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[1] At the time of writing this study.

Non-Technical Summary

This issue of Economic and Financial Debates provides new insights on offshore financial centers (OFCs) and their role in the international financial system. We first develop a statistical methodology to identify and quantify the importance of these OFCs as counterparties in the total of cross-border banking positions, based on international banking data. This allows us to establish a list of OFCs based on objective and transparent statistical criteria. A list of 13 countries/jurisdictions is derived from this work.

We subsequently compute an indicator measuring the degree of extraterritoriality for each banking system based on the OFC list previously compiled in order to quantify their importance in the international financial architecture. It appears that the banking system of a reporting country holds, on average, 1/5 of its asset positions on entities resident in OFCs and receives 1/6 of its liability positions from entities resident in OFCs. Should the scope be limited to interbank positions only, this ratio is 15% on both asset and liability sides. The French banking system is at the median of global distribution and slightly below it compared to banking systems of similar maturity. Overall, the French banking system has more recourse to OFCs for funding purposes than for capital investment purposes and favors 5 OFCs among the 13 we identified.

We conduct an analysis of cross-border banking flows during the major stress caused by the financial crisis in 2008 to better understand the financial stability issues raised by OFCs. On the one hand, the volatility of flows vis-à-vis OFCs is, on average, higher than or equal to that observed vis-à-vis major banking systems. On the other hand, the volume of flows to and from the OFCs is similar to those between the largest banking systems. The large volume and very significant volatility of these flows thus underline the financial stability challenges that OFCs are likely to raise.

Finally, we apply a community detection method to the graph representing the interbank positions network in order to analyze the organizational pattern of banking systems interactions. Four communities emerge and indicate a very clear regionalization pattern whose perimeters reflect the importance of economic, commercial or geopolitical links in interbank links. The OFCs participate in this regionalization and are each integrated into the nearest geographical area. This integration has been taking place since 2003 and suggests that, despite the increasing interconnection of banking systems, OFCs retain a form of geographical specialization.

Résumé non-technique

Ce Débats économiques et financiers offre un nouvel éclairage sur les centres financiers extraterritoriaux (*Offshore Financial Centers*, OFC par la suite) et leur rôle au sein du système financier international. Pour ce faire, nous développons pour commencer une méthodologie statistique permettant, à partir de données bancaires internationales, d'identifier et de quantifier l'importance de ces OFC en tant que contreparties dans le total des positions bancaires transfrontières. L'objectif est d'établir une liste d'OFC fondée sur des critères statistiques objectifs et transparents. De ce travail émerge une liste de 13 pays/juridictions.

Afin de quantifier l'importance des OFC dans l'architecture financière internationale, nous construisons ensuite un indicateur mesurant le degré d'extraterritorialité des positions de chaque système bancaire à partir de la liste précédemment constituée. Il en ressort que le système bancaire d'un pays déclarant détient, en moyenne, 1/5 de ses positions à l'actif vis-à-vis d'entités résidentes dans des OFC et reçoit 1/6 de ses positions au passif d'entités résidentes dans des OFC. Si le périmètre est restreint aux seules positions interbancaires, ce ratio est de 15% à l'actif comme au passif. Le système bancaire français se situe au niveau de la médiane de la distribution mondiale et légèrement en dessous de celle-ci comparativement à des systèmes bancaires de maturité similaire. Globalement, le système bancaire français a davantage recours aux OFC pour se financer que pour y placer des capitaux et privilégie 5 OFC parmi les 13 que nous retenons.

Pour mieux comprendre les enjeux de stabilité financière soulevés par les OFC, nous procédons à une analyse des flux bancaires transfrontaliers lors du stress majeur engendré par la crise financière en 2008. On constate d'une part que la volatilité des flux vis-à-vis des OFC est, en moyenne, supérieure ou égale à celle constatée vis-à-vis des grands systèmes bancaires. D'autre part, le volume des flux en provenance ou en direction des OFC est d'un ordre de grandeur comparable à ceux s'établissant entre les plus importants systèmes bancaires. Le volume important et la volatilité très significative de ces flux soulignent ainsi les enjeux en termes de stabilité financière que sont susceptibles de poser les OFC.

Enfin, nous appliquons une méthode de détection des communautés au graphe représentant le réseau des positions interbancaires afin de mieux comprendre l'organisation des interactions entre systèmes bancaires. Quatre communautés émergent et indiquent une régionalisation très nette dont les périmètres témoignent de l'importance des liens économiques, commerciaux ou encore géopolitiques dans les liens interbancaires. Les OFC participent à cette régionalisation et s'intègrent chacun dans l'ensemble géographique le plus proche. Cette intégration se vérifie depuis 2003 et suggère que, malgré l'interconnexion croissante des systèmes bancaires, les OFC conservent une forme de spécialisation géographique.

I. Introduction

Interest in Offshore financial centers (hereinafter OFCs)[2] has been growing in recent years. This is due in part to the fact that, since the outbreak of the 2008-2009 economic and financial crisis, policy-makers and tax administrations have come under regular pressure to take strong action against tax evasion, money laundering and terrorist financing. More recently, owing to the wave of new banking regulations that emerged following the crisis, academia has begun to study the role of these jurisdictions in regulatory arbitrage (Frame et al., 2016; Abad et al., 2017).

While recent work has shed light on these issues (Houston et al., 2012; Zucman, 2013; Zucman, 2014; Koijen and Yogo, 2016), the question of the interconnectedness of offshore financial centers in the international banking system remains relatively undocumented to date, partly because of the opacity surrounding them. Indeed, lacunae in the definition of offshore financial centers hamper the analysis of their importance and integration into the international financial architecture. These are the questions to which this document seeks to offer an initial response.

The first step is thus to establish a relevant indicator making it possible to draw up a transparent list of offshore financial centers. This indicator must be relatively stable over time, and grounded in a "statistical" basis rather than simply legal or administrative aspects. Indeed, a number of lists have emerged in recent years (OECD "black" and "grey" lists, lists put forth by the EU, the BIS, tax administrations, etc.) but they are not always based on measurable and transparent criteria and therefore have an undesirable discretionary aspect when it comes to economic analysis. Secondly, on the basis of the list thus compiled, an extraterritoriality coefficient will be established for each economy. This coefficient will make it possible to quantify the significance of offshore financial centers as counterparties in the total cross-border bank outstandings (assets and liabilities) of each economy, and to identify major trends.

Thirdly, we will focus on the period of the 2008 financial crisis to describe and quantify the role played by OFCs during this time of sharp decline in cross-border banking activities. This section will highlight the financial stability challenges posed by OFCs and why it is essential for supervisors to address them. Finally, the last part will focus on the organization and geographic distribution of interactions among banking systems and the integration of OFCs into this architecture. In this regard, network analysis methods (community detection) will be used.

A. Data on International Banking Statistics

This analysis is based on the international banking statistics published by the Bank for International Settlements (BIS) on a quarterly basis[3]. More specifically, we use the "locational" dataset[4], which is constructed according to a residence approach and on a non-consolidated basis[5]. As such, this dataset is consistent with balance of payments statistics. It has more than 200 counterpart countries for about

[2] Commonly known as tax shelters. We follow established terminology in use in international institutions such as the IMF (https://www.imf.org/external/NP/ofca/OFCA.aspx) and discussed in the Banque de France Bulletin No. 82 (https://www.banque-france.fr/sites/default/files/medias/documents/bulletin-de-la-banque-de-france_82_2000-10.pdf)

[3] https://www.bis.org/statistics/bankstatsguide_repregloc.pdf

[4] This dataset includes cross-border bank positions and flows for around 40 reporting countries according to a residency approach. As such, these data are consistent with the international investment position data.

[5] It is of primary importance to work on non-consolidated data because a significant proportion of cross-border liabilities vis-à-vis jurisdictions that could be identified as OFCs are intra-group liabilities. For example, in the last quarter of 2017, the BIS OFC countries reported holding $4,568 billion of cross-border banking assets worldwide, almost one-third of which were intra-group ($1,431 billion). Cf. https://stats.bis.org/statx/srs/table/A6.1?c=1N&m=F&p=20174

40 reporting countries. Overall, the LBS (Locational Banking Statistics) data cover nearly 95% of cross-border banking activities[6].

In addition, this data set has the advantage of being broken down into several dimensions:

- Balance sheet position (claims/liabilities)
- Currency denomination
- Counterparty country
- Parent country
- Counterparty sector
- Type of instruments
- Type of reporting institution

However, public data alone restricts the extent to which these dimensions can be combined. This requires the use of restricted data (Appendix A provides a general framework of the public dataset). In this analysis, we will only examine the breakdowns of the balance sheet position, country and counterparty sector.

Previous work has focused on the use of BIS dataset known as "Consolidated" (Houston et al., 2014). This provides a consolidated view of cross-border exposures. From a risk analysis perspective, it is indeed advantageous to use dataset where the ultimate counterparty can be identified. However, a consolidated view has the drawback of not recording intra-group transactions that structure the final exposure to a counterparty. Yet, not only are these transactions very large in volume, but they can also raise financial stability issues. In addition, the study of unconsolidated data makes it possible to understand where risks pass through. For instance, consolidated data indicate that French banks have an overall exposure of $7 billion to counterparties resident in Mexico. However, they do not provide us with any information about which entities are actually exposed to these risks (subsidiaries vs. branches? domestic or foreign entities?).

Lastly, it is worth mentioning an important limitation to our analysis that arises from the data: we do not directly observe the activity of non-bank financial entities. In other words, our analysis of OFCs focuses primarily on the activity of the major international banks. Yet, it is generally accepted that a significant fraction of the activity in these OFCs may come from non-bank financial entities such as captive insurance companies in Bermuda, for example.

B. Why focus on offshore financial centres?

The first reason to focus on offshore financial centers lies directly in their significant impact on international financial architecture. Indeed, the amount of outstandings domiciled in OFCs, according to a list drawn up by the BIS itself, shows that they occupy an essential position in the international banking system. Since 2003, the share of cross-border bank outstandings domiciled in banks resident in OFCs (as defined by the BIS) in the worldwide total has varied between 10% and 15%. Furthermore, at the end of 2017, reported outstandings reached a considerable USD 4.6 trillion, surpassing the previous 2008 peak.[7]

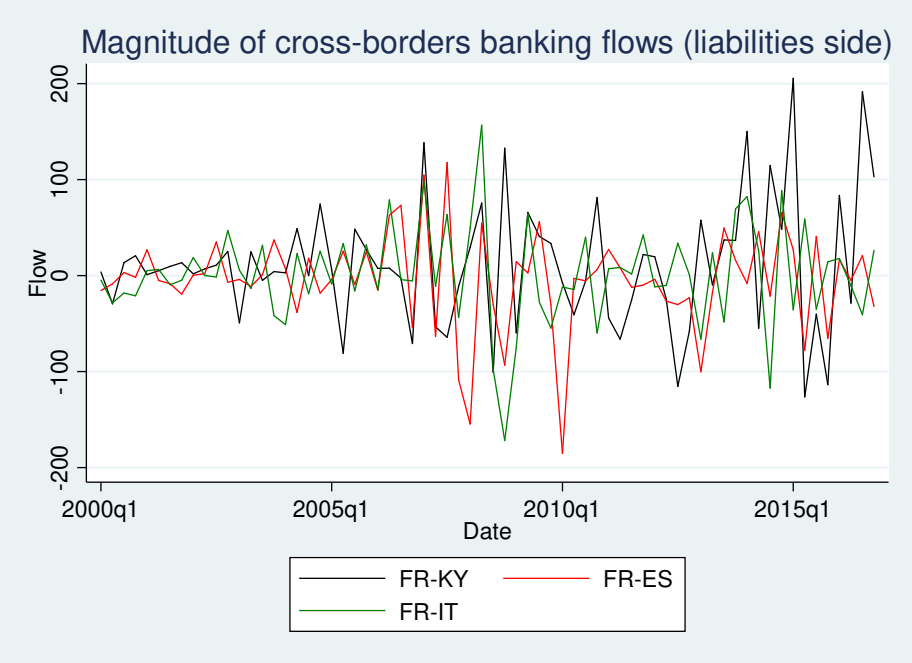
However, a more fundamental reason for supervisors to focus on offshore financial centers lies in financial stability objectives. This question will be examined in detail at a later date, but a first chart (Chart 1 below) points out the associated problems straight away. It shows that banking flows from the

[6] https://www.bis.org/statistics/lbs_globalcoverage.pdf

[7] http://stats.bis.org/statx/srs/tseries/LBS_D_PUB/Q.S.C.A.TO1.A.5J.A.5A.A.1N.N?t=a1&c=&m=S&p=20172&i=5.1 and https://www.bis.org/statistics/rppb1804.pdf

Cayman Islands to France (FR-KY) are comparable in volume to those from agents resident in Italy (FR-IT) and Spain (FR-ES), two of France's main economic partners. It also shows that the volatility of these flows increased significantly during the 2008 crisis and has continued to grow since 2014.

