Risk-based analysis of Illicit Financial Flows

Methodology and Instructions

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1 Introduction

Illicit Financial Flows (IFFs) are flows that are deliberately hidden, either to obscure the illicit origin of capital, and/or the illicit nature of the transactions undertaken. As such, they do not lend themselves easily to measurement or quantification. Given that secrecy is an enabling condition for IFFs to occur, an alternative approach is to analyze the degree to which countries are exposed to IFFs through their cross-border transactions with more or less secretive partners.

The more secretive a partner is, the more vulnerable to IFFs is the country that does a lot of business with it. And the more important that economic flow/stock is to the country's GDP, the more exposed it is to IFFs. For a particular flow or stock, a country's vulnerability to IFF is defined as the sum of secrecy-weighted flows as a share of total flows with all partners. The intensity of that flow or stock is then the sum of those flows/stocks as a share of a country's GDP. Therefore, a country's exposure to IFFs in a particular flow or stock is its vulnerability to IFFs multiplied by the intensity of that flow or stock.

This data-set presents a global set of results of vulnerability, intensity, and exposure to IFFs for a range of economic and financial flows and stocks. It includes cross-border transactions for 246 jurisdictions on banking positions, direct investment positions, portfolio investment holdings, and trade.

There are two types of results, depending on how secrecy has been measured. The first set of results uses the overall Secrecy Score of the Financial Secrecy Index. The second set of results uses individual Key Financial Secrecy Indicators (KFSIs) of the Financial Secrecy Index in order to zoom in on the consequences of different types of secrecy.

2 Methods

2.1 Formalization

Define the following:

$i \in \{1, \ldots, I\}$	reporting country
$j \in \{1, \ldots, J\}$	partner country
$t \in \{2008, \ldots, 2018\}$	year
X_{ijt}	flow or stock value of cross-border transaction between reporter i and partner j at time t
Y_{it}	GDP of reporting country i at time t
SS_j	Secrecy Score (or individual KFSI) of partner country j

For jurisdiction-level scores:

Vulnerability

$$V_{it} = \frac{\sum_{j=1}^{J} X_{ijt} \cdot SS_j}{\sum_{j=1}^{J} X_{ijt}}$$

Intensity

$$I_{it} = \frac{\sum_{j=1}^{J} X_{ijt}}{Y_{it}}$$

Exposure

$$\begin{aligned} E_{it} &= V_{it} \cdot I_{it} \\ &= \frac{\sum_{j=1}^{J} X_{ijt} \cdot SS_j}{\cancel{\sum_{j=1}^{J} X_{ijt}}} \cdot \frac{\cancel{\sum_{j=1}^{J} X_{ijt}}}{Y_{it}} \\ &= \frac{\sum_{j=1}^{J} X_{ijt} \cdot SS_j}{Y_{it}} \end{aligned}$$

For country group averages $\{g \mid i \in \mathcal{G}\}$, where $\mathcal{G}$ is the set of geographic regions as classified by the UN (Africa, Americas, Asia, Europe, and Oceania), or the set of income groups as classified by the World Bank (Low Income Countries, Lower-Middle Income Countries, Upper-Middle Income Countries, High Income Countries):

Vulnerability

$$V_{gt} = \frac{\sum_{i\in\mathcal{G}}^{I}\sum_{j=1}^{J} X_{ijt} \cdot SS_j}{\sum_{i\in\mathcal{G}}^{I}\sum_{j=1}^{J} X_{ijt}}$$

Intensity

$$I_{gt} = \frac{\sum_{i\in\mathcal{G}}^{I}\sum_{j=1}^{J} X_{ijt}}{\sum_{i\in\mathcal{G}}^{I} Y_{it}}$$

Exposure

$$\begin{aligned} E_{gt} &= V_{gt} \cdot I_{gt} \\ &= \frac{\sum_{i\in\mathcal{G}}^{I}\sum_{j=1}^{J} X_{ijt} \cdot SS_j}{\cancel{\sum_{i\in\mathcal{G}}^{I}\sum_{j=1}^{J} X_{ijt}}} \cdot \frac{\cancel{\sum_{i\in\mathcal{G}}^{I}\sum_{j=1}^{J} X_{ijt}}}{\sum_{i\in\mathcal{G}}^{I} Y_{it}} \\ &= \frac{\sum_{i\in\mathcal{G}}^{I}\sum_{j=1}^{J} X_{ijt} \cdot SS_j}{\sum_{i\in\mathcal{G}}^{I} Y_{it}} \end{aligned}$$

2.2 Worked example

For illustration purposes, consider the simple example of a world where there is only one reporting country, Zambia, that transacts with a single partner country, and let us focus on a single flow: exports. Imagine that the country that Zambia exports to has a Secrecy Score of 50. Thus, Zambia's vulnerability to IFFs in that particular flow is 50. Moreover, imagine that exports represent 10% of Zambia's GDP. Therefore, Zambia has an Exposure score of 5. In other words, 5% of Zambia's GDP is exposed to IFFs.

The exposure score represents Zambia's pure secrecy-equivalent economic activity as a ratio to its GDP. An exposure score of 5 is equivalent to Zambia carrying out 5% of its exports with a pure secrecy jurisdiction (i.e. one scoring 100 out of 100), and all other exports with completely transparent trading partners.

3 Data

3.1 Banking Positions

Data on banking positions come from table A6.2 of the Locational Banking Statistics (LBS) data-set of the Bank for International Settlements (BIS). I obtain data on cross-border claims and liabilities of reporters resident in the partner country, measured as amounts outstanding/stocks, for all sectors and all instruments, in US dollars. There are 57,064 unique recorded positions between 2008-2018 for 31 reporting countries and 215 partner countries. The data coverage of liabilities is better than the coverage of claims.

3.2 Direct Investment

Data on direct investment positions come from the Coordinated Direct Investment Survey (CDIS) of the International Monetary Fund (IMF). These data represent direct investment positions, and are thus stocks. I obtain data on inward direct investment positions into the reporting country, and outward direct investment abroad by the reporting country. Additionally, data is obtained on derived inward positions and derived outward positions, where these data are calculated based on mirror data from the partner country. There are 97,432 unique recorded cross-border positions between 2008 and 2016 for 246 reporting jurisdictions and 246 partner jurisdictions. The data coverage for inward direct investment positions and derived outward direct investment

positions is better than the coverage for derived inward and outward direct investment. Thus, this analysis uses the variables with the better coverage (inward and derived outward).

3.3 Portfolio Investment

Data on portfolio investment holdings come from Coordinated Portfolio Investment Survey (CPIS) of the IMF. I obtain data on holdings of portfolio assets (securities held) by the reporting economy, and holdings of portfolio investment liabilities (securities issued) by the reporting economy. Data is also obtained on derived portfolio investment liabilities (securities issued by the reporting economy), where the data is derived from the perspective of the partner country (the holder of the securities). There are 79,804 unique recorded transactions between 2008 and 2016 for 240 reporting economies and 241 partner economies. The data coverage is better for derived liabilities than liabilities. Thus, this analysis makes use of the data on portfolio investment assets and derived portfolio investment liabilities.

3.4 Trade

Data on trade comes from the Comtrade database of the United Nations (UN). I obtain data on total exports, total imports, total re-exports, and total re-imports between 2009-2017, measured in the HS 2007 classification. There are 230,373 unique recorded cross-border flows between 176 reporting jurisdictions and 237 partner jurisdictions. The analysis uses data on total exports and total imports. The data coverage is better for imports than for exports.

3.5 Financial Secrecy

Data on financial secrecy comes from the 2018 edition of the Financial Secrecy Index (FSI) of the Tax Justice Network. The FSI calculates an overall Secrecy Score and individual Key Financial Secrecy Indicators (KFSIs) for 112 jurisdictions.

For the analysis that uses individual KFSIs, the following indicators are used:

- KFSI 1: Banking Secrecy
- KFSI 18: Automatic Exchange of Information
- Average of KFSI 3 (Company Ownership Registration) and KFSI 6 (Company Ownership Publication) to obtain a composite secrecy measure on Company Ownership

The theoretical range of the overall Secrecy Score is 0-100 in the FSI. The individual KFSIs range from 0 to 1, so they are multiplied by 100 before being used in the analysis.

