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INTERNATIONALISATION, SPECIALISATION AND TECHNOLOGICAL COLLABORATION IN THE EU OUTERMOST REGIONS

A PATENT DATA-BASED ANALYSIS

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Internationalisation, specialisation and technological collaboration in the EU Outermost Regions

A patent data-based analysis

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This document was authorised for publication by Ragnheiður Elín Árnadóttir, Director of the OECD Development Centre.

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Abstract

This paper explores the innovation dynamics of the EU Outermost Regions (EU ORs) through patenting behaviour. It emphasises the potential for international collaborations with a wide range of partners, and recommends to mobilise the resources and strategies provided by the EU to strengthen research and innovation in the private sector; enhance the impact of public research centres and universities; and foster intra-regional co-operation. It also calls for stronger ties with African countries, the Latin American and Caribbean region, as well as Small Island Developing States (SIDS), to foster innovation-based collaborations, particularly around sustainable agriculture, renewable energy and the ocean economy. The paper is developed within the framework of the EU-OECD project on Global Outermost Regions.

Foreword

The global economic landscape is uncertain, complex and fast changing. Governments, businesses and societies are endeavouring to better understand and, ultimately, govern the ongoing reorganisation of global trade with a view to optimising exchanges, preserving openness and inclusiveness, and achieving an environmental and sustainable transition.

This paper is part of the OECD-EU project on "Transforming economies in EU outermost regions (EU ORs): fostering learning and making the most of global interconnectedness", funded by the European Commission Directorate General for Regional and Urban Policy. Between 2021 and 2023, this project has supported a process of dialogue and knowledge sharing between EU ORs and international partners to identify opportunities for sustainable value creation and enhanced participation in global and regional value chains.

The European Outermost Regions (EU ORs) are EU member states' territories located in the Atlantic Ocean, Caribbean basin, South America and the Indian Ocean and they are an integral part of the Union. They include Guadeloupe, French Guiana, Martinique, Réunion, Saint Martin and Mayotte (France), the Azores and Madeira (Portugal), and the Canary Islands (Spain). Due to their remoteness, insularity, small size, difficult topography and climate they benefit from targeted support measures. Thanks to their distinctive characteristics and assets, including a rich biodiversity and strategic location, the EU ORs can play an important role in the overreaching EU internationalisation and co-operation strategy and policy.

This paper explores the innovation dynamics of the EU Outermost Regions (EU ORs) through patenting behaviour, revealing their unique strengths and growth opportunities. The study emphasises the potential for international collaborations with a wide range of partners. It also clarifies future opportunities for increasing internationalisation and co-operation with partners beyond the EU, including neighbouring countries in Africa, Latin America and the Caribbean and other developing and emerging economies like Small Island Developing States (SIDS). Furthermore, the paper identifies opportunities for future reforms to make the most of the multi-annual planning and resources of the EU, including the Communication on "Putting people first, securing sustainable and inclusive growth, unlocking the potential of the EU's outermost regions" adopted in 2022.

This paper is one of several outputs of the project, which include two Production Transformation Policy Reviews: Spotlight on the Azores' and Guadeloupe's internationalisation and four policy papers on the ocean economy, renewable energies, the agro-food sector, and cultural and creative sectors.

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This report also benefited from information provided by the policy makers and experts in the EU Outermost Regions: Guadeloupe, French Guiana, Martinique, Réunion, Saint-Martin, and Mayotte (France); the Azores and Madeira (Portugal); and the Canary Islands (Spain).

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Abbreviations and acronyms

CEA	*Commissariat à l'énergie atomique et aux énergies alternatives*
CELAC	Community of Latin American and Caribbean States
CIRAD	*Centre de coopération internationale en recherche agronomique pour le développement*
CNRS	French National Center for Scientific Research
CSIC	Spanish National Research Council
EPA	Economic Partnership Agreement
EPO	European Patent Office
ERDF	European Regional Development Fund
EU	European Union
FCT	Portuguese national funding agency for science, research and technology
GDP	Gross domestic product
iEPA	Interim Economic Partnership Agreement
IITAA	Institute of Agricultural and Environmental Research and Technology
INPI	*Institut national de la propriété industrielle*
INSERM	*Institut national de la santé et de la recherche médicale*
IPC	International Patent Classification
IRD	*Institut de recherche pour le développement*
LAC	Latin America and the Caribbean
LEAP-RE	Research and Innovation Partnership on Renewable Energy
NACE	Statistical Classification of Economic Activities in the European Community
NDICI	Neighbourhood, Development and International Cooperation Instrument
OACPS	Organisation of African, Caribbean and Pacific States
OECD	Organisation for Economic Co-operation and Development
ORs	Outermost Regions
PCT	Patent Cooperation Treaty
R&D	Research and development
SIDS	Small Island Developing States
SMEs	Small and medium-sized enterprises
STI	Science, technology and innovation
TFEU	Treaty of the Functioning of the European Union
USPTO	United States Patent and Trademark Office
WIPO	World Intellectual Property Organization

Executive summary

The European Outermost Regions (EU ORs), including Guadeloupe, French Guiana, Martinique, Mayotte, Réunion, and Saint-Martin (France); the Azores and Madeira (Portugal); and the Canary Islands (Spain), are strategically positioned in the Atlantic Ocean, Caribbean basin, South America, and the Indian Ocean. Their extensive maritime economic zones, unique biodiversity, and natural attributes make them ideal laboratories for scientific and innovative activities. While these regions exhibit heterogeneity in various socio-economic aspects, they share common challenges such as remoteness, small size, and vulnerability to climate change, akin to nearby countries and territories.

This policy paper delves into the innovation dynamics of the EU ORs, highlighting their strengths and growth prospects through patenting activities. It explores past and present international collaborations while charting a course for future partnerships that can propel these regions towards sustainable development. This paper embarks on a comprehensive exploration of innovation possibilities and technological advancements in the EU ORs. It commences with a patent analysis, with three primary objectives:

- Technological specialisation and development trajectories: To unveil the unique technological specialisations and developmental pathways of the EU ORs.
- Economic and value chain development opportunities: To explore the potential opportunities for economic growth and value chain participation.
- Collaboration opportunities: To identify potential collaboration opportunities that can enhance research, innovation activities, and value chain integration.

While patents represent just one facet of the broader research, development, and innovation landscape, they serve as valuable “input” indicators with a high correlation to firm-level R&D. Additionally, patents offer a rich source of information for identifying key actors in innovative activities, their technological expertise, and the potential for intra-regional and interregional collaboration.

The findings of this paper provide invaluable insights to guide policy makers in supporting the development of scientific and innovation ecosystems within the EU ORs. By understanding their unique strengths and growth potential, policy makers can make informed decisions on resource allocation and policy formulation.

To capitalise on these insights, the EU ORs must leverage the European Union's resources and strategies for internationalisation. Strengthening research and innovation within the private sector, amplifying the impact of public research centres and universities, and fostering greater intra-regional co-operation are key drivers of transformative advancements.

Moreover, forging international collaborations holds immense promise. Establishing robust ties with African countries, the Latin American and Caribbean (LAC) region and Small Island Developing States (SIDS), opens avenues for innovation-based partnerships. Shared interests, such as sustainable agriculture, renewable energy, and the ocean economy, offer substantial opportunities for collaborative value chain development, economic growth, and addressing common challenges.

The EU ORs represent untapped potential as innovation-driven partners on the global stage. By strategically aligning with diverse international stakeholders, these regions can shape a sustainable and prosperous future while playing a pivotal role in advancing inclusive and resilient development models in various technological and industrial sectors, including agro-food, renewable energies, and the ocean economy. Embracing innovation and international collaboration is the pathway to unlock their full potential and contribute meaningfully to the overarching EU internationalisation and co-operation strategy.

1 Introduction

Together the EU Outermost Regions (EU ORs), Guadeloupe, French Guiana, Martinique, Mayotte, Réunion, and Saint-Martin (France); the Azores and Madeira (Portugal); and the Canary Islands (Spain) represent important actors of the European Union around the world. Strategically located in the Atlantic Ocean, the Caribbean basin, South America and the Indian Ocean with distinctive assets, such as extensive maritime economic zones, unique biodiversity, are natural laboratories suitable for sciences and innovation activities. While heterogeneous in many social and economic aspects, the ORs also face similar challenges, including remoteness, small size and vulnerability to climate change that they share with nearby countries and territories. In this context, promoting science and innovation by leveraging on the opportunities associated with EU structural funds and scaling-up inter- and intra-regional partnerships, the ORs could reverse their structural constraints and transform them into factors of renewed competitiveness.

Promoting innovation capabilities and benefiting from the untapped opportunities of international partnerships are at the core of the EU Commission's Renewed Strategy for the EU ORs (Box 1). The long-term growth of living standards depends on the capacity of an economy to sustain technological progress, via its own technological innovations and adoption and learning from abroad. This is even more important as the global landscape of innovation activities is changing rapidly. While both OECD countries and some emerging economies are increasing their R&D efforts and industrial capabilities in a variety of industrial sectors more R&D is being off-shored by multinational companies. In particular, innovation is crucial for peripheral regions such as the EU ORs to catch up and construct their economic capacities in the coming decades.

However, because of the lack of consolidated innovation practices, peripheral regions need to rely on international flows of technological knowledge as a source of learning and knowledge accumulation. Nevertheless, because of their insularity, difficult topography and climate, international flows are particularly complex to capture, with the consequence that only research and technology collaborations can complement or compensate for a lack of knowledge spillovers (Grillitsch and Nilsson, 2014[1]).

The scope of the paper is to explore future possibilities for innovation and technological advancements in the EU ORs. It starts through a patent analysis, followed by an exploration of the potential opportunities for international co-operation for the EU ORs and the broader research and innovation implications to close the gaps.

In particular, by quantitatively assessing the patenting activities of the EU ORs this paper has three main objectives:

1. *Revealing* their technological specialisation and development trajectories;
2. *Exploring* their opportunities for economic and value chain development; and
3. *Disclosing* their potential collaboration opportunities that can strengthen research and innovation activities and value chain participation.

Although patents are only one part of the broad research, development and innovation landscape that can lead to technological development and collaboration, they traditionally show a high level of correlation with R&D at the firm level, although with some heterogeneity across industries (Orsenigo and Sterzi, 2010[2]),

which indicates that patents should be used as an "input" indicator (Box 2).[1] Furthermore, patents offer an extremely useful and rich source of information for identifying the main actors involved (applicants) in innovative activities, their technological specialisation as well as the present and future potential for both intraregional and interregional collaboration.

The findings of this paper aim to support policy makers to better support the development of scientific and innovation ecosystems in the EU ORs while at the same time providing them with an overview of the potential partnerships and value chains that can be developed.

Box 1. The European Union Outermost Regions and the new Commission Communication to support them

The EU outermost regions (EU ORs) are nine European territories geographically located in the Atlantic Ocean, the Caribbean basin, the Amazonian Forest and the Indian Ocean. They include French Guiana, Guadeloupe, Martinique, Mayotte, Réunion and Saint-Martin (France), the Azores and Madeira (Portugal), and the Canary Islands (Spain). In total, they are home to 4.8 million citizens, the equivalent of 1% of the total EU population. Due to the idiosyncratic challenges related to remoteness, vulnerability to climate change, small market size and high economic dependence from the mainland, since 2004 the EU has provided ad-hoc derogations and specific measures to the common market legislation in accordance with Article 349 of the Treaty of the Functioning of the European Union (TFEU). With their rich biodiversity and unique ecosystems, they provide unique assets for the EU in the three geographical areas.

The European Commission adopted on 3 May 2022 a Communication on "Putting people first, securing sustainable and inclusive growth, unlocking the potential of the EU's outermost regions". This Communication reflects the Commission's commitment towards the EU ORs in line with Article 349 TFEU. The Communication presents the priorities for EU action with and for the EU ORs to foster their development, as well as recommendations for action by the EU ORs and their Member States – France, Portugal and Spain. Following the strong impact of the coronavirus pandemic on the EU ORs, the Commission set forth action needed to foster a sustainable recovery and growth in these regions. The Communication focuses on:

- Putting people first – improving living conditions for people in the EU ORs, ensuring people's quality of life, tackling poverty, and developing opportunities for the youth.
- Building on each region's unique assets such as biodiversity, the blue economy or research potential.
- Supporting a sustainable, environmentally friendly and climate-neutral economic transformation grounded on the green and digital transition.
- Strengthening EU ORs regional co-operation with neighbouring countries and territories.
- Intensifying partnership and dialogue with the EU ORs via, among others, dedicated administrative capacity support to step up their participation in EU programmes.

Source: European Commission (2022[3]), *Putting People First, Securing Sustainable and Inclusive Growth, Unlocking the Potential of the EU's Outermost Regions*, https://ec.europa.eu/regional_policy/en/information/publications/communications/2022/putting-people-first-securing-sustainable-and-inclusive-growth-unlocking-the-potential-of-the-eu-s-outermost-regions.

[1] Since at least three decades many scientific papers have considered the use of patents as indicators of technological and innovative output (Grupp and Schmoch, 1999[28]; Griliches, 1990[30]; Grupp, 1990[29]; Pavitt, 1985[27]; Pavitt, 1988[26]).

2 The EU ORs show heterogeneous patterns in patenting activities

This section compares the patterns of patenting activity of the EU ORs relative to geographical areas in which they are located. Three areas are thus selected which refers to the Ocean/Sea where they are located: (1) the Caribbean Sea, (2) the Southwest Indian Ocean, and (3) the Atlantic Ocean/Macaronesia.[2]

Figure 1 shows the number of Patent Cooperation Treaty (PCT) filed by inventors residing in the EU ORs and their neighbouring countries in the period 2000-19.[3] A patent is assigned to a given region (or country) if there is at least one inventor residing in that region (or country).[4] Three key facts emerge:

- First, countries located in the Caribbean Sea are on average more innovative than countries located in other areas (with the notable exception of the Canary Islands), suggesting that EU ORs located in this area are the ones that may benefit the most by collaborating with their neighbouring countries. Top patentees in the Caribbean Sea are Cuba, Bahamas, Dominican Republic and Trinidad Tobago, all of them having a number of patents larger than their neighbouring EU ORs (Guadeloupe, Martinique and French Guiana).
- Second, EU ORs on average perform quite well with respect to their neighbouring countries. In particular, Réunion and the Canary Islands are both ranked first in the macro region where they are located.
- Third, we observe a strong heterogeneity across EU ORs, with four EU ORs (the Azores, French Guiana, Madeira and Mayotte,) showing a relatively low level of patenting activity.

[2] The Caribbean Sea area includes the EU ORs of Guadeloupe and Saint Martin (the statistics presented in the chapter refer to both the regions together), Martinique and French Guiana, and the following countries: Antigua and Bermuda, Bahamas, Barbados, Belize, Cuba, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, and Trinidad and Tobago. The Southwest Indian Ocean includes the EU OR regions of Réunion and Mayotte, and the following countries: Comoros, Madagascar, Mauritius, Seychelles, and Mozambique. The Atlantic Ocean/Macaronesia includes the EU ORs regions of Canary Islands, Azores, and Madeira and the following countries: Angola, Cape Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Mauritania, Senegal, Sierra Leone, Togo, and Sao Tomé and Principe.

[3] Figures for EPO and USPTO are shown in Figure A A.1and Figure A A.2 in the annex.

[4] The patent counting method used may overestimate the patenting activity of the region because some inventor teams are international and the share of inventors from a given region in the team may be low. In order to take this possibility into account, in Figure A A.3 in the annex we consider a patent as invented in that region (or country) if at least two inventors are from that region (or country) or if the share of inventors in that region (or country) is greater than or equal to 50%. This more stringent counting method leads on average to a reduction of the number of patents in the ORs over the period, in particular in the case of French EU ORs. Martinique and Guadeloupe are particularly affected with a division by 1.69 (from 44 to 26 patents) and 1.74 (from 54 to 31 patents). Conversely, the performance of the Canary Islands remains relatively unchanged (from 375 to 333 patents). Nevertheless, the relative ranking of the ORs compared to their neighbouring countries remains the same.

A similar picture is found when we look at the number of patents per 100 000 inhabitants, in order to control for the fact that some countries/regions are smaller than others (Figure 2). A strong heterogeneity across EU ORs persists, where the Canary Islands, Réunion, Guadeloupe, and Martinique are the top innovative regions with, respectively, an average of 17 patents per 100 000 inhabitants, 14, 13 and 12 patents. Bahamas and Seychelles are ranked first and second, respectively, among the neighbouring countries in terms of the highest number of patents per 100 000 inhabitants. Bahamas has over 35 patents and Seychelles has over 26 patents. This significant number of patents per capita can be attributed, in part, to their favourable fiscal and/or banking policies.

Box 2. Patent as indicator of innovation dynamics

Patents are widely used to analyse the technological activities of inventors, firms, regions and countries. They are valuable because they provide the researcher with a coherent set of data across geographical locations and specific technological fields for long time series. Patent documents contain comprehensive information about assignees' and inventors' personal information (e.g. name, country, city, address, etc.), technology areas, as well as specific information about inventions (e.g. claims, filing date, issuing date, etc.).

There are two ways of assigning a patent to a region/country. It is possible to look at the country of the inventors or at the country of the applicants. The former normally reflects more directly the inventive activity of laboratories and researchers in a given country (Montobbio and Sterzi, 2010[4]); which is why this chapter uses this criterion. Furthermore, there are various ways to assess the technological output of a region using patent data. Patents filed at the national patent offices (i.e. in the case of French ORs the French Patent Office – the INPI (*Institut national de la propriété industrielle*) can be used or patents filed at large patent offices such as the EPO or USPTO, or by counting patents filed internationally at the WIPO (PCT procedure).