Graph 1. Quarterly cross-border banking flows received from the Cayman Islands, Italy and Spain (standardised by the average of banking flows received by the French banking system from all countries)



Sources: Banque de France and Bank for International Settlements, authors' calculations.

Note: *in the first quarter of 2015, banking flows vis-à-vis the Cayman Islands were nearly 200 times higher than the average of total quarterly banking flows received from other counterparty countries.*

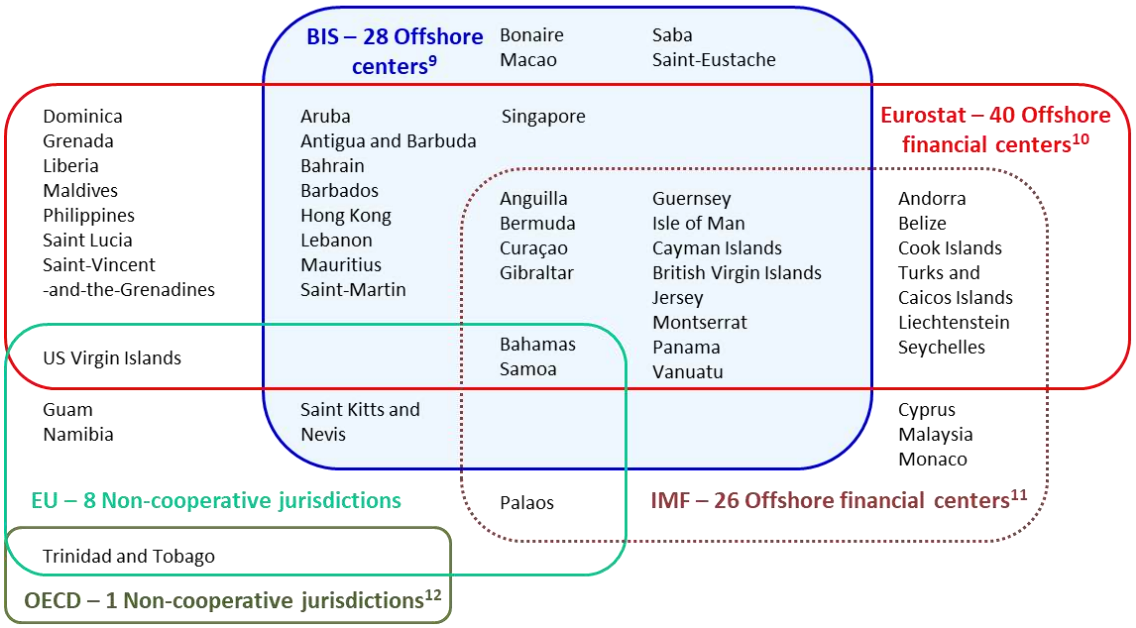
II. Establishing a list of extraterritorial financial centers

A. Identification and limits of existing lists

Several international institutions have been addressing the issue of combating tax evasion for almost a decade following the onset of the crisis, with the significant increase in public deficits and the rapid escalation of inequalities that ensued. They have thus drawn up lists of jurisdictions that can be qualified as offshore (financial) centers on the basis of various criteria: lack of cooperation in the exchange of tax information; lenient regulation, supervision and/or taxation; and orientation of economic and financial activities toward non-residents. While such lists have existed since the early 2000s, the G20 summit in April 2009 was undeniably a turning point.[8] For example, the graph below shows the respective perimeters of the lists drawn up by the IMF, the OECD and Eurostat as well as the jurisdictions classified as OFCs by the BIS.

[8] Black and grey lists of uncooperative territories were drawn up during this summit: http://www.senat.fr/rap/r11-673-1/r11-673-111.html

Figure 1. Comparison of the perimeter of extraterritorial financial centers as set out by official international institutions



Sources: Bank for International Settlements, European Union, Eurostat, International Monetary Fund, Organisation for Economic Cooperation and Development

However, these lists do not converge insofar as each is based on a set of variable criteria, often difficult to identify and even confidential and/or discretionary. To address these problems, our objective is to set out an alternative list based on measurable, transparent and replicable indicators.

A first step in our work therefore consists in developing such an indicator with an eye to classifying jurisdictions based on the work initiated by Zoromé (2007), who supported initiatives to apply his own work to other databases such as that of the BIS. The overall approach is to identify countries whose significant role in international capital flows is not proportional to their actual economic weight.

B. Establishing a list based on a statistical indicator

The proposed metric combines the following two characteristics: simple construction and ease of replication. According to our approach, offshore centers are countries in which the banking sector has a disproportionate weight in relation to their real economy.[13] This gap is potentially observable in many statistics. For example, the ratio of *Cross-border bank outstandings to GDP* could be considered as a relevant indicator. However, this ratio is limited in that the revenues generated by these cross-border financial activities are recorded in GDP, which leads to double counting. Therefore, it will not be used

[9] Source: http://www.bis.org/statistics/dsd_cbs.pdf; OFCs are defined in this document as "A term used to describe countries with banking sectors dealing primarily with non-residents and/or in foreign currency on a scale out of proportion to the size of the host economy", without further methodological clarification.
[10] Source: http://ec.europa.eu/eurostat/documents/3859598/5922981/KS-RA-12-016-EN.PDF/c93cdf48-5efa-459f-b218-731a9a5476e9?version=1.0 with no methodological details.
[11] Source: IMF Staff Assessments http://www.imf.org/external/NP/ofca/OFCA.aspx – This list is not certified by the IMF Board of Directors. It is based on various reports published between 1998 and 2000 (Edward, KPMG and FATF reports) without clarifying the methodology used.
[12] Source: http://www.oecd.org/tax/transparency/exchange-of-information-on-request/ratings/
[13] By selecting a measure based on financial interconnection, our approach leaves aside offshore centers that specialize in non-financial services, such as legal and tax services - hosting of holding companies or vehicles specialized in property rights management, etc. - provided that these activities do not go along with international financial activities on a large scale, to ensure that the centre in question does not constitute a direct link for the spread of systemic risk liable to oblige the local central bank to act as lender of last resort at one time or another.

as a main indicator but as a secondary indicator for stress tests. In the end, we use one key criterion to identify OFC jurisdictions:

- *the ratio of cross-border banking positions to the resident population*

For stress testing purposes, we also use a second criterion:

- *the ratio of cross-border assets and liabilities to domestic assets and liabilities*

Despite significant variations between countries, the number of people living in a country or jurisdiction is a good approximation of the intensity of its economic activity. The data used are those of the World Bank, with the exception of Guernsey, Jersey, Taiwan and the Netherlands Antilles, for which we used local statistical offices.[14] The results are presented in Table 4 in Appendix H. In order to ensure the robustness of this list, we present the results for 2015 alone as well as the average for the period 2007-2015. We present the measurement from two angles: assets and liabilities. There emerge three quite distinct groups:[15]

- A first group consists of very small jurisdictions or countries with particularly high ratios. This is the group ranging from the Cayman Islands (19.11) to Bahrain (0.1). This group is itself very heterogeneous but has the attribute of bringing together the countries or jurisdictions generally mentioned in the existing lists. All of these countries have a level of cross-border positions exceeding USD 100,000 per capita.
- This group is followed by a category of countries with cross-border positions of between USD 50,000 and USD 70,000 per capita, including the United Kingdom, Ireland, the Netherlands and Belgium. Unlike the countries of the first group, they exhibit real economic activity but with extremely significant and, above all, highly internationalized weight in banking activities.
- The remaining countries exhibit levels of cross-border positions below USD 50,000 per capita.

On the basis of this simple statistic, we can establish a list of offshore financial centers comprising the 13 countries or jurisdictions with more than USD 100,000 per capita of cross-border bank outstandings: **Cayman Islands, Guernsey, Jersey, Luxembourg, Isle of Man, Bahamas, Bermuda, Macao, Hong Kong, Curacao, Singapore, Switzerland and Bahrain.** The stability of this list is studied in Appendix B for the period from 2000 to 2016 – particularly the case of Ireland, which does not appear in our list because of the significant drop in its cross-border bank outstandings since the European crisis of 2012; it has had ratios well below our threshold of USD 100,000 per capita for the past four years. Among these 13 countries or jurisdictions, it should be noted that five of them account together for 85% of total outstandings (Appendix H, Table 2).

C. Robustness checks of the list of 13 OFCs

For robustness purposes, three other approaches are tested, combining other criteria and/or methodologies:

- a simple comparison is made between the ranking from our central criterion (population ratio) and that obtained using our second criterion (ratio between cross-border positions on assets and liabilities and domestic positions on assets and liabilities);

[14] https://www.gov.gg/CHttpHandler.ashx?id=107410&p=0 and https://www.gov.je/SiteCollectionDocuments/Government%20and%20administration/R%20Population%20Estimate%202015%2020160621%20SU.pdf

[15] The following figures indicate asset positions for 2015. The results are similar using either asset or liability positions and regardless of the indicator applied (both for 2015 alone and for the 2007-2015 average).

- a method for detecting outliers, based on the Grubbs test[16], is applied to the ranking from our central criterion;
- a k-means clustering is applied to the rankings derived from our central criterion, our secondary criterion and a third criterion (ratio between cross-border asset positions and GDP).

Finally, we compare the list of the 13 OFCs with that of Zoromé (2007), whose construction is also based on criteria derived from international statistics.

Simple comparison between the rankings from the central and secondary criteria: the results obtained using the "domestic positions" ratio are presented in Table 5 in Appendix H. The countries detected using this criterion are very similar to those detected using the central criterion (Spearman rank correlation of 0.87). The only notable differences are the emergence of Panama at the top of the ranking, Finland's high ranking and Switzerland's fall at the bottom. In the first case, there is uncertainty about the perimeter of domestic positions.[17] For Switzerland, the decline is explained by the strong domestic base of its banking system driven by local economic activity as well as by Switzerland's privileged position in the international financial architecture, on a par with the United Kingdom. As a result, interbank transactions between resident foreign banks increase the basis for domestic positions and reduce the ratio accordingly. Lastly, Finland's ranking is explained by the particular nature of Scandinavian banking systems with very high interconnectivity (cf V. Integration of OFCs into the international financial architecture). Despite these differences, the similarity in rank between these two classifications remains very strong.

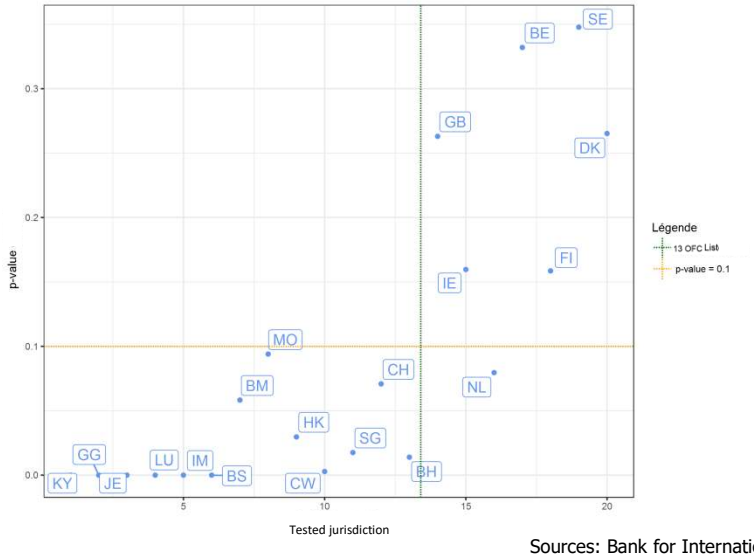
Method for detecting outliers: the Grubbs test is applied to the ranking from the central criterion. This method allows us both to statistically measure the intensity of the "non-standard" nature of our OFCs and to analyze whether the break between the ratios of the thirteenth country (Bahrain) and the fourteenth country (United Kingdom) is significant enough to determine our list of 13-country OFCs.

We successively apply the Grubbs test to the twenty jurisdictions with the highest ratios of cross-border banking positions to the resident population. The graph below shows the p-value obtained by each of them, i.e. the probability that it is not an outlier. It is noteworthy that the countries in our list of 13 OFCs have a p-value of less than 0.1, which means that they can be considered statistically outliers. In addition, the Grubbs test carried out on the 14th country in our ranking - the United Kingdom - has a p-value of more than 0.25; in other words, after excluding the countries from our list of 13 OFCs, the remaining data sample appears to be statistically homogeneous, i.e. without any outliers.

[16] From a methodological standpoint, the Grubbs test determines whether there is no outlier among the series of data considered.