In practice, the lowest overall Secrecy Score is 41.825 (Slovenia) and the highest overall Secrecy Score is 88.575 (Vanuatu).

This analysis applies the 2018 secrecy indicators to all of the cross-border transactions across all years. It would be preferable to use previous editions of the FSI for the other years in the panel.

3.6 Gross Domestic Product

Data on countries' GDP comes from the World Development Indicators (WDI) of the World Bank, specifically indicator NY.GDP.MKTP.CD. Data is obtained on the GDP (in current US dollars) of 205 countries between 2008 and 2017.

3.7 Codebook and naming of variables

Please refer to the Codebook for more detailed information on the variables used in the analysis.

Given the scope of the work, many variables are used in the analysis. The naming convention of the variables is detailed in the following table.

Resolution		Weight		Measure		Secrecy		Flow/Stock	
`(omitted)`	Value at year t	`(omitted)`	Jurisdiction-level	`(omitted)`	Value of flow/stock	`(omitted)`	Calculated using Overall Secrecy Score	`Claims`	Banking Claims
`x`	Value averaged across years	`wr`	Region-level	`V`	Vulnerability	`1`	Calculated using KFSI 1	`Liabilities`	Banking Liabilities
		`wi`	Income group-level	`I`	Intensity	`18`	Calculated using KFSI 18	`DII`	Direct Investment Inward
				`E`	Exposure	`3.6`	Calculated using average of KFSIs 3 and 6	`DIdI`	Direct Investment Inward (derived)
								`DIO`	Direct Investment Outward
								`DIdO`	Direct Investment Outward (derived)
								`PIA`	Portfolio Investment Assets
								`PIL`	Portfolio Investment Liabilities
								`PIdL`	Portfolio Investment Liabilities (derived)
								`Export`	Exports
								`Import`	Imports
								`Banking`	Average of measure of Claims and Liabilities
								`DirectInv`	Average of measure of DII and DIdO
								`PortInv`	Average of measure of PIA and PIdL
								`Trade`	Average of measure of Export and Import

Table 1: Naming convention of variables

4 Results

4.1 Organization of figures

The analysis has generated 3,915 figures: 3,513 for the results that use the overall Secrecy Score, and 402 for the results that use the individual KFSIs. These figures are located in the Figures folder.

The organization of the figures for both types of results is detailed in the diagrams below. Jurisdiction-level figures provide the unweighted measures of vulnerability, intensity, and exposure, for each of the various flows/stocks in the analysis, for each jurisdiction in the panel. Since the number of reporting jurisdictions is large, the figures are broken up either by region or by income group. In addition, the folder Conduits contains figures of the jurisdictions whose score is higher than the 90th percentile of that particular measure and particular flow/stock. The script file allows the possibility to run the analysis at different cut-off levels (e.g. 75th percentile, 99th percentile, etc) by changing the variable `choose.cut`.

The folders Country risk figures provide an overview of the vulnerability, intensity, and exposure for all of the flows/stocks for each of the 246 countries in the analysis.

The folders Regional scores and Income group scores contain the country group averages, weighted according to geographic region and income group classification, respectively.

The folders Scores over time include time series graphs of how the vulnerability, intensity, and exposure measures have changed between 2008 and 2018.

The folders Yearly snapshots provide graphs of the measures at a particular point in time, in this case 2015. The script can be re-run by modifying the `choose.year` variable to any year between 2008-2018. This will then generate an additional set of 156 figures that will be saved in the Yearly snapshots folder.

Unless they are contained in a Yearly snapshots or Scores over time folder, the figures depict the average of the scores between 2008 and 2018. These are variables prefixed by `x` as set out in table 1.

The circled numbers denote the amount of figures contained in each folder. These are full-page, publication-quality graphics. Please refer to the file Catalogue of figures for a convenient way to see all of the available figures at once (apart from the yearly snapshots). The Catalogue of figures provides smaller versions of the figures. It allows users to flip through the catalogue to gain a bird's eye view of the main results, and to subsequently choose the types of figures to be included in publications. Once a figure is chosen by the user, they can navigate to the appropriate folder to select the high-resolution version of the image. The naming convention set out in the previous page, and the file directory diagrams below, should assist in easily locating the chosen figure.

The publication-quality graphics are PDF files. The script can easily be re-run to generate JPEG or PNG images. Moreover, since the Catalogue of figures is generated using LaTeX, and the figures are generated automatically by the script, one can easily modify the scripts (e.g. choose to use outward direct investment rather than the derived variable) and visualize how the results change by re-compiling the LaTeX file and looking at the Catalogue of figures.