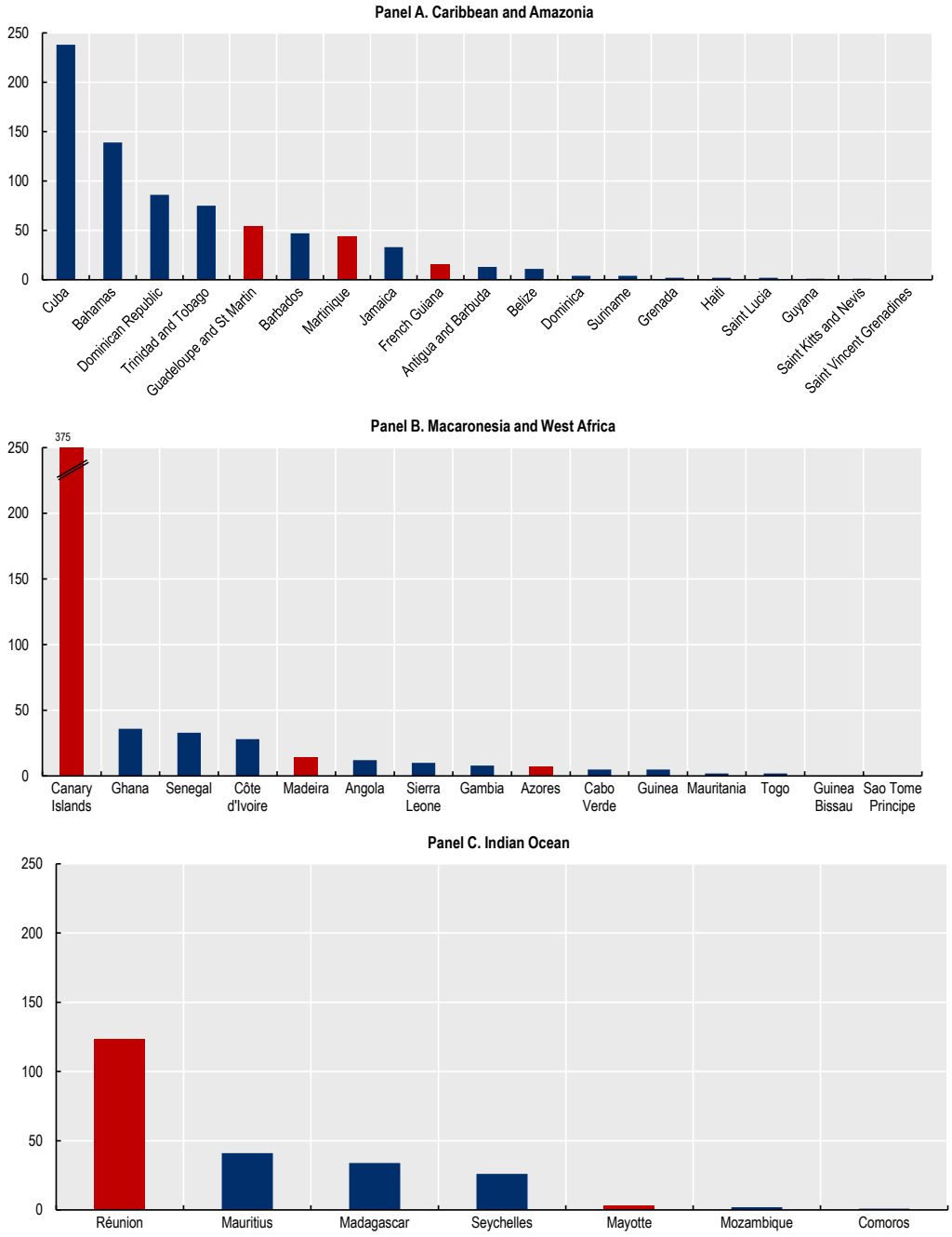
In the main analysis, we rely on PCT-WIPO applications (figures based on EPO and USPTO are available from authors upon request). The benefit of using indicators based on international patenting (PCT) come from the comparability of data and the relatively higher homogeneity of patents (in terms of expected value). In addition, national databases are largely influenced by changes in national legislations.

Source: Montobbio, F. and V. Sterzi (2010[4]), "Inventing together: Exploring the nature of international knowledge spillovers in Latin America", https://doi.org/10.1007/s00191-010-0181-5.

EU ORs are heterogeneous not only in terms of their *performance* in innovative activities, but also with respect to their *progress* in the last two decades. Figure 3 presents some basic data on performance levels and trends for EU ORs and the selected neighbouring countries. While the vertical axis shows the total number of patents per 100 000 inhabitants over the period (2000-19), the horizontal axis reports the growth between the two periods considered, i.e. 2000-09 and 2010-19. By combining these two aspects, level and trend, four different quadrants emerge (Fagerberg, Srholec and Knell, 2007[5]). First, the upper left quadrant shows the regions with above average level of patenting activity per capita but relatively slow growth ("*losing momentum*"). No EU ORs are in this quadrant, although Guadeloupe and Madeira are near to the border. In contrast, the upper right quadrant includes countries that continue to grow fast despite a high level of patenting activity ("*moving ahead*"). In this quadrant we observe only the four most innovative EU ORs (the Canary Islands, Réunion, Martinique, and Guadeloupe), while their neighbouring countries are completely absent. Of particular interest is the performance of the low innovative regions, those in the lower half of the graph. In this respect, we do not observe a particular macro region growing more than the

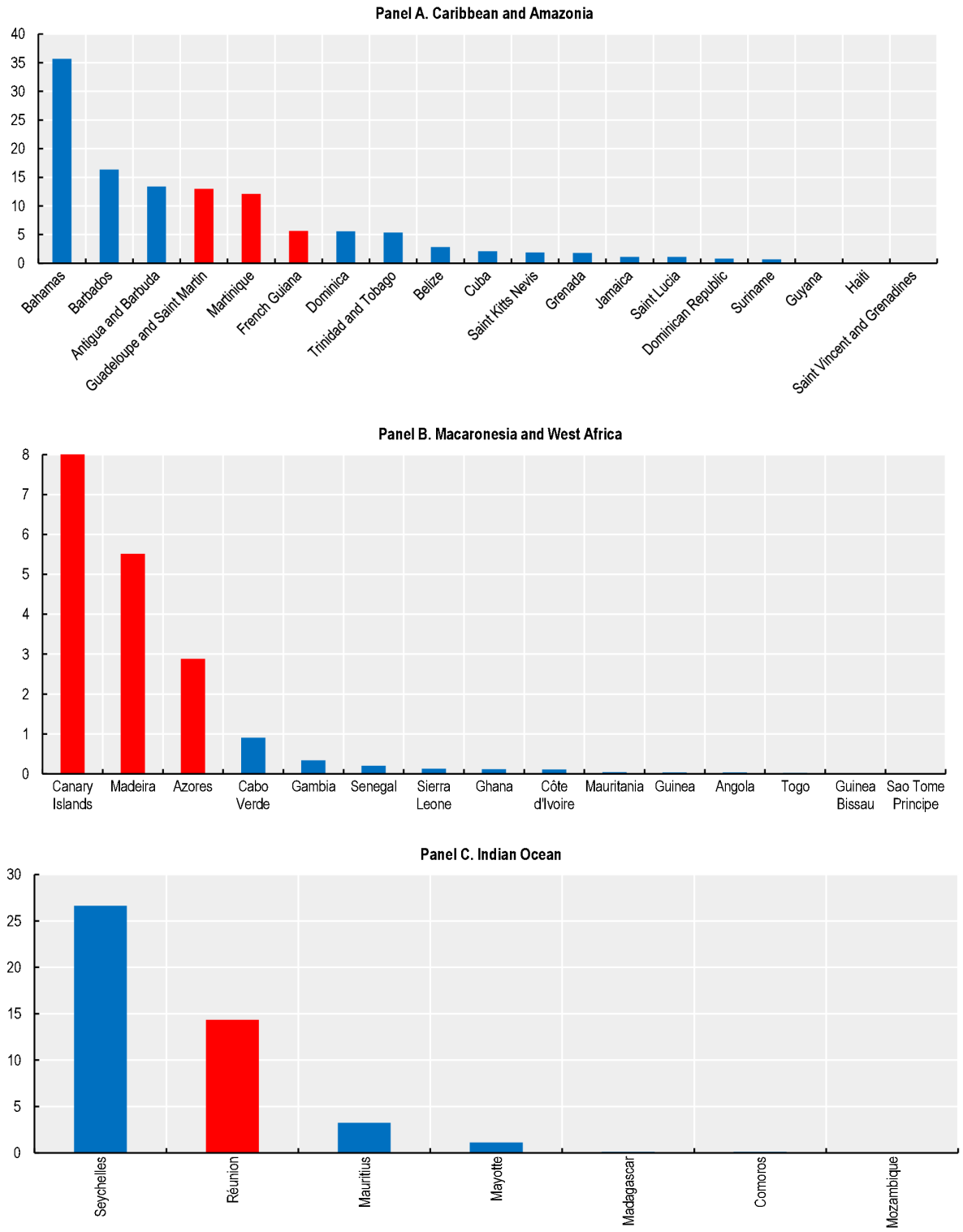
others as we observe regions and countries both in the bottom-left quadrant ("*falling further behind*") and bottom-right quadrant ("*catching up*"). The former includes Mayotte, showing the lowest performance and growth among the EU ORs, and Madeira. This diverging performance is shared with many of the neighbouring countries included in our sample. In sharp contrast to this diverging development, French Guiana is instead characterised by a relative high growth in patenting activity in the last decade.

Figure 1. Total number of PCT-WIPO patents over the period 2000-19



Note: Patents are localised by inventor's address. When the patent is a co-invention by inventors from different countries/regions it is counted more than once. Elaboration based on patent applications filed under the PCT between 2000 and 2019.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

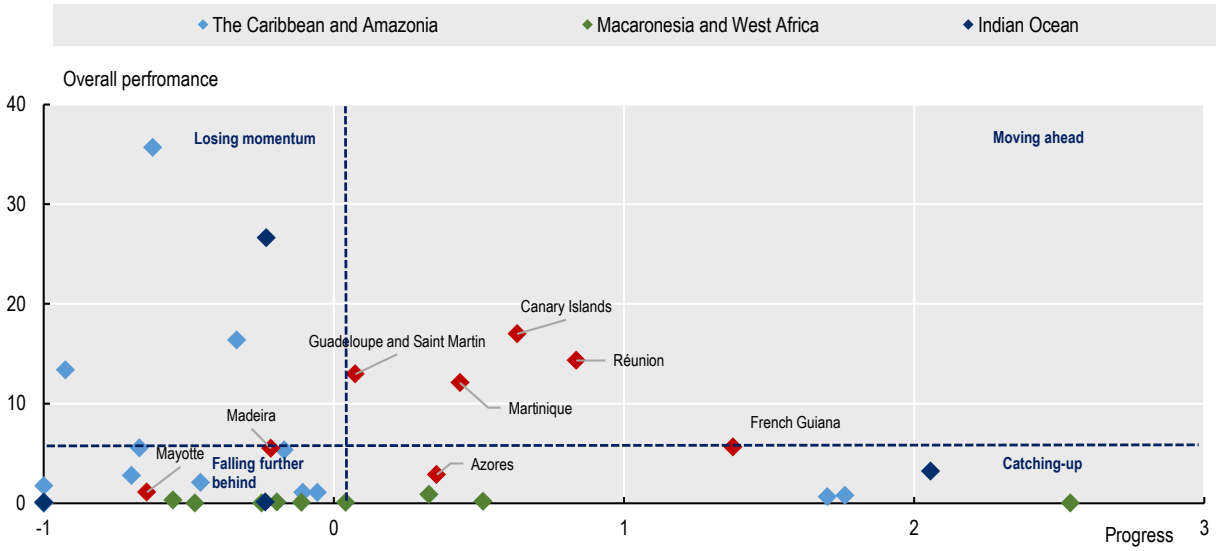
Figure 2. Total number of PCT-WIPO patents per 100 000 inhabitants over the period 2000-19



Note: Patents are localised by inventor's address. When the patent is a co-invention by inventors from different countries/regions it is counted more than once. Elaboration based on patent applications filed under the PCT between 2000 and 2019. The number of inhabitants refers to 2019.

Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

Figure 3. Average levels of country performance (2009) and progress (2009-19)



Note: Patents are localised by inventor's address. When the patent is a co-invention by inventors from different countries/regions it is counted more than once. Elaboration based on patent applications filed under the PCT between 2000 and 2019. Y axis: Total number of patents filed over the period 2000-19 per 100 000 inhabitants. X axis:
$Progress = \frac{Number\ of\ patents\ filed\ per\ 100K\ inhab.in\ P2 - Number\ of\ patents\ filed\ per\ 100K\ inhab.in\ P1}{Number\ of\ patents\ filed\ per\ 100K\ inhab.in\ P1}$.

P1 = 2000-2009 (Population 2009); P2 = 2010-2019 (Population 2019). The red axes correspond to the average values of the indicators. Outliers have been removed from the figure, i.e. Antigua-Barbuda and the Bahamas in the Caribbean; Seychelles in the Southwest Indian Ocean.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

3 A snapshot on the innovative trajectories of EU ORs

The EU ORs tend to be more specialised in basic sciences and human necessities

Patents are classified according to very specific technological classes and therefore can be used to measure innovative activities in specific technological domains. Figure 4 shows the distribution of the patents of the EU ORs and the average of the selected neighbouring countries across eight International Patent Classification (IPC) macro sectors: 1) Human necessities (which includes Agriculture, Foodstuffs, Personal and domestic articles, and Health), 2) Performing Operations and Transporting (separating and mixing, shaping, printing, transporting, microstructural technology and nanotechnology), 3) Chemistry and Metallurgy, 4) Textile and Paper, 5) Fixed Constructions, 6) Mechanical Engineering, Lighting, Heating, Weapons and Blasting, 7) Physics, and 8) Electricity.[5]

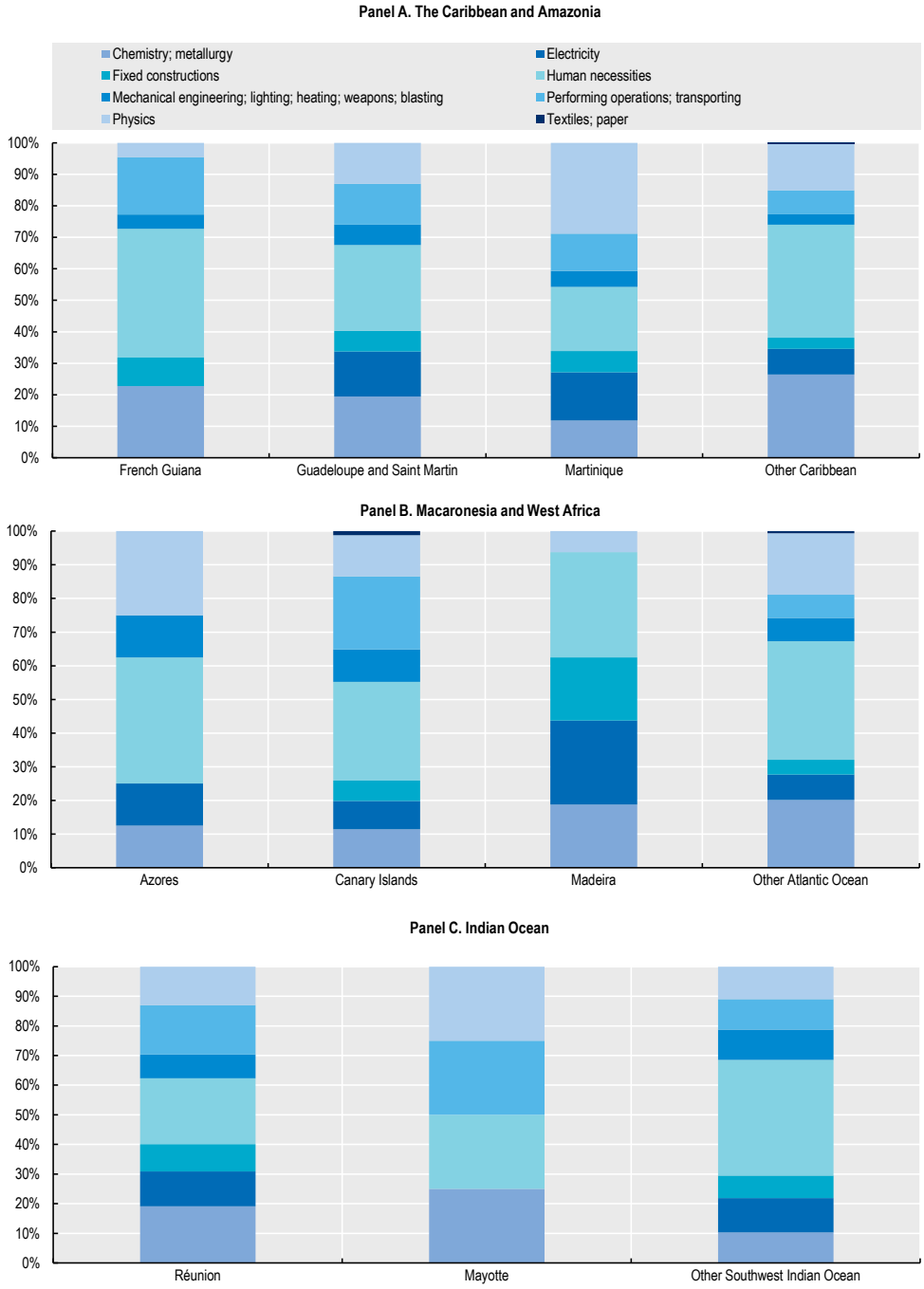
In particular, if we focus only on the top four innovative EU ORs (the Canary Islands, Réunion, Martinique, and Guadeloupe) we observe that they have a relatively low share of patents in human necessities contrary to other EU ORs. On the contrary, Martinique has a relatively high share of patents in Physics (in particular in Measuring; Testing (G01)), and Guadeloupe has a relatively high share of patents in Chemistry and Electricity. The Canary Islands and Réunion have a more balanced distribution of their patenting activities among technological classes with respect to other EU ORs. By looking at a more granular level, the majority of patents in Human necessities, fall in the 3-digit IPC class A61 “medical or veterinary science; hygiene”, patents in performing operations and transporting fall in classes c07 “organic chemistry” and c12 “biochemistry; beer; spirits; wine; vinegar; microbiology; enzymology; mutation or genetic engineering”. These technological classes reflect on the one hand the current economic specialisation of the EU ORs, in which agro-food account for the largest share of exports and manufacturing production, but also the knowledge base to further developing capabilities for other important high value-added sectors for the EU ORs such as marine biotechnologies and circular economy activities (Box 3).