[17] Since 2012-Q2, countries have had to report to the BIS not only their domestic positions in foreign currency, but also in local currency, which is more or less the same as recording all loans granted to domestic agents. However, in the case of Panama, it is not entirely clear that this change has been implemented.
Cf. http://www.bis.org/statistics/count_rep_practices/locstatsbycountry.pdf page 205 : " *Panama reports its positions in US dollars this currency is used throughout the national territory*"

Figure 2. Grubbs tests on the top 20 jurisdictions for the ratio of cross-border claims to population



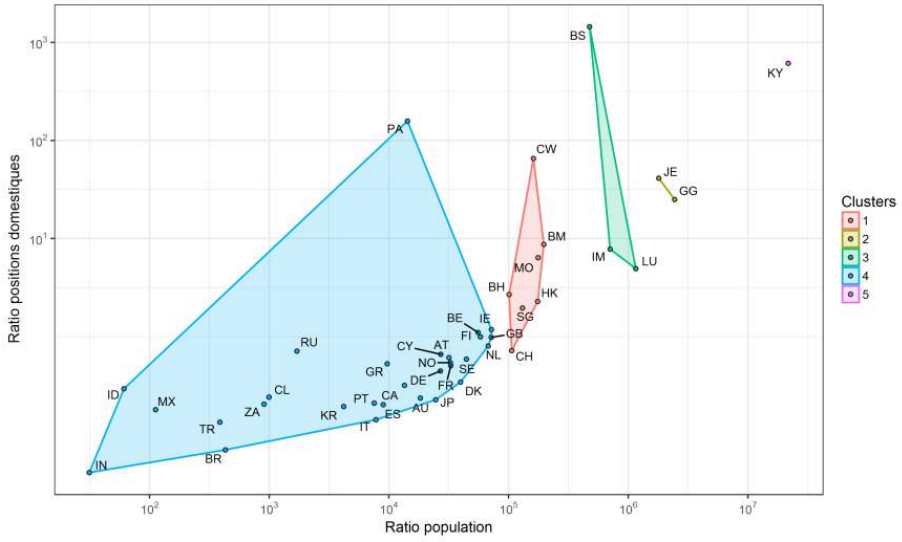
Iso-code 2	Country name	Iso-code 2	Country name
AT	Austria	ID	Indonesia
AU	Australia	IE	Ireland
BE	Belgium	IM	Isle of Man
BH	Bahrain	IN	India
BM	Bermuda	IT	Italy
BR	Brazil	JE	Jersey
BS	Bahamas	JP	Japan
CA	Canada	KR	South Korea
CH	Switzerland	KY	Cayman Islands
CL	Chile	LU	Luxembourg
CW	Curacao	MO	Macao
CY	Cyprus	MX	Mexico
DE	Germany	NL	Netherlands
DK	Denmark	NO	Norway
ES	Spain	PA	Panama
FI	Finland	PT	Portugal
FR	France	RU	Russia
GB	United Kingdom	SE	Sweden
GG	Guernsey	SG	Singapore
GR	Greece	TR	Turkey
HK	Hong Kong	ZA	South Africa

Sources: Bank for International Settlements and World Bank, authors' calculations.

Note: Grubbs' tests performed on the top three of the "cross-border claims over population" ranking (Cayman Islands, Guernsey and Jersey) show that they are outliers (p-values close to 0).

K-means clustering: we use a k-means clustering methodology to classify countries with strong similarities into groups. This method has the advantage of processing several ratios simultaneously. We combine three of them: the two mentioned above to which we add the ratio of cross-border debt to GDP. In addition, a principal component analysis shows that the information given by the cross-border debt to GDP ratio is redundant with that given by the cross-border debt to population ratio (Annex C). Hence, it is possible to represent the detected clusters according to the domestic position ratio and the population ratio only (Figure 3).

Figure 3. K-means clustering of the BIS reporting countries – Clusters are represented according to the "population" and "domestic positions" ratios (log 10 scale)



Sources: Bank for International Settlements and World Bank, authors' calculations.

Note: Countries of the same color are considered close with respect to their respective ratios.

The classification in five clusters confirms the singularity of the list of 13 OFCs.

On the one hand, the densest cluster, in blue, includes the majority of BIS reporting countries, i.e. the "classical countries", and does not contain any of our 13 OFCs. On the other hand, the remaining four clusters have in total 13 jurisdictions corresponding to our 13 OFCs. Their distribution into 4 distinct clusters suggests structural differences between the OFCs. The Cayman Islands stand out from the other OFCs and alone constitute a cluster (pink cluster, North-East of the Figure 3). The Anglo-British islands also deviate from the central clusters but to a lesser extent (yellow cluster). The Isle of Man, Luxembourg and the Bahamas form a third cluster (green cluster). A fourth cluster, located near the "classical countries" cluster, is composed of Hong Kong, Singapore, Bahrain, Macao, Bermuda, Curacao and Switzerland (cluster in red). Switzerland, although part of this cluster, remains extremely close to some members of the "classical country" cluster, such as the United Kingdom and the Netherlands, respectively 14th and 16th in our main ranking.

Comparison with the OFC list of Zoromé (2007): the list of 13 CFOs coincides with that of Zoromé, who nevertheless uses other international databases (CPIS, IIP). In fact, 11 of the OFCs in our list also appear in Zoromé's list. Only Curacao (which did not exist as a State in 2007) and Macao (which for the first time exceeds the OFC threshold in 2012 and whose cross-border banking activity continues to grow) are not included. Conversely, countries included in Zoromé's list do not appear in our list of OFCs: countries that are not yet reporting to the BIS (Barbados - which however appears in our extended list in Annex D, Latvia, Malta, Mauritius, Uruguay and Vanuatu), countries whose cross-border banking activity has declined significantly since 2007-2008 (Ireland, Cyprus) and finally countries that, although positioned at the top of our ranking, do not cross the OFC threshold (Netherlands, Panama, United Kingdom).

III. What is the impact of offshore financial centres in the international financial architecture?

A. Extraterritoriality coefficient of a banking system

With a list of OFCs based on a statistical approach, it is now possible to establish, for each banking system, an indicator to track the proportion of cross-border bank outstandings vis-à-vis an OFC as a proportion of its total cross-border bank outstandings. This ratio makes it possible to identify reporting countries that record proportionally more banking assets (and respectively banking liabilities) vis-à-vis counterparties resident in an OFC.

In order to construct an extraterritoriality coefficient for all banking positions, all counterparty sectors combined, only data from BIS reporting countries (46 countries) broken down by the counterparty's country of residence, can be used. This therefore limits the analysis to reporting countries; however, this category includes the most important banking systems.

It is nonetheless possible to extend the analysis by considering cross-border banking positions vis-à-vis banking sectors alone. Indeed, the interbank assets declared by country A on counterparty country B are *theoretically* equivalent to the interbank liabilities declared by country B vis-à-vis country A (which in this case becomes the counterparty country). By adding up mirror positions, the construction of the extraterritoriality coefficient can be generalized to a much larger number of countries in the case of interbank outstandings.[18] However, this expansion of geographical coverage leads to less sectoral

[18] In practice, however, there may be significant differences between what A reports about B and what B reports about A, due to differences in the definition of interbank business. Nonetheless, this is a reasonable approximation in the absence of other sources. Furthermore, interbank positions between non-reporting countries are not included in the analysis and cannot be included in the total cross-border interbank outstandings of a non-reporting country.

coverage since the non-banking sector, which is of great interest for this type of analysis,[19] is excluded. Thus, for each country, we construct the following variables:

$$Extraterritoriality(p,s,j,t) = \frac{\sum_i Exposures(p,s,j,i,t) \cdot OFC_i}{\sum_i Exposures(p,j,i,t)}$$

where p denotes the nature of the position (asset/liability), s denotes the counterparty sector, j denotes the reporting country in question, t indexes the period and i denotes the counterparty country. For interbank exposures, when j is not a reporting country, j denotes the counterparty country, i denotes the reporting countries, and the position p is inverted. As for the equation OFC_i, it is an indicator with a value of 1 when the counterparty country (or reporting country in the reverse case) is included in our list of OFCs; otherwise it has a value of zero.

B. Analysis of BIS reporting countries alone: on average, one-sixth of worldwide banking positions pass through OFCs

The analysis concerns the last quarter available at the time of this study, i.e. Q4 2016. All outstandings are taken into consideration, i.e. all counterparty sectors combined. The table below contains descriptive statistics as well as information regarding the distribution of indicators.

Table 3a. Descriptive statistics: degree of extraterritoriality of banking systems with regard to assets as %; (Q4 2016)

Variable	Assets	Liabilities
N	22	22
Mean	17.4%	16.4%
Standard deviation	15.1%	12.4%
P25	7.1%	7.7%
Median	14.7%	13.3%
P75	24.6%	21.9%

Source: Bank for International Settlements, authors' calculations.

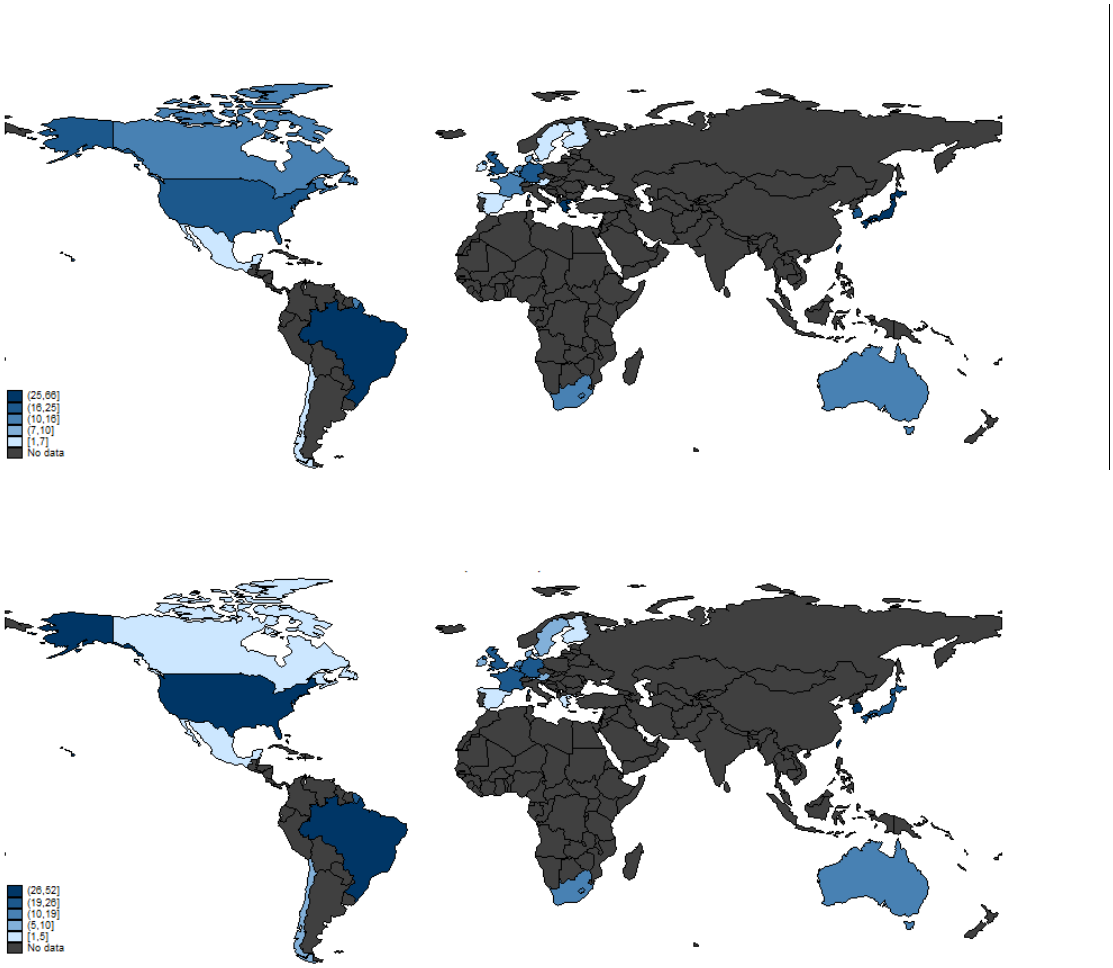
Coefficients are attributed to 22 reporting countries.[20] Analyzing the distribution of this list, we note that:

- On the assets side, 25% of countries have a degree of extraterritoriality of less than 7%, 50% less than 15% and 75% less than 25%. The average coefficient stands at 18%, with high variance: **on average, nearly 1/5 of assets of banking systems in average reporting countries involve entities resident in OFCs.** However, this does not presuppose the overall share of cross-border assets held by reporting banking systems vis-à-vis entities resident in OFCs. Indeed, calculating this proportion would require weighting the average according to the importance of each of the banking systems under consideration.
- On the liabilities side, 25% of countries have a degree of extraterritoriality of less than 8%, 50% less than 13% and 75% less than 22%. The average is 16.4%, with a slightly lower variance. **Thus, on average, 1/6 of the liabilities of the main banking systems involve entities located in an OFC as counterparties.**

For a more holistic view, we created a map representing the distribution of this extraterritoriality coefficient for reporting countries. The colors are spread over 5 levels. For more details, Table 6 identifies the degree of extraterritoriality of these countries.

[19] Indeed, many financial "vehicles" and other shadow banking entities are domiciled in these jurisdictions (Abad *et al.*, 2017).
[20] The 29 countries that break down receivables by counterparty country (cf. Appendix A) minus the seven OFCs that break down receivables by counterparty country.

Figure 4a and 4b: Share of assets (upper map) and liabilities (lower map) held by the banking systems of countries reporting to the BIS on agents resident in an OFC (Q4 2016)



Source: Bank for International Settlements, authors' calculations.

