting that the DOLS method has the possibility to minimize the freedom degrees for the variables studied, including leads and lags, which tend to weaker the estimation results. For our sample we have an important size which can revealed an acceptable DOLS results.

5.6 The long run relationship for the Mediterranean countries

The long run relationship estimation results are presented in the following table

Table(4): Estimated long run relationship for 15 Mediterranean countries.

	DOLS		FMOLS	
Dependent variable LOGMIG	LOGINNOV		LOGINNOV	
Heterogeneous panel	Pooled estimation	Grouped estimation	Pooled estimation	Grouped estimation
	0.338857 (0.0006)	3.021129 (0.0000)	-0.162998 (0.0509)	2.788316 (0.0000)

Significance * 1%, **5%

Source: (EViews12)

The results presented in table 04 for FMOLS/DOLS show that the coefficients of the heterogeneous panel pooled estimation and grouped estimation are positive and significant at 5%. The obtained results suggest that 1% increase in innovation increases the migration by 0.338857% and 3.021129%.

5.7 Panel Granger causality

We have confirmed that migration is Co-integrated in the long-term with innovation. Now we execute Granger Causality test to examine the causal relationship between the variables.

Table(5): panel causality results.

2 Lags		**INNOV**
MIG	←	6.85285* (0.0015)
		1.99888 (0.1402)

Note: * indicate the rejection of the null hypotheses at 5% level (No causality).

Source: (EViews12)

The Ganger causality results presented in table 05 shows that there is a causal relationship and effect way from innovation to migration for different Mediterranean countries. Moreover, the causality from migration to innovation is not significant, which means that there is no causal relationship from migration to innovation. Therefore, the movement of migration is sensitive to innovation level in the Mediterranean countries. The results obtained is very close to that estimated by Zucker and Darby (2006); Pudryk et al (2021) and Djelti (2021), who reported an important effect from innovation to migration for the countries of Mediterranean region.

6.Conclusion

The need to understand drivers of migration and to define the relationship between migration and innovation. a review of literature about the relationship between migration and innovation have been presented including the classical theories and the new logic of the osmosis theory of human migration. After that we have presented an overview of existing empirical studies about migration and innovation.

For the next steep, we have examined the relationship between migration and innovation between 15 Mediterranean countries (Algeria, Morocco, Egypt, Tunisia, Syrian, France, Italy, Germany, Spain, Greece, Turkey, United Kingdom, Malta, Portugal, and Palestine) for the period 1972 - 2017. Empirically, this research has used the cointegration and the granger causality testing procedures for panel data.

First, the estimation of cointegration relationship using the cointegration test has been proceeded. The obtained results have shown the importance and the strength of the panel cointegration tests. Second, the FMOLS and DOLS tests have confirmed the existence of a long run relationship between innovation and migration. This means that innovation and migration are positively correlated in the Mediterranean basin.

Economically, the results obtained confirms that innovation is an important factor of migration movement between the Mediterranean countries. Moreover, the level of innovation is a driver of migration flows between countries within the Mediterranean region.

The empirical results of granger causality showed that the causality direction between innovation and migration is sensitive to innovation level in the Mediterranean countries. The results have confirmed that innovation had a statistically significant effect on the migration.

Economically, the high level of innovation in some countries act as an atracttive factor for immigrants from other countries among the Mediterranean region.Therefore, the migration flows increase towards the countries With high levels of innovation.

These findings are in line with most of recent studies ((Djelti (2021); Pudryk et al (2021); Bahar et al (2018); Kerr et al (2014); Zucker et darby (2006)).

It should be noted that the result obtained is strongly supported by the results presented by Djelti (2021), who reported an existence of a long run relationship between innovation and migration with the existence of causality direction from innovation to migration.

Overall, migration between the southern shore and the northern shore is correlated with the level of innovation. Therefore, our findings confirm the importance of innovation as a sub-deteminant of migration in the Mediterranean region.

