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UNCOVERING REGIONAL TYPOLOGIES IN EUROPE IN TERMS OF INTERREGIONAL REMITTANCES FLOWS

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Abstract. Information regarding remittances flows across European space is scarce, and available only at the national level. Such a scarcity limits the capacity to undertake the required analyses and to derive the corresponding conclusions on the interrelations among European regions. The paper uncovers regional typologies in Europe in terms of interregional (NUTS 2 level) remittances flows in year 2018, the year prior to the eruption of the COVID-19 pandemic. To this end, the paper compiles and utilizes O-D matrices for interregional remittances flows in Europe, compiles and utilizes tailor-made clustering indicators and employs the k-means clustering technique.

Keywords: Europe, interregional remittances flows, k-means clustering, O-D matrices, regional typologies.

Introduction

Europe is gradually moving from a 'space of States' to a 'State of spaces' (Karanika & Kallioras, 2018) and from a 'space of places' to a 'space of flows' (Castells, 2020). In a nutshell, the pure essence of the European economic integration process is the gradual 'thinning' of (the artificial) border impediments (Kallioras, Topaloglou & Venieris, 2009). Obviously, crossing borders involves formalities that cost time and money, thus reducing interaction in terms of trade, investment and migration (Petrakos & Topaloglou, 2008). In addition, borders are often associated with the existence of different cultures and perceptions, imposing non-pecuniary obstacles to interaction (Topaloglou, Kallioras, Manetos & Petrakos, 2005). Thus, as the process of European economic integration is in full swing, European territories have been experiencing a period of unprecedented change (Brülhart, Crozet & Koenig, 2004; Crescenzi, Pietrobelli & Rabelloti, 2014), being transformed into integral parts of the European economic space (Petrakos, Rodriguez-Pose & Rovolis, 2005; Petrakos, Kallioras & Anagnostou, 2011). Yet, although economic integration has greatly enhanced the mobility of products, people, and money this does not imply the ubiquity

of economic activity (Scott, Agnew, Soja & Storper, 2001). In fact, such 'stickiness' (McCann, 2008; Rodriguez-Pose & Crescenzi, 2008) may even reinforce spatial externalities (Kemeny, 2011). Thus, it becomes apparent why geography 'matters' so much (Gertler, 2003).

The emerging European reality necessitates the thorough understanding of the spatial dynamics that are generated and / or reproduced within the framework of the European economic integration process. Apparently, access to (high-quality) data is a necessary condition for undertaking the required analyses and deriving the corresponding conclusions on the interrelations among European regions. Unfortunately, data on flows is scarce and available only at the national level. Data on interregional flows, practically, do not exist. Thus, due to this limitation, important issues regarding the success and the impact of the European economic integration process and policies remain unexplored and unsolved, for both scholars and policymakers. This is an important drawback, especially in the light of the global mega-trends that are currently taking place.

The paper contributes to the discussion on interregional flows in Europe and uncovers regional typologies in terms of interregional (NUTS 2 level) remittances flows. To this end, the paper compiles and utilizes origin-destination (O-D) matrices for interregional remittances flows in Europe and employs the k-means clustering technique. It should be noted that European regions are classified based on interregional remittances flows *per se* (i.e., construction of tailor-made clustering indicators), and not on already-existing regional typologies. It should, also, be noted that the analysis is conducted separately for incoming and outgoing remittances flows. The analysis covers 329 European regions (i.e., regions from the EU, the UK, Switzerland, Liechtenstein, Norway, and Iceland)[1] and focuses on the year 2018, the year prior to the eruption of the COVID-19 pandemic. The findings of the paper offer an, up-to-now, unknown layer of analysis corresponding to interregional remittances flows in Europe, providing insight to both theory and policymaking.

The current section of the paper is introductory. The next section discusses on the definition of remittances and the determinants of remittances flows. The third section describes the methodology for the compilation of the interregional O-D matrix, the construction of the tailor-made clustering indicators, and the k-means clustering technique for the classification of European regions. The penultimate section conducts and comments on the empirical analysis. The last section of the paper offers the conclusions and provides a recommendation to international organizations and statistical agencies as regards data provision.

Definition of Remittances and Determinants and Growth Impact of Remittances Flows

Definition of Remittances

Remittances 'represent household income from foreign economies arising mainly from the temporary or permanent movement of people to those economies' (IMF, 2009, p. 272). Remittances may flow either through formal channels (such as e-banking) or through informal channels (such as money carried across borders). The main components relating to remittances in a national Balance of Payments (BoP) are personal transfers and compensation of employees (Azizi, 2019). Personal transfers refer to those transactions to resident households from non-resident households,

[1] Regions under participation belong to countries that participate in the ESPON (European Spatial Planning Observation Network) Programme. ESPON is an EU-funded programme that supports public authorities responsible for designing territorial policies with quality expertise.

while compensation of employees refers to the income of border, seasonal, and other short-term workers who are employed in an economy where they are not resident and of residents employed by non-resident entities.

It is worth noting that the income of migrant workers will not be entirely transferred to their country of origin, because an important part of it will remain in the country in which they are working to meet their needs. In fact, literature highlights that the volume of remittances decreases with the length of stay (Merkle & Zimmermann, 1992; Bauer & Sinning, 2011; Sinning, 2011; *inter alia*). Factors influencing this decline, might be setting up a business on return, buying a house or when a migrant obtain a permanent resident status in the host country (Ghosh, 2006). It is, also, worth noting that a (statistical) problem with the definition of remittances is that it entails the risk of including earnings of locals working for foreign embassies and international organizations, which do not typically refer to remittances (Giuliano & Ruiz-Arranz, 2009; Clemens & McKenzie, 2018).

By default, remittances flows are international flows. Intraregional remittances flows, and interregional intranational remittances flows cannot be defined. Thus, remittances flows may theoretically describe solely as interregional international flows. Remittances flows retain an inverse relation with migration flows. This means that incoming remittances flows are related with the corresponding outgoing migration flows, and outgoing remittances flows are related with incoming migration flows.

Determinants of Remittances Flows

Literature indicates that migrants' motivations to remit are either pure altruism motivations or self-interested motivations (like investment or insurance). Since the nature of altruism is intangible, and therefore difficult to measure its impact on the behavior of migrants, indirect tests have, mostly, been used (Lucas & Stark, 1985; Agarwal & Horowitz, 2002; Bouhga-Hagbe, 2006; *inter alia*). Antoniades, Seshan, Weber and Zubrickas (2017) provide a direct test for measuring altruism, detecting a positive effect of altruism on remitting behavior only for migrants with explicit loan obligations. Azizi (2017) assumes that in the case that migrants remit to support their families in the country of origin, the main motivation is either pure altruism or self-interest. Particularly, in the case of pure altruism motivations, remittances should decrease in response to the growth phase in the home-country economy and increase in response to a corresponding recession, whereas in the case of self-interested motivations the results are the opposite compared to the ones for altruism. In the case of self-interest motivations, it is considered that migrants choose an individual remittance strategy either because of their intention to return to their home country or because of their willingness to investment in the community of their origin. Hagan-Zanker and Sieger (2007) and Carling (2008) highlight the incentive of tempered altruism (or enlightened self-interest), which is a mixture of the pure altruism and the self-interest incentives.