On the assets side, Greece and Brazil take the top two positions. Among the most developed banking systems, Japan, the United States and Germany have a relatively higher ratio, with a quarter of their cross-border assets going to OFCs. In contrast, Finland, Denmark and Sweden, generally cited for their high degree of transparency,[21] are among the least extraterritorialised countries. Finally, Brazil, Canada, Greece and, to a lesser extent, Japan and Finland, show significant differences in the degree of extraterritoriality between their assets and liabilities, as illustrated by the ratio presented in the third column of Table 6 in Appendix H.[22] The absence of some countries may seem surprising (e.g. Cyprus, Lebanon or Russia). This is due to the availability of the public data on which we based this first analysis. That is why we are now turning to an analysis using "Restricted" data and limited to interbank positions.

C. Analysis including all countries: interbank positions

As mentioned above, analyzing only cross-border interbank outstandings makes it possible to use mirror positions, thereby increasing the sample size by including more countries (an initial analysis of data consistency is presented in Appendix E). This analysis is based on "Restricted[23]" BIS data. The period studied is Q2 2016 rather than Q4 2016.

[21] Cf. https://www.transparency.org/news/feature/corruption_perceptions_index_2016
[22] Subsequent work may attempt to clarify these variations; in any case, that issue is well beyond the scope of this paper.
[23] Access to the "Restricted" database requires accreditation issued by the BIS according to strict rules. This database is more extensive than the public database. For our purposes, it provides access to a more detailed breakdown by counterparty sector.

Table 3b. Descriptive statistics: degree of interbank extraterritoriality of banking systems on the assets side as %; (Q4 2016)

Variable	Assets	Liabilities
N	145	143
Mean	14.5%	13.9%
Standard deviation	17.2%	17.6%
P5	0%	0%
P25	2.4%	0.4%
Median	8.8%	6.5%
P75	21%	19.6%
P95	48.8%	55.1%

Source: Bank for International Settlements, authors' calculations.

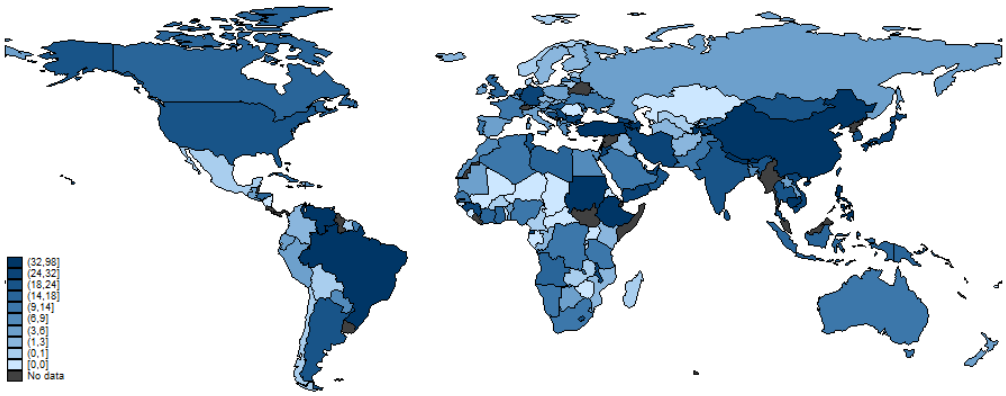
According to the line item in question (asset or liability), 143 to 145 countries are studied. Analyzing the distribution of this list, we note that:

- On the assets side, 25% of countries have a degree of extraterritoriality of less than 2.5%, 50% less than 9% and 75% less than 21%. At the top of the breakdown, 5% of countries hold nearly half of their interbank assets vis-à-vis OFCs.[24] **On average, 15% of cross-border interbank asset positions have a bank resident in an OFC as counterparty.**

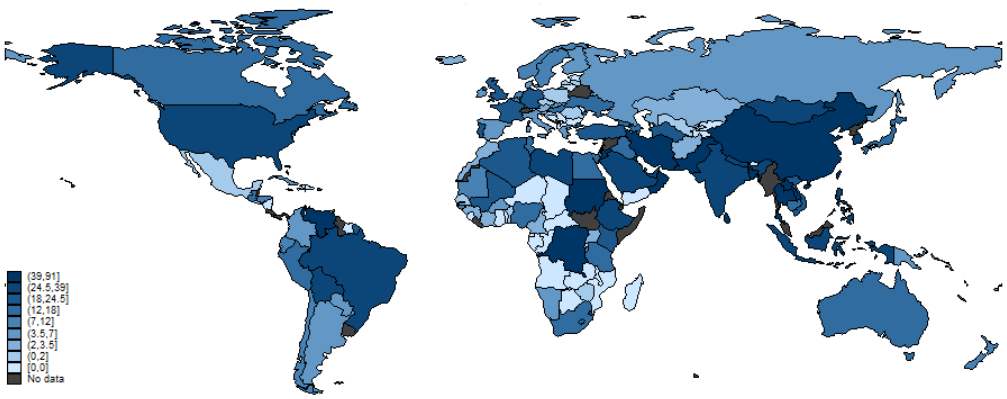
- On the liabilities side, 25% of countries have a degree of extraterritoriality of less than 0.4%, 50% less than 6.5% and 75% less than 20%. For 5% of countries, more than half of liabilities originate from OFCs.[25] **On average, 14% of cross-border interbank liability positions have a bank resident in an OFC as counterparty.**

The two maps below present a summary of the extraterritoriality coefficient for all countries.

Figure 3a and 3b: Share of interbank assets (upper map) and liabilities (lower map) held by banking systems vis-à-vis the 13 countries on our OFC list (Q2 2016)



[24]The following countries are concerned: Ethiopia, Armenia, Brazil, Nepal, Sudan, Tajikistan and Bhutan.
[25]The following countries are concerned: Pakistan, Bangladesh, Iran, Sri Lanka, DRC, Kuwait and Sudan.



Source: Bank for International Settlements, authors' calculations.

We see a high rate of extraterritoriality for banking systems in Asia, the Middle East, eastern and northern Africa and Latin America. In comparison, continental Europe, some countries of the former USSR and southern Africa seem to rely proportionately less on OFCs. Various profiles stand out among the most extraterritorialised countries: Nepal, Ethiopia, Sudan, Venezuela, Tajikistan, Azerbaijan, Kuwait and China.[26]

Finally, the degree of extraterritoriality of banking systems varies relatively little, with regard both to counterparties in general and for banking counterparties alone. The difference is within ±3ppts for France, the United Kingdom, the United States and Germany.

D. The case of France: greater reliance on OFCs for financing than for capital investment

The French banking system holds 14.5% of its cross-border assets vis-à-vis agents located in OFCs. **This puts France at the median in terms of worldwide distribution for both assets and liabilities.** Comparing France's situation with that of countries with equivalent banking systems, it appears that France has a degree of extraterritoriality on the assets side comparable to that of the Netherlands, 10 points lower than that of Germany or the United States, half that of Japan, but three times higher than that of Spain.[27] On the liabilities side, its degree of extraterritoriality is comparable to that of Japan or Germany, slightly lower than that of the United Kingdom, and 15 points lower than that of the United States. Appendix F presents the history of the extraterritoriality coefficients for these banking systems.

In addition, the specific role played by Luxembourg vis-à-vis the French banking sector in terms of providing banking services and raising funds from local branches is confirmed. The positions of the French banking sector vis-à-vis Luxembourg account for 6.5% of assets and 11.7% of liabilities. By way of comparison, positions vis-à-vis Switzerland account for only 2.8% on the assets side and 3.8% on

[26] These results are consistent with those of Alstadsaeter *et al.*, 2017, whose study focused on another counterparty sector (households) available in BIS statistics.

[27] These conclusions are similar to those presented in Banque de France Bulletin No. 210 "*Les banques françaises confortent leur quatrième rang à l'international (French banks confirm their fourth-place position worldwide*", https://publications.banque-france.fr/sites/default/files/medias/documents/bdf210_web.pdf#page=44.

the liabilities side.[28] The top 15 counterparties of the French banking system for interbank asset and liability positions are presented in Table 8 below.

Table 8. List of the top 15 counterparty banking systems of the French banking system (Q4 2016, OFCs are highlighted in a different color)

Assets		Liabilities	
Counterparty country	% of total	*Counterparty country*	% of total
Great Britain	16.2%	*Great Britain*	19.5%
United States	12.1%	*United States*	13.9%
Japan	9.0%	*Luxembourg*	11.7%
Italy	8.2%	*Germany*	10.8%
Luxembourg	6.5%	*Japan*	6.4%
Germany	5.5%	*Netherlands*	4.5%
Spain	5.4%	*Switzerland*	3.8%
Belgium	4.8%	*Italy*	3.7%
Netherlands	4.7%	*Belgium*	3.5%
Switzerland	2.8%	*Ireland*	3.3%
Ireland	2.8%	*Cayman Islands*	2.0%
Cayman Islands	1.7%	*Hong Kong*	1.7%
China	1.6%	*Spain*	1.6%
Hong Kong	1.4%	*Australia*	1.0%
Singapore	1.0%	*Singapore*	0.8%

Source: Bank for International Settlements, authors' calculations

With regard to interbank positions, the extraterritoriality coefficient of the French banking system is 12% on the assets side compared to 19% on the liabilities side. This means that, proportionally, banks finance themselves nearly twice as much from banks resident in an OFC as they lend to them.

These figures place France slightly above the median on the assets side and significantly above the median on the liabilities side, without falling into the last quartile. Compared to other major banking systems, France has a much lower degree of extraterritoriality on the assets side than the United Kingdom (18.2%), the United States (23.5%), Japan (25.9%) or Germany (27.4%) but twice as high as Italy (6.3%) or Spain (4.7%). By contrast, on the liabilities side, its degree of extraterritoriality is comparable to that of Germany (20.9%), the United Kingdom (23.6%), and Japan (17.4%), and far behind the United States (34.3%). Here again, the French banking system is much more extraterritorial than the Spanish (4.5%) or Italian (7.3%) banking systems.

Overall, it therefore appears that the French banking system relies neither more nor less on offshore financial centers in its cross-border banking operations than do comparable banking systems.

However, when we examine the ratio of extraterritoriality coefficients for assets and liabilities, presented in column 3 of Tables 6 and 7, Appendix H, we see that France tends to use OFCs more for financing than for capital investment (ratio of 0.67 overall and 0.64 for interbank outstandings alone). In this respect, it is close to the United States (with ratios of 0.73 and 0.68 respectively) or Great Britain (with ratios of 0.78 and 0.77 respectively). On the other hand, these three banking systems seem to differentiate themselves from their German, Japanese and Dutch counterparts, all three of which exhibit ratios above 1, indicating that banks resident in these countries invest more in OFCs than they rely on OFCs for financing.

[28] At this stage of the analysis, these are "first counterparty" positions. This means, for example, that the portion of French bank financing provided to Luxembourg and then re-lent in Switzerland by Luxembourg branches would not be allocated to Switzerland.

IV. A financial stability issue

Having quantified the importance of OFCs in the international banking architecture, we now examine the financial stability issues raised by these exposure levels. Recent literature has indeed demonstrated the importance of understanding the nature and dynamics of these cross-border financial flows to ensure greater financial stability (Bruno and Shin, 2015, Passari and Rey, 2015 & Reinhardt and Riddiough, 2015). To do so, we use flow data (rather than outstandings), adjusted for exchange rate variations and variations in reporting procedures.

Table 9 below shows, for each of the main banking systems, the share of negative flows on the liabilities side (i.e. bank capital outflows) to bank subsidiaries or branches resident in an OFC. We select a symbolic date corresponding to a period of intense financial stress: Q4 2008, the quarter following the collapse of Lehman Brothers. During this quarter, USD 1.68 trillion in net negative flows were recorded as liabilities for all reporting banks, the largest amount on record.[29] More generally, from the first quarter of 2008 onwards, cross-border bank outstandings began to contract on a scale not seen since international banking statistics have been collected.[30]

What role could OFCs have played in this process? Of this USD 1.68 trillion in negative net flows on the liabilities side, USD 410 billion (i.e. nearly 25%) had a counterparty among the 13 jurisdictions that we classify as OFCs. Table 9 below presents details of this proportion for each of the world's largest banking systems.

Table 9. Share of net flows with an entity resident in an OFC as counterparty (Q4 2008, USD millions)

Reporting country	Total net flows	Net flows towards an OFC	Ratio
All countries	-1,676,439	-411,154	25%
Belgium	-175,771	-26,167	15%
Germany	-211,446	-71,477	34%
France	-219,839	-5,072	2%
United Kingdom	-539,009	-96,776	18%
Ireland	-64,793	-10,886	17%
Japan	142,142	6,150	4%
Netherlands	-195,508	-18,784	10%
USA	-131,576	9,007	-7%

Source: Bank for International Settlements, authors' calculations

Note: in Q4 2008, bank capital inflows net of bank capital outflows vis-à-vis OFCs fell by USD 411 billion for all countries combined. The United States benefited from capital inflows from OFCs.