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Appendices

Appendix (I):

VAR Lag Order Selection Criteria
Endogenous variables: LOGMIG LOGINNOV
Exogenous variables: C
Date: 03/09/22 Time: 20:28
Sample: 1972 2017
Included observations: 90

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-211.5470	NA	0.394450	4.745490	4.801041	4.767891
1	-91.82157	231.4692	0.030140	2.173813	2.340467	2.241017
2	-81.21526	20.03414*	0.026030*	2.027006*	2.304762*	2.139014*
3	-79.98365	2.271640	0.027692	2.088526	2.477385	2.245336
4	-79.13155	1.533783	0.029720	2.158479	2.658441	2.360093

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix (II):

Pedroni Residual Cointegration Test
Series: LOGMIG LOGINNOV
Date: 03/09/22 Time: 21:45
Sample (adjusted): 1972 2017
Included observations: 150 after adjustments
Cross-sections included: 15
Null Hypothesis: No cointegration
Trend assumption: No deterministic intercept or trend
User-specified lag length: 2
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	1.982680	0.0237	0.117670	0.4532
Panel rho-Statistic	-3.103619	0.0010	-1.723805	0.0424
Panel PP-Statistic	-4.122376	0.0000	-3.656709	0.0001
Panel ADF-Statistic	-2.160966	0.0153	-2.660872	0.0039

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	0.142410	0.5566
Group PP-Statistic	-4.822358	0.0000
Group ADF-Statistic	-3.107148	0.0009

Dependent Variable: LOGMIG
Method: Panel Fully Modified Least Squares (FMOLS)
Date: 03/09/22 Time: 22:05
Sample (adjusted): 1977 2017
Periods included: 9
Cross-sections included: 15
Total panel (balanced) observations: 135
Panel method: Grouped estimation
Long-run covariance estimates (Bartlett kernel, Newey-West fixed bandwidth)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGINNOV	2.788316	0.114613	24.32809	0.0000

R-squared	-44.480583	Mean dependent var	6.702261
Adjusted R-squared	-44.480583	S.D. dependent var	0.484478
S.E. of regression	3.267285	Sum squared resid	1430.471
Long-run variance	4.147465		

Dependent Variable: LOGMIG
Method: Panel Dynamic Least Squares (DOLS)
Date: 03/09/22 Time: 22:07
Sample (adjusted): 1982 2012
Periods included: 7
Cross-sections included: 15
Total panel (balanced) observations: 105
Panel method: Grouped estimation
Fixed leads and lags specification (lead=1, lag=1)
Long-run variances (Bartlett kernel, Newey-West fixed bandwidth) used for individual coefficient covariances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGINNOV	3.021129	0.204688	14.75967	0.0000

R-squared	-44.635966	Mean dependent var	6.694293
Adjusted R-squared	-79.443058	S.D. dependent var	0.549551
S.E. of regression	4.928922	Sum squared resid	1433.362
Long-run variance	1.846895		

Dependent Variable: LOGMIG
Method: Panel Fully Modified Least Squares (FMOLS)
Date: 03/09/22 Time: 22:12
Sample (adjusted): 1977 2017
Periods included: 9
Cross-sections included: 15
Total panel (balanced) observations: 135
Panel method: Pooled estimation
Cointegrating equation deterministics: C
Coefficient covariance computed using default method
Long-run covariance estimates (Bartlett kernel, Newey-West fixed bandwidth)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGINNOV	-0.162998	0.082662	-1.971868	0.0509

Dependent Variable: LOGMIG
Method: Panel Dynamic Least Squares (DOLS)
Date: 03/09/22 Time: 22:12
Sample (adjusted): 1982 2012
Periods included: 7
Cross-sections included: 15
Total panel (balanced) observations: 105
Panel method: Pooled estimation
Cointegrating equation deterministics: C
Fixed leads and lags specification (lead=1, lag=1)
Coefficient covariance computed using default method
Long-run variance (Bartlett kernel, Newey-West fixed bandwidth) used for coefficient covariances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGINNOV	0.338857	0.091736	3.693816	0.0006

R-squared	0.968130	Mean dependent var	6.694293
Adjusted R-squared	0.924671	S.D. dependent var	0.549551
S.E. of regression	0.150830	Sum squared resid	1.000985
Long-run variance	0.008295		

Appendix (III):

Pairwise Granger Causality Tests
Date: 03/09/22 Time: 22:58
Sample: 1972 2017
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
LOGINNOV does not Granger Cause LOGMIG	120	6.85285	0.0015
LOGMIG does not Granger Cause LOGINNOV		1.99888	0.1402