Regardless of the migrants' motivations to remit, remittances flows in a country depend, greatly, on the number of migrants (Freund & Spatafora, 2008). By and large, the greater the number of migrants the greater the flows of remittances to the home country. Based on this finding, the educational background of migrants has been shown to be a decisive factor in increasing remittances to the home countries, as more-educated people tend to send more money compared to less-educated ones, which, in fact, have far fewer opportunities to go abroad (Yoshino, Taghizadeh-Hesary & Otsuka, 2018). The income of migrants, and most importantly, the wage difference between the origin and the home country, has, also, been shown to be decisive factors in increasing remittances to the home countries (Bunduchi, Vasile, Comes & Stefan, 2019). Remittances, also, depend on the unemployment rate of the host country, as it turns out that migrants choose to mi-

grate to countries with low unemployment to have a better chance of a lasting work and a permanent salary (Hunt, 2006). Geographical distance may, also, impact on remittances as, by and large, the greater the distance the lower the remittances (Mayda, 2010).

Growth Impact of Remittances Flows

In the case that a migrant remit to his / her homeland with pure altruistic motive, remittances end-up in consumption. This is considered to be a loss of resources for promoting long-term growth (Glytsos, 2005). In the case that a migrant remit to his / her homeland with self-interest motive, remittances may finance growth of his / her home country. Even when remittances are not used for investment purposes, they may extend domestic production intended for consumption and production of intermediate goods necessary to support consumption growth (Perez-Saiz, Dridi, Gursoy & Bari, 2019). Giuliano and Ruiz-Arranz (2009) state that well-regulated financial markets may direct remittances to projects that increase growth rates by reducing transaction costs and stress that in cases of inefficient markets, remittances may help local firms alleviate credit constraints, starting productive activities and thus fostering economic growth.

Remittances, apart from helping in financial development of recipient countries, through the inflow of foreign exchange, bolster migrants home countries' economies by increasing investments in education, improving access to public goods, and creating multiplier effects through the increased amount of final consumption expenditure made by resident households (Gupta, Pattillo & Wagh, 2009). It is, also, evident, that they help in poverty reduction through financing infrastructures and business ventures (Yoshino, Taghizadeh-Hesary & Otsuka, 2018).

The claim that remittances inflows do not promote growth on a recipient economy is supported by the studies of Gapen, Chami, Montiel, Barajas and Fullenkamp (2009) and Rao and Hassan (2011), whose results indicate that remittances either have no impact at all on economic growth of the recipient country or their direct growth impact is insignificant. Moreover, it has been supported that remittances may have a negative impact on the development of recipient countries by reducing locals' interest in work and, consequently, by reducing labor supply (Perez-Saiz et al., 2019).

Methodology

Interregional O-D matrix

Information regarding remittances flows across European space is scarce, and only at the national level. Such a scarcity limits the capacity to undertake the required analyses and to derive the corresponding conclusions on the interrelations among European regions.

TWorld Bank (WB, 2022) and EUROSTAT (2022) provide only national-level data on remittances flows. Thus, according to the available data, only the compilation of country-to-country (C2C) O-D matrices[2] is feasible. To this end, the paper utilizes WB national-level remittances flows data, given that the corresponding EUROSTAT data refer to significantly less observations (i.e., country-pairs) due to more missing values. The WB dataset presents some missing values as well. Where possible, missing values were replaced through interpolation or extrapolation. Where not possible, the choice made is to leave the cells with missing values as they are (i.e., blank cells). In any case, WB data are filtered to verify that there are no 'problematic' data (e.g., due to typos). It is worth noting that WB estimates national-level remittances flows, utilizing migrant stocks, origin coun-

[2] See https://irie.espon.eu/ for details. C2C and R2R O-D matrices are provided for the years 2010 to 2018

tries' incomes and destination countries' incomes. Unfortunately, neither WB nor EUROSTAT provide regional-level data on remittances flows. Thus, due to non-available data, the compilation of region-to-region (R2R) O-D matrices is feasible subject to the 'regionalization' of the corresponding national-level data.

Ratha and Shaw (2007) provide estimates of national-level remittances flows based on three different allocation rules: a) weights based on migrant stocks abroad; b) weights based on migrant incomes, proxied by migrants' stocks multiplied by per capita income in the destination countries; and c) weights that consider migrants' incomes abroad as well as source-countries incomes. A shortcoming of the first allocation rule is that it assumes that each migrant sends the same number of remittances regardless the place that he / she lives and no matter what his / her income in the host country is. The larger variance of incomes across migrant-receiving countries limits the usefulness of this allocation rule. A shortcoming of the second allocation rule is that it assumes that each migrant sends a fixed share of his / her income, regardless of the level of that income. The third allocation rule is superior to the previous ones. However, it requires a large bulk of data.

Towards 'regionalizing' national-level data a methodology is development on the basis of the first allocation rule. The shortcoming of this rule is vanished in the particular case of European regions since the variance of regional incomes is not extremely high (since all European countries are included in the group of developed countries). Particularly, the paper adjusts the methodological suggestion of Petrakos and Kallioras (2007) and Kallioras and Petrakos (2010) and estimates regional-level remittances flows based on a formula that links national-level remittances flows and the share of regional migration flows to the corresponding national ones. The application of the method rests on a couple of assumptions: a) the ratio of regional to national incoming (outgoing) migration flows is equal to the ratio of regional to national outgoing (incoming) remittances flows; and b) remittances flows follow the corresponding pattern of migration stocks. The latter assumption must be made since C2C and R2R migration data that are utilized refer to flows and not to stocks.

Table 1. Formula for the estimation of regional-level remittances flows

$$REM_{rd\_ro,t} = REM_{cd\_co,t} * (\frac{MGR_{rd\_ro,t}}{MGR_{cd\_co,t}})$$
REM=remittances, MGR = migration, cd = destination country, co = origin country, rd = destination region (rd $\in$ cd), ro = origin region (ro $\in$ cd), t = time (i.e., year)

Source: authors' adjustment from Petrakos and Kallioras (2007), Ratha amd Shaw (2007), and Kallioras and Petrakos (2010).

To the end of 'regionalizing' the national-level remittances flows, the C2C O-D matrices and the R2R O-D matrices on incoming and outgoing migration flows compiled by IGSO PAS (Institute of Geography and Spatial Organization, Polish Academy of Sciences), within the framework of ESPON IRiE (Interregional Relations in Europe) Project, have been utilized. [3], Since available data on migration flows are inconsistent between countries of origin and destination, even when migrants are counted by the common EUROSTAT definition, IGSO PAS filled the gaps in migration flows on the basis of estimation measures based on migrant stock, population, and GDP.[4]

[3] See https://irie.espon.eu/ for details . C2C and R2R O-D matrices are provided for the years 2010 to 2018

[4] See https://gis-portal.espon.eu/arcgis/sharing/rest/content/items/5505351249ab476b9168483380902a3b/data for details

Stylized Facts

FR10 (Île de France), FRK2 (Rhône-Alpes), LU00 (Luxemburg), BE21 (Prov. Antwerpen), ES51 (Cataluña), ES30 (Comunidad de Madrid), BE23 (Prov. Oost-Vlaanderen), FRL0 (Provence-Alpes-Côte d'Azur), PT11 (Norte), and CZ01 (Praha) are the top-10 European regions in terms of total volume incoming intra-European remittances flows for the year 2018 (Fig. 1). Correspondingly, FR10 (Île de France), CH01 (Lake Geneva region), DE21 (Oberbayern), ES51 (Cataluña), ES52 (Comunitat Valenciana), DE71 (Darmstadt), ES61 (Andalucía), ITC4 (Lombardi), LU00 (Luxemburg), and CH04 (Zurich) are the top-10 European regions in terms of total volume outgoing intra-European remittances flows for the year 2018 (Fig. 2).