The share of net flows with an entity resident in an OFC as counterparty varies considerably. In some countries, such as the USA, OFCs even play a compensatory role, accounting for a positive contribution that is consistent with the "safe haven" status of the United States, in conjunction with the appreciation of the US dollar. However, this table presents a problem in that, although it provides a comprehensive view of flows (as we use the *any counterparty country* category to calculate total net flows, in which case bilateral positive and negative flows cancel each other out), it does not allow for a separate analysis of gross negative flows. For such an analysis, we must consider bilateral flows and the summation thereof, thereby leading to a less comprehensive result. In Table 10 below, not only do we replicate the previous table using the sum of bilateral flows (rather than total net flows) as the denominator, but we also consider all positive and negative bilateral net flows separately.

[29] http://stats.bis.org/statx/srs/tseries/LBS_D_PUB/Q.F.L.A.TO1.A.5J.A.5A.A.5J.N?t=a1&c=&m=F&p=20172&i=1.2
[30] http://stats.bis.org/statx/srs/tseries/LBS_D_PUB/Q.S.C.A.TO1.A.5J.A.5A.A.5J.N?t=a1&c=&m=S&p=20172&i=1.1

Table 10. Share of net flows with an entity resident in an OFC as counterparty; breakdown between negative and positive net flows (Q4 2008, USD millions)

Reporting country	Total net flows	Net flows towards an OFC	Ratio	Total negative flows	Negative flows towards an OFC	Ratio	Total positive flows	Positive flows towards an OFC	Ratio
All countries	-1,676,439	-411,154	25%	-1,727,649	-457,502	26%	110,660	46,348	42%
Belgium	-175,771	-26,167	15%	-188,717	-35,155	19%	17,828	8,988	50%
Germany	-211,446	-71,477	34%	-238,863	-84,834	36%	33,744	13,357	40%
France	-219,839	-5,072	2%	-267,180	-32,895	12%	46,119	27,823	60%
United Kingdom	-539,009	-96,776	18%	-678,051	-157,886	23%	146,815	61,109	42%
Ireland	-64,793	-10,886	17%	-84,253	-13,261	16%	19,964	2,375	12%
Japan	142,142	6,150	4%	-21,341	-15,200	71%	165,421	21,350	13%
Netherlands	-195,508	-18,784	10%	-196,484	-18,815	10%	4,792	31	1%
USA	-131,576	9,007	-7%	-271,024	-36,963	14%	158,813	45,970	29%

Source: Bank for International Settlements, authors' calculations

Overall, we find that there are only small differences for these reporting countries between the net flows reported in the "all-counterparty" category (Table 9) and the sum of bilateral flows (first 3 columns of Table 10). As such, the ratios are similar to those in Table 9. If we now look at the sum of positive and negative net flows separately, several facts emerge.

First, all these countries have experienced negative flows larger than is suggested by the total (net flows), these negative flows having been offset by positive flows. Focusing on negative flows, we see that for between 10% and 36% of those flows, the counterparty is an entity located in an OFC.[31] For France, this ratio stands at 12% for an amount of USD 33 billion. By way of comparison, this corresponds to a volume similar to that of bilateral flows vis-à-vis the USA (- USD 42 billion), the United Kingdom (- USD 37 billion) or Germany (- USD 23 billion) over the same period. In other words, in the widespread movement of cross-border capital withdrawals that took place at the height of the crisis, OFCs acted as a drain for the French banking system to the same extent as the USA or the United Kingdom.

Let us now examine the volatility of these flows. We would like to construct a measurement of volatility that does not reflect the considerable differences in terms of outstandings, which we have just examined.[32] A standard measure from this standpoint is to use the *coefficient of variation*, which is nothing more than the standard deviation standardized by the mean. However, insofar as we are studying flows that may be negative or positive, standardizing these flows by the mean makes no sense, as the result is fairly likely to be close to zero. We therefore construct a *hybrid coefficient of variation* in which we standardize the standard deviation of flows, not by the mean of *flows*, but by the mean of *outstandings*. Specifically:

- for each *reporting country/counterparty country* pair, we calculate: (i) the standard deviation of *bilateral flows* as well as (ii) the average of *total bilateral outstandings.*
- This makes it possible to calculate our *hybrid coefficient of variation* as the ratio of the standard deviation of flows to average outstandings for each *reporting country/counterparty country* pair.
- We calculate these two values over (i) the entire period and (ii) the period of the financial crisis alone, i.e. from Q1 2008 to Q4 2009
- Then, for each *reporting country*, we calculate the average of these *hybrid bilateral coefficients of variation* according to whether the counterparty country is (i) an OFC, (ii) a major banking

[31] Japan stands out as something of a special case. While the ratio is quite high, its total balance is positive, meaning that it cannot be interpreted the same way.

[32] Standard deviation as a measurement is sensitive to the magnitude of the underlying variable.

system (France, United Kingdom, USA, Germany, Japan, Netherlands, Belgium and Ireland) and (iii) a third country

Table 11 below summarises the results. Several observations can be made: the variability of flows for each reporting country, regardless of size, appears systematically higher vis-à-vis counterparties resident in an OFC than in a major banking system (between 1.5 and 2.7 times higher) but systematically lower than vis-à-vis other countries (which, however, do not exhibit anywhere near the same level of outstandings; part of the variability seen in these countries probably arises from the more erratic nature of their cross-border banking relationships).

Table 11. Average of hybrid bilateral coefficients of variation by reporting country according to the nature of the counterparty country and the period in question.

Reporting country	All periods			Q1 2008 to Q4 2009		
	Major banking systems	OFCs	Other countries	Major banking systems	OFCs	Other countries
Belgium	0.17	0.40	0.64	0.27	0.68	0.78
Germany	0.13	0.29	0.53	0.19	0.37	0.58
France	0.09	0.26	0.61	0.10	0.35	0.56
United Kingdom	0.09	0.21	0.53	0.14	0.28	0.61
Ireland	0.24	0.58	1.10	0.51	0.37	1.04
Japan	0.26	0.61	0.99	0.30	0.27	0.60
Netherlands	0.16	0.24	0.74	0.24	0.21	0.60
USA	0.17	0.31	0.39	0.22	0.17	0.42

Source: Bank for International Settlements, authors' calculations

This pure variability systematically comes out higher during the 2008-2009 financial crisis, as expected. With regard to France, the volatility of flows vis-à-vis OFCs is 2.9 times higher than that vis-à-vis other major banking systems in normal periods, and as much as 3.5 times higher in times of financial stress. This is the highest ratio observed among these eight countries. Similarly, while in all countries combined the volatility of flows vis-à-vis OFCs increased relatively less than vis-à-vis other major banking systems, France, like Belgium, saw this volatility increase proportionally more during the 2008 crisis.

To conclude this section, our analysis shows that studying OFCs is important in terms of financial stability, as these OFCs are counterparties to the main banking systems with very significant outstandings, comparable to those vis-à-vis major banking systems; in addition, regardless of the size of the amounts in question, these flows are more volatile from a structural standpoint than those vis-à-vis major banking systems.

V. Integration of OFCs into the international financial architecture: community detection via network analysis

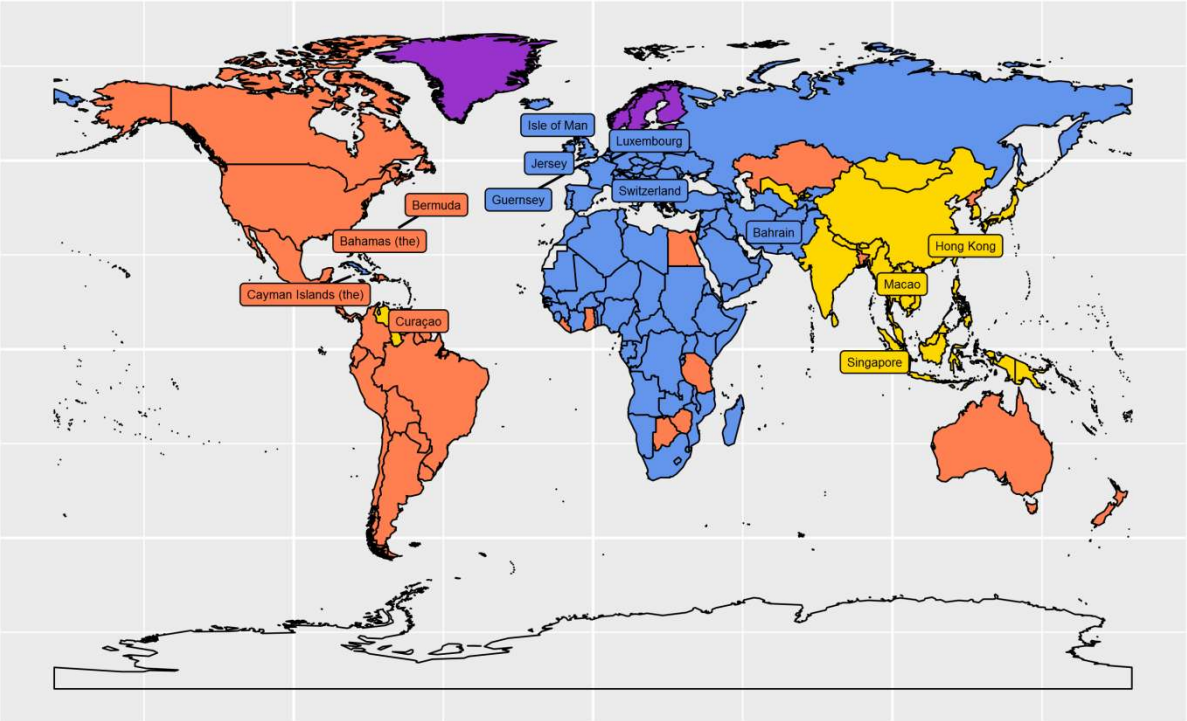
A. Scope of data, methodology and objectives

Having quantified the importance of offshore financial centers in the international financial architecture, one question remains: how are OFCs integrated into the network of international banking positions?

To answer this question, a community detection method is applied on the graph representing the network of interbank positions (like in II.C, interbank positions are favored to increase the country sample). Intuitively, the banking systems of countries within a community interact more often and intensely with each other than with those of countries outside the community. Community detection serves to highlight these groups, taking into account all interactions between countries.

B. Results: essentially regional communities

Figure 6. Communities detected among the network of cross-border banking positions, 2015



Source: Bank for International Settlements, authors' calculations.

The four communities that appear (Figure 4) indicate a pronounced regional character for interbank relations. It can therefore be surmised that, despite their intangible nature, bank flows appear to be affected by the distance variable. These four communities are:

- the Americas and Oceania (hereinafter "America"): this community includes G20 countries such as the United States, Brazil, Argentina, Australia and Mexico;
- Europe, Africa, the Middle East and the countries of the Commonwealth of Independent States[33] ("Europe"): this area includes G20 members such as France, Germany, the United Kingdom, Saudi Arabia, South Africa, India, Russia and Turkey;
- the countries belonging to the ASEAN Plus Three (APT)[34] group and India ("South-East Asia"): this community includes three G20 countries: China, India and Indonesia;
- Scandinavia and the Baltic States (see the precision in Part II).

[33] The CIS is an intergovernmental organization comprising nine countries: Belarus, Russia (founding members), Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Moldova, Uzbekistan and Tajikistan. In addition, Turkmenistan is an associate member state and Mongolia has observer status. Georgia and Ukraine have withdrawn from the organization.

[34] ASEAN Plus Three is a forum which takes place during ASEAN summits. It includes the ASEAN countries as well as China, Japan and South Korea.

These communities seem to illustrate the prevalence of historic, commercial and geopolitical relations in relationships between banking systems. A recent analysis by the IMF further confirms this result.[35]

Some countries do not belong to the nearest geographical regions and thus stand out as exceptions. For example, Australia, Israel, and Egypt belong to the "America" community, which is not the case of Venezuela - although much closer geographically - which belongs to the "South-East Asia" community. These particular cases may be due to commercial links, an economy that is highly dependent on - or independent from - another power, or based on geopolitical rationales. For other countries, such as Togo, Botswana or Bangladesh, this may simply be the result of a lack of data and, therefore, insufficient information to link countries to a closer community (see data limitations for non-reporting countries in II.C).

As for OFCs, far from being a network on their own, they participate in this system of regionalization. The "America" community includes the Cayman Islands, Panama, Bermuda and the Bahamas; the "Europe" community includes Switzerland, Luxembourg, the Isle of Man, Jersey, Guernsey and Bahrain; and the "South-East Asia" community includes Singapore, Hong Kong and Macao.

Incorporation of OFCs into a particular community has been verified since 2003[36] (Table 12). As such, for the years under review (2003, 2007, 2011, 2015, Figures 7 to 9 in Appendix H), only Curacao and Bahrain changed communities (in 2011 and 2015 respectively). Moreover, the case of Curacao is particular: no pre-2011 data are available, as this country was created by the dissolution of the Federation of the Netherlands Antilles on 10 October 2010. The apparent change in community for Bahrain is due to the merging of the "Persian Gulf"[37] and "Europe" communities after 2007. The overall stability observed in OFCs illustrates their strong regional integration, which could corroborate the idea of enduring geographical specialization despite the increasing interconnection of banking systems.