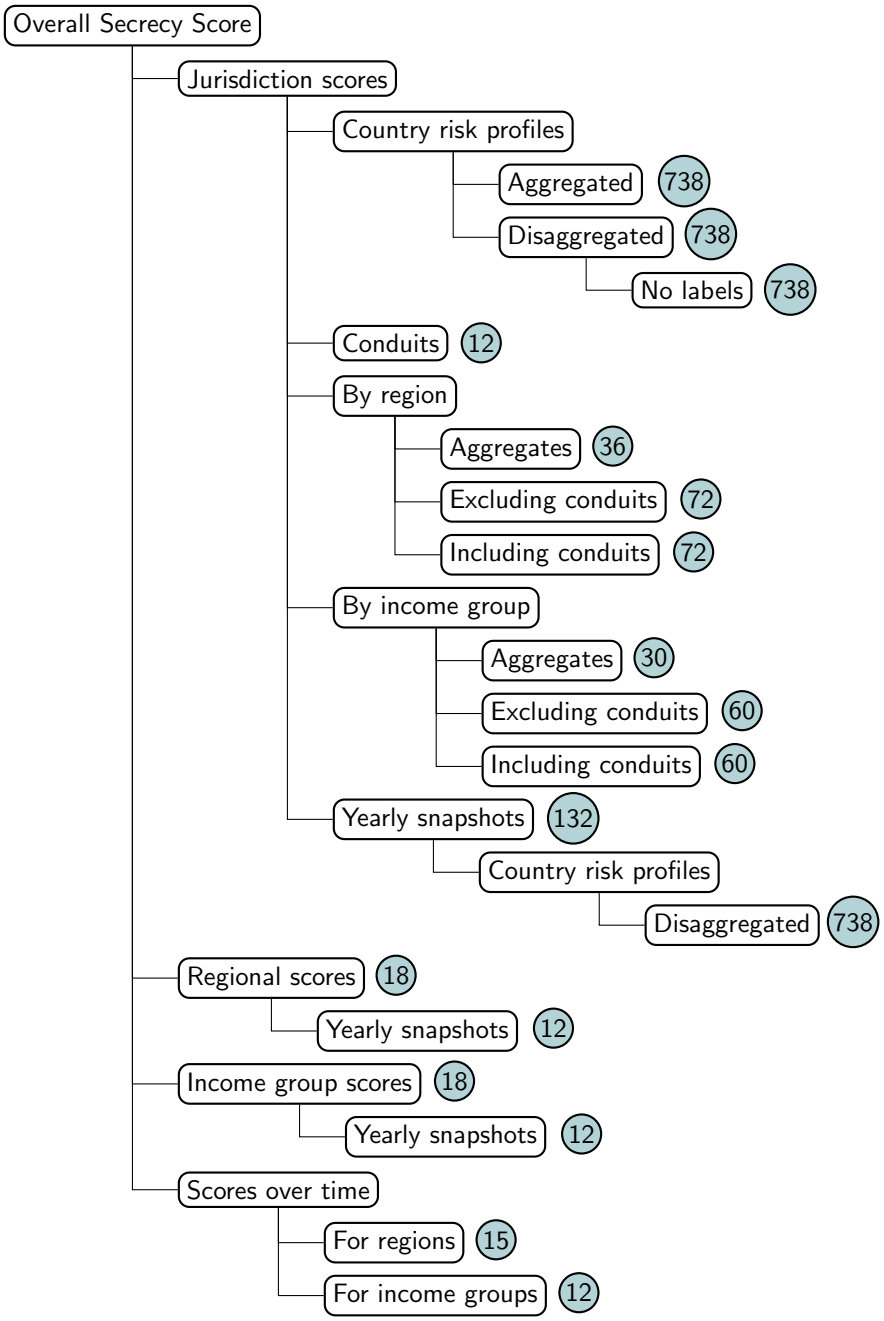


Figure 1: Directory list of figures for overall Secrecy Score

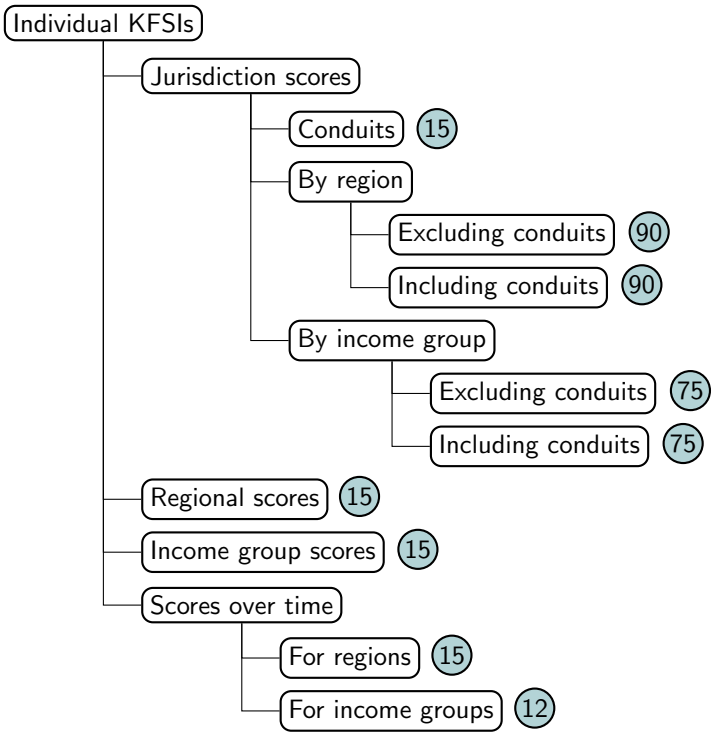


Figure 2: Directory list of figures for individual KFSIs

4.2 Organization of data-sets

The analysis has generated a variety of data tables with results that are located in the Results folder. The contents of that directory are listed in figure 3 below.

The folder Summary statistics contains histograms of all of the vulnerability, intensity, and exposure scores for jurisdictions, regions, and income groups. It also contains text files with the quartiles and range of the variables. Once more, these variables follow the naming convention of table 1.

The suffixes _Secrecy Score and _KFSI refer to whether the results have been calculated using the overall Secrecy Score, or using individual KFSIs, respectively.

The files panelSJ_ contain the entire (clean) panel of cross-border transactions for every reporter, every partner, and every year, in addition to the calculated measures. That means there is more than one observation per reporter per year. The variable `id` contains the unique identifier for each reporter-partner-year combination. These are the largest files ($\approx$ 320 MB) in the folder. It is recommended to open these in R. The RData format of these files can be found in the folder Data.

The files Results_ contain the results only: the vulnerability, intensity, and exposure measures for each jurisdiction, region, and income group, in every year. Since they do not contain the bilateral transaction-level data, there is only one observation per reporter per year, and the files are consequently much smaller.

The files VIE averages_ contain the average measures of vulnerability, intensity, and exposure for each flow/stock across the years. That is, they contain the types of variables prefixed by `x`.

The files VIE time series_ contain the country group average vulnerability, intensity, and exposure scores across all years, for regions and income groups.

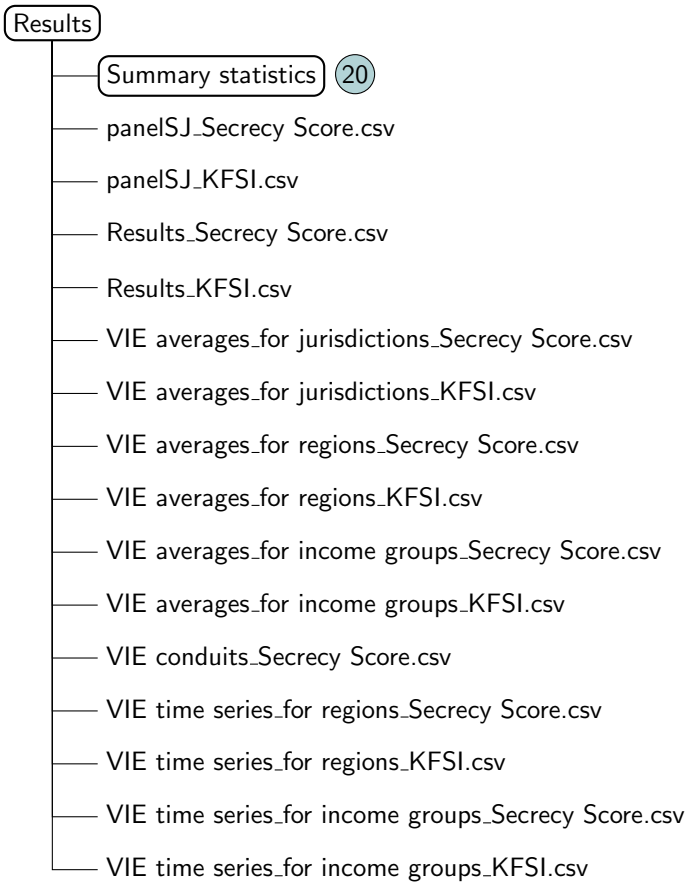


Figure 3: Directory list of results

5 Workflow and scripts

The workflow that generated those results is entirely replicable using the scripts found in the Scripts folder, and listed in figure 4. These scripts are also available under Version Control on BitBucket. They have not been made publicly available (yet).

The workflow can be broken down in three main components:

1. Prepare the data
2. Run the analysis
3. Create interactive data visualizations

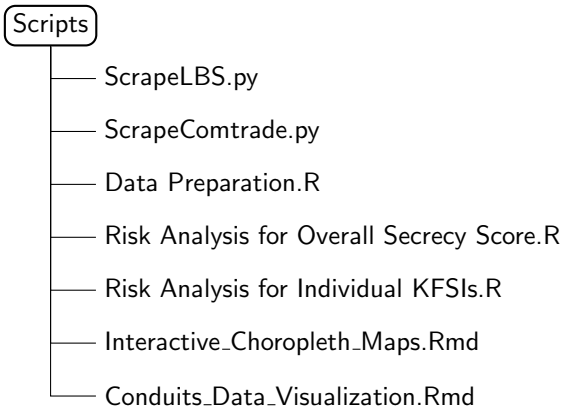


Figure 4: Directory list of scripts

5.1 Prepare the data

All clean data-sets can be found in the folder Data as RData files with the suffix _clean.RData.

The raw data-sets for the Coordinated Direct Investment Survey, the Coordinated Portfolio Investment Survey, the Financial Secrecy Index, and the World Development Indicators were downloaded as Excel or csv files directly from the relevant websites.

The data for the Locational Banking Statistics and Comtrade, however, had to be scraped from their respective websites. The Python scripts ScrapeLBS.py and ScrapeComtrade.py will accomplish this, respectively. Please note that the Comtrade scraping code must be run in batches, as Comtrade limits the API usage to 100 requests per hour (or else you will get kicked off by the server).

Once these preliminary scraping scripts are run, the user can then run the R file Data Preparation.R.

5.2 Run the analysis

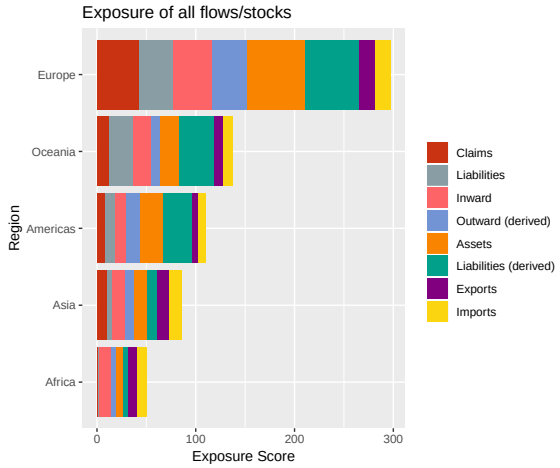
Once the data has been prepared, the script files Risk Analysis for Overall Secrecy Score.R and Risk Analysis for Individual KFSIs.R can be run to generate both types of results. These script files also generate the static figures described in section 4.1.