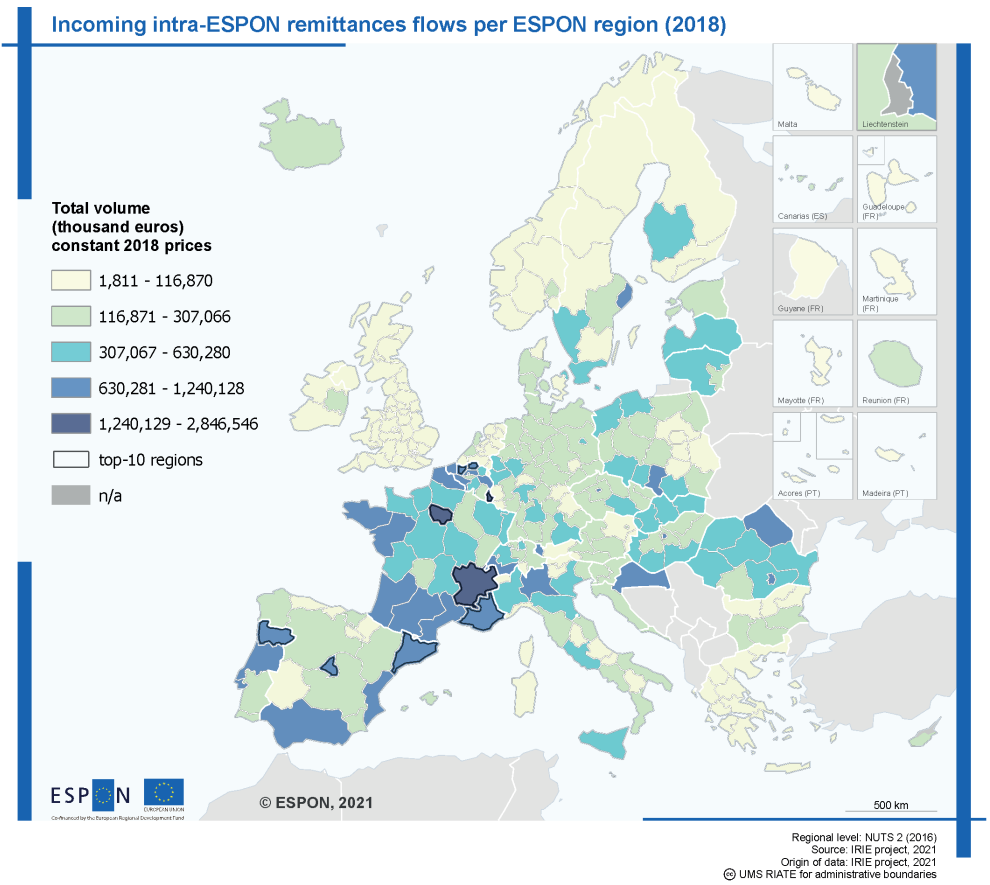

Figure 1. Total volume of incoming intra-ESPON remittances flows per ESPON region, remittances (thousand euros); constant 2018 prices, year 2018 (the boundaries of the top-10 regions are highlighted)
Source: WB database / authors' elaboration.

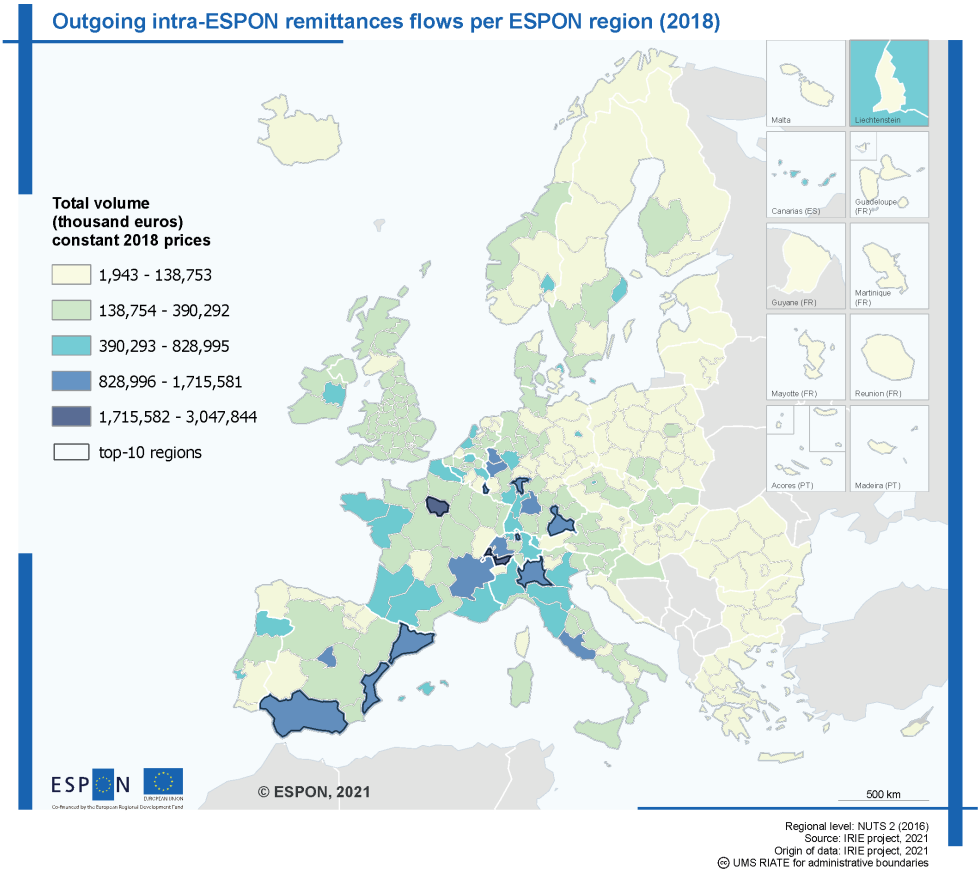

Figure 2. Total volume of outgoing intra-ESPON remittances flows per ESPON region, remittances (thousand euros); constant 2018 prices, year 2018 (the boundaries of the top-10 regions are highlighted)
Source: WB database / authors' elaboration.

The top-10 European region-pairs in terms of intra-European remittances flows are CH01-FR10 (Lake Geneva region - Île de France), FR10-PT11 (Île de France - Norte), FR10-ES51 (Île de France - Cataluña), FR10-ES30 (Île de France - Comunidad de Madrid), ES51-FR10 (Cataluña - Île de France), CH01-FRK2 (Lake Geneva region - Rhône-Alpes), FR10-BE21 (Île de France - Prov. Antwerpen), FR10-ES52 (Île de France - Comunitat Valenciana), DE21-AT34 (Oberbayern - Vorarlberg), and DEB3-LU00 (Rheinhessen-Pfalz - Luxemburg), for the year 2018 (Table 2, Fig. 3). The sum of the remittances flows that refer to the top-10 European region-pairs accounts for millions €1,466,868 (in constant, year 2018, prices). It is noteworthy that FR10 (Île de France) is present 7 times in the top-10 European region-pairs, either as a receiver or as a sender of remittances. It is, also, noteworthy that both FR10-ES51 (Île de France - Cataluña) and ES51-FR10 (Cataluña - Île de France) region-pairs are both present in the top-10 European region-pairs.

Correspondingly, the region-pairs that are present in the top-50 European region-pairs refer, mainly, to regions situated in the Western and Northern Europe. The presence of regions situated in the Eastern and Southern Europe is, rather, anemic (Fig. 4).