Table 12. Community of affiliation of OFCs over time

	2003	2007	2011	2015
Bahrain	Persian Gulf	Persian Gulf	Europe	Europe
Bermuda	America	America	America	America
Bahamas	America	America	America	America
Switzerland	Europe	Europe	Europe	Europe
Curaçao			Europe	America
Guernsey	Europe	Europe	Europe	Europe
Hong Kong	South-East Asia	South-East Asia	South-East Asia	South-East Asia
Isle of Man	Europe	Europe	Europe	Europe
Jersey	Europe	Europe	Europe	Europe
Cayman Islands	America	America	America	America
Luxembourg	Europe	Europe	Europe	Europe
Macao	South-East Asia	South-East Asia	South-East Asia	South-East Asia
Singapore	South-East Asia	South-East Asia	South-East Asia	South-East Asia

Source: Bank for International Settlements, authors' calculations.

[35] Cerutti and Zhou, 2017. https://www.imf.org/en/Publications/WP/Issues/2017/11/07/The-Global-Banking-Network-in-the-Aftermath-of-the-Crisis-Is-There-Evidence-of-De-45342

[36] Table 10 includes a community of Persian Gulf countries (GP). This community is not shown as it only appears in the beginning of the period (2000-2008). This community, comprising Persian Gulf countries as well as India, Pakistan and Sudan merged with the "Europe" community as of 2007.

[37] Saudi Arabia is the principal member of the "Persian Gulf" community

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VII. Appendices

A. Descriptive elements of the public database

The purpose of our analysis is to study the geographical location of claims (and liabilities) for each of the reporting countries. To do so, we use the breakdown by counterpart country available in the public database.

In Q4 2016, the public database includes data for 48 countries, 29 of which break down their claims by counterpart country. On average, these 29 countries report their claims for 123 counterparty countries.

The quality of the open access database increases over time (as shown in the table below) both qualitatively and quantitatively. On the claims side, while in 2000, only 15 countries broke down their claims by counterpart country - with an average of 106 counterpart countries reported, 29 do so in 2016, with an average of 123 counterpart countries reported.

Table 13. Evolution of the number of reporting countries breaking down their banking positions by counterparty country, minimum, maximum and average of reported counterparty countries per year.

	Balance Sheet Position	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
# of countries that break down their banking position by counterparty country	Claims	15	18	20	23	23	24	24	26	26	27	27	27	27	27	29	29	29
Minimum	Claims	20	22	22	14	14	23	23	26	27	26	25	25	25	23	31	28	27
Mean	Claims	106	98	93	91	94	97	99	100	98	98	98	99	104	115	123	123	123
Maximum	Claims	178	180	178	179	184	185	183	184	188	185	188	187	187	200	203	201	197
# of countries that break down their banking position by counterparty country	Liabilities	15	18	20	23	23	24	24	26	26	27	27	27	27	27	29	29	29
Minimum	Liabilities	22	22	22	11	10	13	22	21	21	23	26	28	29	29	28	29	28
Mean	Liabilities	114	110	105	100	102	105	109	109	108	108	110	110	121	136	152	153	152
Maximum	Liabilities	191	198	197	202	199	202	201	205	202	202	205	205	207	209	209	209	210

Source: Bank for International Settlements, authors' calculations.

Note: In 2000, 15 reporting countries broke down their claims by counterparty country. These 15 countries provided an average of 106 counterpart countries, with a minimum of 20 counterparty countries and a maximum of 178.

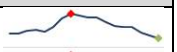
B. Stability analysis of the OFC list over the period 2000-2017 and comparison with the Zoromé list (2007)

To illustrate the stability of the list over the period 2000-2017, this annex provides detailed tables that specifically examine countries or jurisdictions that exceed the $0.1 million per capita threshold at least once over the period.

Note Tables 13a and 13b: The Cayman Islands has a banking asset-to-population ratio of 19.11 (column 2). Over the period 2000-2016, the Cayman Islands exceeded the ratio of 0.1 (column 3) 17 times (over 17 years). The average of their ratio over the period is 25.26 (column 4) with a minimum of 16.71 (column 5) and a maximum of 36.39 (column 6). The evolution of ratio over the period is plotted in column 7 with the maximum ratio in red and the minimum ratio in green.

Tables 14a and 14b. Cross-border banking claims and liabilities of the countries on the list of OFCs (millions of dollars)

Countries	2015 ratio	No of times the OFC threshold has been exceeded since 2000	Mean (2000-2017)	Min	Max	Profile 2000-2017
Cayman Islands	19,11	18/18	24,68	14,86	36,39	
Jersey	1,63	17/17	3	1,38	5,52	
Guernsey	2,29	17/17	2,69	1,87	4,02	
Luxembourg	1,08	18/18	1,47	0,96	2,22	
Bahamas	0,32	18/18	0,89	0,32	1,61	
Isle of Man	0,69	17/17	0,8	0,46	1,2	
Bermuda	0,2	16/16	0,17	0,13	0,22	
Bahrain	0,1	7/8	0,13	0,08	0,17	
Curaçao	0,17	17/17	0,12	0,46	1,2	
Switzerland	0,1	13/18	0,12	0,08	0,15	
Singapore	0,13	11/18	0,12	0,06	0,2	
Hong-Kong	0,17	11/18	0,12	0,06	0,2	
Ireland	0,07	10/18	0,12	0,04	0,23	
Macao	0,18	6/15	0,1	0,03	0,19	
United Kingdom	0,07	1/18	0,07	0,03	0,11	
Belgium	0,05	1/10	0,06	0,02	0,1	
Cyprus	0,02	1/18	0,05	0,03	0,11	

Countries	2015 ratio	No of times the OFC threshold has been exceeded since 2000	Mean (2000-2017)	Min	Max	Profile 2000-2017
Cayman Islands	19,3	18/18	24,48	14,20	36,06	
Jersey	1,08	17/17	2,09	0,92	3,71	
Guernsey	1,46	17/17	2,06	1,43	3,36	
Luxembourg	0,72	18/18	1,02	0,68	1,53	
Bahamas	0,3	18/18	0,90	0,30	1,60	
Isle of Man	0,54	17/17	0,58	0,32	0,88	
Bahrain	0,1	15/18	0,12	0,08	0,19	
Ireland	0,06	9/18	0,12	0,04	0,26	
Curaçao	0,17	7/8	0,11	0,07	0,17	
Singapore	0,12	14/18	0,11	0,08	0,14	
Switzerland	0,11	13/18	0,11	0,09	0,18	
Hong-Kong	0,14	6/18	0,08	0,04	0,16	
United Kingdom	0,07	1/18	0,07	0,03	0,10	
Macao	0,13	4/15	0,06	0,01	0,13	
Finland	0,06	1/18	0,04	0,00	0,10	

Source: Bank for International Settlements, authors' calculations.

On the assets side (respectively on the liabilities side), 17 (respectively 15) countries exceed the $0.1 million per capita threshold at least once. The countries on our OFC list are highlighted in red.
A typology emerges from these tables:

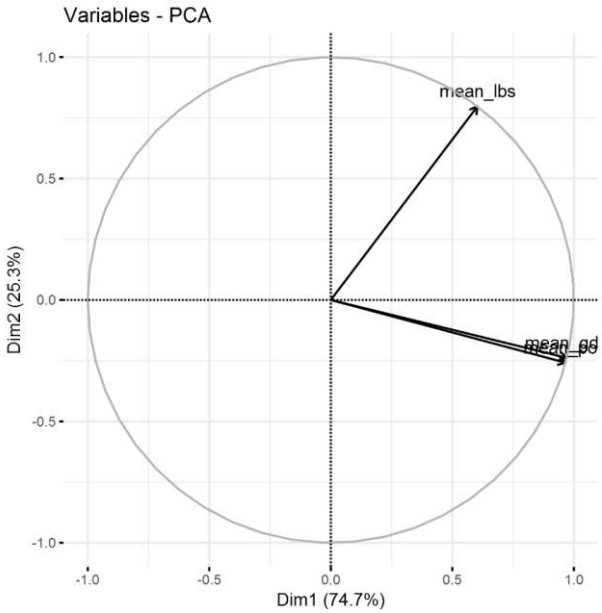
- The (4) countries exceeding the 0.1 threshold only once over the period 2000-2017: United Kingdom, Belgium, Cyprus and Finland. As these countries are not recurrent above the threshold of $0.1 million per capita, they are not intended to be included in our list;
- The (11) countries systematically or very regularly exceeding the threshold of $0.1 million per capita: Cayman Islands, Luxembourg, Bahamas, Guernsey, Jersey, Isle of Man, Bahrain, Singapore, Curacao, Switzerland and Singapore. These countries have a sufficiently regular profile to be included in our list;
- The (2) countries regularly exceeding the threshold without it being systematic: Macao and Ireland. In the former case, the continuous upward trend since 2003 (Profile 2000-2017 column) and the systematic exceeding of the threshold since 2012 on the assets side suggest that Macao should be included in the list of OFCs. In the latter case, the 2004-2013 points exceed systematically the threshold. Since then, Ireland has presented ratios below the 0.1 threshold with a sharply decreasing trend. For instance, in 2016, its ratios stand at 0.06 on the assets side and 0.05 on the liabilities side. These elements suggest that Ireland should not be included in the list of OFC.

In addition, it is noteworthy that the majority of countries reached their maximum ratios (claims or liabilities/population) in 2007, before the financial crisis burst out. This type of profile is consistent with the generalized contraction of cross-border banking positions. However, one group of countries is the exception: Asian OFCs (Macao, Hong Kong and Singapore) show little (or no) impact from the financial crisis, with ratios that remain high and/or growing. As a result, these countries reach their maximum ratios at the end of the period.

C. What additional information does the ratio of cross-border claims to GDP provide?

Figure 5 presents the results of the principal component analysis carried out on the ratios "population", "domestic positions" and "GDP". The projection of these variables on the first two axes (which represent 100% of the variance of the data) shows a very strong collinearity between the "population" ratio and the "GDP" ratio. It is thus possible to keep all the information by representing the "domestic positions" ratio with alternatively the "GDP" ratio or the "population" ratio.

Figure 4. Principal component analysis of the three ratios



Sources: Bank for International Settlements and World Bank, authors' calculations.

D. Extended OFC list: the case of interbank positions

The list presented in this document is based, for each of the 45 BIS filers, on the calculation of ratios reflecting the intensity of international banking activity.

Following the approach of Part III.c., i.e. restricting the analysis to interbank outstanding only, it is possible to extend this calculation to all counterparty countries included in the LBS database (214 countries). However, this measure entails several limitations:

- It de facto excludes important counterparty sectors such as the non-bank sector and households, which reduces the denominator of the ratio and, therefore, the ratio itself;
- It does not capture banking linkages between non-reporting countries, which systematically results in an underestimation of the denominator for non-reporting countries.

Nevertheless, as an indication, we present hereafter the list of countries for which the ratio of bank claims to population or bank liabilities to population exceeds, in 2015, the threshold of $0.1 million per capita.