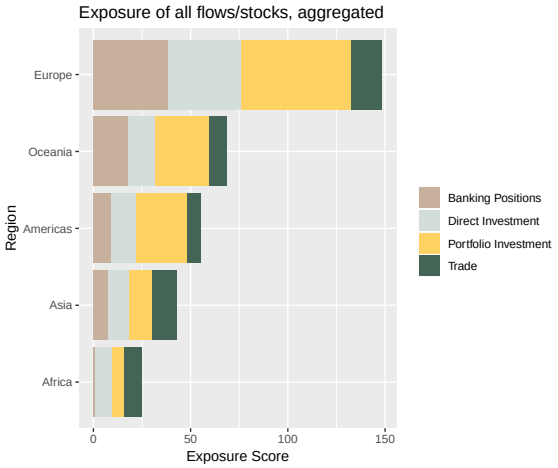
5.3 Create interactive data visualizations

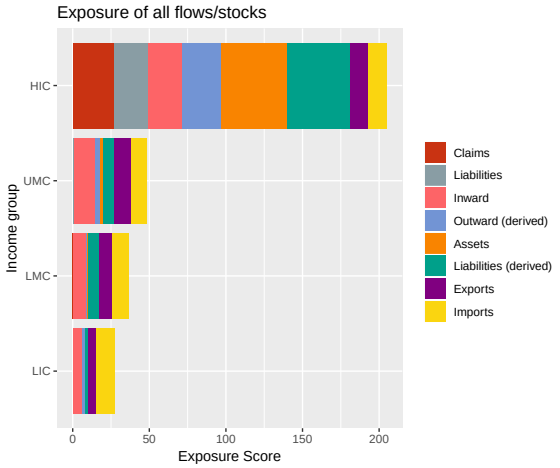
Finally, once the analysis has been run and the publication-quality figures have been generated, two additional scripts are available to create interactive data visualizations. The scripts Interactive_Choropleth_Maps.Rmd and Conduits_Data_Visualization.Rmd will generate HTML documents that can be opened in a browser. These files display various maps and figures that can be interacted with by the user, such as adding or removing layers, and hovering to reveal additional information.

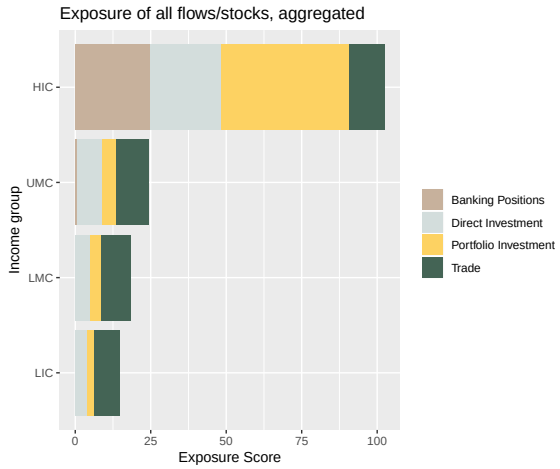
6 Selected figures

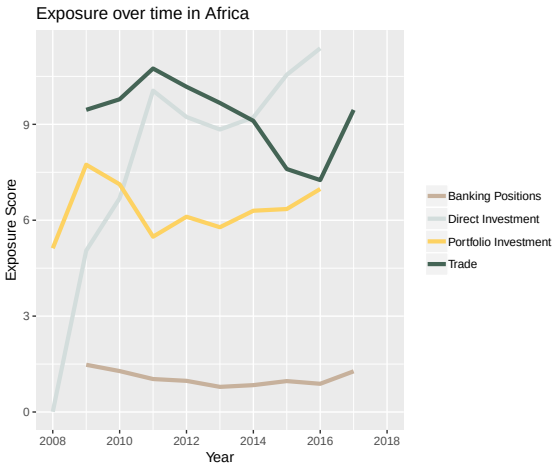
The pages below display some of the main results. Please refer to the Catalogue of figures for the full set of figures. For publication-quality graphics, please navigate to the appropriate folder listed in the directory.

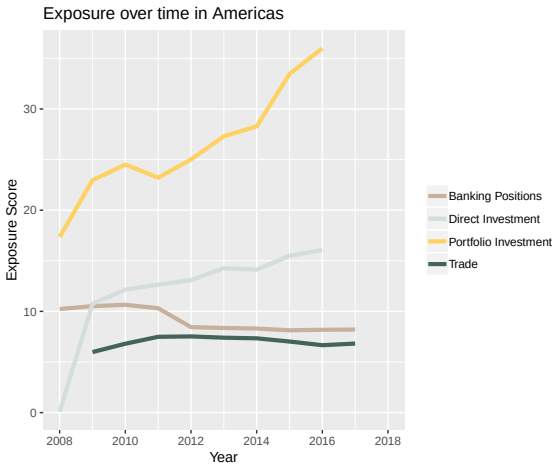

Exposure of all flows/stocks
Europe
Oceania
Americas
Asia
Africa
Region
0
100
200
300
Exposure Score
Claims
Liabilities
Inward
Outward (derived)
Assets
Liabilities (derived)
Exports
Imports

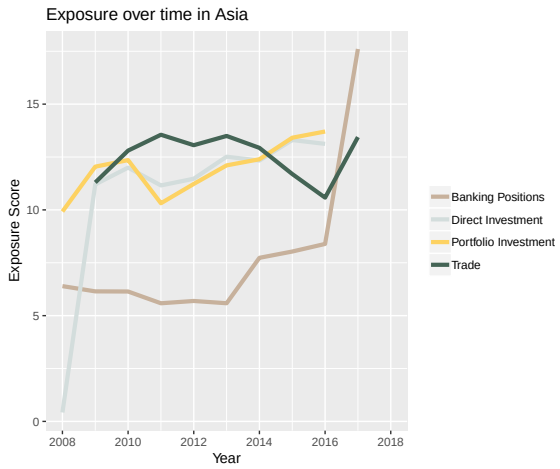

Exposure of all flows/stocks, aggregated
Europe
Oceania
Americas
Asia
Africa
Region
0
50
100
150
Exposure Score
Banking Positions
Direct Investment
Portfolio Investment
Trade

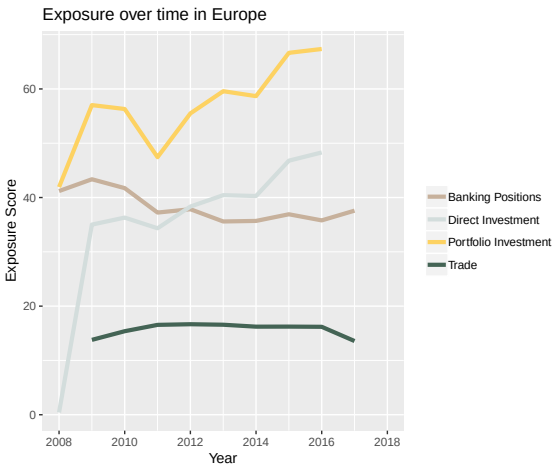

Exposure of all flows/stocks
HIC
UMC
LMC
LIC
Income group
0
50
100
150
200
Exposure Score
Claims
Liabilities
Inward
Outward (derived)
Assets
Liabilities (derived)
Exports
Imports

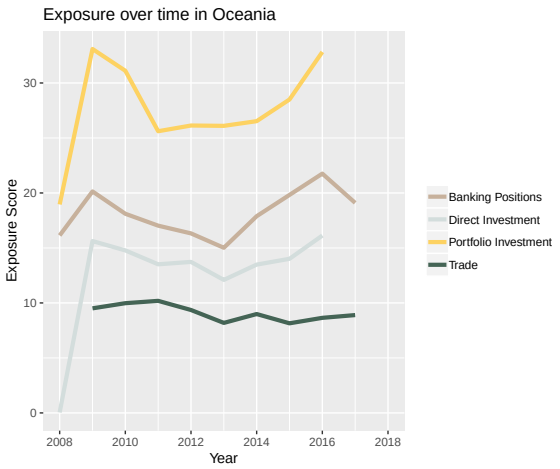

Exposure of all flows/stocks, aggregated
HIC
UMC
LMC
LIC
Income group
0
25
50
75
100
Exposure Score
Banking Positions
Direct Investment
Portfolio Investment
Trade