The technology classification (IPC) used in the previous section reflects the composition of knowledge and technological capabilities of the EU ORs, but it cannot be used to understand or highlight linkages with the existing value chains. For this purpose, we rely on a reliable concordance that allows us to link technology to industry sectors. In doing so, we use the EUROSTAT-LEUVEN concordance table (ver. October 2014) that links IPC 4-digit technology classes to NACE2 industry sectors. Table 1 shows the top industrial sectors for the EU ORs. Most of the regions – the Canary Islands, Guadeloupe, and Réunion - develop technologies linked to the Manufacture of Basic Pharmaceutical Products and Pharmaceutical Preparations sector. Other industrial sectors where EU ORs are present are: Manufacture of Communication Equipment (Guadeloupe, Martinique, Réunion, Madeira, and the Azores), Manufacture of

[5] https://www.wipo.int/classifications/ipc/ipcpub/?notion=scheme&version=20210101&symbol=none&menulang=en&lang=en&viewmode=f&fipcpc=no&showdeleted=yes&indexes=no&headings=yes&notes=yes&direction=o2n&initial=A&cwid=none&tree=no&searchmode=smart.

medical and dental instruments and supplies (the Canary Islands), and Manufacture of Instruments and Appliances for Measuring, Testing and Navigation; Watches and Clocks (Martinique).

Figure 4. Industry specialisation of EU ORs and neighbouring countries



Note: Patents are localised by inventor's address. Elaboration based on patent applications filed under the PCT between 2000 and 2019. Distribution based on the 8 IPC macro sectors. When the patent is a co-invention by inventors from different countries/regions, or when it is associated to more than one macro sector, it is counted more than once. In each sub-figure, the last bar corresponds to the average distribution of countries in the macro-region.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

Box 3. TASCMAR: Leveraging on marine assets for value chain development in the EU ORs

TASCMAR *(Tools and Strategies to access to original bioactive compounds from Cultivation of MARine invertebrates and associated symbionts)* was a EUR 6.7 million H2020 funded project that in 2015-19 developed new tools and strategies in order to develop novel marine derived biomolecules with applications in the pharmaceuticals, nutraceuticals, cosmeceuticals and fine chemicals industries.

As a public and private consortium led by the French National Center for Scientific Research (CNRS) in co-operation with other 12 institutions from other Member States including Italy, Greece, Spain as well as Israel and Thailand, it developed innovative approaches for the cultivation and extraction of marine organisms using the unique prototypes Platotex™ and Zippertex™ that ensure sustainable supply of biomass and promote the production of high added value bioactive marine compounds.

Réunion, with a contribution of EUR 400 000 also participated through the Laboratory of Chemistry of Natural Substances and Food Sciences of the local University.

Source: Université de La Réunion (2020[6]), *Projet TASCMAR - Recherche de l'Université de La Réunion*, https://recherche.univ-reunion.fr/europe/projets-europeens-de-luniversite/projet-tascmar; European Commission (2023[7]), *CORDIS*, https://cordis.europa.eu/en.

Table 1. Top industrial sectors for the EU ORs

EU OR	Top economic sector - NACE 2 - and number of patents in brackets
Guadeloupe	Manufacture of basic pharmaceutical products and pharmaceutical preparations [13]
	Manufacture of communication equipment [6]
	Manufacture of food products [5]
	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms [5]
	Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks [5]
Martinique	Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks [8]
	Manufacture of communication equipment [5]
	Manufacture of basic pharmaceutical products and pharmaceutical preparations [4]
	Manufacture of medical and dental instruments and supplies [4]
	Manufacture of batteries and accumulators [4]
French Guiana	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms [4]
	Manufacture of pesticides and other agrochemical products [4]
	Specialised construction activities [2]
Réunion	Manufacture of basic pharmaceutical products and pharmaceutical preparations [21]
	Manufacture of communication equipment [12]
	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms [11]
	Manufacture of other general-purpose machinery n.e.c. [11]
Mayotte	Manufacture of basic pharmaceutical products and pharmaceutical preparations [1]
	Manufacture of medical and dental instruments and supplies [1]
	Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks [1]
	Manufacture of rubber and plastic products [1]
Canary Islands	Manufacture of basic pharmaceutical products and pharmaceutical preparations [52]
	Manufacture of medical and dental instruments and supplies [37]
	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms [33]
	Manufacture of other general-purpose machinery n.e.c. [32]

EU OR	Top economic sector - NACE 2 - and number of patents in brackets
Madeira	Manufacture of communication equipment [4]
	Manufacture of basic pharmaceutical products and pharmaceutical preparations [3]
	Specialised construction activities [2]
	Manufacture of electronic components and boards [2]
Azores	Manufacture of office machinery and equipment [except computers and peripheral equipment] [2]
	Manufacture of communication equipment [1]
	Manufacture of medical and dental instruments and supplies [1]
	Manufacture of agricultural and forestry machinery [1]
	Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms [1]
	Manufacture of general-purpose machinery [1]
	Manufacture of other taps and valves [1]

Note: The table shows the top industrial sectors for the EU ORs, based on the EUROSTAT-LEUVEN concordance table (version dated October 2014) that links IPC 4-digit technology classes to NACE2 industry sectors. Patents are localised by inventor's address. Elaboration based on patent applications filed under the PCT between 2000 and 2019.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

Public institutions play a pivotal role in the Outermost Regions

Who is patenting in EU ORs? Is it mainly private or public institutions? Are they domestic or foreign? In this section, for each patent with inventors residing in the EU ORs or in one of the selected neighbouring countries, we analyse applicant type (assignees) to investigate the ownership of the invention.

The patent assignees' address conveys important pieces of information (Montobbio and Sterzi, 2013[8]). If the inventor's address normally identifies the origin of the invention, the assignee's address refers to the ownership of the invention. Moreover, in terms of knowledge spillovers, it makes a difference whether the assignee is from the domestic OR/country or from a foreign country. In the last case, knowledge spillovers are less likely and mainly depend on the international mobility of inventors working abroad or foreign multinational firms.

In order to distinguish public institutions from private organisations we use keywords (such as "university", "school", "college", "institute", "centre", "CNRS").[6,7] Then, the number of public/private patents is measured using the fractional counting method. This method is based on the assumption that each inventor/assignee has contributed equally to the patent. In practice, each assignee is credited with an equal share of the patent.[8]

Furthermore, we use the address of the applicant to differentiate patents assigned to domestic organisations from those assigned to foreign organisations; in particular, taking the perspective of the OR/country, we consider "domestic" a patent where the applicant or, in case of co-applicants at least one applicant, is resident in the OR/country; on the contrary, we consider "foreign" a patent where the

[6] In doing so, we use English, French, Spanish and Portuguese names.

[7] Universities are always considered public institutions, even when they are private.

[8] The use of fractional counting has been encouraged by Eurostat (Grupp and Schmoch, 1999[28]) and used in many research papers (see among others Bergek and Bruzelius (2005[31]).

applicant(s)' address is outside the region/country.[9] In this exercise, EU ORs are considered countries, meaning that a patent with applicants residing on the mainland (and none in the EU OR being studies) is considered foreign.

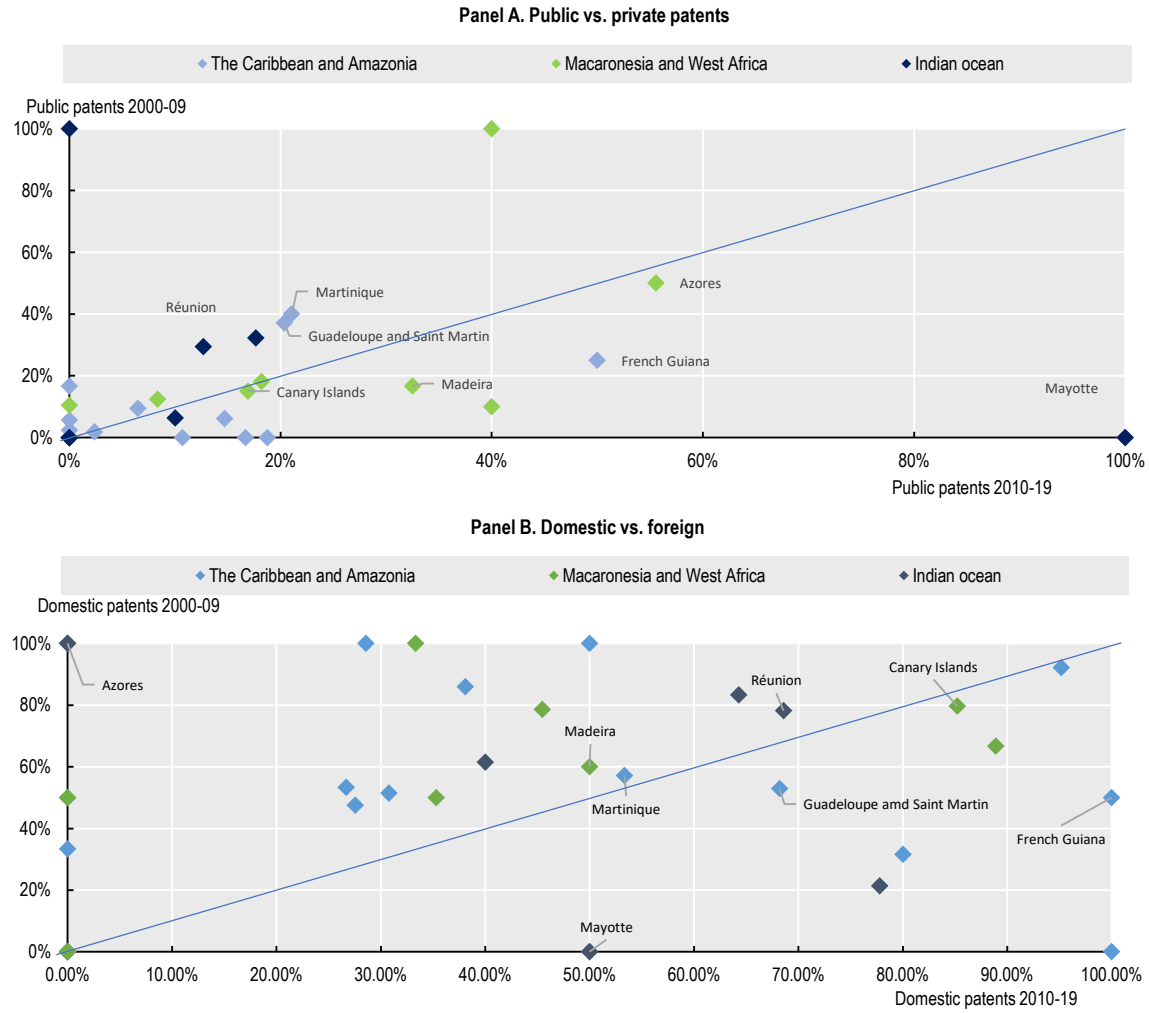
Figure 5 shows the share of patents assigned to public (Panel A) and to domestic (Panel B) institutions in the two sub-periods (2000-09, 2010-19). We can draw the following key observations:

- The role of the public sector is particularly important in all the EU ORs, where about one out of every three patents is assigned to a university or public research organisation. On the contrary, a relative low share of patents is owned by the public sector in all neighbouring countries, with the exceptions of some small and less dynamic neighbouring countries where the top patentee is a public institution. Interestingly, in four neighbouring countries a French research institution is the top patentee: Madagascar, Comoros, Senegal, and Guiana. In the case of French ORs, CIRAD ("*Centre de coopération internationale en recherche agronomique pour le développement*") plays a major role, especially in Guadeloupe where it is ranked first; the CNRS ("*Centre national de la recherche scientifique*") is the most important assignee among the public institutions in French Guiana and Réunion, and the CEA ("Co*mmissariat à l'Énergie Atomique et aux Énergies Alternatives*") in Martinique and Mayotte. Furthermore, the Universidad de la Laguna is the top patentee in the Canary Islands and the Instituto Superior Tecnico in Azores.
- As regards the private organisations, many of them have only a few patents. In the Canary Islands (see Table A A.2 in the annex), the most innovative companies are Guradoor Sl, Adventia Pharma Sl and Santander Cerbell Roberto. Among the top companies patenting in EU ORs, a few of the major companies include Air Liquide Sa, Reuniwatt, Ercane in Réunion, Intel in Martinique, and Becton Dickinson in Guadeloupe. Looking at the five main private applicants residing in the Canary Islands, first we can notice that there are very few patents in co-ownership. Second, most of the patents listed have a single location of the inventors which is the Canary Islands. Together, these elements suggest that the innovative activity of these five private entities has indeed taken place in the OR. Table A A.2 I in the annex presents the list of patents owned by these private entities.
- The growth observed for the most innovative EU ORs is mainly explained by the growth in the number of patents involving public institutions. This is the case for Martinique, with the increase in the number of patents owned by the CEA (one in the first period compared with six in the second), Guadeloupe, where the CIRAD rises from one patent in the first period to four in the second, and Réunion. This last case presents the most important change in absolute terms between the two periods considered, with a sharp increase in the number of patents owned by the CNRS (from two to eight patents) and the University of Réunion (from two to seven patents), accompanied by the appearance in the second period of a few public entities with significant patenting activities: IRD ("*Institut de recherche pour le développement*"), INSERM ("*Institut national de la santé et de la recherche médicale*") and Institut Pasteur, involved in seven, six and four patents respectively. The main public applicants residing in Réunion are all French national research institutions: CNRS, IRD, and INSERM. Most of their patents are co-owned with universities. As regards the location of co-owners, there is a strong collaboration with the University of Réunion: four out of six patents for INSERM, three out of seven for IRD, two out of ten for CNRS. In addition, a particular relationship with Montpellier and Lyon in France can be noted, both in terms of co-ownership (Université Montpellier II, Université Lyon) and co-inventorship. Finally, the most frequent technology sectors are "Medical or veterinary science; Hygiene" (A61), "Organic chemistry" (C07) and "Biochemistry; Beer; Spirits; Wine; Vinegar; Microbiology; Enzymology; Mutation or genetic engineering" (C12), which appear several times together. Table A A.1 in the annex provides more details.

[9] In this last case, the foreign patent may correspond to two distinct situations: (1) the origin of the invention is in the OR/country and the invention is assigned to an affiliate of a foreign multinational that report the address of the parent company in the patent application; (2) the origin of the invention is abroad.

- Most of the patents involving inventors residing in the EU ORs are owned by domestic organisations (both public and private). In particular, this is the case especially for high innovative EU ORs, such as the Canary Islands and Réunion, where about 80% of patent applicants are domestic organisations. Besides universities and PROs, there are several domestic private entities particularly active in patenting, such as Guradoor SI (nine patents) or Adventia Pharma SI (five patents) in the Canary Islands, and Reuniwatt (three patents) in Réunion. Furthermore, we observe that most of the ORs are characterised by an increasing share of "foreign patents" over time, in contrast to what we observe for most of the neighbouring countries. If this increasing presence of foreign institutions as patentees is a signal of an increased attractiveness of the EU ORs and may be conducive to future technological spillovers, it may also be a warning sign since it means that the knowledge produced can be more difficult to be appropriated by the EU ORs.

Figure 5. Ownership of EU OR patents: Public vs. private and domestic vs. foreign



Note: Patents are localised by inventor's address. When the patent is a co-invention by inventors from different countries/regions it is counted more than once. Elaboration based on patent applications filed under the PCT between 2000 and 2019. The figure shows the percentage of patents assigned to public (left figure) and domestic (right figure) institutions in two sub-periods: P1 = 2000-09; P2 = 2010-19. Public institutions are identified using keywords such as university, school, college, institute, centre, CNRS, etc. A patent is considered domestic when at least one applicant resides in the country/region to which the patent is assigned. The number of public and private patents is measured using the fractional counting method.

Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

4 Past and present international collaborations

International technological collaborations are an important vehicle of knowledge diffusion, especially for less developed countries (Montobbio and Sterzi, 2010[4]; Montobbio and Sterzi, 2013[8]). In particular, international collaboration in inventive activity is extremely valuable for the transfer of tacit knowledge, experiences and routines which derives from face-to-face interactions and from the development of common shared practices ensuing from research collaborations (Montobbio, Primi and Sterzi, 2015[9]).For less developed economies, international knowledge flows are seen as critical in the push for territories to catch up, while collaboration in research is one of the channels through which information, knowledge and to some extent know-how flow between partners.

In this section, we thus focus on the international patent collaborations carried out by EU ORs, analysing both the volume of this activity and the countries most involved in these collaborations.

Figure 6 shows the share of international collaborative patents in each EU OR and neighbouring countries. A patent is considered “international collaborative” if it is associated with several inventors, of whom at least one resides in the OR/country under consideration and at least one resides outside the OR/country. As explained before, in this exercise EU ORs are treated as if they were independent countries, meaning that a patent with inventors residing in both a French EU OR and in Mainland France is considered an international collaboration.

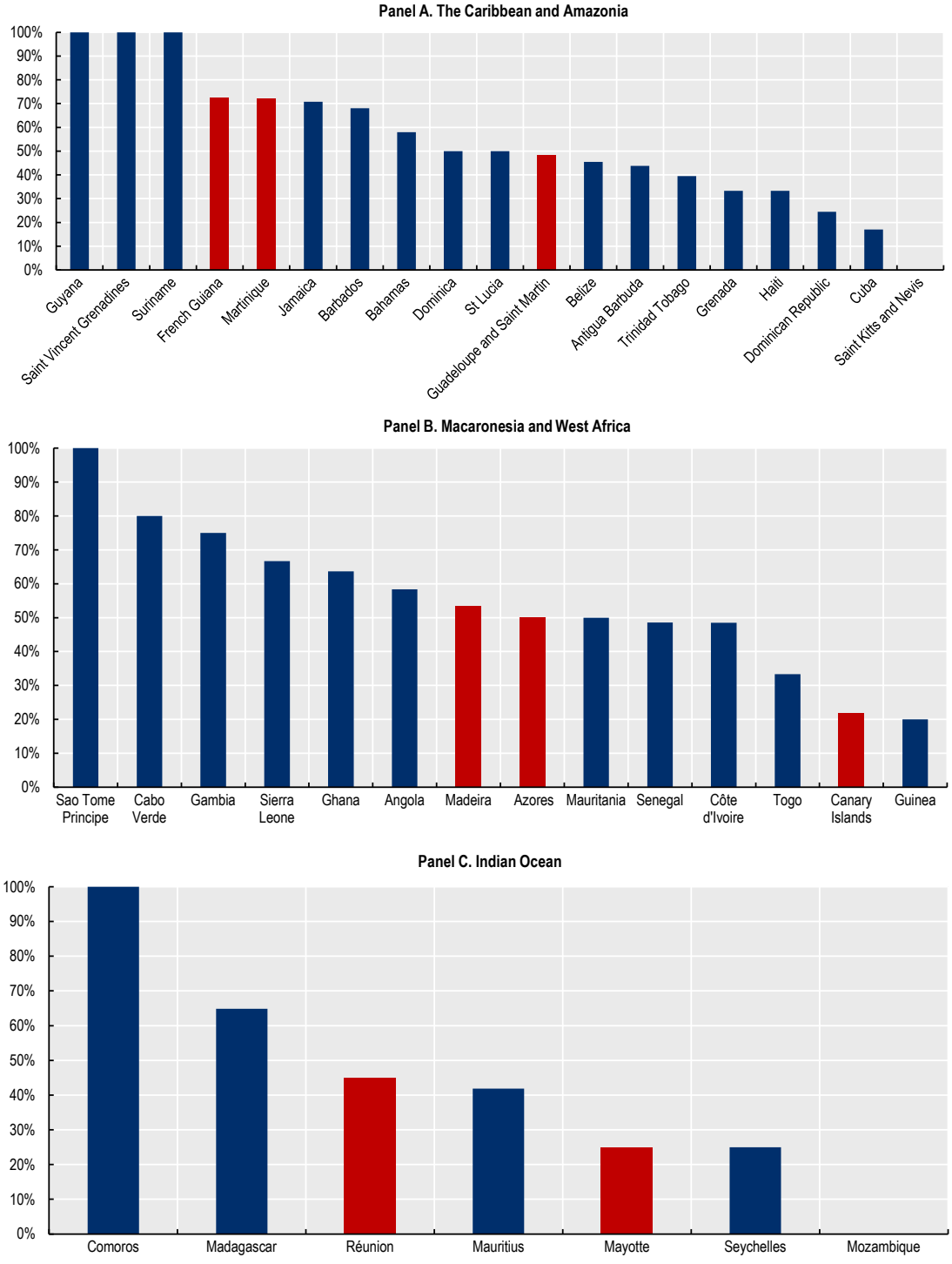
A high degree of heterogeneity can be observed within the EU ORs. Indeed, the Canary Islands and Mayotte have some of the lowest rates (respectively 22% and 25%) of international collaborative patents, while Martinique and French Guiana are at the top of the distribution (both with 72%), suggesting that in their case the innovative structure is highly dependent from abroad (mainland included). The remaining four ORs have a share of collaboration ranging from 45% to 53%. The high share of international collaboration for French ORs – with respect to Spanish and Portuguese ORs – is at least partially due to its more structured innovation system, where public institutions such as CNRS, IRD, INSERM file a significant number of patent applications, as previously mentioned (see also Table A A.1 in the annex).

Compared to more innovative countries, these shares are overall particularly high. Indeed, two of the most innovative countries in terms of PCT filings, namely the United States and Germany, have a significantly lower international collaboration rate, 11% and 16% respectively.

A strong heterogeneity is also observed for neighbouring countries, without showing a clear link between innovation dynamic and collaboration share. For example, in the Caribbean Sea, the two countries with the highest number of patents – as shown in Figure 7 (Cuba and the Bahamas) – have very different level of international collaboration rates: 17% for the former, against 58% for the latter.

Table 2 displays with whom the EU ORs collaborate. Collaborations between EU ORs are presented in the first row of the table. Interestingly, EU ORs collaborate very little with each other, with the exception of two French ORs: Martinique and Réunion. In particular, Martinique shows the highest level of collaborations, with almost one in three international collaborative patents with other French ORs.

Figure 6. Share of international collaborative patents



Note: Patents are localised by inventor's address. Elaboration based on patent applications filed under the PCT. A patent is considered collaborative if it is associated with several inventors, of whom at least one resides in the region/country under consideration and at least one resides outside this region/country. EU ORs are considered as country, meaning that a patent with inventors residing in both a French EU OR and in Mainland France is considered as an international collaboration.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

Despite geographical proximity, the EU ORs do not have patenting collaboration with neighbouring countries in our analysis. On the contrary, the vast majority of EU ORs' co-operation is with 1) the mainland and 2) other European countries. Together, these two areas account for at least 80% of collaboration for half of the ORs. Collaboration with other continents is therefore still a relatively rare phenomenon. A few collaborations are observed with North America only for the Canary Islands, Guadeloupe and Martinique.

The evidence also highlights:

- **The French ORs are strongly related to domestic innovative actors.** In the data we observe 13 patents (see Table A A.3 in the annex) produced by teams of inventors residing in more than one French EU OR. The majority of these collaborations (11 patents) involve inventors residing in Martinique and Réunion. One patent involves a team of inventors residing in four EU ORs (Guadeloupe, Martinique, French Guiana, and Réunion). The applicant of this patent is Michelin. By analysing the applicants of these patents: with the exception of the "Commune du Tampon" which appears as an applicant in two patents, other applicants appear in one patent only. This suggests that these patents are the result of one-off research collaboration or the will of the inventors, rather than the result of a long-term partnerships. Table A A.4 in the annex is divided into two parts. The upper part lists 17 patents filed in collaboration with foreign inventors, but without the inventors living in mainland France. The lower part presents the 22 patents with inventors residing both in mainland France and abroad. Beyond the slightly higher share of collaborations involving mainland France (56% vs. 44%), we observe that these collaborations are mainly with European and Mediterranean countries, whereas collaborations without mainland France are more diversified in terms of inventors' place of residence, with a strong presence of the US and, to a lesser extent, of Asia. Moreover, while patents involving mainland France are predominantly held by French organisations (mostly public) such as CNRS, Institut Pasteur and Orange, patents without inventors from mainland France are largely held by foreign companies, such as Sony Corporation, Phoseon Technology, Inc. and Société des Produits Nestlé S.A.
- **The Canary Islands tend to have more collaborations with other European countries**. The Canary Islands appear to have relatively strong connections with Germany and the United Kingdom with 13 and 10 collaborations respectively. Interestingly, the mainland does not seem to play a major intermediary role in the creation of these relationships with Europe. Indeed, only four out of 35 collaborative patents include an inventor residing on the Spanish mainland. These strong relations with Europe are a particularity of the Canary Islands, which differentiates it from other ORs. A possible explanation could be its greater geographical proximity to the European continent compared to the others. Table A A.5 and Table A A.6 in the annex present the distribution of the Canary Islands' collaborations with European countries.

Table 2. Distribution of EU ORs' international patent collaborations by macro area as share of total co-patents

	Canary Islands	Guadeloupe Saint Martin	Martinique	French Guiana	Réunion	Mayotte	Azores	Madeira
Other EU ORs	0 *0%*	4 *9.30%*	13 *28.89%*	2 *11.11%*	11 *14.67%*	0 *0%*	0 *0%*	0 *0%*
Mainland (excluding other ORs)	51 *48.11%*	23 *53.49%*	24 *53.33%*	11 *61.11%*	51 *68.00%*	1 *50.00%*	4 *100%*	2 *20.00%*
Europe (excluding Mainland)	35 *33.02%*	7 *16.28%*	2 *4.44%*	4 *22.22%*	4 *5.33%*	0 *0%*	0 *0%*	6 *60%*
Other countries in the relative macro area*	0 *0%*	0 *0%*	0 *0%*	0 *0%*	0 *0%*	0 *0%*	0 *0%*	0 *0%*
North America	10 *9.43%*	5 *11.63%*	4 *8.89%*	1 *5.56%*	1 *1.33%*	0 *0%*	0 *0%*	2 *20%*

Other countries	10 *9.4%*	4 *9.3%*	2 *0%*	0 *0%*	8 *10.66%*	1 *50%*	0 *0%*	0 *0%*
Total number of collaborations	**106**	**43**	**45**	**18**	**75**	**2**	**4**	**10**

Note: Patents are localised by inventor's address. Elaboration based on patent applications filed under the PCT. If a patent has several inventors located in different geographical areas, the number of corresponding collaborations is equal to the number of geographical areas represented (excluding the OR under consideration). Mainland corresponds to France for French ORs, Spain for Canary and Portugal for Portuguese ORs.
* The macro area corresponds to the area in which the EU ORs are located.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

5 Future potential international collaborations

EU ORs have no patent collaborations with their neighbouring countries. In what follows, we look at the technological proximity between EU ORs regions and their neighbouring countries in order to point out potential future collaborations. Since technological proximities between countries is found to be a facilitator of the creation of R&D collaborations (Montobbio and Sterzi, 2013[8]), strengthening international ties with neighbouring countries would create economies of scale, foster knowledge transfer and share risks connected to investments in R&D.

In order to calculate technology proximity between region *i* and *j* we compare the text of the abstracts of the patents.[10] In doing so, we first compute the vector representation of each abstract using a language model trained on patent data (BERT for patents). Then we apply the cosine similarity between each pair of patents and then we calculate the average similarities by pair of regions. The average similarity between ORs and neighbouring countries is 0.1457. Results are displayed in Table 3. In the diagonal we show the average technological similarity based on the comparison of the abstracts with respect to other patents within the same region; outside the diagonals, values represent the technological similarities between different regions/countries. Values in bold are similarities higher than the 25th percentile of the distribution (0.1546).

To make the results more readable, Figure 7 shows the network based on Table 3 where a link between two regions identifies a technological proximity higher than the average. The colours identify different clusters in the network calculated through the modularity algorithm. Regions/countries with the same colours are more technologically similar to other regions/countries. The size of the node is proportional to the degree of centrality (number of links). The link between nodes is weighted using the cosine measure.

The figure provides some interesting insights. Indeed, the analysis shows that EU ORs are the more central in the network, and therefore could benefit from enhancing future collaborations.

- Regarding the EU ORs, there is a notable potential for collaboration among Guadeloupe, Réunion, and to a lesser extent, French Guiana. An analysis of the IPC classes in which Guadeloupe and Réunion hold patents reveals their relatively strong activity in A61 (“medical or veterinary science; hygiene”), C12 (“biochemistry; beer; spirits; wine; vinegar; microbiology; enzymology; mutation or genetic engineering”), and, to a lesser extent, H04 (“electric communication technique”).
- Moreover, Guadeloupe and Réunion appear to be the regions with more potential to develop international collaborations also with other regions and countries; in particular, Réunion shows a relatively high level of technological similarity with the Canary Islands, Cuba, Dominican Republic, and the nearby Madagascar. For instance, apart from the fields mentioned earlier, Réunion, Cuba, and the Canary Islands exhibit a significant number of patents in the IPC class A01, which covers areas such as agriculture, forestry, animal husbandry, hunting, trapping, and fishing.

[10] In the annex, we report the table of technological similarities between regions by using IPC (30 technological classes) correlations and Euclidean distance.

Table 3. Technological similarity based on semantic analysis of abstracts (BERT)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) Guadeloupe – Saint Martin	**0.1792**															
(2) Martinique	0.1464	**0.1852**														
(3) French Guiana	**0.1553**	0.1533	**0.2217**													
(4) Réunion	**0.1589**	0.1523	**0.1630**	**0.1720**												
(5) Madeira	0.1131	0.1177	0.1247	0.1160	**0.1704**											
(6) Canary Islands	0.1506	0.1458	**0.1601**	**0.1568**	0.1186	**0.1626**										
(7) Barbados	0.1310	0.1310	0.1339	0.1349	0.1038	0.1333	**0.1700**									
(8) Bahamas	**0.1555**	0.1493	0.1418	0.1461	0.1171	0.1475	0.1546	**0.1949**								
(9) Cuba	0.1523	0.1161	0.1425	0.1504	0.1131	0.1355	0.1242	0.1237	**0.2768**							
(10) Dominican Republic	0.1485	0.1456	**0.1559**	0.1514	0.1104	**0.1588**	0.1347	0.1542	0.1217	**0.1746**						
(11) Ghana	0.1493	0.1359	0.1540	0.1488	0.1203	0.1478	0.1414	0.1494	**0.1554**	0.1440	**0.1810**					
(12) Jamaica	0.1386	0.1246	0.1430	0.1373	0.1067	0.1377	0.1342	0.1387	0.1591	0.1327	0.1524	**0.1839**				
(13) Madagascar	**0.1557**	0.1492	**0.1742**	**0.1638**	0.1234	**0.1628**	0.1417	0.1442	**0.1753**	**0.1571**	**0.1622**	0.1543	**0.2164**			
(14) Mauritius	0.1491	0.1502	0.1458	0.1523	0.1157	0.1523	0.1380	**0.1577**	0.1189	**0.1594**	0.1375	0.1293	0.1521	**0.1941**		
(15) Senegal	0.1377	0.1328	0.1370	0.1379	0.1014	0.1324	0.1171	0.1319	0.1412	0.1313	0.1338	0.1224	0.1419	0.1261	0.1534	
(16) Trinidad and Tobago	**0.1547**	0.1499	0.1544	0.1526	0.1229	0.1542	0.1409	**0.1598**	0.1279	**0.1565**	0.1455	0.1390	**0.1616**	**0.1654**	0.1263	**0.1926**

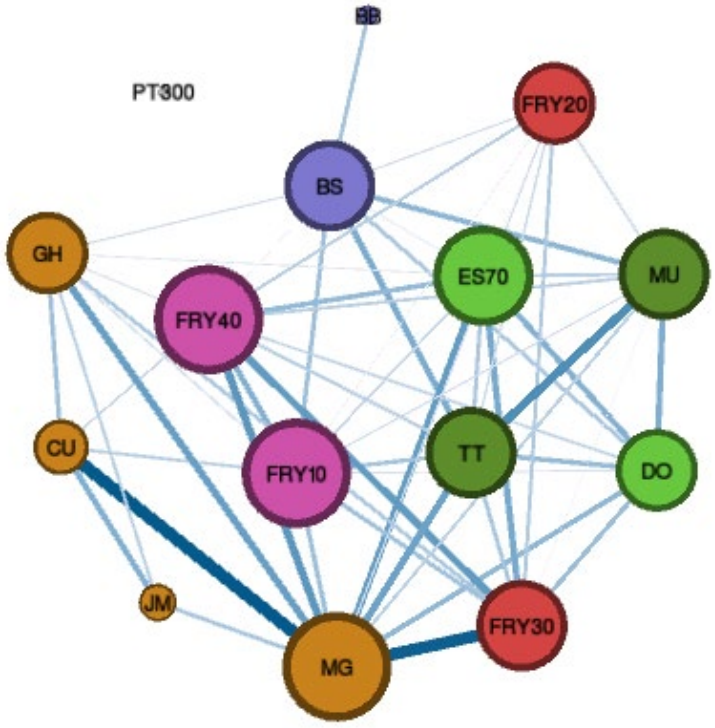
Note: This table shows the cosine similarities between the ORs and neighbouring countries based on natural language processing (NLP) semantic analysis. Vectors of words are created with BERT (Bidirectional Encoder Representations from Transformers). The average similarity between ORs and neighbouring countries is 0.1457. Values in bold are similarities higher than the 25th percentile of the distribution (0.1546).

Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

- Furthermore, a relative high technological proximity is also observed for Guadeloupe with Bahamas, and Trinidad and Tobago; French Guiana appears to be particularly technological close to Madagascar. Martinique is the only French OR that appears to be specialised in technologies that are relatively unlike those developed by the other three French ORs and to their neighbouring countries.
- Regarding Portuguese ORs, Madeira seems to be technologically distant from other regions, which may be partly due to its relative geographical isolation. Figure 7 does not show any links, indicating that Madeira has below-average technological similarities with all other regions and countries. Additionally, the figure highlights a cluster that includes the Canary Islands, Mauritius, Dominican Republic, and Trinidad and Tobago. Lastly, the Canary Islands exhibits a significant degree of similarity with French Guiana, Réunion, and Madagascar.

Furthermore, the breakdown of the IPC class in human necessities displays a comparative advantage for the EU ORs to co-operate with their nearby countries. Medical and veterinary science, followed by agriculture and food are the main specialisation of the EU ORs and their partner countries facing the Caribbean, the Atlantic and the Indian Oceans. Medical and veterinary and agricultural sciences cover important share for the EU ORs including 100% for Mayotte and 33% of the Azores patenting in human necessities (Figure 8).

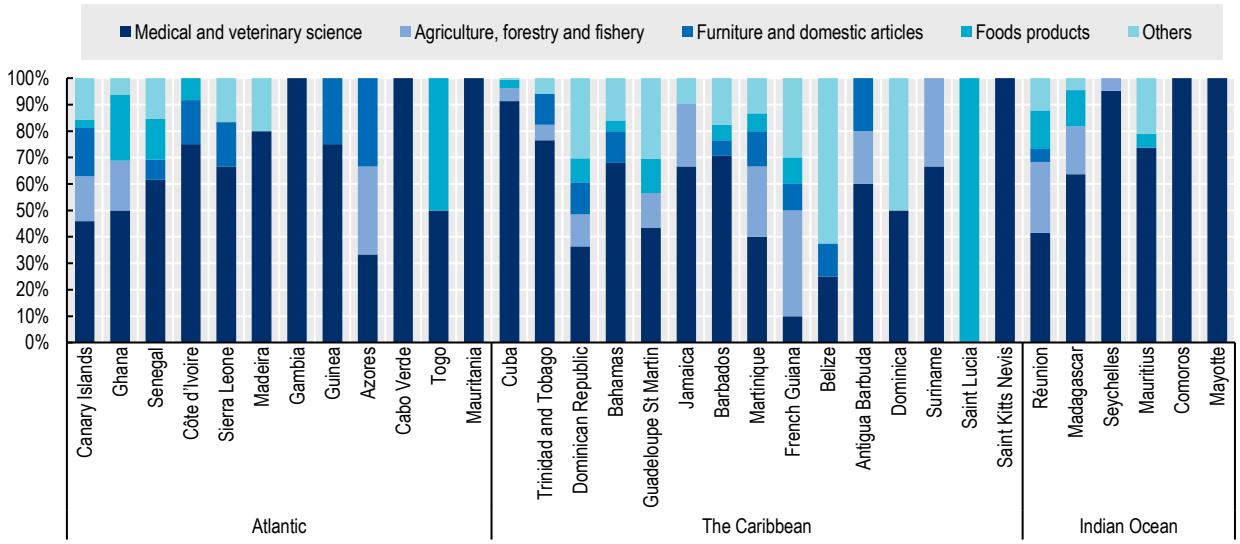
Figure 7. Technology proximity between EU ORs and neighbouring countries



Note: This figure shows the network based on Table 3 where a link between two regions identifies a technological proximity higher than the average. The colours identify different clusters in the network calculated through the modularity algorithm. The size of the node is proportional to the degree of centrality (number of links). The link between nodes is weighted using the cosine measure. Country code: ES70: Canary Islands; FRY10: Guadeloupe – Saint Martin; FRY20: Martinique; FRY30: French Guiana; FRY40: Réunion; BB: Barbados; BS: Bahamas; CU: Cuba; DO: Dominican Republic; GH: Ghana; JM: Jamaica; MG: Madagascar; MU: Mauritius; SN: Senegal; TT: Trinidad and Tobago.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database https://www.epo.org/en/searching-for-patents/business/patstat.

Figure 8. Breakdown of patenting in human necessities by territories and geographical regions

Share of total patents filed under human necessities



Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

6 Policy implications and ways forward

The analysis of patenting activity in the EU ORs – based on PCT-WIPO patent applications filed between 2000 and 2019 – reveals some specific characteristics of innovative and market-oriented innovation activities carried out in and by the EU ORs:

- These regions file a limited number of patents, with the Canary Islands leading in terms of number of patent filings, followed by Réunion, Guadeloupe, and Martinique.
- These regions are not highly involved in international patent networks, even in areas where they do have assets and relative specialisation, including innovative oceans, and sustainable agriculture and healthcare.
- When involved in co-patenting, these regions co-operate little between themselves, with most of the activities jointly done in collaboration with public research institutes on the mainland, in addition to leading global players such as the United States, the United Kingdom and Germany.
- Public research centres, especially in French EU ORs, are driving patent filing activities. These institutes file on average about one of every three patents applied for in these regions.
- The patenting areas of the EU ORs show a relative technological specialisation that reflect their economic structure, such as agro-food, but also important scientific and technological fields that can nurture the next generation of value chain participation. These include pharmaceutical application and biotechnologies activities but also healthcare and chemistry, which are associated with the natural endowment of the EU ORs.

The above-mentioned findings suggest the following considerations.

Scale up the efforts of public research centres and universities

Public research centres are key actors of the innovation ecosystem in EU ORs, they are not only the most active in patenting, they are also involved in supporting international collaborations and in implementing experimental and applied research that can result in innovative business opportunities and homegrown solutions to emerging local and global challenges, including in bioeconomy and the circular economy.

Public research centres at local level could benefit more from linkages with their national counterparts. These include for example the Spanish National Research Council (CSIC), the Portuguese national funding agency for science, research and technology (FCT) and the French National Centre for Scientific Research (CNRS). This is already the case for French EU ORs, which can count on strong partnerships with the national branches of CNRS. The CNRS has an extensive network of 80 international research laboratories and 26 joint units that cover multiple disciplines including chemistry, biological sciences, engineering and earth and astronomy science among others. Located in partner institutes abroad, they provide opportunities for researchers, students, postdoctoral fellows, engineers, and technicians for both

domestic and foreign institutions to pursue international collaboration in research and innovation and could also represent for the ORs a springboard for enhanced international collaboration.

Several essential options are available for developing strong research and innovation networks. In order to establish technology transfer offices, other inter-related factors contribute to successful knowledge transfer and spillover effects including the availability of science and engineering resources, the quality of research faculty as well as supporting organisational and management mechanisms that encourage industry co-funding and grants to support universities' and research centres' innovation activities (O'Shea et al., 2007[10]).

There is also an untapped potential with respect to generating linkages and collaboration between universities, public research between EU ORs and with their partners. This is particularly evident in the case of shared opportunities such as inter-island and archipelago mobility, marine biotechnologies and sustainable agriculture. A renewed innovation policy approach could also generate synergies with the international partnerships managed at the national level. For example, in Madagascar, Comoros, Senegal and Guiana the top patentee is a French research institution, and specific incentives could be developed to facilitate the participation of public research institutes in EU ORs in these collaborations.

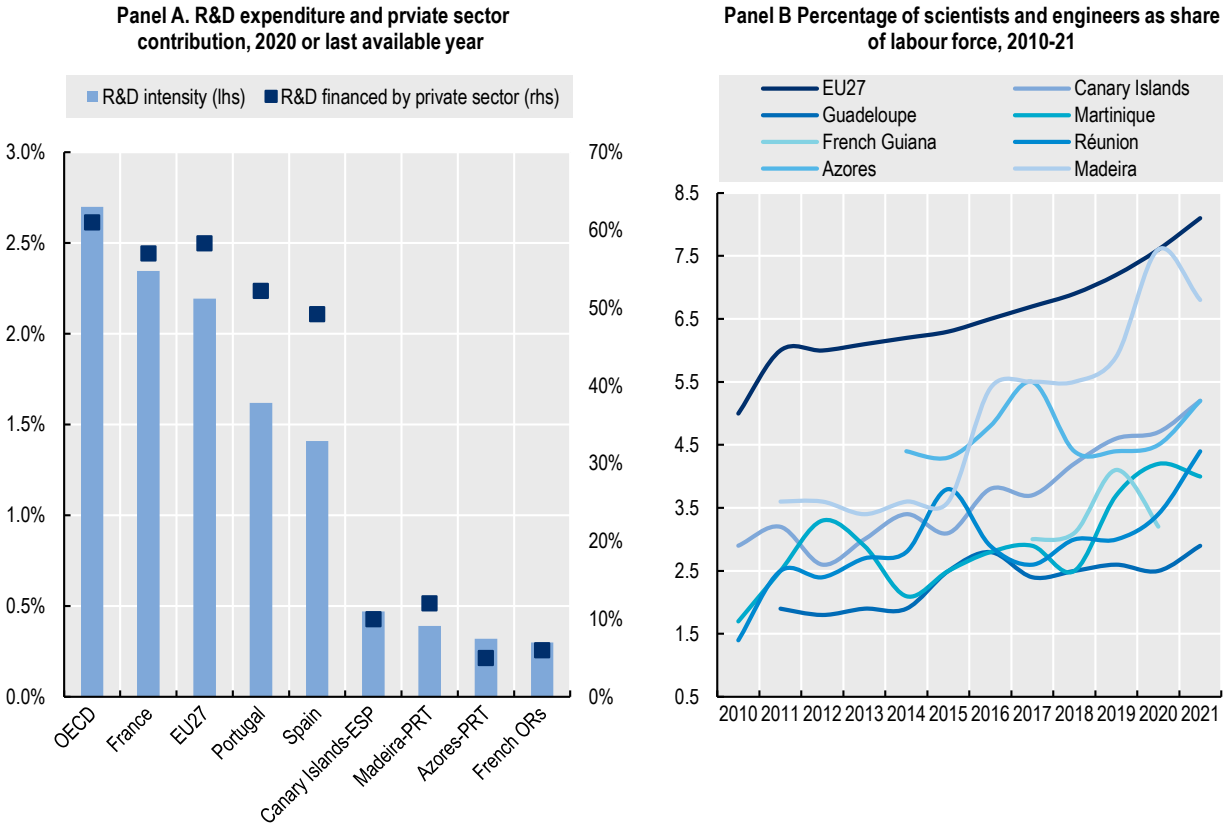
Increase private sector commitment to research and innovation on a larger scale

The relatively small patenting propensity of the EU ORs reflects the limited investment in R&D activities and the marginal role played by the private sector. The increase of investments and support in science, research and innovation is essential for several reasons. Besides the traditional gains in terms of productivity growth, trade diversification and investment attraction, increased innovation activities can open the doors to opportunities to strengthen current and explore new international partnerships for value chain participation, which is also applicable in sectors where knowledge intensity is lower (Toselli, 2016[11]; Piva, Tani and Vivarelli, 2017[12]).

Despite efforts, the innovation ecosystem in the EU ORs is still limited if compared to other EU territories. R&D investment is below 0.5% of regional GDP, well below the national, the OECD and the EU averages and similar to developing and emerging economies in Latin America. These figures also corroborate the patenting analysis of the previous paragraphs that depicted a stronger role played by public institutions while private sector investment and contribution remain feeble. In the EU ORs, the private sector contribution to R&D varies from the 12% of Madeira to the 5% of the Azores (Figure 9, Panel A). If on the one hand this reflects the production structures of the EU ORs dominated by less sophisticated economic activities such as commercial and public administration services, on the other hand, it also calls for a greater commitment from the private sector to pursue innovation in a broader sense. The most recent Community Innovation Survey in Portugal shows that over the triennium 2018-20 the share of business enterprises that introduced an innovation (either a new product, a new business process or both) in Madeira and in the Azores reached 43% compared to 33% and 24% in 2016-18. Likewise, between 2015 and 2019 the number of firms that introduced an innovation increased by 10% from 1 040 to 1 183 (INE, 2022[13]; 2022[14]).

The EU ORs can leverage recent progress and fill the gap between science and innovation. Innovation activities, from radical to marginal or from technological to more market-oriented strategies, require an adequate and prepared human capital. The EU ORs are advancing in this respect. Over the last decade, almost all regions have increased their shares of scientists and engineers in total workforce. Although the figures remain below the EU and national averages, in several EU ORs such as Madeira, Martinique and Réunion the incidence of scientists and engineers doubled (Figure 9, Panel B).

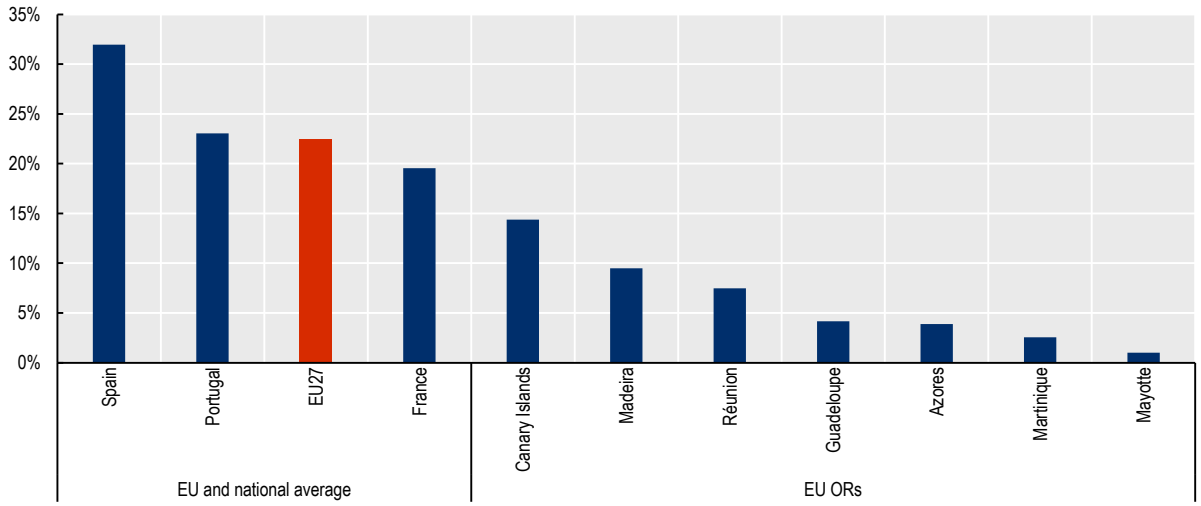
Figure 9. R&D investment & scientists and engineers in the EU ORs



Note: Panel A. data on the French ORs refers to 2017.
Source: Based on OECD (2022[15]), *Main Science and Technology Indicators, Volume 2022 Issue 1*, https://doi.org/10.1787/4db08ff0-en; Eurostat (2022[16]), *Eurostat Database*, https://ec.europa.eu/eurostat/web/main/data/database.

A key area for the future and to sustain the international competitiveness of EU ORs is to incentivise risk taking and innovation-oriented mindset in start-ups and local businesses. Next to indirect measures such as R&D tax credit, which might not be best suited to the EU ORs (given the limited number of large firms and conglomerates with in-house R&D capacities) other solutions such as grants for collaboration with public research centres or incentives for adopting digital technologies and modernising business strategies might lead to important results. The EU cohesion policy funds can contribute to this effort. For example, the European Regional Development Fund (ERDF) provides the framework and the multiannual resources to strengthen research and innovation activities with economic, social and territorial impact. While the EU multiannual budget and plan for 2021-27 is currently being rolled out, the ORs should consider allocating more resources to innovation activities involving matching funds from the private sector. By analysing the ERDF allocation for 2014-20 all the ORs devoted less than 15% of resources to research and innovation whereas the average for EU regions is 23%. The private sector could be engaged via established instruments such as regional science and innovation funds and provide additional resources to research projects whose outcomes could benefit their business activities in the long run. Some cases of fruitful research collaboration between research centres and business with the support of EU cohesions funds already exist, and are often driven by specific challenges that can turn into new opportunities (Box 4). Engaging private sector in substantive science and innovation activities will not only allow the EU ORs to develop innovative solutions with strong local impact such as energy and food security but will also initiate and nurture the necessary collaboration efforts with near countries in common areas of interest such as sustainability, climate change and digitalisation.

Figure 10. Share of ERDF allocated to research and innovation in the Outermost Regions, 2014-20



Note: a. Figures include both national and EU allocation; b. Allocation to research and innovation refers to the thematic objective 1 of the 2014-20 programming period: Strengthening research, technological development and innovation.
Source: Based on European Commission, *Cohesion Open Data Platform*, https://cohesiondata.ec.europa.eu/.

Box 4. From applied research to market opportunities: the case of TEAhealth in the Azores

Introduced in the middle of the 19th century from the People's Republic of China, the Azores proved to be an ideal environment for growing tea, and the region today still hosts the only commercial production facility in Europe.

With the support of the Operational Program for the Azores 2020, in 2022 the local business Chá Gorreana, launched two new tea products. The main characteristics of the new blends relate to the unique high level of L-theanine in their composition and over 70% of amino acid content.