Table 15. Mirror cross-border banking positions claims and liabilities as a proportion of population size (millions of dollars per capita)

				Reminder	
Countries		**Mirror claims / Population 2015**	**Mirror liabilities / Population 2015**	**Mirror claims / Population 2015**	**Mirror liabilities / Population 2015**
1	Cayman Islands	12,674	10,198	19,113	19,294
2	Jersey	1,513	0,539	1,625	1,076
3	Guernsey	1,214	0,990	2,281	1,452
4	Luxembourg	0,571	0,596	1,076	0,724
5	Isle of Man	0,511	0,116	0,652	0,509
6	Liechtenstein	0,270	0,142	\	\
7	Bahamas	0,240	0,222	0,319	0,3
8	Gibraltar	0,197	0,093	\	\
9	Macao	0,125	0,073	0,179	0,128
10	Barbados	0,101	0,068	\	\

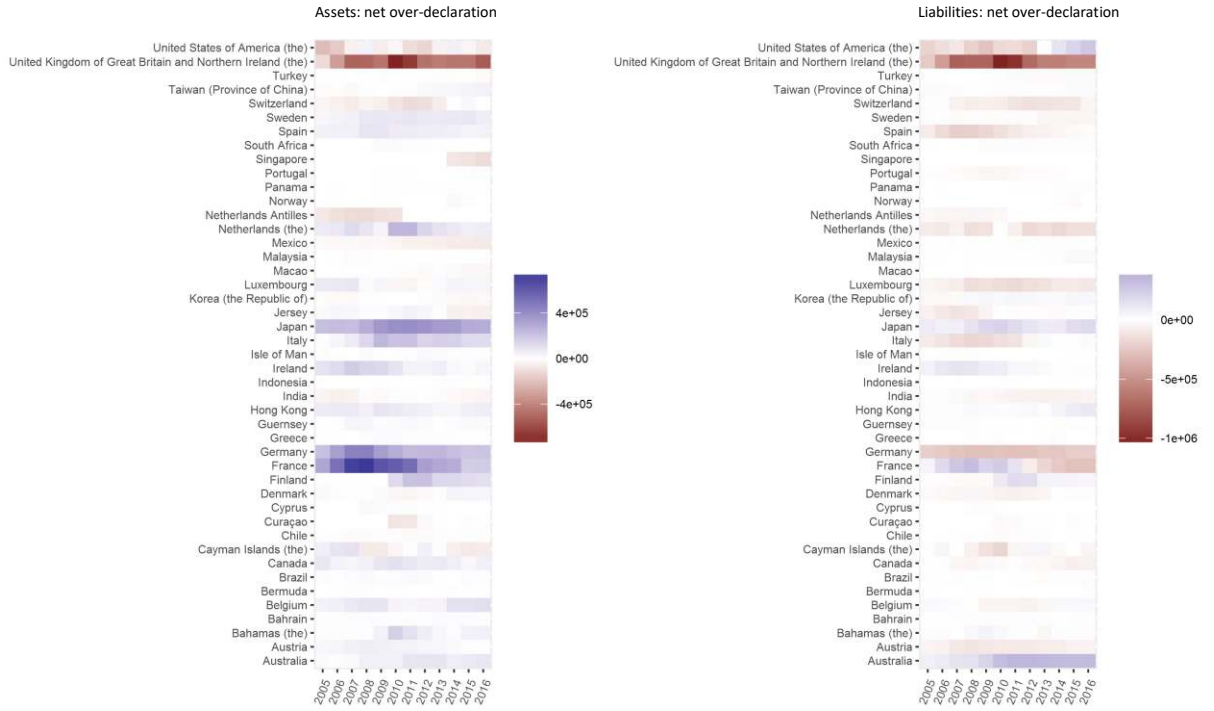
Source: Bank for International Settlements, authors' calculations.

Among this new list are seven of the thirteen CFOs identified in our list (highlighted in red). Three "new" OFCs have also joined the list: Liechtenstein, Gibraltar and Barbados. To enable us to measure the loss induced by the restriction to interbank exposures only, we recall the ratios obtained by our central methodology. The new ratios are 1.1 to 4.4 times lower than our original ratios (median at 1.5): interbank stocks therefore seem to constitute only 2/3 of the total bank stocks for these countries.

E. Preliminary analysis of the homogeneity of mirror data

A preliminary analysis was carried out on the homogeneity of the mirror data[38]. For each reporting country, we compare the sum of the claims they report (data that we will call "direct") with the sum of the liabilities recorded by the counterpart countries (mirror data). It appears that, overall, there is a high degree of homogeneity between direct and mirror data. The only noteworthy cases are the United Kingdom, whose direct claims are systematically lower than those reported by counterparty countries (symbolized by the ochre color in figures 7a and 7b); Japan, France and Germany, which report more assets than their counterparty countries report (in purple figures 7a and 7b). For France, this "relative over-declaration" is decreasing over time after reaching its peak in 2007-2008.

Figures 7a et 7b. Comparison of direct and mirror data by reporting country on claims and liabilities side



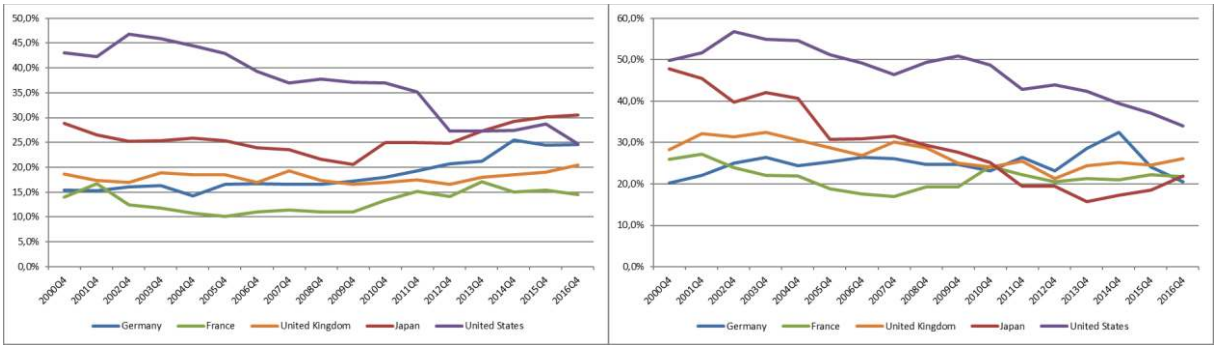
Source: Bank for International Settlements, authors' calculations.

Note: Reporting countries whose sum of declarations is lower (respectively higher) than those reported by the counterparty countries appear in ochre (respectively purple).

[38] This analysis will be the subject of a more detailed note.

F. Exposure of the largest international banking systems to OFCs: evolution of the extraterritoriality coefficient over the period 2000-2016, all counterparty sectors combined

Figures 16a et 16b. Extraterritoriality ratio of assets (left panel) and liabilities (right panel) held by the five largest banking systems



Source: Bank for International Settlements, authors' calculations

The extraterritoriality coefficients of the main international banking systems remain at high levels over the period 2000-2016. On the assets side, there is remarkable stability for three of the banking systems: the Japanese banking system, which has increased from 29% to 31%; the British banking system, from 19% to 20%; and the French banking system, from 14% to 15%, which also has the lowest extraterritoriality coefficient among these five banking systems. The coefficient of the German banking system increased from 15% to 25% over the period. Conversely, the United States banking system reduced its exposure to OFCs with a 43% coefficient in 2000 to 25% in 2016. However, this sharp decline should be qualified. Indeed, the scope of countries reported by the United States increases over time[39], suggesting that the extraterritoriality coefficients at the end of the period are closer to reality.

On the liabilities side, extraterritoriality coefficients decrease over time. This is partly due to their high levels of exposure in the early 2000s, with rates close to 50% for Germany and the United States. By 2016, these banking systems seem to be converging towards a coefficient of 20 to 25%. Only the United States remains at a higher level with 34% of its liabilities originating from an OFC.

[39] The United States expands its geographic reporting scope in Q1 2003, Q2 2006 and Q2 2012. This last expansion is the most significant with an increase in assets of more than $11 billion and more than $36 billion in liabilities. The French, German, Japanese and British banking systems do not experience such significant adjustments.

G. Louvain algorithm methodology

The graph of a network is composed of a set of vertices connected by edges.

The vertices, in this analysis, represent countries and can alternatively be a reporting country or a counterparty country.

The edges represent the bilateral banking positions between two countries and can be oriented or non-oriented.

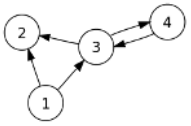


Figure 4a: example of an oriented graph

- The oriented edge is an arrow from country A to country B. It represents the value of the assets held by country A in country B. Therefore, a position on the liabilities side of a country A on a country B is understood as an arrow from country B to country A. If two edges represent the same position, for instance a claim vis-à-vis Germany reported by France and a liability vis-à-vis France reported by Germany, then the average of the two edges is used. This helps to neutralize any reporting problems, errors or omissions.

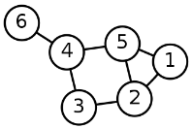


Figure 4b: example of a non-oriented graph

- The non-oriented edge between two countries is the sum of the edges oriented between these two countries.

The Louvain method (Blondel et al., 2006) allows to detect communities in large graphs. The method is based on optimizing modularity (Newman & Girvan, 2004a; Newman 2004b) which is a measure of a network structure that enables to quantify the proper segmentation of the network into different communities.

Intuitive explanation

Intuitively, there is a community if the fraction of edges that fall in this community is much higher than the fraction of edges expected if they were randomly distributed (while controlling the degree of each vertex). The figure on the right shows an example of a proper segmentation into communities: there are many links between summits within the same community, and a smaller number of links between communities.

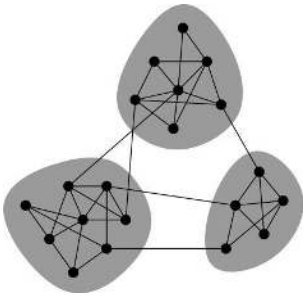


Figure 5: example of detected communities

Mathematical definition of modularity with two groups in and an unweighted graph

Modularity is the sum for all groups of the fractions of the edges falling within a given group minus the expected fraction if the edges were randomly arranged in a graph with the same degree distribution as the graph in question. Modularity can be written as:

$$Q = \frac{1}{2m}\sum_{vw}\left[A_{vw} - \frac{k_v k_w}{2m}\right]\delta(c_v, c_w)$$

With A_{vw} a dummy variable equal to 1 if an edge links two vertices v et w and 0 otherwise, $\delta(c_v, c_w)$ equal to 1 if the vertices v et w belong to the same community and 0 if not, m the number of edges in the graph, k_v the degree of the vertex v et c_v he community to which the vertex v belongs.

The term $\left[A_{vw} - \frac{k_v k_w}{2m}\right]$ is therefore the difference between the dummy of the existence of an edge between the vertices v et w and the number of edges expected if the edges were randomly distributed (the quantity $\frac{k_v k_w}{2m}$) while preserving the degree of the vertices. Controlling by the degree of the vertices

allows taking into account the fact that two nodes with high degrees are more likely to be connected to each other than if they both had a low degree. Thus, suppose that an edge exists between two vertices v and w then the contribution to modularity is all the more important when these two vertices have a low degree (or when one of them has a low degree). This is because two summits with few connections in the network are unlikely to be connected to each other; if they are, it indicates that they have a particular affiliation and thus belong to the same community.

The modularity Q is the sum of this difference for all vertex pairs belonging to a community, normalized by $2m$ to obtain a fraction.

The algorithm seeks the community segmentation (i.e. the vector **c** of component c_v) that maximizes modularity. The modularity has values between - 0.5 and 1, and the closer the value is to 1, the better the separation into different communities.

H. Tables

Table 2. Cross-border banking positions of the countries on the list of OFCs (millions of dollars)

Country	Asset positions	% of total	Cumulative %	Liability positions	% of total	Cumulative %
Hong Kong	1 351 454	26,37%	26,37%	1 070 416	23,57%	23,57%
Cayman Islands	1 015 623	19,82%	46,20%	985 470	21,70%	45,26%
Switzerland	783 523	15,29%	61,49%	875 188	19,27%	64,53%
Singapore	693 431	13,53%	75,02%	663 894	14,62%	79,15%
Luxembourg	557 645	10,88%	85,90%	393 963	8,67%	87,82%
Jersey	144 264	2,82%	88,72%	95 682	2,11%	89,93%
Guernsey	140 866	2,75%	91,47%	88 804	1,96%	91,89%
Bahrain	130 177	2,54%	94,01%	130 683	2,88%	94,76%
Bahamas	123 958	2,42%	96,43%	116 478	2,56%	97,33%
Macao	102 972	2,01%	98,44%	62 334	1,37%	98,70%
Isle of Man	49 954	0,97%	99,41%	39 353	0,87%	99,57%
Curaçao	17 191	0,34%	99,75%	16 203	0,36%	99,92%
Bermuda	12 950	0,25%	100,00%	3 472	0,08%	100,00%
Total	**5 181 449**	**100%**		**4 592 546**	**100%**	

Source: Bank for International Settlements, authors' calculations.

Table 4. Cross-border banking positions as a ratio of population size (millions of dollars per capita)

Country		Asset positions / Population		Liability positions / Population	
		2015	2007-2015	2015	2007-2015
1	Cayman Islands	19,113	28,105	19,294	28,434
2	Guernsey	2,281	3,093	1,452	2,326
3	Jersey	1,625	3,089	1,076	1,975
4	Luxembourg	1,076	1,580	0,724	1,094
5	Isle of Man	0,652	0,862	0,509	0,646
6	Bahamas	0,319	1,019	0,300	1,032
7	Bermuda	0,203	0,180	0,042	0,051
8	Macao	0,179	0,106	0,128	0,067
9	Hong Kong	0,172	0,136	0,137	0,099
10	Curacao	0,171	0,127	0,166	0,123
11	Singapore	0,129	0,133	0,123	0,128
12	Switzerland	0,102	0,121	0,109	0,118
13	Bahrain	0,100	0,133	0,100	0,130
14	United Kingdom	0,070	0,084	0,070	0,078
15	Ireland	0,068	0,145	0,061	0,140
16	Netherlands	0,064	0,065	0,054	0,059
17	Belgium	0,050	0,071	0,041	0,057
18	Finland	0,049	0,049	0,064	0,060
19	Sweden	0,041	0,042	0,023	0,027
20	Denmark	0,039	0,037	0,031	0,038
21	France	0,031	0,038	0,031	0,036
22	Austria	0,030	0,047	0,020	0,031
23	Norway	0,030	0,028	0,038	0,041
24	Germany	0,025	0,034	0,019	0,018
25	Japan	0,025	0,023	0,010	0,009
26	Cyprus	0,023	0,062	0,026	0,056
27	Australia	0,018	0,014	0,030	0,028
28	Panama	0,015	0,012	0,013	0,010
29	Canada	0,014	0,013	0,012	0,010
30	Greece	0,010	0,013	0,002	0,008
31	Spain	0,009	0,011	0,007	0,012
32	United States	0,008	0,010	0,010	0,011
33	Italia	0,007	0,010	0,008	0,011
34	Portugal	0,007	0,012	0,007	0,014
35	Korea (Republic of)	0,004	0,003	0,005	0,004
36	Malaysia	0,002	0,002	0,003	0,002
37	Russia	0,002	0,002	0,001	0,001
38	Chile	0,001	0,001	0,002	0,001
39	South Africa	0,001	0,001	0,001	0,001
40	China	0,001	0,001	0,001	0,001
41	Brazil	0,000	0,000	0,001	0,001
42	Turkey	0,000	0,000	0,002	0,001
43	Mexico	0,000	0,000	0,000	0,000
44	Indonesia	0,000	0,000	0,000	0,000
45	India	0,000	0,000	0,000	0,000

Sources: Bank for International Settlements and World Bank, authors' calculations.