Table 2. Top-10 European region-pairs in terms of intra-European remittances flows, remittances (millions of euros); constant 2018 prices, year 2018

Region-pairs		Remittances flows (millions of euros)
origin	destination	
CH01 (Lake Geneva region)	FR10 (Île de France)	247,741
FR10 (Île de France)	PT11 (Norte)	150,804
FR10 (Île de France)	ES51 (Cataluña)	147,975
FR10 (Île de France)	ES30 (Comunidad de Madrid)	143,125
ES51 (Cataluña)	FR10 (Île de France)	142,427
CH01 (Lake Geneva region)	FRK2 (Rhône-Alpes)	134,660
FR10 (Île de France)	BE21 (Prov. Antwerpen)	131,596
FR10 (Île de France)	ES52 (Comunitat Valenciana)	125,759
DE21 (Oberbayern)	AT34 (Vorarlberg)	121,938
DEB3 (Rheinhessen-Pfalz)	LU00 (Luxemburg)	120,843

Source: WB database / authors' elaboration.

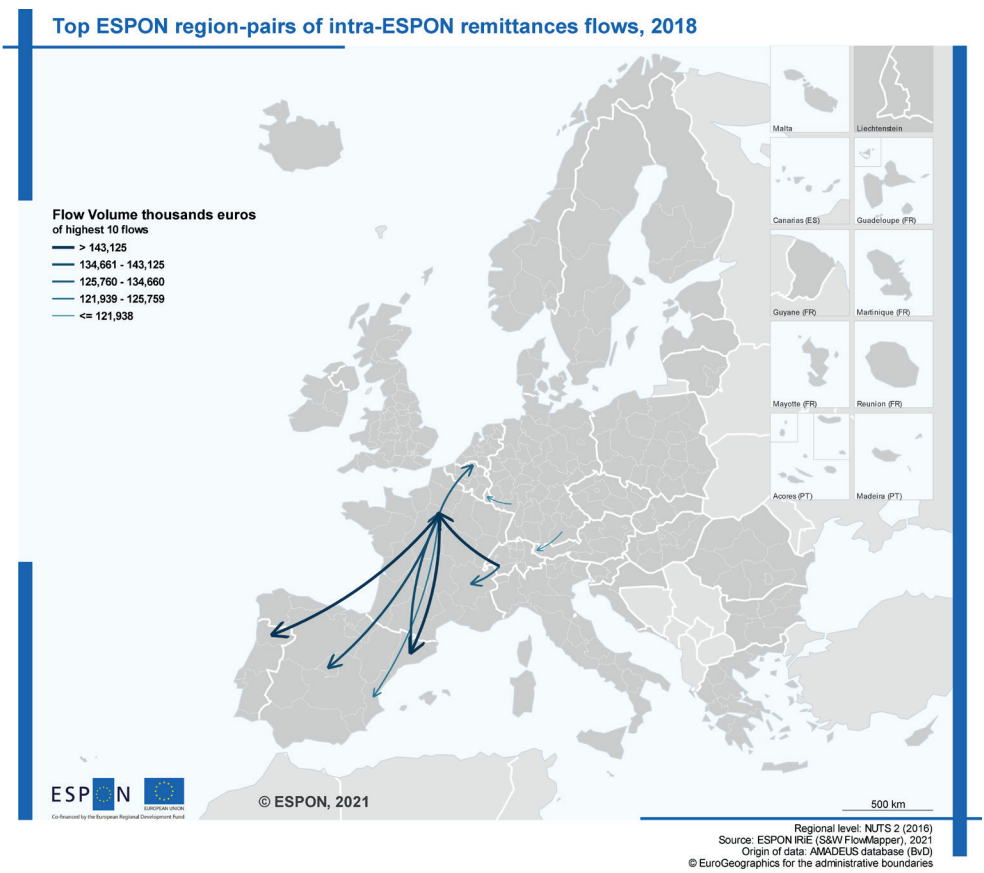

Figure 3. Top-10 ESPON region-pairs in terms of intra-ESPON remittances flows, remittances (thousand euros); constant 2018 prices, year 2018
Source: WB database / authors' elaboration.

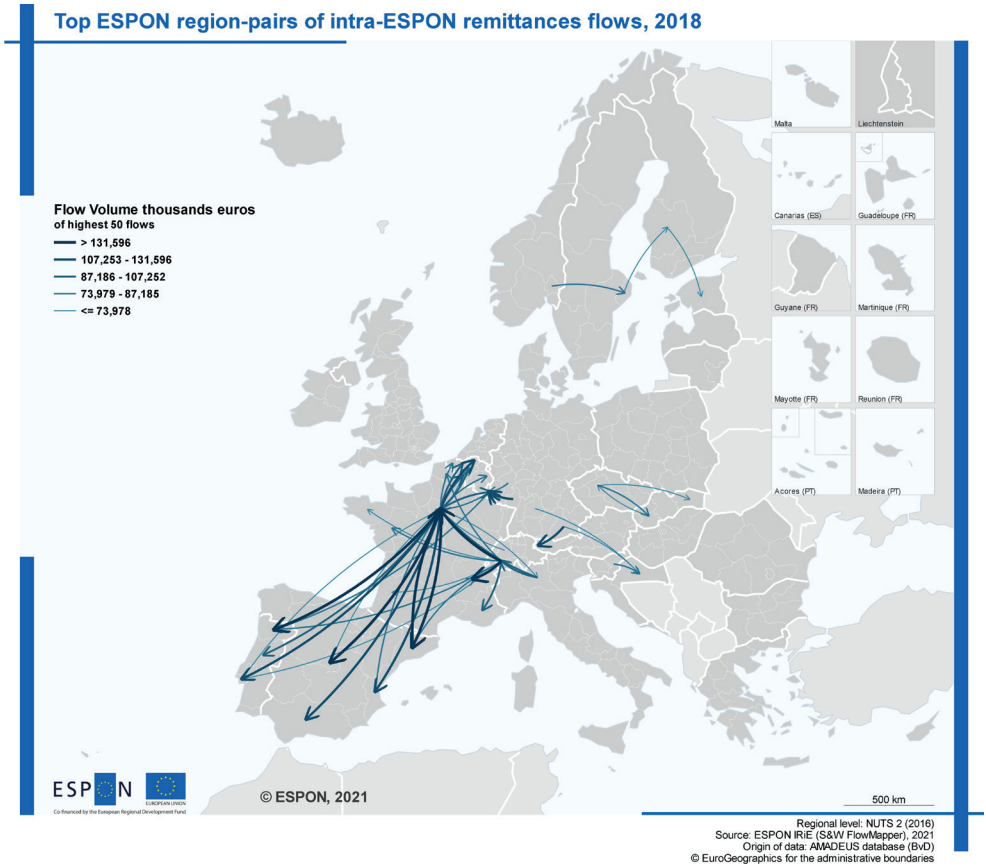

Figure 4. Top-50 ESPON region-pairs in terms of intra-ESPON remittances flows, remittances (thousand euros); constant 2018 prices, year 2018
Source: WB database / authors' elaboration.

Clustering Indicators

The paper classifies European regions based on interregional remittances flows per se (i.e., construction of tailor-made indicators), and not on already-existing regional typologies (such as urban-rural, coastal-landlocked, border-inner). Particularly, for the needs of the empirical analysis the indicators of CONNECTIVITY (CONN), INTENSITY (INTEN), WEIGHTED INTENSITY (WINTEN), INTERREGIONAL BALANCE (IBAL), NETWORK SELECTIVITY (NETSEL), EXTERNAL INFLUENCE (EXTI), and SEND-RECEIVE BALANCE (SRB) are constructed, separately for incoming and outgoing remittances flows (Table 3). These indicators have been, jointly, constructed by ESPON IRiE Project partners and may use for the analysis of different types of flows.