It is the result of a four-year research partnership that involved the Institute of Agricultural and Environmental Research and Technology (IITAA), University of Azores, which developed a new production technique that preserves the natural properties of *Camellia sinensis.* The new blends, richer in polyphenols, provide several health benefits, including antioxidant, antimutagenic, anticarcinogenic, cardioprotective, antimicrobial, antidiabetic, and neuroprotective effects on cognitive function, which is particularly relevant to senior adults.

Source: Paiva, L. et al. (2020[18]), "Variability of antioxidant properties, catechins, caffeine, L-theanine and other amino acids in different plant parts of Azorean Camellia sinensis", https://doi.org/10.1016/j.crfs.2020.07.004; Paiva, L. et al. (2021[19]), "Influence of seasonal and yearly variation on phenolic profiles, caffeine, and antioxidant activities of green tea (Camellia sinensis (L.) Kuntze) from Azores", https://doi.org/10.3390/app11167439.

Making the most of EU internationalisation strategies, resources and partnerships

The EU has a new internationalisation strategy for science and innovation that could support the ORs. Adopted by the Council and Commission in 2021, the EU Global Approach to Research and Innovation, is

the renewed multilateral research and innovation that serves as a guide for a comprehensive innovation agenda that aims to tackle crosscutting global challenges. It does so by promoting responses based on international science and innovation (European Commission, 2021[20]). Together with the Interreg and Horizon Europe (i.e. the two main programmes that support the development of science and innovation activities) EU Global Approach to Research and Innovation defines the boundaries - bilaterally and multilaterally - through which the ORs develop the internationalisation of scientific research and innovation activities (Figure 11).

- Launched in 1989, Interreg supports cross-border science and innovation-based projects within and beyond the EU. The EU ORs are active in five Interreg programmes associated with their respective geographical regions for a total amount of EUR 329 million (3% of total Interreg budget). For the 2021-27 EU multiannual budget, there are five Interreg programmes that involve the ORs: in Latin America and the Caribbean, French Guiana, Martinique, Guadeloupe and Saint Martin, the Amazonia and Caribbean programmes with EUR 19 and 68 million each. In the Atlantic, the Interreg MAC includes the Azores, Madeira and the Canary Islands and has a total budget of EUR 170 million. In addition, these regions are also involved in the Interreg Atlantic that involves an additional 22 regions from France, Spain and Portugal for a total budget of EUR 113 million. In the Indian Ocean, the Mozambique Channel and India Interreg (covering Mayotte and Réunion) has a budget of EUR 10 and 62 million, respectively. Since the aim of these collaborations is to facilitate the regional integration of EU ORs with neighbouring countries and regions, each project can be financed by combining ERDF with the Neighbourhood, Development and International Cooperation Instrument –Global Europe (NDICI-Global Europe). Each of the programmes involve one of multiple ORs and several third-party countries and overseas countries or territories and investment. Projects involving research and innovation activities are following a challenge-driven approach that includes digitalisation, low carbon and the green transition and health areas in line with the EU 2021-27 priorities (European Commission, 2022[21]).
- Horizon Europe with a total budget of EUR 96 billion for the 2021-27 opens up new international collaboration opportunities to develop breakthrough scientific and innovation solutions. The financing options include competitive research grants, co-financing schemes and infrastructure investments channelled over three priorities: i) breakthrough frontier and excellence in research as well as researchers' mobility, training and world-class infrastructure; ii) develop key technologies and industrial competitiveness in six clusters: health, culture and creative industry, civil security, digital, space, climate energy, mobility, and food, bioeconomy and agriculture; and iii) scale-up innovation of firms, especially SMEs with high market potential (European Commission, 2021[22]). Horizon Europe also includes specific opportunities for the outermost regions under the Widening Participation and Spreading Excellence actions,[11] which contributes to building research and innovation capacity for countries lagging behind. Horizon Europe supports partnerships within and outside the EU27 borders and includes the participation of legal entities from member countries in the funded actions. These include countries with an association agreement and low- to middle-income countries that are automatically eligible. The ORs would benefit from capacity building and targeted support to benefit the most from the opportunities provided by Horizon Europe by reinforcing and expanding the collaboration mechanisms, such as the one provided by the Forward project (Box 5).

[11] https://rea.ec.europa.eu/funding-and-grants/horizon-europe-widening-participation-and-spreading-excellence_en.

Box 5. FORWARD: Boosting R&D Capacity in EU Outermost Regions

Evidence shows that the participation of ORs in Horizon 2020 has been limited with respect to other European Regions. The large potential for research activities associated with their natural laboratories for research and development remains unexplored due to the fragmentation of the research community. The EU-funded FORWARD project launched in 2019 under Horizon 2020 intends to improve ORs' excellence in research and innovation potential, supporting their participation in EU-funded projects.

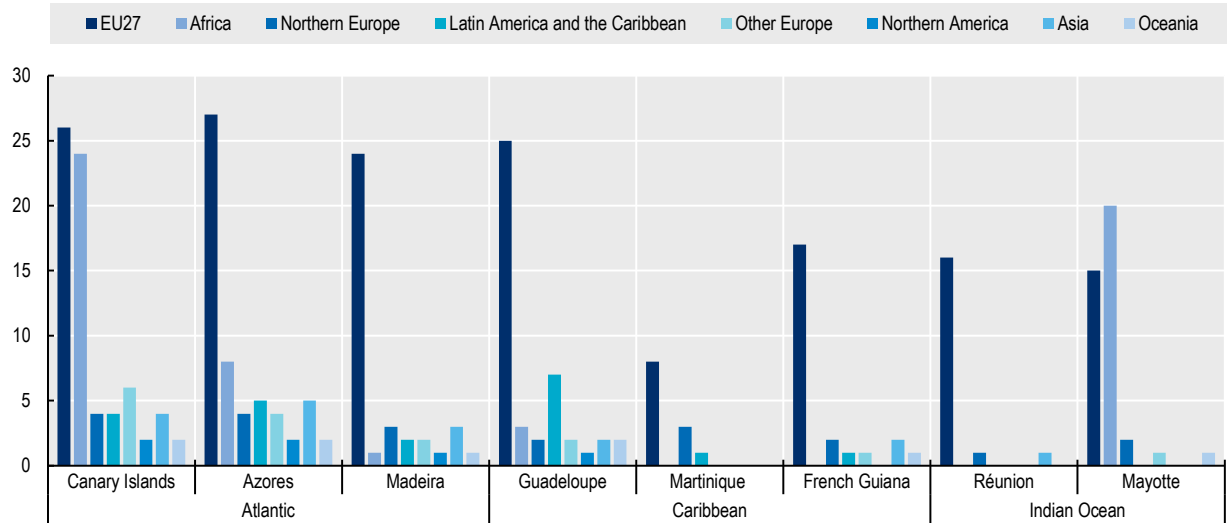
Co-ordinated by the Canary Islands Agency for Research, Innovation and Information Society (ACIISI) together with other 23 institutions and a total budget of EUR 4.3 million is the first attempt to pull together resources and skills from all nine outermost regions in the areas of research and innovation.

Through a diagnosis of R&I ecosystems in the ORs, it aims to define a joint strategy of thematic action plans to strengthen participation by these regions in EU-funded research and innovation projects, networking, capacity building. Based on a multi-actor, multidisciplinary and cross-sectorial approach, the project aims also to support the collaboration and networking among representatives of university, industry, government and civil society at regional level and with their counterparts from EU Member States and Third Countries.

- The consolidated and established networks in research activities through EU programmes such as H2020 can serve as a platform for innovation-oriented and business partnerships. For example, while the EU ORs show limited number of patenting partnership with their nearby countries, they are already embedded in research collaboration with many of them through H2020 projects. While national and other EU partners are and should remain the focal point for enhanced research and innovation collaboration given the availability of researchers and knowledge, the EU ORs can play a pivotal role in connecting with different countries in their respective geographical areas. While the Canary Islands, the Azores and Madeira show a diversified and larger pool of collaboration the French ORs remain firmly anchored in intra-national collaboration – with limited exposure to Caribbean, Amazonia and the Indian Ocean basin (Figure 12).

Figure 11. A variety of scientific partnerships for the EU ORs

Number of established scientific collaborations through H2020 projects by region



Source: Based on EU research projects under H2020 (2014-20) in European Commission (2023[7]), *CORDIS*, https://cordis.europa.eu/en (accessed on 28 March 2023).

- EU ORs could better leverage on *EU international partnerships* to increase their internationalisation. For example, the EU CELAC roadmaps on STI established in 2010 facilitate bi-regional dialogue on common priorities, encouraging mutual policy learning and ensuring co-operation through biannual action plans. The 2021-23 plan includes co-operation in research and innovation activities in health, digital transformation and the green transition with specific focus on sustainable oceans. Also, the EU and the African Union high-level policy dialogue on Science, Technology and Innovation established in 2010 could be better leveraged by the EU ORs. In 2020, a roadmap was defined as the basis of the jointly funded research and innovation partnership. It comprises three areas: food and nutrition security and sustainable agriculture; climate change and sustainable energy; and research and innovation in health. In addition, the EU has a crosscutting Research and Innovation programme with Organisation of African, Caribbean and Pacific States (OACPS). The programme endowed with EUR 60 million will be implemented between 2021 and 2025 and has two components: the Innovation Fund that supports research and innovation actors in OACPS member countries and the Policy Support Facility to enhance the quality and efficiency of research and innovation policies, strategies and systems (European Commission, 2020[23]). Some existing partnerships, with a challenge-driven approach to renewable energies, can be good examples of potential collaborations that could also involve the EU ORs in the future (Box 6).

Box 6. LEAP-RE: a joint EU-AU research partnership on renewables

The Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy (LEAP-RE) is a EUR 32 million (50% co-financed by the EU as part of Horizon 2020) project that promotes the development of renewable energies in Africa. It aims to reduce the fragmentation of current initiatives by aligning existing bilateral and multilateral frameworks. It brings together a large-scale consortium of 96 partners from 34 countries and two international organisations. The partnership benefits from a well-

balanced mix of projects in the areas of research, demonstration and technology transfer that spans both continents, with the ultimate goal of increasing the use of renewable energies.

LEAP-RE is structured around three Pillars: Pillar 1, the focus of this call, comprises the implementation of transnational proposals for research, innovation and capacity building, funded by national/regional funding agencies and by the EU; Pillar 2, is a cluster of individual R&I and capacity building projects implemented by members of the consortium, whilst Pillar 3 focuses on programme management and the design of a long-term AU – EU strategic partnerships on renewable energy.

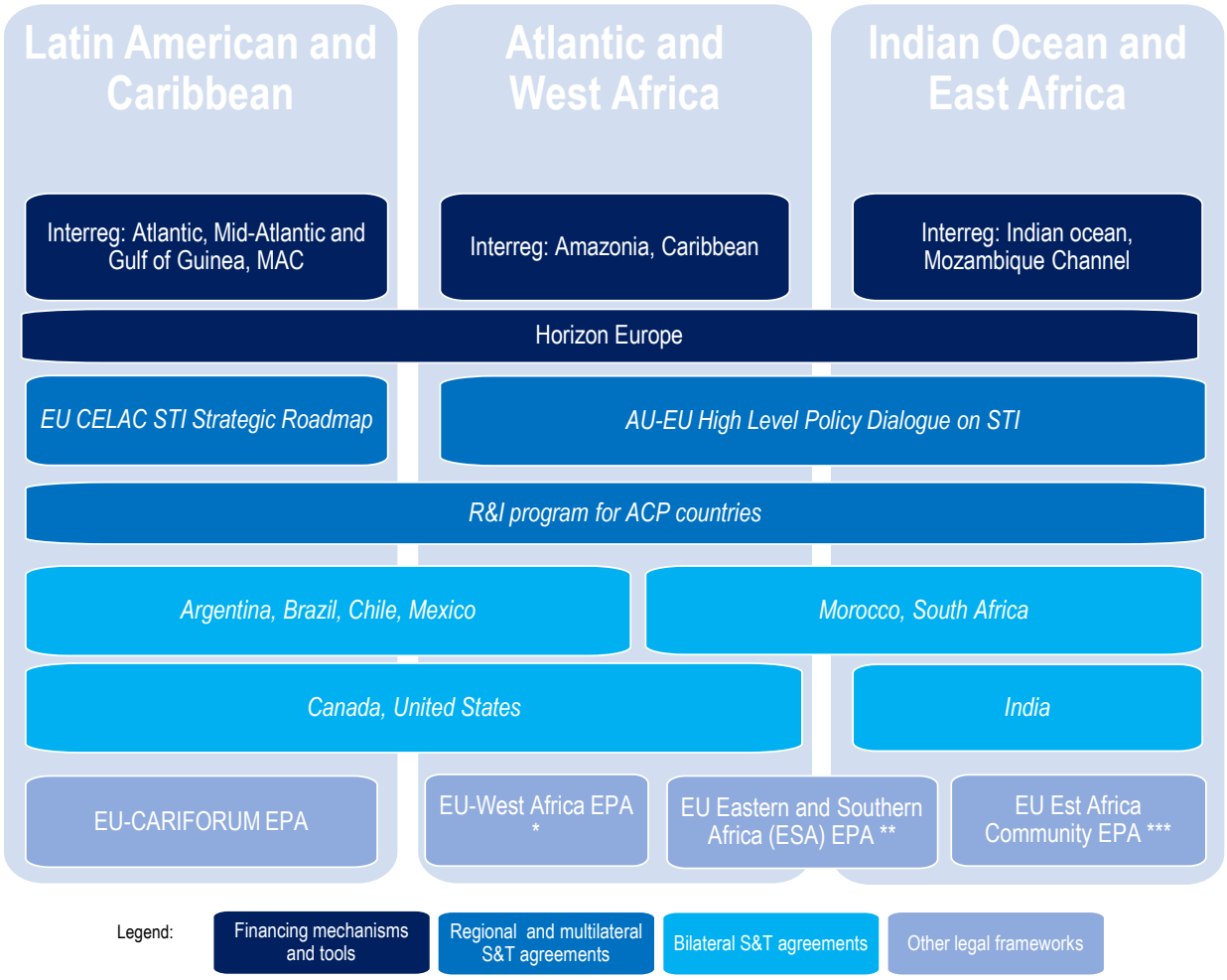
Each project consortium that applies for funding under Pillar 1 must consist of research teams from a minimum of four countries from the two continents, with at least two from European countries and at least two from African countries.

The range of activities for collaboration under LEAP-RE focuses on six areas: i) Mapping renewable energy joint research and innovation, ii) End of life of renewable energy components, iii) Smart stand-alone systems, iv) Smart grids, v) Productive uses of energy, and vi) Domestic uses of energy.

Source: European Commission (2022[24]), *Long-Term Joint EU-AU Research and Innovation Partnership on Renewable Energy - LEAP-RE Project - Fact Sheet - H2020*, https://cordis.europa.eu/project/id/963530.

- The EU has bilateral agreements with 20 individual countries around the world. These agreements are based on common interests and priorities that range from health to agriculture, Information and communication technology (ICT) circular economy and the earth sciences. A crosscutting area of research and innovation, which includes several countries, is related to oceans, which is a key area for the EU ORs. Launched in 2011, the All Atlantic Ocean Research Alliance is an initiative that aims to deepen research and innovation activities on marine environment, pollution and climate change. The United States, Canada, Argentina, Brazil and Morocco participates together with the EU in the implementation of the projects. Other areas of bilateral co-operation are health and agriculture that involves bilateral agreements with several countries including India and South Africa (European Commission, 2021[25]).

Figure 12. EU programmes and instruments to support the internationalisation of the EU ORs in science technology and innovation



Note: the figure is not meant to be complete. Rather it aims to provide an overview of the current mechanism to support internationalisation in STI. * The agreement is applied provisionally with Côte d'Ivoire and Ghana. After signature by all the Parties, the agreement will be submitted for ratification. ** The Agreement has been provisionally applied since 14 May 2012 with Mauritius, Seychelles, Zimbabwe and Madagascar. *** EU and Kenya launched talks on the interim Economic Partnership Agreement (iEPA). Kenya and Rwanda signed the Economic Partnership Agreement between the East African Community and the EU. All EU Member States and the EU have also signed the Agreement. All EAC members need to sign and ratify the EPA to be implemented. **** Pending ratification by all EU Member States, the agreement came provisionally into force as of 10 October 2016. MAC: Macaronesia; ACP African, Caribbean and Pacific Group of States; S&T Science and Technology; EPA: European Partnership Agreement.
Source: Authors' elaboration.

7 Conclusion

This paper sheds light on the diverse dynamics of innovation activities in the EU ORs through patenting behaviour, highlighting their unique strengths and areas for growth. The study underscores the potential for forging international collaborations with a wide spectrum of partners.

To capitalise on these opportunities, the EU ORs must harness the resources and strategies offered by the European Union for internationalisation. Strengthening research and innovation efforts within the private sector, scaling up the impact of public research centres and universities, and fostering greater intra-regional co-operation will be instrumental in driving transformative advancements.

In addition to leveraging partnerships within Europe, establishing strong ties with African countries, the LAC region, and SIDS holds promise for fostering innovation-based collaborations. By capitalising on shared interests, such as sustainable agriculture, oceans, and healthcare, the EU ORs can jointly nurture value chains, bolster economic growth, and address common challenges.

Overall, the EU ORs possess untapped potential as innovation-driven partners in the global arena. By strategically aligning with diverse international stakeholders, these regions can shape a sustainable and prosperous future while playing an important role in advancing inclusive and resilient development models in different technological and industrial areas including agro-food, renewable energies and ocean economy.