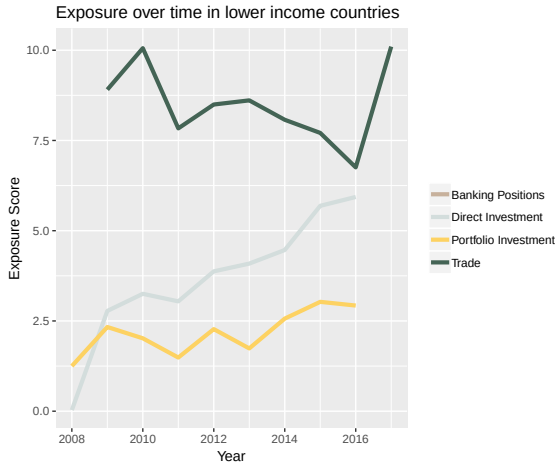

Exposure over time in Africa
Exposure Score
0
3
6
9
2008
2010
2012
2014
2016
2018
Year
Banking Positions
Direct Investment
Portfolio Investment
Trade

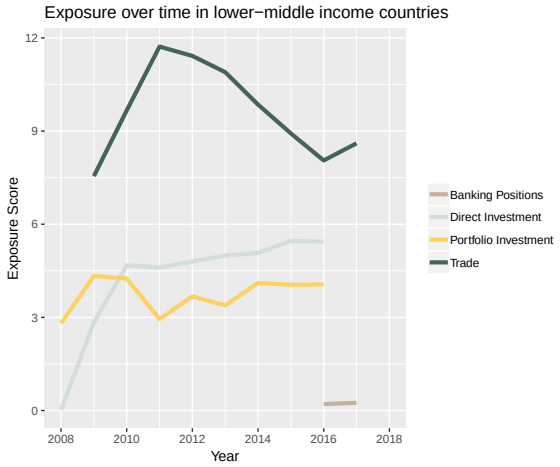

Exposure over time in Americas
Exposure Score
0
10
20
30
2008
2010
2012
2014
2016
2018
Year
Banking Positions
Direct Investment
Portfolio Investment
Trade

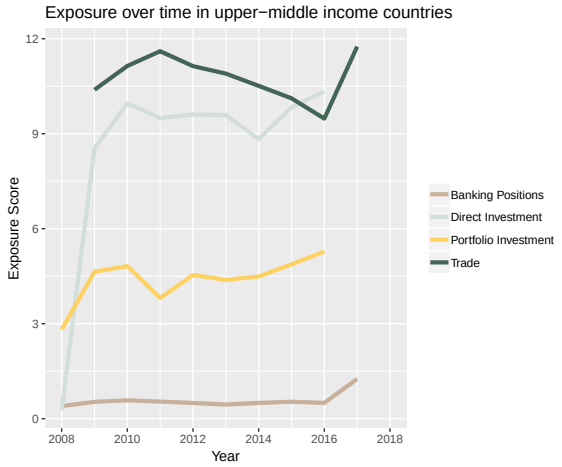

Exposure over time in Asia
Exposure Score
0
5
10
15
2008
2010
2012
2014
2016
2018
Year
Banking Positions
Direct Investment
Portfolio Investment
Trade

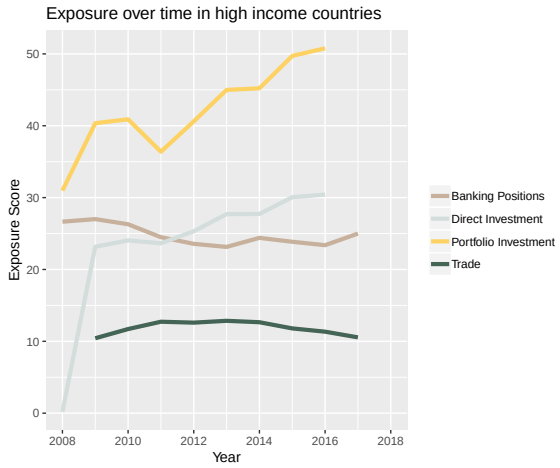

Exposure over time in Europe
Exposure Score
0
20
40
60
2008
2010
2012
2014
2016
2018
Year
Banking Positions
Direct Investment
Portfolio Investment
Trade

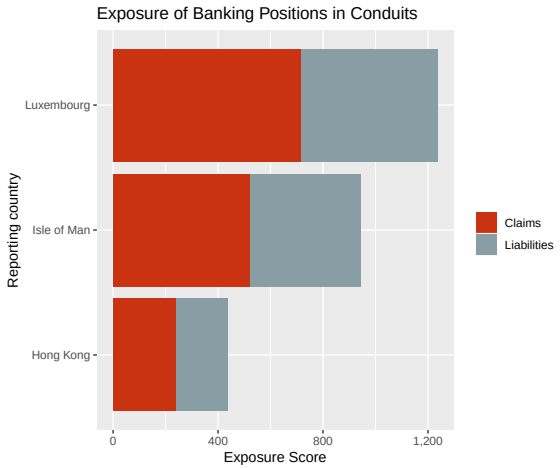

Exposure over time in Oceania
Exposure Score
0
10
20
30
2008
2010
2012
2014
2016
2018
Year
Banking Positions
Direct Investment
Portfolio Investment
Trade

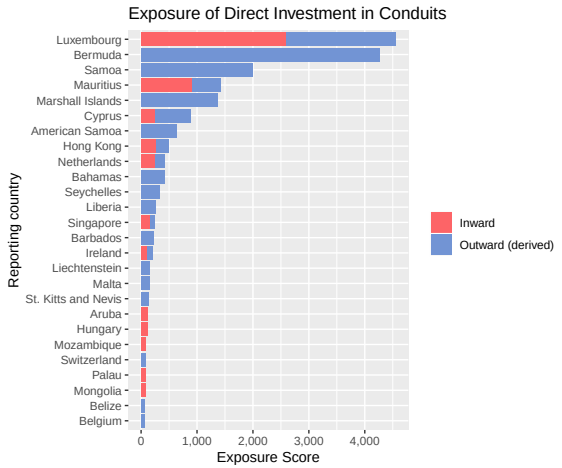

Exposure over time in lower income countries
Exposure Score
Year
Banking Positions
Direct Investment
Portfolio Investment
Trade

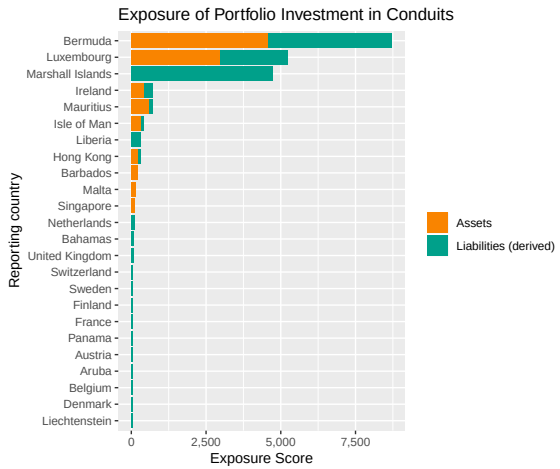

Exposure over time in lower−middle income countries
Exposure Score
Year
Banking Positions
Direct Investment
Portfolio Investment
Trade

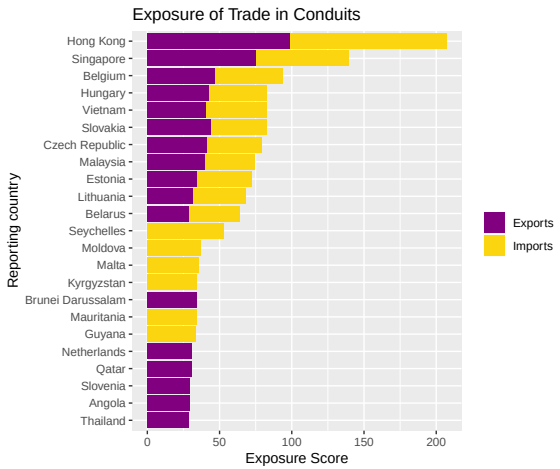

Exposure over time in upper−middle income countries
Exposure Score
Year
Banking Positions
Direct Investment
Portfolio Investment
Trade