CONNECTIVITY measures the number of nodes each region is connected to. Regardless of the intensity of the connections, this indicator differentiates between regions which are focused on a small set of partners, and those which have many dispersed connections across the European space.

Table 3. Clustering indicators description

Indicator	Flow Type	Description
CONNECTIVITY	INC	Number of distinct origin regions that send remittances to the destination region
	OUTG	Number of distinct destination regions that receive remittances from the origin region
INTENSITY	INC	Volume of remittances that are sent from distinct origin regions to the destination region
	OUTG	Volume of remittances that are sent to distinct destination regions from the origin region
WEIGHTED INTENSITY	INC	Volume of remittances that are sent from distinct origin regions to the destination region as a share of the sum of the corresponding incoming and outgoing remittances activity
	OUTG	Volume of remittances that are sent to distinct destination regions from the origin region as a share of the sum of the corresponding outgoing and incoming remittances activity
INTERREGIONAL BALANCE	INC	Volume of remittances that are sent from distinct origin regions to the destination region as a share of the corresponding volume of remittances that are sent from distinct origin countries to the destination country
	OUTG	Volume of remittances that are sent to distinct destination regions from the origin region as a share of the corresponding volume of remittances that are sent to distinct destination countries from the origin country
NETWORK SELECTIVITY	INC	Maximum incoming remittances to the destination region as a share of the corresponding total incoming remittances
	OUTG	Maximum outgoing remittances from the origin region as a share of the corresponding total outgoing remittances
EXTERNAL INFLUENCE	INC	Maximum incoming remittances to the destination region as a share of the total outgoing remittances from the origin regions
	OUTG	Maximum outgoing remittances from the origin region as a share of the total incoming remittances to the destination regions
SEND-RECEIVE BALANCE	INC	Difference between the volume of remittances that are sent to the destination region from the origin regions and the corresponding outgoing remittances
	OUTG	Difference between the volume of remittances that that are sent from the origin region to the destination regions and the corresponding incoming remittances

Source: authors' elaboration.

INTENSITY is a measure of the strength of each region as a destination or as an origin of remittances (millions of euros). Although it is biased in favor of larger regions (e.g., in terms of GDP), the indicator is important to assess the level of dominance of these regions, establish the scale of regional hierarchies and build rank-size tables.

WEIGHTED INTENSITY looks at intensity in relation to the total remittances flows. This corrects the bias of the previous indicator and allows for the assessment and comparison of the performance of regions according to their own capacity.

INTERREGIONAL BALANCE assesses the level of dominance vs. decentralization of a region within its country. Some regions capture a vast majority of the flows in their country (i.e., centralized national pattern), whereas other regions are not.

NETWORK SELECTIVITY measures how much a region is dependent on a single destination or on a single origin. This is important because unexpected events in the destination or in the origin may greatly affect the incoming or the outgoing flows of a region, if that region has a large focus on that destination or origin.

EXTERNAL INFLUENCE measures the importance of a destination or an origin region from the perspective of the corresponding top origin region or the corresponding top destination region, respectively. Even though a region may be dependent on a single destination or on a single origin, this may not hold from the perspective of the corresponding origin or destination region, respectively. If this is the case, the influence of a region on its corresponding top destination or top origin region is, rather, limited.

SEND-RECEIVE BALANCE tests whether regions are specialized senders or receivers, or whether they have balanced incoming and outgoing flows.

k-means clustering technique

The paper follows the methodological approach of k-means for the classification of regions and the consequent construction of typologies. k-means aims at partitioning n observations into k clusters in such a way that the within-cluster variances are minimized (Rogerson, 2001).

Prior to implementation of the method, a data cleaning approach is necessary to be applied to avoid error in clustering process. Particularly, cases (i.e., regions) with: a) no values in all variables; and b) missing values in more than one variable are removed. Then by applying descriptive statistics, quality data problems are identified. For this reason, an outlier detection process is selected to improve cluster analysis results, but at the same time maintain as much cases as possible in the process.

Due to the complexity of the primary data set and the calculated variables, the Local Outlier Factor (LOF) algorithm is applied to detect outliers in the datasets (i.e., separately for incoming remittances flows and for outgoing remittances flows) before the clustering process. The LOF algorithm detects an outlier based on its local neighborhood, and it gives better results than the global approach to find outliers. Since there is no threshold value of LOF, the selection of a point as an outlier is user-dependent (Breunig, Kriegel, Ng & Sander, 2000). In general, when applying the LOF algorithm, a value below 1 indicates a denser area (which would be an inlier), while values significantly larger than 1 indicate outliers. But due to the previous fact, the threshold value chosen was 2, to be able to include as many observations as possible. This algorithm's 'flexibility' allows for the proper identification of the above threshold (i.e., 2), over with data observations are excluded from the clustering procedure. These observations (i.e., regions) are not excluded simply as 'false outliers' but, mostly, because their values are significantly differentiated. By following this method, the overall quality of the indicators is significantly improved, allowing for a more meaningful cluster analysis. The outlier detection process is applied using the total of the variables / indicators available.

For the optimal cluster interpretation, 4 distinct clustering processes are applied (Table 4). This approach is followed to secure that the results are going to be more meaningful since remittances flows have a plethora of underlying factors. Due to the complexity of the initial dataset, an enhancement of k-means algorithm is applied (x-means), which, after running several models, leads to more effective clustering. x-means is used after each run of k-means, considering local measures on each subset of the current centroids that could split themselves to obtain a better fit. At the same time, the k-means (x-means) process estimates the optimal number of variables to be included in each clustering process. The next step in the clustering process is the statistical normalization. The z transformation is applied. Such a normalization subtracts the mean of the data from all values and then divides them by the standard deviation. The distribution of the transformed data has a mean of zero and a variance of one. This is a common and very useful normalization technique. It preserves the original distribution of the data and is less influenced by outliers, especially in the cases with very different means and variances.

Table 4. Clustering indicators formulas

Indicator	Flow Type	Description
CONNECTIVITY	INC	$CONN_j = \sum_{i=1}^{n} N_i$ N_i = number of origin regions
	OUTG	$CONN_i = \sum_{j=1}^{n} N_j$ N_j = number of destination regions
INTENSITY	INC	$INTEN_j = \sum_{i-1}^{n} V_i$ V_i = volume of remittances from origin regions
	OUTG	$INTEN_i = \sum_{j=1}^{n} V_j$ V_j = volume of remittances to destination regions
WEIGHTED INTENSITY	INC	$WINTEN_j = \frac{\sum_{i=1}^{n} V_i}{\sum_{i=1}^{n} V_i + \sum_{j=1}^{1} V_j}$ V_i = volume of remittances from origin regions V_j = volume of remittances to destination region
	OUTG	$WINTEN_i = \frac{\sum_{j=1}^{n} V_j}{\sum_{j=1}^{n} V_j + \sum_{ro=1}^{1} V_i}$ V_j = volume of remittances to destination region V_i = volume of remittances from origin regions
INTERREGIONAL BALANCE	INC	$IBALj = \frac{\sum_{i=1}^{n} V_i}{\sum_{ci} V_{ci\_cj}}$ V_i = volume of remittances from origin regions V_{ci_cj} = volume of remittances from the origin countries to the destination country $j \in cj$ $i \in cj$
	OUTG	$IBAL_i = \frac{\sum_{j=1}^{n} V_j}{\sum_{cj} V_{cj\_ci}}$ V_j = volume of remittances to destination regions V_{cj_ci} = volume of remittances to the destination countries from the origin country $i \in cj$ $j \in cj$