Annex A. Additional information on patent applications in the EU ORs

Table A A.1. Réunion's top public applicants

Applicant	Number of patents	PCT number	App. year	Co-ownership	Public co-owner	Inventors' residence	Sub-sector
CNRS	10	WO2014049094	2013	Yes	CNRS; PASTEUR	Réunion; Australia; Germany; Mainland France	A61; C07; C12
		WO2015014861	2014		CNRS; Univ Montpellier II	Réunion; Mainland France	A47; C08
		WO2016091836	2015		CNRS; PASTEUR	Réunion; Mainland France; United States	A61; C07; C12
		WO2017134036	2017		CNRS; INRA	Réunion; Mainland France	A01
		WO2017220748	2017		CNRS; IRD; INSERM	Réunion	A61; C07; C12
		WO2018007575	2017		CNRS; IRD; INSERM; Univ RÉUNION	Réunion; Mainland France	C07; C12
		WO2019185579	2019		CNRS; IRD; INSERM; Univ RÉUNION	Réunion	A61
		WO2009043937	2008		CNRS; INRA; CIRAD	Réunion; Mainland France; Tunisia	C12
		WO2014096305	2013		CNRS; Univ Lyon I	Réunion; Lebanon; Mainland France	C07
		WO2006024751	2005		CNRS; INRA; ENS Lyon; Univ Lyon I	Réunion; Mainland France	C12
IRD	7	WO2011055099	2010	Yes	IRD; Univ RÉUNION	Réunion; New Caledonia	G03; H04
		WO2012143644	2012	No		Réunion; Guadeloupe – Saint Martin; Martinique; French Guiana; Mainland France	A01
		WO2013088058	2012	No		Réunion	A01
		WO2017220748	2017	Yes	CNRS; IRD; INSERM	Réunion	A61; C07; C12
		WO2018007575	2017	Yes	CNRS; IRD; INSERM; Univ RÉUNION	Réunion; Mainland France	C07; C12
		WO2019185579	2019	Yes	CNRS; IRD; INSERM; Univ RÉUNION	Réunion	A61
		WO2016098044	2015	Yes	IRD; ENS Lyon	Réunion; Mainland France	A01; G06

Applicant	Number of patents	PCT number	App. year	Co-ownership	Public co-owner	Inventors' residence	Sub-sector
INSERM	6	WO2017167763	2017	Yes	Univ RÉUNION; PARIS 7; PARIS 13	Réunion; Spain	C07; G01
		WO2017220748	2017		CNRS; IRD; INSERM	Réunion	A61; C07; C12
		WO2018007575	2017		CNRS; IRD; INSERM; Univ RÉUNION	Réunion; Mainland France	C07; C12
		WO2019063634	2018		INSERM; Univ RÉUNION	Réunion	A61; C07
		WO2019185579	2019		CNRS; IRD; INSERM; Univ RÉUNION	Réunion	A61
		WO2014095922	2013		INSERM; CH ST DENIS	Réunion; Mainland France	C12

Note: A01: Agriculture; Forestry; Animal husbandry; Hunting; Trapping; Fishing. A47: Furniture; Domestic articles or appliances; Coffee mills; Spice mills; Suction cleaners in general. A61: Medical or veterinary science; Hygiene. C07: Organic chemistry. C08: Organic macromolecular compounds; their preparation or chemical working-up; compositions based thereon. C12: Biochemistry; Beer; Spirits; Wine; Vinegar; Microbiology; Enzymology; Mutation or Genetic Engineering. G01: Measuring; Testing. G03: Photography; Cinematography; Analogous techniques using waves other than optical waves; Electrography; Holography. G06: Computing; Calculating or Counting. H04: Electric communication technique.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

Table A A.2. Canary Islands' top private applicants

Applicant	Number of patents	PCT number	Co-ownership	Public co-owner	App. year	Inventors' residence	Sub-sector
GURADOOR SL	9	WO2006120260	Yes		2005	Canary Islands	F24
		WO2012025642			2010		F24; G02
		WO2012025643			2010		F24; G02
		WO2013030412			2011		A61
		WO2013030413			2011		A61
		WO2013030414			2011		A61
		WO2013030415			2011		F24; G02
		WO2013076318			2011		F24
		WO2013135917			2012		A61
ADVENTIA PHARMA SL	5	WO2018178406			2017		C07; C10; F24; F03
		WO2019002637			2017		F24
		WO2019058003	Yes		2017		C10
		WO2019073093			2017		B01; C07
		WO2019193213			2018		B01; C10
SANTANDER CERBELL ROBERTO	5	WO1996015411			1995		B01; C07
		WO1997042452			1997		B01; F24; F28
		WO1999060311			1999		C12
		WO2006079671			2005		G01
		WO2017212092			2017		G01
FOSTER FINDLAY ASSOCIATES LTD	4	WO2014001750			2013	Canary Islands; United Kingdom	G01
		WO2015004416			2014		G01
		WO2015040375			2014		F24; G02
		WO2016124878			2015		A23; A61
MONOPOLI FORLEO DONATO	4	WO2005027764	Yes	Instituto tecnologico de canarias SA ITC	2003	Canary Islands	B65
		WO2005053549			2003		B65
		WO2005053551			2003		A47; B65; B01
		WO2006125835			2005		A61; B65

Note: ES70: Canary Islands; GB: United Kingdom. A23: Foods or foodstuffs; Treatment thereof, not covered by other classes. A47: Furniture; Domestic articles or appliances; Coffee mills; Spice mills; Suction cleaners in general. A61: Medical or veterinary science; Hygiene. B01: Physical or chemical processes or apparatus in general. B65: Conveying; Packing; Storing; Handling thin or filamentary material. C07: Organic chemistry. C10: Petroleum, gas or coke industries; Technical gases containing carbon monoxide; Fuels; Lubricants; Peat. C12: Biochemistry; Beer; Spirits; Wine; Vinegar; Microbiology; Enzymology; Mutation or Genetic Engineering. F03: Machines or engines for liquids; Wind, spring, or weight motors; Producing mechanical power or a reactive propulsive thrust, not otherwise provided for. F24: Heating; Ranges; Ventilating. F28: Heat exchange in general. G01: Measuring; Testing. G02: Optics.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

Table A A.3. List of collaborative patents involving inventors residing in different French EU ORs

PCT number	Inventors' residence	Applicants' name	App. year	Sub-sector
WO2000058525	Guadeloupe–Saint Martin; Martinique	INRA	2000	A23; C13
WO2001077335	Guadeloupe–Saint Martin; Martinique	INSTITUT PASTEUR; GOEBEL WERNER	2001	A01; A61; C07; C12; G01
WO2006021644	Martinique; Réunion	INDIVIDUAL INVENTOR	2005	A61; C08
WO2006075111	Martinique; Réunion	SCI COLBY STE CIVILE IMMOBILIERE	2006	E04
WO2010103198	Martinique; Réunion	EUROS SA	2010	A61
WO2011080471	Guadeloupe–Saint Martin; Martinique; French Guiana; Réunion	MICHELIN RECHERCHE ET TECHNIQUE SA; STE DE TECH MICHELIN	2010	B29
WO2012143644	Martinique; French Guiana; Réunion	IRD	2012	A01
WO2015055958	Martinique; Réunion	INDIVIDUAL INVENTOR	2014	F03
WO2016046309	Martinique; Réunion	REUNIWATT	2015	G01
WO2016170273	Martinique; Réunion	INDIVIDUAL INVENTOR	2016	A45; A47
WO2019175520	Martinique; Réunion	COMMUNE DU TAMPON 7210 MAIRIE DU TAMPON	2019	G06
WO2019175521	Martinique; Réunion	COMMUNE DU TAMPON 7210 MAIRIE DU TAMPON	2019	G06; H04
WO2019215408	Martinique; Réunion	INDIVIDUAL INVENTOR	2019	G08; G16; H04

Note: A01: Agriculture; Forestry; Animal husbandry; Hunting; Trapping; Fishing. A23: Foods or foodstuffs; Treatment thereof, not covered by other classes. A45: Hand or travelling articles. A47: Furniture; Domestic articles or appliances; Coffee mills; Spice mills; Suction cleaners in general. A61: Medical or veterinary science; Hygiene. B29: Working of plastics; Working of substances in a plastic state in general. B62: Land vehicles for travelling otherwise than on rails. C07: Organic chemistry. C08: Organic macromolecular compounds; their preparation or chemical working-up; Compositions based thereon. C12: Biochemistry; Beer; Spirits; Wine; Vinegar; Microbiology; Enzymology; Mutation or genetic engineering. C13: Sugar industry. E04: Building. F03: Machines or engines for liquids; Wind, spring, or weight motors; Producing mechanical power or a reactive propulsive thrust, not otherwise provided for. G01: Measuring; Testing. G06: Computing; Calculating or counting. G08: Signalling. G16: Information and communication technology [ICT] specially adapted for specific application fields. H04: Electric communication technique.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

Table A A.4. List of collaborative patents involving inventors residing in French EU ORs and abroad

PCT number	Inventors' residence	Applicants' name	App. year	Sub-sector
International collaborations without mainland France among inventors				
WO1998006778	Guadeloupe– Saint Martin; United States	Tietek, Inc. (US)	1997	C08; E01
WO2004002802	Réunion; South Africa	Inventors	2003	B62
WO2005100961	Guadeloupe– Saint Martin; United States	Phoseon Technology, Inc. (US)	2005	G01
WO2007140101	Martinique; United States	Arkema Inc. (US)	2007	C08
WO2008028688	Guadeloupe– Saint Martin; Switzerland; Germany	Piramal Imaging SA (CH)	2007	A61; C07
WO2009040817	Réunion; Israel	Université De Réunion (FRY40); Ramot at Tel-Aviv University Ltd. (IL)	2008	A61; C07
WO2010064414	Martinique; Japan	Sony Corporation (JP)	2009	G06
WO2011068643	Guadeloupe– Saint Martin; Germany; United States	Blue Cube IP LLC (US)	2010	C08
WO2012138625	Guadeloupe– Saint Martin; United States	Kanasao BV (NL)	2012	C12; C13
WO2015121090	French Guiana; Belgium	Inventors	2015	E04
WO2017111785	Martinique; United States	Intel Corporation (US)	2015	H04
WO2017112111	Martinique; United States	Inventors	2016	A63; G06
WO2017123528	Réunion; China	SOUTHCO, INC. (US)	2017	E05; G09; H01
WO2017167763	Réunion; Spain	Université de Réunion Saint Denis (FRY40); Inserm (FR); Université Paris Diderot - Paris 7 (FR); Université Paris XIII Paris-Nord (FR)	2017	C07; G01
WO2019014384	Martinique; United States	Inventors	2018	G16
WO2019036767	Guadeloupe– Saint Martin; Australia	The University of Queensland (AU)	2018	B01
WO2020109173	French Guiana; Switzerland; Germany; United States	Société Des Produits Nestlé S.A. (CH)	2019	A23
International collaborations with mainland France among inventors				
WO1990000554	Martinique; Mainland France; Morocco	Furchim (FRY20)	1989	C07; C13
WO1992003552	French Guiana; Mainland France; Germany	Institut PastEUR (FR)	1991	A61; C07; C12
WO2000044316	Martinique; Mainland France; Germany	Aesculap (FR)	2000	A61
WO2001003778	Guadeloupe– Saint Martin; Mainland France; Andorra	Inventors (FR)	2000	A63
WO2001077335	Guadeloupe– Saint Martin; Martinique; Mainland France; Germany; Spain	Institut PastEUR (FR)	2001	A01; A61; C07; C12; G01
WO2005125154	Guadeloupe– Saint Martin; Mainland France; Spain	Gemalto SA (FR)	2005	H04

PCT number	Inventors' residence	Applicants' name	App. year	Sub-sector
WO2007060550	Guadeloupe– Saint Martin; Mainland France; United Kingdom	Institut PastEUR (FR); CNRS (FR)	2006	A61; C07
WO2008119914	Réunion; Mainland France; Morocco	Orange (FR)	2008	H04
WO2008119915	Réunion; Mainland France; Morocco	Orange (FR)	2008	H04
WO2009043937	Réunion; Mainland France; Tunisia	CNRS (FR); CIRAD (FR); INRA (FR)	2008	C12
WO2011067506	Réunion; Mainland France; Germany	L'Air Liquide Société Anonyme pour l'Etude et l'Exploitation des Procédés Georges Claude (FR)	2010	C01
WO2012093162	Mayotte; Mainland France; Tunisia	Commissariat à l'Energie Atomique et aux Energies Alternatives (FR)	2012	C07; C12; G01
WO2013083373	Réunion; Mainland France; Germany	L'Air Liquide Société Anonyme pour l'Etude et l'Exploitation des Procédés Georges Claude (FR)	2012	B01
WO2014049094	Réunion; Mainland France; Australia ; Germany	CNRS (FR); Institut PastEUR (FR); Themis Bioscience GmbH (AT)	2013	A61; C07; C12
WO2014057358	French Guiana; Mainland France; United Kingdom; Sweden	Hyperion Materials & Technologies (Sweden) AB (SE)	2013	C04; C09; C22
WO2014096305	Réunion; Mainland France; Lebanon	Université Claude Bernard Lyon 1 (FR); CNRS (FR); Ercane (FR)	2013	C07
WO2016091836	Réunion; Mainland France; United States	Institut PastEUR (FR); CNRS (FR)	2015	A61; C07; C12
WO2016205117	Guadeloupe– Saint Martin; Mainland France; United States	Centre Technologique Alphanov (FR); Electro Scientific Industries, Inc. (US)	2016	B23; C03; H01
WO2018166793	Guadeloupe– Saint Martin; Mainland France; China	CIRAD (FR)	2018	C12
WO2018166794	Guadeloupe– Saint Martin; Mainland France; China; Madagascar	CIRAD (FR); Axlr, Satt Du Languedoc Roussillon (FR); FOFIFA (MG)	2018	C12
WO2019057909	Guadeloupe– Saint Martin; Mainland France; Ireland	CIRAD (FR)	2018	A61

Note: A01: Agriculture; Forestry; Animal husbandry; Hunting; Trapping; Fishing. A23: Foods or foodstuffs; Treatment thereof, not covered by other classes. A45: Hand or travelling articles. A47: Furniture; Domestic articles or appliances; Coffee mills; Spice mills; Suction cleaners in general. A61: Medical or veterinary science; Hygiene. A63: Sports; Games; Amusements. B01: Physical or chemical processes or apparatus in general. B23: Machine tools; Metal-working not otherwise provided for. B29: Working of plastics; Working of substances in a plastic state in general. B62: Land vehicles for travelling otherwise than on rails. C01: Inorganic chemistry. C03: Glass; Mineral or slag wool. C04: Cements; Concrete; Artificial stone; Ceramics; Refractories. C07: Organic chemistry. C08: Organic macromolecular compounds; their preparation or chemical working-up; Compositions based thereon. C09: Dyes; Paints; Polishes; Natural resins; Adhesives; Compositions not otherwise provided for; Applications of materials not otherwise provided for. C12: Biochemistry; Beer; Spirits; Wine; Vinegar; Microbiology; Enzymology; Mutation or genetic engineering. C13: Sugar industry. C22: Metallurgy; Ferrous or non-ferrous alloys; Treatment of alloys or non-ferrous metals. E01: Construction of roads, railways, or bridges. E04: Building. E05: Locks; Keys; Window or door fittings; Safes. F03: Machines or engines for liquids; Wind, spring, or weight motors; Producing mechanical power or a reactive propulsive thrust, not otherwise provided for. F24: Heating; Ranges; Ventilating. G01: Measuring; Testing. G06: Computing; Calculating or counting. G08: Signalling. G09: Educating; Cryptography; Display; Advertising; Seals. G16: Information and communication technology [ICT] specially adapted for specific application fields. H01: Basic electric elements. H04: Electric communication technique.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

Table A A.5. Number of collaborations in the Canary Islands by European country (Spain excluded)

Country	Number of collaborations
Germany	13
United Kingdom	10
Netherlands	5
France	4
Italy	3
Sweden	2
Norway	2
Switzerland	1
Portugal	1
Austria	1
Belgium	1
Total	**43**

Note: The total number of collaborations displayed in this table (43) is higher than the one indicated in Table 1(35) because in the latter, a collaboration with Europe may correspond to cases of patents associated with inventors located in more than one European country, as it is the case for example for patent WO2006005409.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

Table A A.6. Canary Islands' patents in collaboration with European countries

PCT number	Co-inventors' country of residence
WO1984004639	Sweden
WO1993007108	Netherlands
WO1999046122	Sweden
WO2005064731	Germany
WO2006005409	Germany; United Kingdom; France
WO2006087266	Germany
WO2007015094	United Kingdom; Italy
WO2008079004	Netherlands
WO2009037669	Italy
WO2010075058	United Kingdom
WO2010087709	Netherlands; Switzerland
WO2010133218	Germany
WO2011036288	Germany
WO2013128068	United Kingdom
WO2014001750	United Kingdom
WO2014029908	United Kingdom
WO2014180580	Norway
WO2015004416	United Kingdom
WO2015040375	United Kingdom
WO2015086303	Norway
WO2015166124	Spain; Netherlands
WO2016050916	Spain; Belgium
WO2016124878	United Kingdom
WO2016151205	France
WO2016156443	Spain; Germany; France; Italy; Austria
WO2017198717	Spain; Germany
WO2018065591	Netherlands; Germany
WO2018095516	France
WO2018189026	Spain; Germany
WO2018197903	United Kingdom
WO2019129883	Spain; Portugal
WO2019133813	Germany
WO2019185921	Germany
WO2020007389	Germany
WO2020010309	Germany