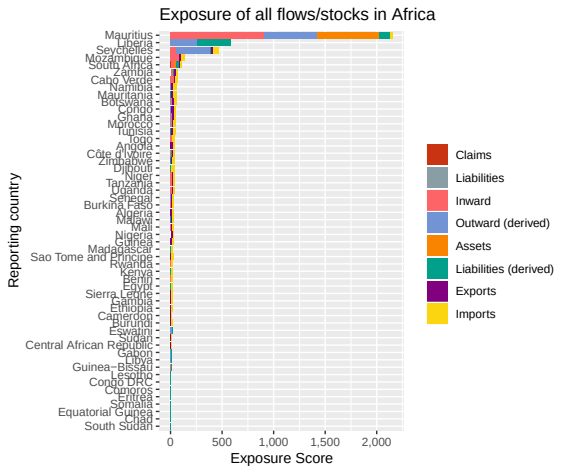

Exposure over time in high income countries
Exposure Score
Year
Banking Positions
Direct Investment
Portfolio Investment
Trade

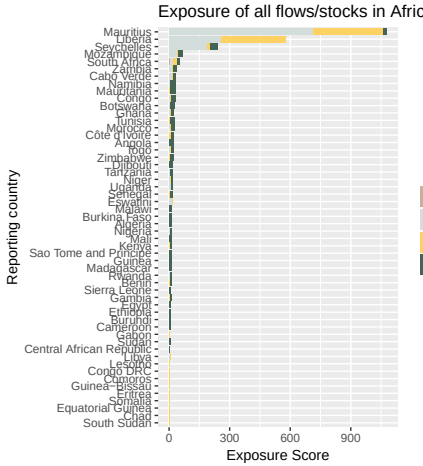

Exposure of Banking Positions in Conduits
Reporting country
Exposure Score
Luxembourg
Isle of Man
Hong Kong
Claims
Liabilities

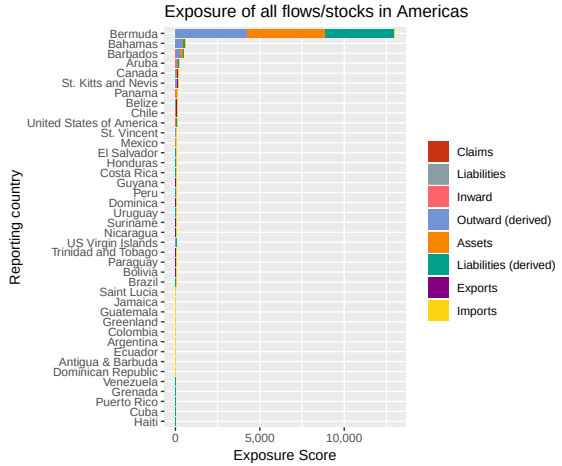

Exposure of Direct Investment in Conduits
Reporting country
Exposure Score
Inward
Outward (derived)

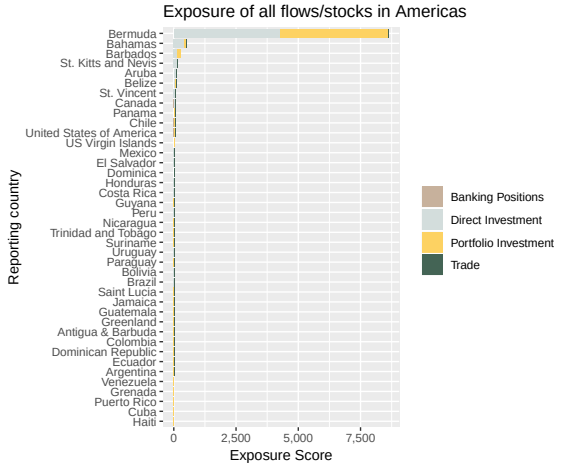

Exposure of Portfolio Investment in Conduits
Reporting country
Exposure Score
Assets
Liabilities (derived)

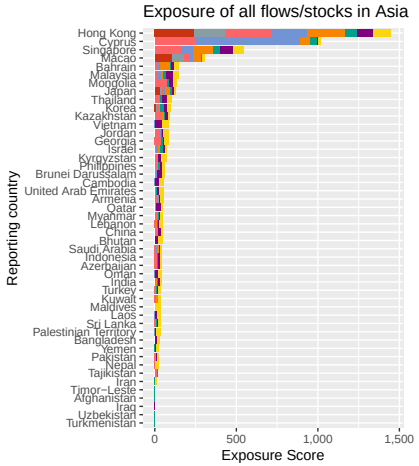

Exposure of Trade in Conduits
Reporting country
Exposure Score
Exports
Imports

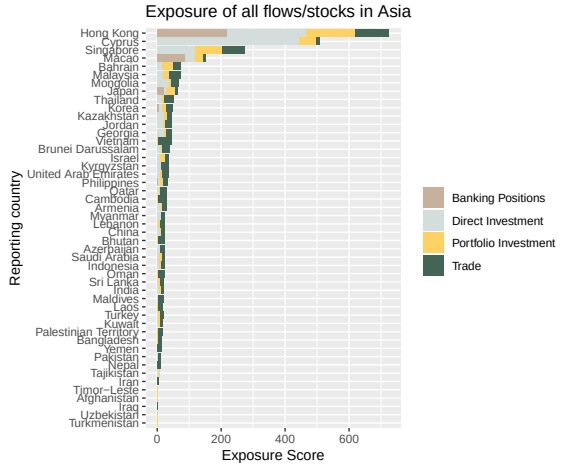

Exposure of all flows/stocks in Africa
Reporting country
Exposure Score
Claims
Liabilities
Inward
Outward (derived)
Assets
Liabilities (derived)
Exports
Imports

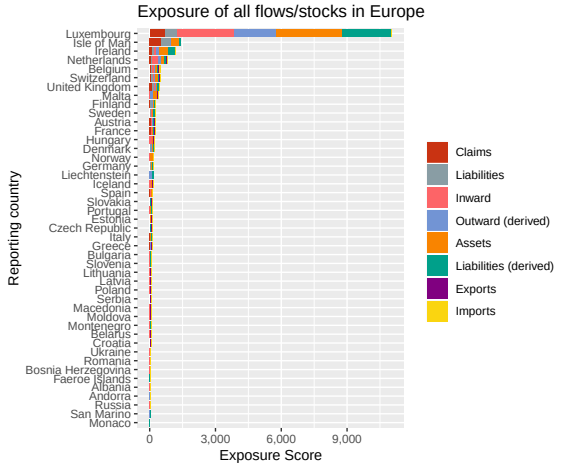

Exposure of all flows/stocks in Africa
Reporting country
Exposure Score
0
300
600
900
Banking Positions
Direct Investment
Portfolio Investment
Trade

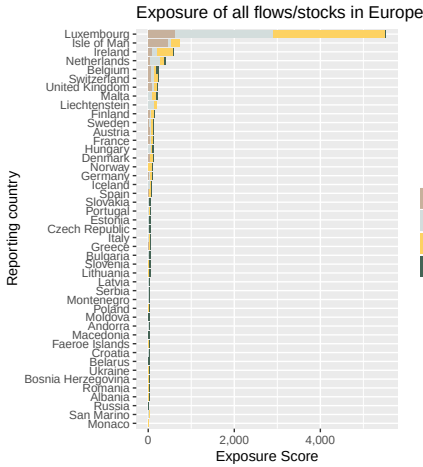

Exposure of all flows/stocks in Americas
Reporting country
Exposure Score
0
5,000
10,000
Claims
Liabilities
Inward
Outward (derived)
Assets
Liabilities (derived)
Exports
Imports

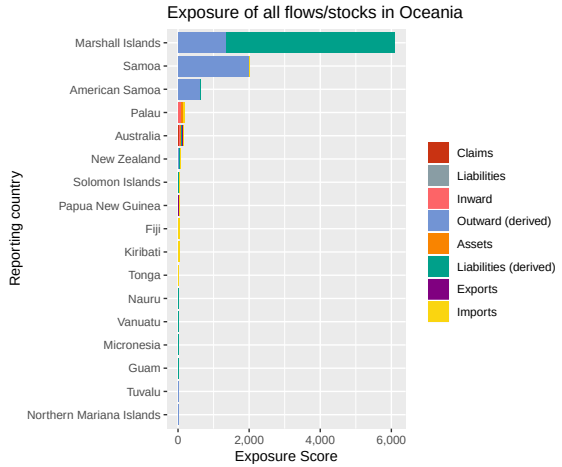

Exposure of all flows/stocks in Americas
Reporting country
Exposure Score
0
2,500
5,000
7,500
Banking Positions
Direct Investment
Portfolio Investment
Trade