NETWORK SELECTIVITY	INC	$NETSELj = \frac{max_{i=1}^{n} MV_i}{\sum_{i=1}^{n} V_i}$ MV_i = maximum volume of remittances from origin regions V_i = volume of remittances from origin regions
	OUTG	$NETSEL_j = \frac{max_{j=1}^{n} MV_j}{\sum_{j=1}^{n} V_j}$ MV_j = maximum volume of remittances to destination regions V_j = volume of remittances to destination regions
EXTERNAL INFLUENCE	INC	$EXTI_j = \frac{max_{i=1}^{n} MV_i}{V_j}$ MV_i = maximum volume of remittances from origin regions V_j = volume of remittances from the corresponding destination region
	OUTG	$EXTI_i = \frac{max_{j=1}^{n} MV_j}{V_i}$ MV_j = maximum volume of remittances to destination regions V_i = volume of remittances to the corresponding origin region
SEND-RECEIVE BALANCE	INC	$SRB_j = \sum_{i=1}^{n} V_i - \sum_{j=1}^{1} V_j$ V_i = volume of remittances from origin regions V_j = volume of remittances from destination region
	OUTG	$SRB_i = \sum_{j=1}^{n} V_j - \sum_{i=1}^{1} V_i$ V_j = volume of remittances to destination regions V_i = volume of remittances from origin region

Source: authors' elaboration.

For improving the cluster quality, a feature selection process is applied to the final data set. The purpose is to improve the final clusters, but without missing the underlying patterns. The Davies-Bouldin Index (criterion) (Davies & Bouldin, 1979) is calculated as a ratio of within-cluster and between-cluster distances. It is calculated as the average similarity of each cluster with a cluster most like it. The lower the average similarity is, the better the clusters are separated. The goal is to retain as many variables as possible from the original data set – in order to retain the highest possible level of information - and only remove the ones that create more 'noise'.

Empirical Analysis

The findings of the empirical analysis offer an, up-to-now, unknown layer of analysis corresponding to interregional remittances flows in Europe (i.e., incoming remittances flows and outgoing remittances flows), providing insight to both theory and policymaking.

From the clustering procedure of European regions in terms of incoming interregional remittances flows and outgoing interregional remittances flows, 21 and 27 regions, respectively, have been excluded as high-level outliers (i.e., regions that exhibit values extremely higher comparing to the corresponding values of the other regions). Most of these regions are either metropolitan areas or (small-sized) countries (Table 5).

Table 5. Regions excluded as high-level outliers from the clustering procedure in terms of interregional remittances flows, year 2018

Incoming remittances	Outgoing remittances
CH01 (Lake Geneva region)	BG41 (Yugozapaden)
CY00 (Kypros)	CH01 (Lake Geneva region)
DE21 (Oberbayern)	CY00 (Kypros)
EE00 (Eesti)	DE13 (Freiburg)
FR10 (Île de France)	DE21 (Oberbayern)
HR04 (Kontinentalna Hrvatska)	DE60 (Hamburg)
IE04 (Northern and Western)	DEF0 (Schleswig-Holstein)
IE05 (Southern)	EE00 (Eesti)
IE06 (Eastern and Midland)	FI19 (Länsi-Suomi)
IS00 (Iceland)	FR10 (Île de France)
ITH3 (Veneto)	FRK2 (Rhône-Alpes)
LT02 (Vidurio ir vakaru Lietuvos regionas)	HR03 (Jadranska Hrvatska)
LU00 (Luxemburg)	HR04 (Kontinentalna Hrvatska)
LV00 (Latvija)	IS00 (Iceland)
MT00 (Malta)	ITC4 (Lombardi)
SI03 (Vzhodna Slovenija)	LI00 (Liechtenstein)
SI04 (Zahodna Slovenija)	LT02 (Vidurio ir vakaru Lietuvos regionas)
UKI3 (Inner London - West)	LU00 (Luxemburg)
UKI4 (Inner London - East)	LV00 (Latvija)
UKJ1 (Berkshire, Backinghamshire and Oxfordshire)	MT00 (Malta)
UKM5 (North Eastern Scotland)	PL52 (Opolskie)
	SE11 (Stockholm)
	UKI3 (Inner London - West)
	UKI4 (Inner London - East)
	UKJ4 (Kent)
	UKM5 (North Eastern Scotland)
	UKN0 (Northern Ireland)

Source: authors' elaboration.

The clustering procedure results in 5 clusters for incoming interregional remittances flows and in 5 clusters for outgoing interregional remittances flows, for the year 2018.

Regarding the incoming interregional remittances flows (Fig. 5-6): a) cluster A exhibits the highest INTEN and SRB values, high EXTI, IBAL, and WINTEN values, and moderate CONN and NETSEL values; b) cluster B exhibits the highest CONN, EXTI, IBAL, and NETSEL values, high INTEN and SRB values, and moderate WINTEN values; c) cluster C exhibits the highest WINTEN values, moderate INTEN, EXTI, and SRB values, and low CONN and IBAL values, and the lowest NETSEL values; d) cluster D exhibits high CONN and NETSEL values, moderate IBAL, and low INTEN, EXTI, SRB, and WINTEN values; and e) cluster E exhibits low NETSEL values, and the lowest CONN, INTEN, EXTI, IBAL, SRB, and WINTEN values.

Cluster A (incoming remittances Europe-wide hubs) contains the topmost absolute and net remittances receivers, cluster B (incoming remittances nation-wide hubs) contains the topmost influencing, dependent, and national remittances receivers, cluster C (incoming remittances Europe-wide relative hubs) contains the topmost relative remittances receivers, and the bottommost dependent remittances receivers, cluster D (second-level incoming remittances Europe-wide hubs) contains the second-level linked and dependent remittances receivers, and cluster E (second-level incoming remittances independents) contains the bottommost linked, influencing, absolute, relative, national, and net remittances receivers.

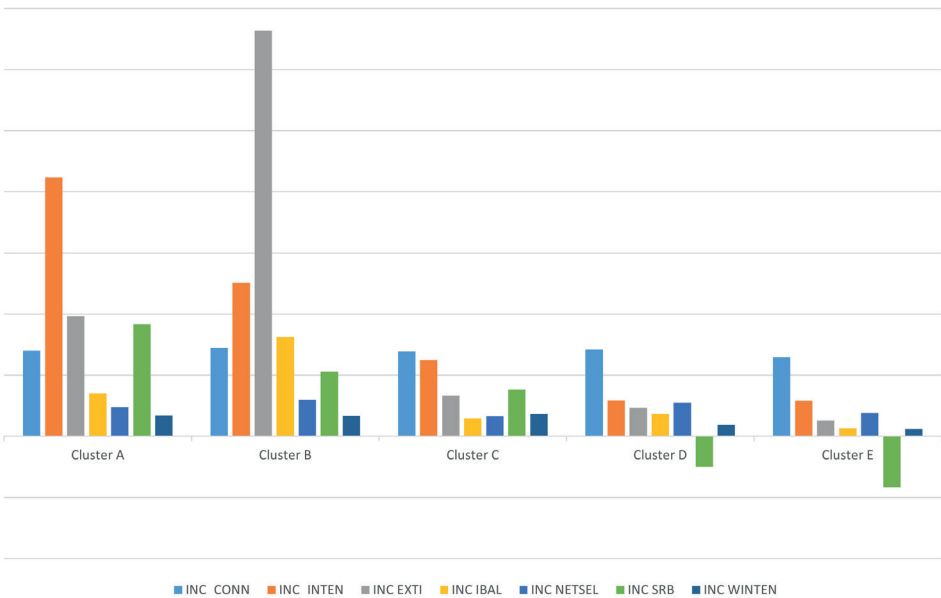

Figure 5. Regional clusters, incoming interregional remittances flows, year 2018
Source: WB database / authors' elaboration.