Table A A.7. Technological similarity based on IPC (technology distribution-correlations)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) Guadeloupe – Saint Martin	1.000															
(2) Martinique	0.719	1.000														
(3) French Guiana	0.259	0.080	1.000													
(4) Réunion	0.881	0.571	0.506	1.000												
(5) Madeira	0.664	0.321	0.413	0.587	1.000											
(6) Canary Islands	0.779	0.651	0.496	0.755	0.465	1.000										
(7) Barbados	0.741	0.831	0.068	0.596	0.275	0.733	1.000									
(8) Bahamas	0.805	0.889	-0.063	0.579	0.434	0.616	0.776	1.000								
(9) Cuba	0.511	0.299	0.608	0.526	0.561	0.645	0.489	0.271	1.000							
(10) Dominican Republic	0.758	0.687	0.293	0.697	0.636	0.812	0.631	0.734	0.439	1.000						
(11) Ghana	0.824	0.681	0.440	0.752	0.660	0.814	0.725	0.709	0.751	0.827	1.000					
(12) Jamaica	0.625	0.515	0.568	0.567	0.564	0.801	0.579	0.450	0.905	0.618	0.856	1.000				
(13) Madagascar	0.526	0.439	0.462	0.516	0.488	0.681	0.561	0.349	0.824	0.637	0.818	0.886	1.000			
(14) Mauritius	0.721	0.589	0.155	0.564	0.663	0.713	0.606	0.636	0.622	0.845	0.807	0.752	0.793	1.000		
(15) Senegal	0.718	0.873	0.103	0.603	0.467	0.680	0.747	0.886	0.483	0.802	0.797	0.621	0.582	0.744	1.000	
(16) Trinidad and Tobago	0.599	0.564	0.470	0.514	0.534	0.770	0.652	0.531	0.885	0.599	0.788	0.911	0.782	0.741	0.687	1.000

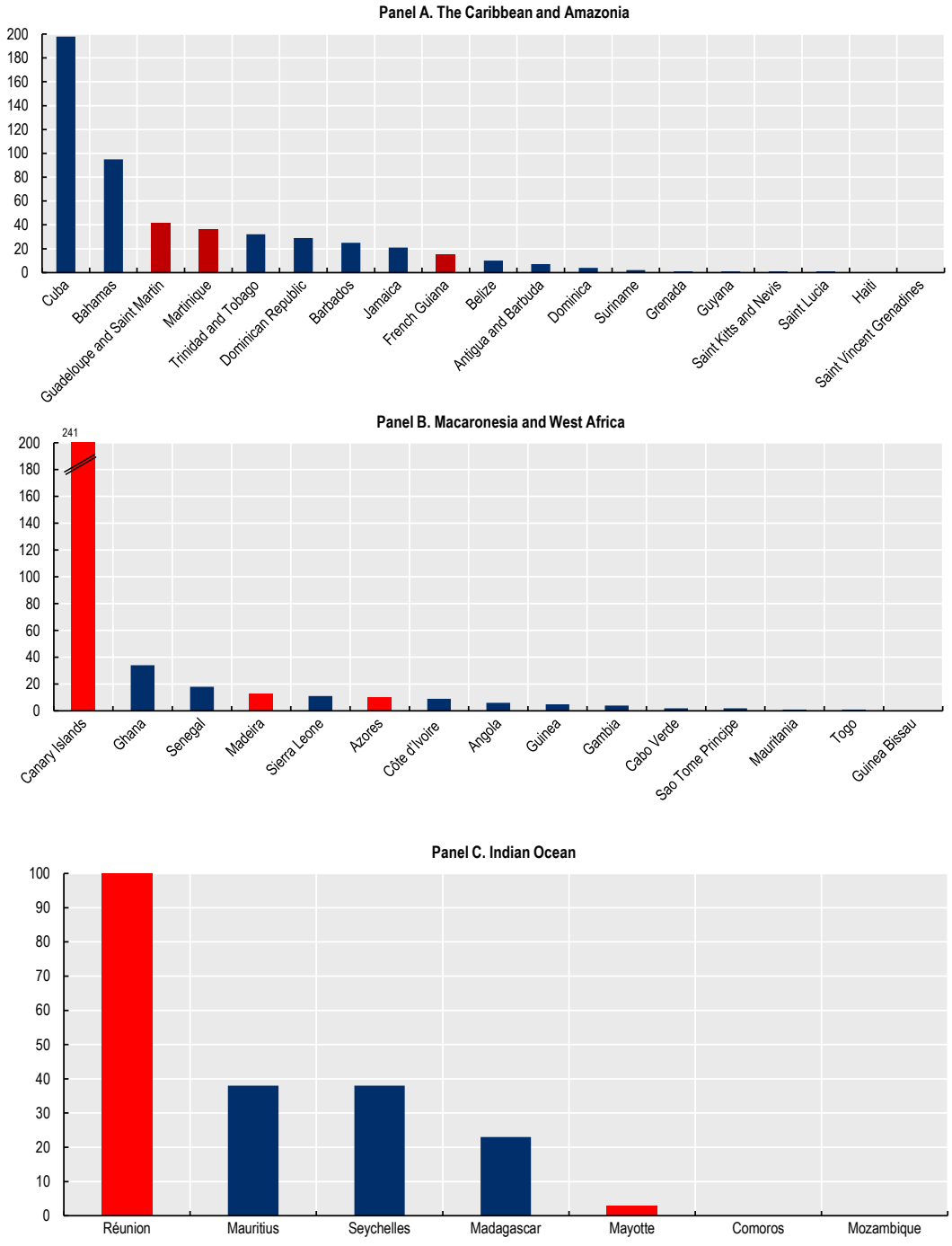
Note: This table shows the un-centred correlation of two regions' vectors of patent shares across 30 technological classes. This indicator typically ranges between 0 and 1 for all pairs of countries. It is equal to one for the pairs of countries with identical distribution of technological activities; it is equal to zero if the distributions are orthogonal.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

Table A A.8. Technological distance based on IPC (technology distribution-Euclidian distance)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) Guadeloupe – Saint Martin	0	0.225	00.34	0.11	0.301	0.151	0.223	0.206	0.435	0.168	0.152	0.261	0.31	0.244	0.243	0.252
(2) Martinique	0.225	0	00.40	0.266	0.426	0.246	0.191	0.158	0.513	0.236	0.241	0.323	0.364	0.307	0.171	0.296
(3) French Guiana	0.314	0.41	0	0.249	0.382	0.256	0.419	0.454	0.403	0.314	0.289	0.289	0.339	0.414	0.423	0.304
(4) Réunion	0.11	0.266	0.249	0	0.325	0.149	0.267	0.278	0.435	0.18	0.176	0.275	0.31	0.29	0.278	0.269
(5) Madeira	0.301	0.426	0.382	0.325	0	0.356	0.444	0.397	0.435	0.309	0.301	0.347	0.386	0.311	0.389	0.351
(6) Canary Islands	0.151	0.246	0.256	0.149	0.356	0	0.227	0.269	0.401	0.146	0.155	0.205	0.266	0.248	0.256	0.198
(7) Barbados	0.223	0.191	00.41	0.267	0.444	0.227	0	0.225	0.449	0.26	0.23	0.305	0.326	0.304	0.242	0.268
(8) Bahamas	0.206	0.158	00.45	0.278	0.397	0.269	0.225	0	0.528	0.231	0.242	0.353	0.401	0.295	0.164	0.316
(9) Cuba	0.435	0.513	00.40	0.435	0.435	0.401	0.449	0.528	0	0.455	0.353	0.249	0.292	0.398	0.455	0.274
(10) Dominican Republic	0.168	0.236	00.31	0.18	0.309	0.146	0.26	0.231	0.455	0	0.153	0.265	0.279	0.194	0.21	0.255
(11) Ghana	0.152	0.241	00.28	0.176	0.301	0.155	0.23	0.242	0.353	0.153	0	0.173	0.21	0.208	0.211	0.192
(12) Jamaica	0.261	0.323	00.28	0.275	0.347	0.205	0.305	0.353	0.249	0.265	0.173	0	0.168	0.242	0.297	0.138
(13) Madagascar	0.31	0.364	00.33	0.31	0.386	0.266	0.326	0.401	0.292	0.279	0.21	0.168	0	0.229	0.324	0.226
(14) Mauritius	0.244	0.307	00.41	0.29	0.311	0.248	0.304	0.295	0.398	0.194	0.208	0.242	0.229	0	0.25	0.241
(15) Senegal	0.243	0.171	00.42	0.278	0.389	0.256	0.242	0.164	0.455	0.21	0.211	0.297	0.324	0.25	0	0.262
(16) Trinidad and Tobago	0.252	0.296	00.34	0.269	0.351	0.198	0.268	0.316	0.274	0.255	0.192	0.138	0.226	0.241	0.262	0

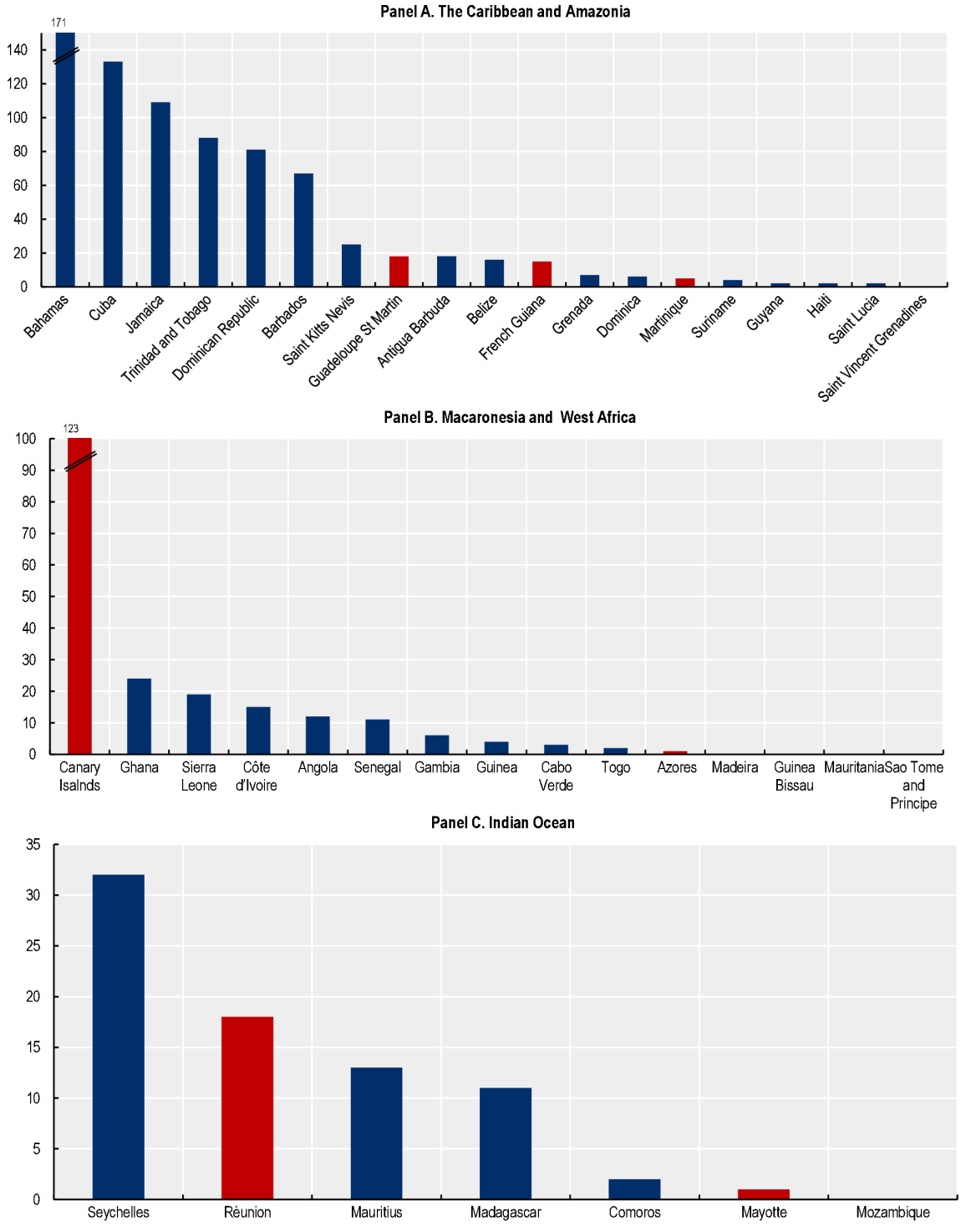
Note: This table shows the Euclidian distance of two regions' vectors of patent shares across 30 technological classes. This indicator typically ranges between 0 and 1 for all pairs of countries. It is equal to zero for the pairs of countries with identical distribution of technological activities.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

Figure A A.1. Total number of EPO patents over the period 2000-19



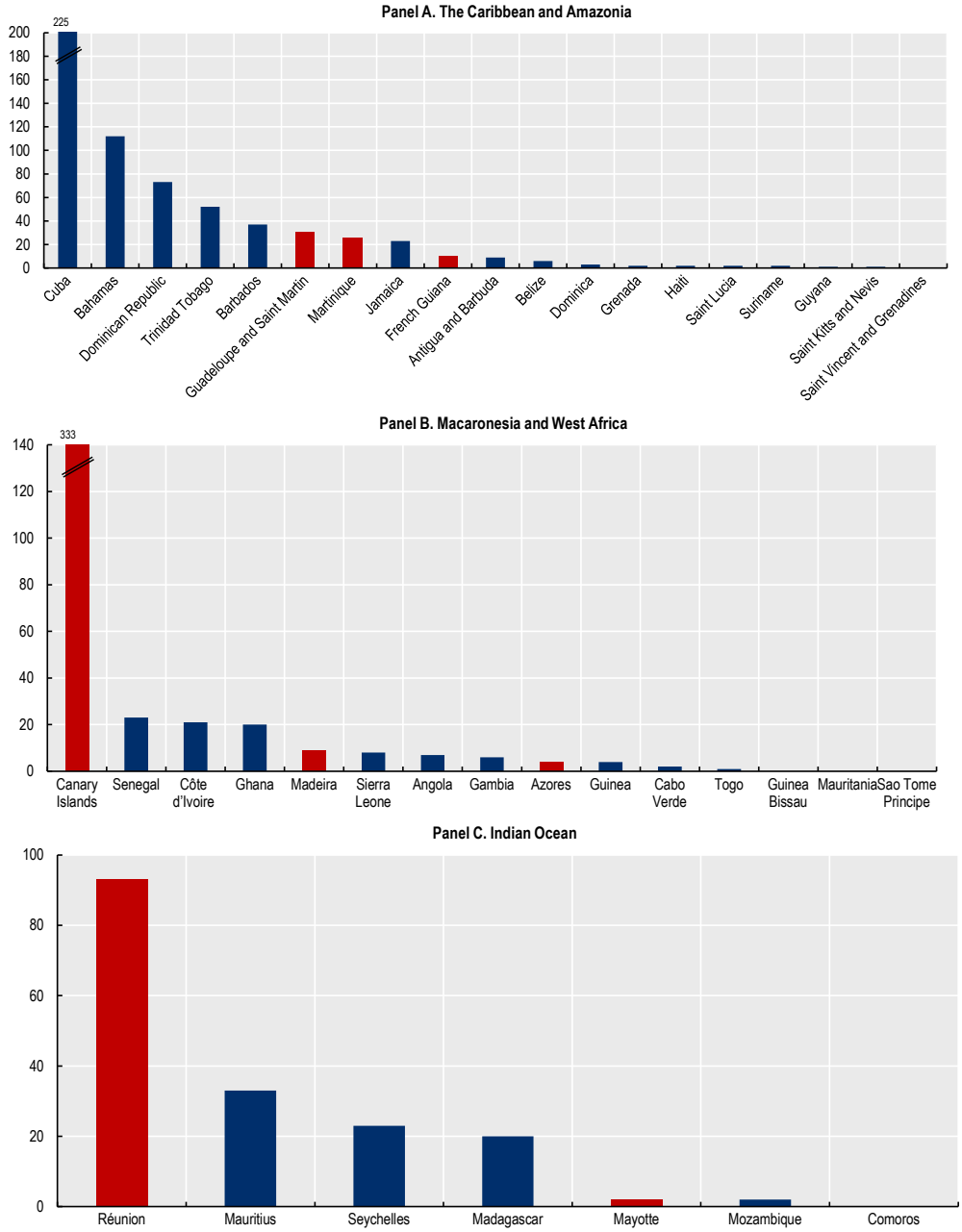
Note: Patents are localised by the inventor's address. When the patent is a co-invention by inventors from different countries/regions it is counted more than once. Elaboration based on patent applications filed at the EPO between 2000 and 2019.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

Figure A A.2. Total number of USPTO patents over the period 2000-19



Note: Patents are localised by the inventor's address. When the patent is a co-invention by inventors from different countries/regions it is counted more than once. Elaboration based on patent applications filed at the USPTO between 2000 and 2019.
Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

Figure A A.3. Total number of PCT-WIPO patents over the period 2000-19 (more stringent rule to assign a patent to a region/country)



Source: Authors' elaboration based on European Patent Office (EPO) PATSTAT Database, https://www.epo.org/en/searching-for-patents/business/patstat.

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