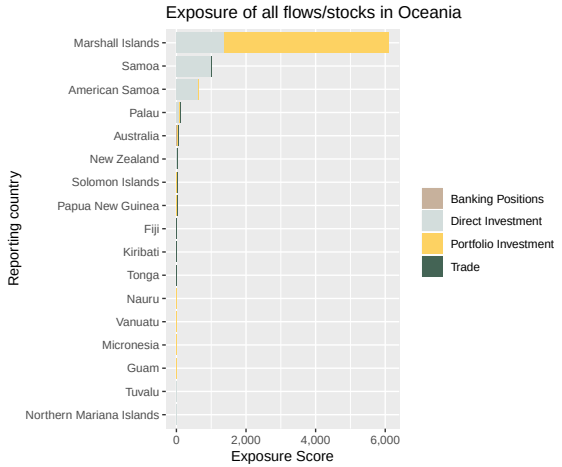

Exposure of all flows/stocks in Asia
Reporting country
Exposure Score
0
500
1,000
1,500
Claims
Liabilities
Inward
Outward (derived)
Assets
Liabilities (derived)
Exports
Imports

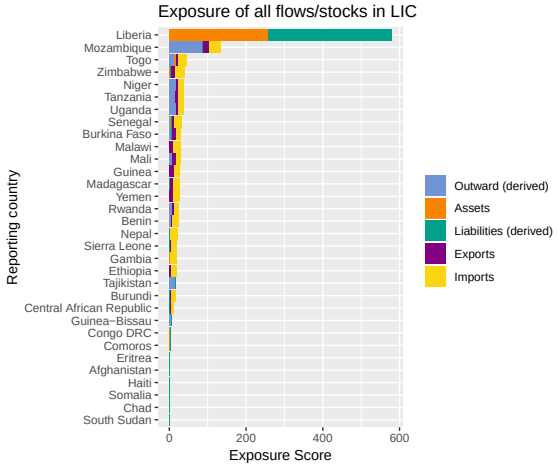

Exposure of all flows/stocks in Asia
Reporting country
Exposure Score
0
200
400
600
Banking Positions
Direct Investment
Portfolio Investment
Trade

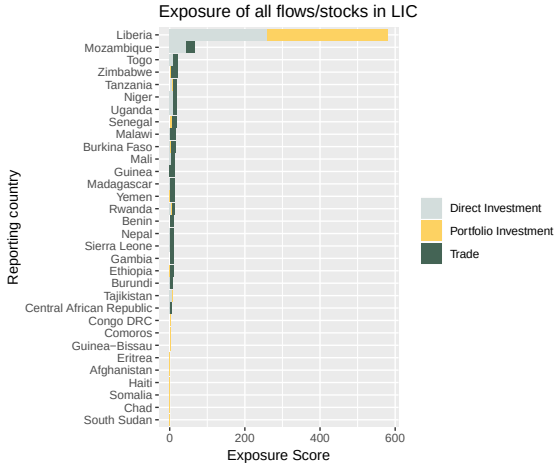

Exposure of all flows/stocks in Europe
Reporting country
Exposure Score
0
3,000
6,000
9,000
Claims
Liabilities
Inward
Outward (derived)
Assets
Liabilities (derived)
Exports
Imports

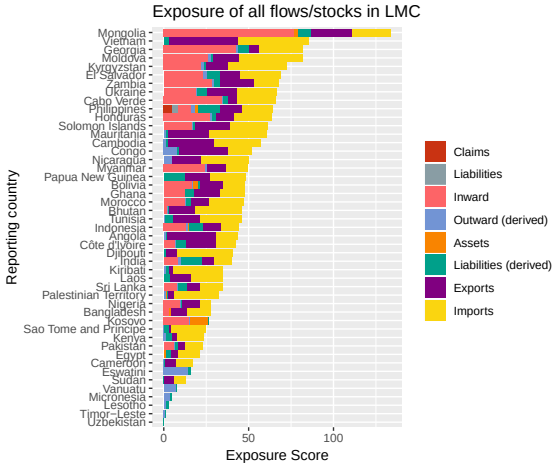

Exposure of all flows/stocks in Europe
Reporting country
Exposure Score
0
2,000
4,000
Banking Positions
Direct Investment
Portfolio Investment
Trade

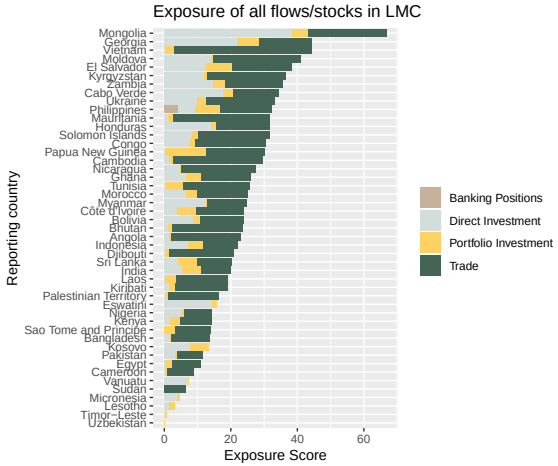

Exposure of all flows/stocks in Oceania
Reporting country
Exposure Score
0
2,000
4,000
6,000
Claims
Liabilities
Inward
Outward (derived)
Assets
Liabilities (derived)
Exports
Imports

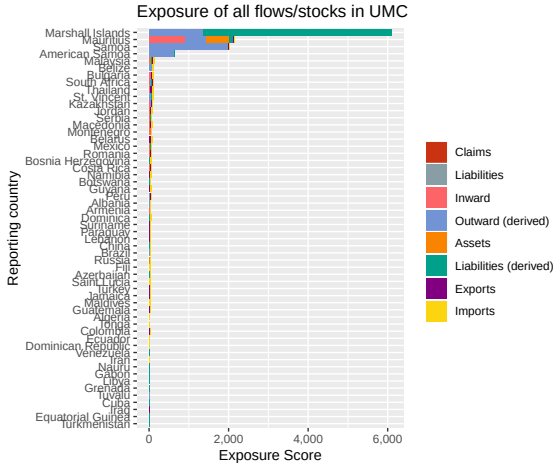

Exposure of all flows/stocks in Oceania
Reporting country
Exposure Score
0
2,000
4,000
6,000
Banking Positions
Direct Investment
Portfolio Investment
Trade

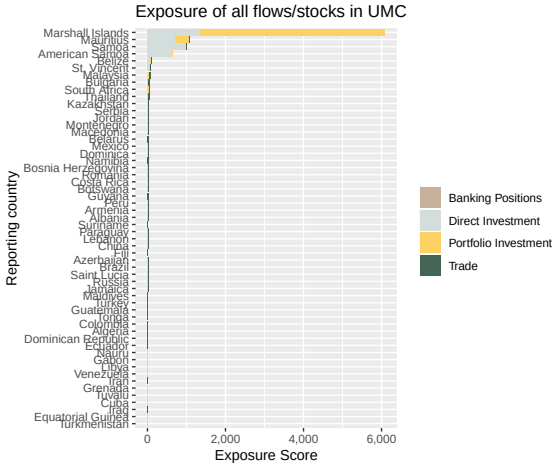

Exposure of all flows/stocks in LIC
Reporting country
Exposure Score
Outward (derived)
Assets
Liabilities (derived)
Exports
Imports

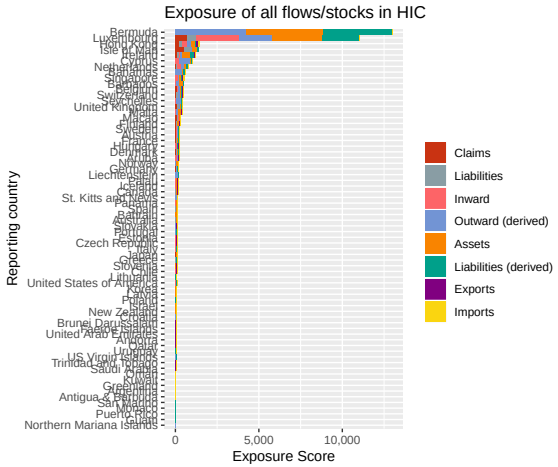

Exposure of all flows/stocks in LIC
Reporting country
Exposure Score
Direct Investment
Portfolio Investment
Trade