Table 5. Cross-border banking positions as a ratio of domestic banking positions

Country		(Cross-border claims and liabilities) / (Domestic claims and liabilities)	
		2016	2012-2016
1	Panama	47,85	69,04
2	Cayman Islands	26,10	31,05
3	Curaçao	25,03	28,41
4	Jersey	13,25	14,49
5	Bahamas	8,55	14,21
6	Guernsey	4,74	4,70
7	Isle of Man	3,82	3,42
8	Bahrain	2,36	2,66
9	Singapore	2,02	2,20
10	Luxembourg	1,88	2,30
11	Finland	0,92	1,19
12	Macao	0,92	1,09
13	Bermuda	0,86	1,03
14	Hong Kong	0,85	0,86
15	Ireland	0,83	0,85
16	Netherlands	0,79	0,74
17	United Kingdom	0,78	0,71
18	Belgium	0,78	0,78
19	Switzerland	0,65	0,72
20	Norway	0,52	0,61
21	France	0,44	0,42
22	Cyprus	0,42	0,54
23	Austria	0,40	0,39
24	Sweden	0,39	0,42
25	Turkey	0,39	0,40
26	Denmark	0,34	0,33
27	Germany	0,34	0,33
28	Canada	0,30	0,29
29	Greece	0,26	0,28
30	Australia	0,25	0,24
31	Taiwan	0,19	0,19
32	Portugal	0,19	0,20
33	Spain	0,19	0,18
34	Malaysia	0,19	0,17
35	Russia	0,17	0,19
36	Korea (Republic of)	0,14	0,13
37	Japan	0,13	0,13
38	South Africa	0,13	0,14
39	Chile	0,08	0,09
40	Indonesia	0,07	0,06
41	Mexico	0,06	0,06
42	India	0,06	0,06
43	Brazil	0,05	0,06

Sources: Bank for International Settlements and World Bank, authors' calculations.

Note table 6: among all cross-border claims that Brazilian banks hold vis-à-vis the rest of the world, 65.7% are held vis-à-vis resident agents in an OFC according to our OFC list and, among all cross-border liabilities that US banks receive from the rest of the world, 34.5% are held vis-à-vis resident agents in an OFC.

Table 6. Extraterritoriality coefficient by country, claims and liabilities sides (2016-Q4)

Country	Claims	Liabilities	Ratio C/L
Brazil	65.7%	27.2%	241%
Greece	39.9%	5.5%	730%
Taiwan	34.3%	52.1%	66%
Japan	30.5%	21.9%	139%
United States	24.8%	34.0%	73%
Germany	24.6%	20.5%	120%
United Kingdom	20.4%	26.0%	78%
Korea (Republic of)	16.8%	31.6%	53%
Canada	16.1%	4.7%	340%
Australia	15.2%	14.3%	106%
South Africa	14.9%	19.5%	76%
France	14.5%	21.8%	67%
Netherlands	13.9%	12.3%	113%
Belgium	9.8%	15.5%	63%
Denmark	7.8%	8.8%	89%
Ireland	7.2%	10.4%	69%
Sweden	7.1%	7.7%	92%
Austria	6.9%	9.3%	74%
Spain	4.6%	4.3%	106%
Chile	3.4%	10.4%	32%
Finland	2.8%	1.6%	178%
Mexico	1.0%	1.4%	74%

Source: Bank for International Settlements, authors' calculations.

Figure 7. Communities detected among the network of cross-border banking positions, 2005 – Exposures restricted to observations available from 2005 onwards

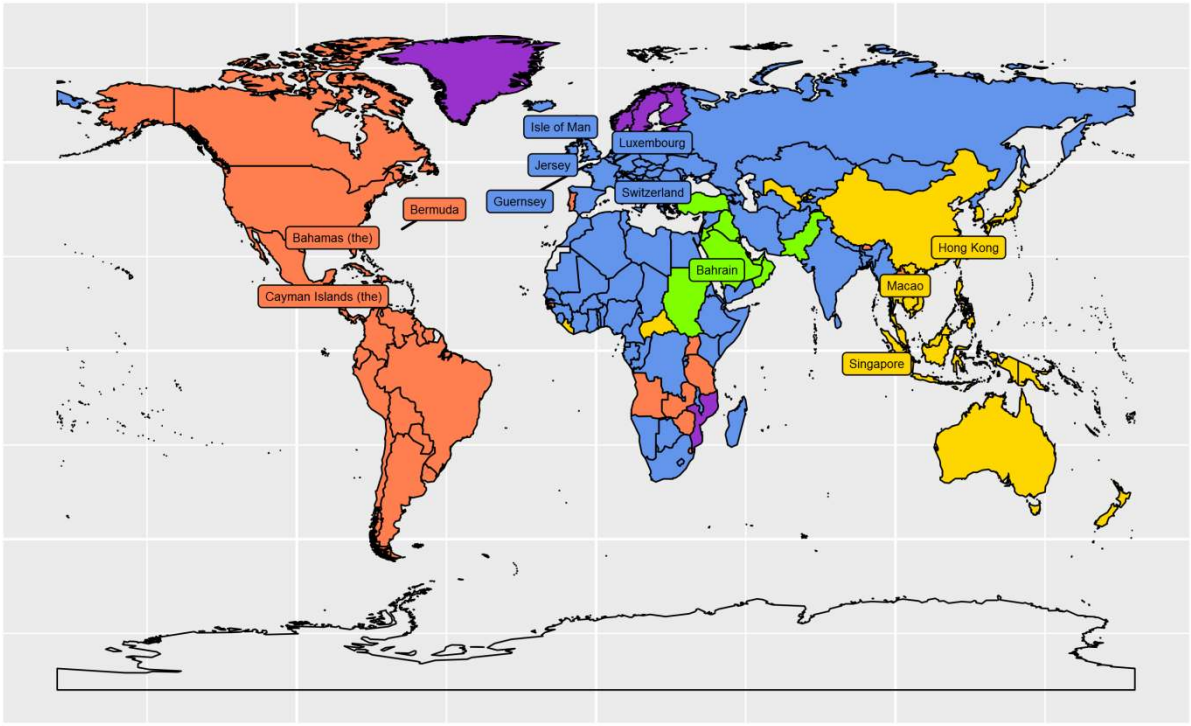


Figure 8. Communities detected among the network of cross-border banking positions, 2007 - Exposures restricted to observations available from 2005 onwards

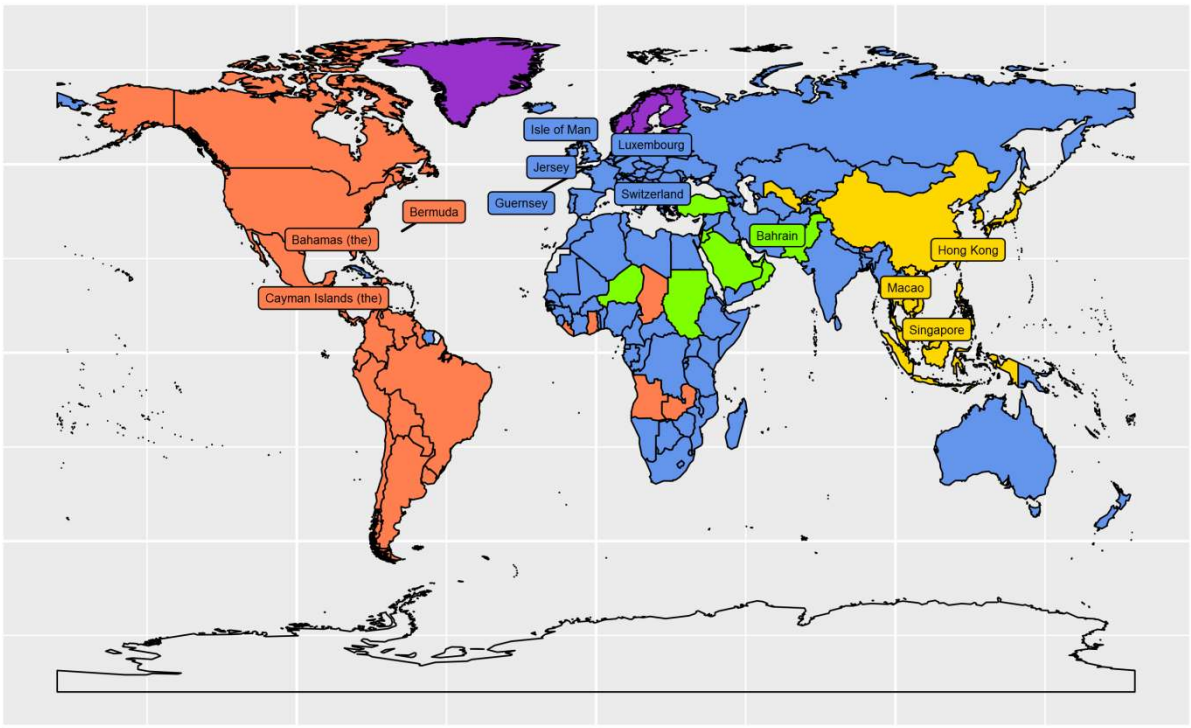
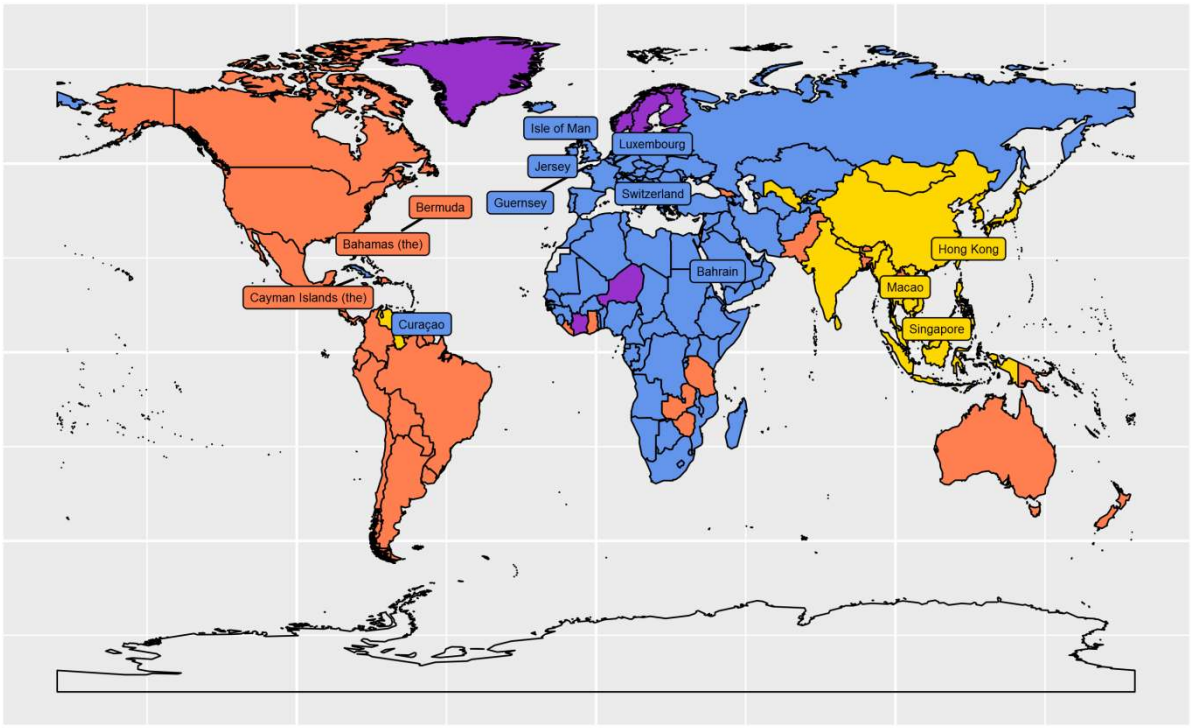


Figure 9. Communities detected among the network of cross-border banking positions, 2011 - Exposures restricted to observations available from 2005 onwards



Source: Bank for International Settlements, authors' calculations.

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