In plain words, and with the exclusion of high-level outliers: a) regions that belong to cluster A are the ones that receive the highest volume of remittances and the ones that receive the highest volume of net remittances (i.e., difference between incoming and outgoing remittances); b) regions that belong to cluster B are the ones that exhibit the highest number of connections, the ones that exhibit the highest level of interrelations with their counterparts, comparing to the corresponding national interrelations, and the ones that exhibit the highest level of selectivity and the highest level of influence; c) regions that belong to cluster C are the ones that exhibit the highest ratios of incoming-to-total remittances; and d) regions that belong to clusters D and E are the ones that exhibit medium-to-low values as regards the indicators that are taken into consideration. Cluster A consists of 30 regions, cluster B consists of 12 regions, cluster C consists of 71 regions, cluster D consists of 89 regions, and cluster E consists of 73 regions.

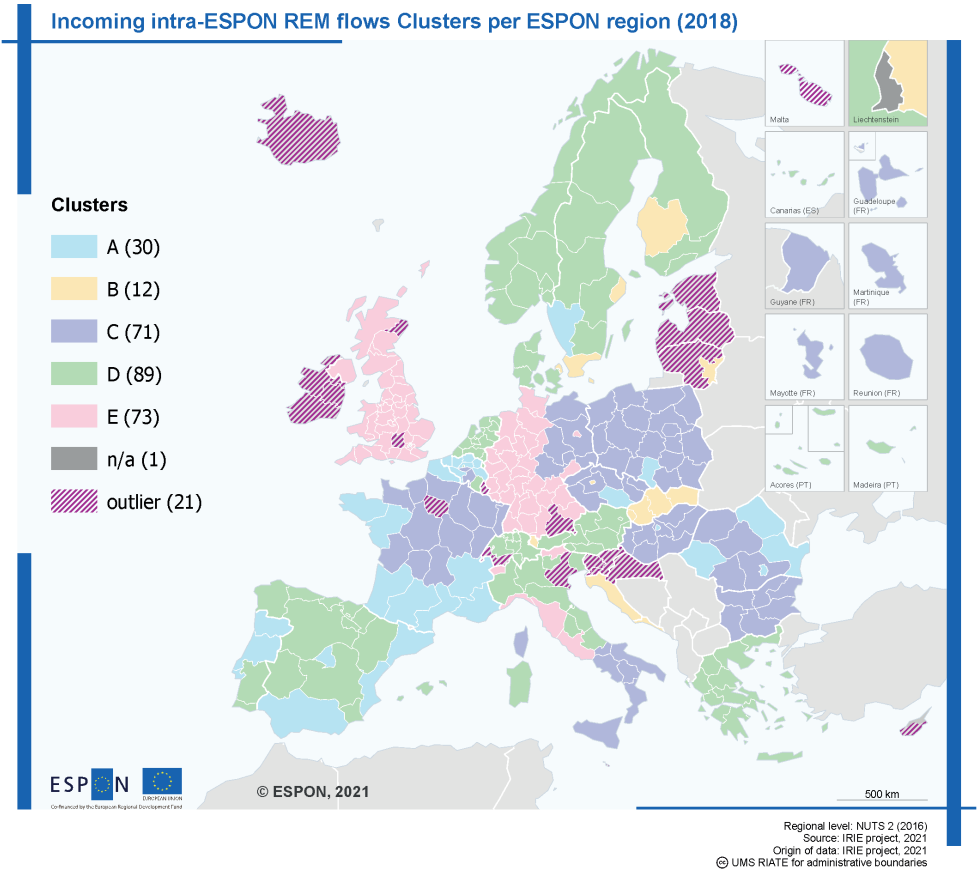

Figure 6. k-means clustering for incoming interregional remittances flows, year 2018
Source: WB database / authors' elaboration.

Regarding the outgoing interregional remittances flows (Fig. 7-8): a) cluster A exhibits the highest INTEN and SRB values, high IBAL and WINTEN values, moderate NETSEL values, and low CONN values; b) cluster B exhibits the highest CONN and IBAL values, high INTEN and NETSEL values, and moderate SRB and WINTEN values; c) cluster C exhibits the highest WINTEN values, high SRB values, moderate INTEN values, low NETSEL values, and the lowest CONN and IBAL values; d) cluster D exhibits the highest NETSEL values, high CONN values, moderate IBAL values, and low INTEN, SRB, and WINTEN values; and e) cluster E exhibits moderate CONN values, low IBAL values, and the lowest INTEN, NETSEL, SRB, and WINTEN values.

Cluster A (outgoing remittances Europe-wide hubs) contains the topmost absolute and net remittances senders, cluster B (outgoing remittances nation-wide hubs) contains the topmost linked and national remittances senders, cluster C (outgoing remittances Europe-wide relative hubs) contains the topmost relative remittances senders, cluster D (outgoing remittances dependents) contains the topmost dependent remittances senders, and cluster E (outgoing remittances independents) contains the bottommost dependent, absolute, net, and relative remittances senders.

In plain words, and with the exclusion of high-level outliers: a) regions that belong to cluster

A are the ones that send the highest volume of remittances and the ones that send the highest volume of net remittances (i.e., difference between outgoing and incoming remittances); b) regions that belong to cluster B are the ones that exhibit the highest number of connections and the ones that exhibit the highest level of interrelations with their counterparts, comparing to the corresponding national interrelations; c) regions that belong to cluster C are the ones that exhibit the highest ratios of outgoing-to-total remittances; d) regions that belong to cluster D are the ones that exhibit the highest level of selectivity; and e) regions that belong to cluster E are the ones that exhibit medium-to-low values as regards the indicators that are taken into consideration. Cluster A consists of 26 regions, cluster B consists of 14 regions, cluster C consists of 58 regions, cluster D consists of 21 regions, and cluster E consists of 151 regions.

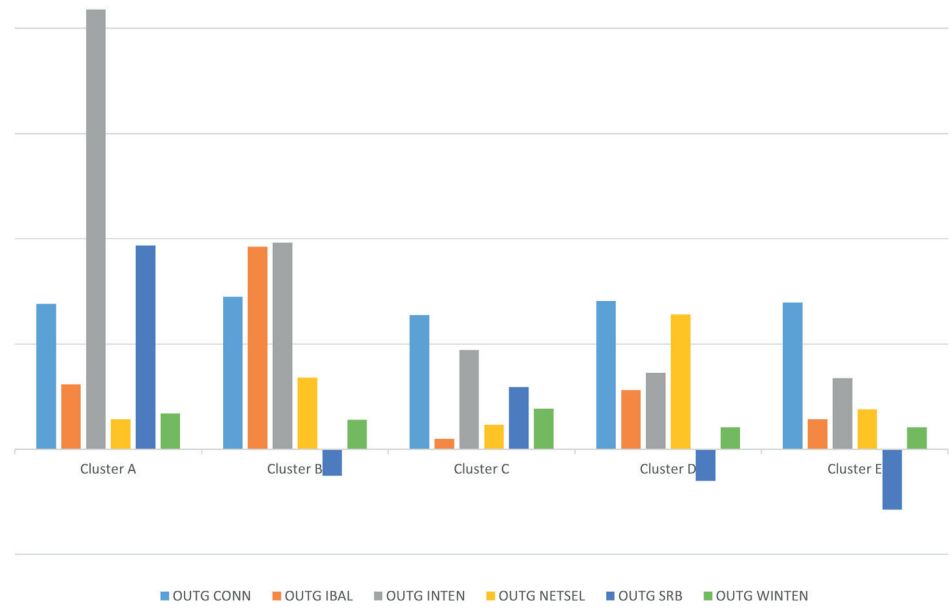

Figure 7. Regional clusters, outgoing interregional remittances flows, year 2018
Source: WB database / authors' elaboration.

Towards easing the understanding of the empirical results, a more thorough commenting as regards region PL22 (Śląskie) is, indicatively, provided.[5] PL22 (Śląskie) belongs to cluster A as regards the incoming interregional remittances flows and to cluster E as regards the outgoing interregional remittances flows. As regards the incoming interregional remittances flows, this means that PL22 (Śląskie) belongs to group of European regions that send the highest volume of remittances and the highest volume of net remittances (i.e., difference between outgoing and incoming remittances). As regards the outgoing interregional remittances flows, this means that PL22 (Śląskie) belongs to the group of European regions that exhibit medium-to-low values as regards the indicators that are taken into consideration.

[5] The results for the full list of European regions are available upon request.

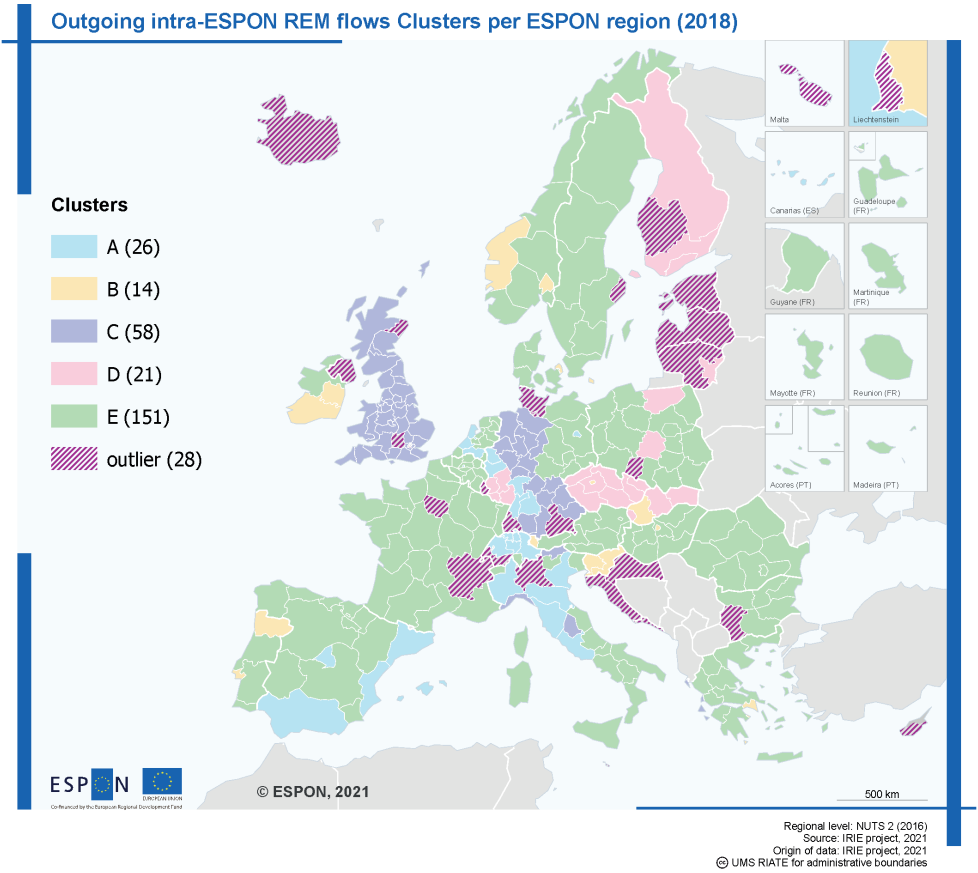

Figure 8. k-means clustering for outgoing interregional remittances flows, year 2018
Source: WB database / authors' elaboration.

Conclusions and Recommendation to International Organizations and Statistical Agencies

The paper uncovers regional typologies in Europe in terms of interregional remittances flows for the year 2018, the year prior to the eruption of the COVID19 pandemic. To this end, the paper compiles and utilizes O-D matrices for interregional remittances flows in Europe, constructs tailor-made clustering indicators (i.e., CONNECTIVITY (CONN), INTENSITY (INTEN), WEIGHTED INTENSITY (WINTEN), INTERREGIONAL BALANCE (IBAL), NETWORK SELECTIVITY (NETSEL), EXTERNAL INFLUENCE (EXTI), and SEND-RECEIVE BALANCE (SRB)), and employs the k-means clustering technique.

The findings of the paper indicate that, in terms of both incoming and outgoing interregional remittances flows, different spatial patterns have been emerged within the unified European economic space. It comes that the process of European economic integration is associated with a set

of divides and contradictions that characterize the European economic space. Even though each region represents a unique case, the empirical analysis reveals that there are groups of regions (i.e., clusters) that exhibit common characteristics. Particularly, having excluded the high-level outliers, the clustering procedure of European regions results in 5 clusters for incoming interregional remittances flows and in 5 clusters for outgoing interregional remittances flows.

Concerning the incoming interregional remittances flows: a) cluster A – regions receiving the highest volume of remittances and the highest volume of net remittances; b) cluster B – regions that exhibit the highest number of connections, the ones that exhibit the highest level of interrelations with their counterparts, comparing to the corresponding national interrelations, and the ones that exhibit the highest level of selectivity and the highest level of influence; c) cluster C – regions with the highest ratios of incoming-to-total remittances; and d) clusters D and E with regions that exhibit medium-to-low values as regards the indicators that are taken into consideration.

Concerning the outgoing interregional remittances flows: a) cluster A – regions that send the highest volume of remittances and the highest volume of net remittances; b) cluster B – regions that exhibit the highest number of connections and the ones that exhibit the highest level of interrelations with their counterparts, comparing to the corresponding national interrelations; c) cluster C represent regions that exhibit the highest ratios of outgoing-to-total remittances; d) cluster D are regions that exhibit the highest level of selectivity; and e) cluster E are the ones that exhibit medium-to-low values as regards the indicators that are taken into consideration.

The findings of the paper tackle the scarcity of data on interregional flows in Europe and offer an, up-to-now, unknown layer of analysis. Thus, the paper provides valuable insight to both academia and policymaking. At the same time, the paper highlights the drawback of the lack of data, especially at the regional level. The provision of data – not only for remittances but also for a wide array of interregional flows – is an imperative. This is especially so for Europe, where an – unprecedented – process of economic integration is in full swing. It behoves international organizations and statistical agencies (EUROSTAT, in particular) to carry on the responsibility of providing such data. To this end, a close collaboration with the European Central Bank (ECB) is *sine qua no*n.

Apparently, further research on the issue is needed and the paper paves the way to this end. The compilation of the R2R (and C2C) O-D matrices for interregional flows in Europe opens new fields for understanding the regional interlinkages in terms of remittances flows. The typologies that the paper uncovers shed light.

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