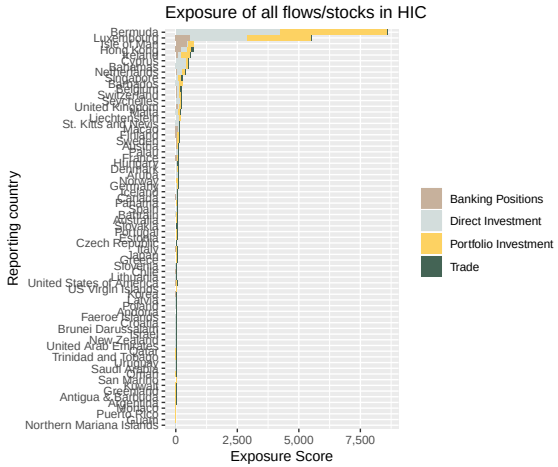

Exposure of all flows/stocks in LMC
Reporting country
Exposure Score
Claims
Liabilities
Inward
Outward (derived)
Assets
Liabilities (derived)
Exports
Imports


Exposure of all flows/stocks in LMC
Reporting country
Exposure Score
Banking Positions
Direct Investment
Portfolio Investment
Trade


Exposure of all flows/stocks in UMC
Reporting country
Exposure Score
Claims
Liabilities
Inward
Outward (derived)
Assets
Liabilities (derived)
Exports
Imports


Exposure of all flows/stocks in UMC
Reporting country
Exposure Score
Banking Positions
Direct Investment
Portfolio Investment
Trade

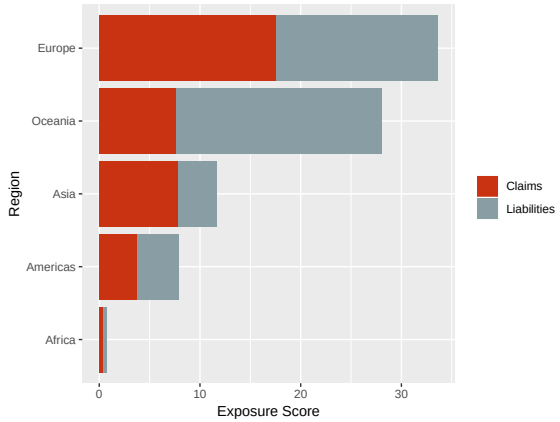

Exposure of all flows/stocks in HIC
Reporting country
Exposure Score
Claims
Liabilities
Inward
Outward (derived)
Assets
Liabilities (derived)
Exports
Imports


Exposure of all flows/stocks in HIC
Reporting country
Exposure Score
Banking Positions
Direct Investment
Portfolio Investment
Trade


Exposure of Banking Positions
KFSI1: Banking Secrecy
Region
Europe
Oceania
Americas
Asia
Africa
Exposure Score
Claims
Liabilities

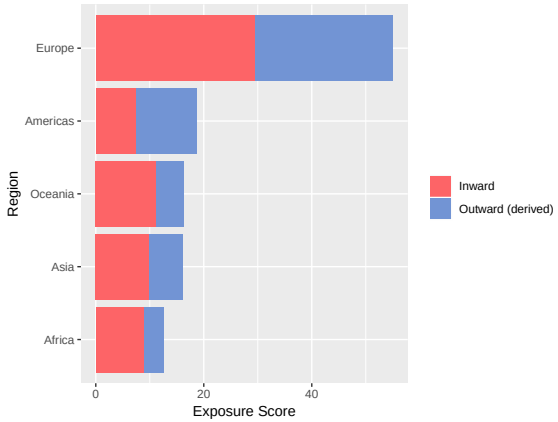
Exposure of Banking Positions

KFSI18: Automatic Exchange of Information



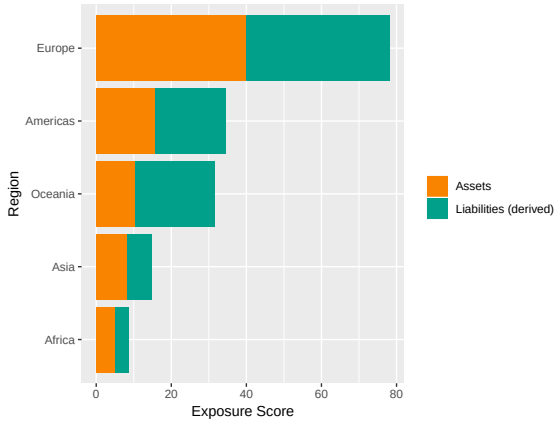
Exposure of Direct Investment

KFSIs 3 and 6: Company Ownership Registration and Publication



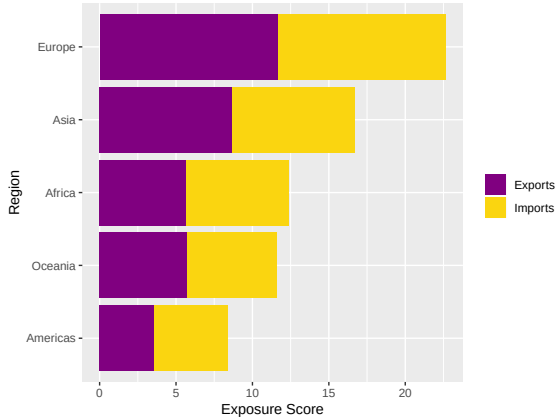
Exposure of Portfolio Investment

KFSIs 3 and 6: Company Ownership Registration and Publication



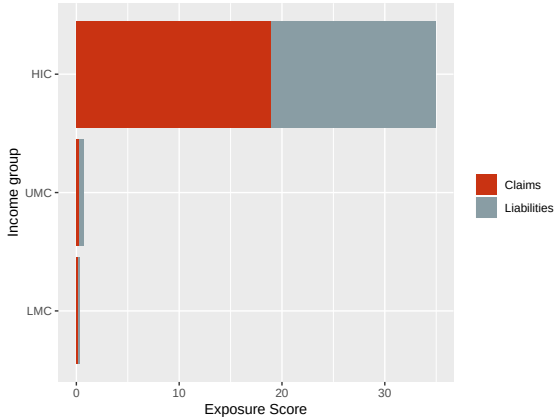
Exposure of Trade

KFSIs 3 and 6: Company Ownership Registration and Publication



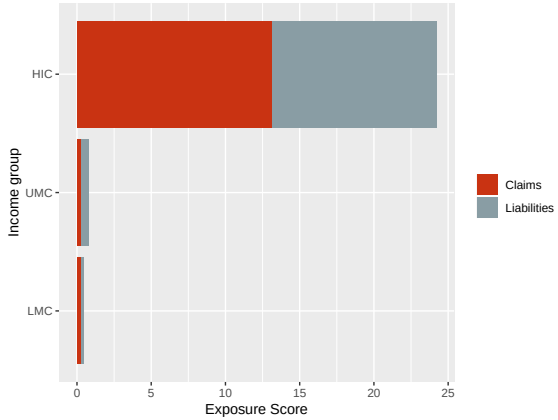
Exposure of Banking Positions

KFSI1: Banking Secrecy



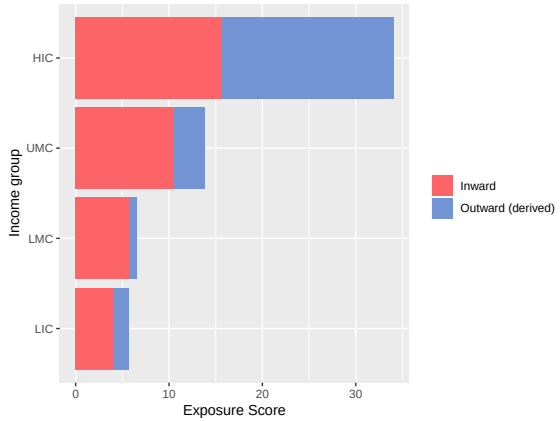
Exposure of Banking Positions

KFSI18: Automatic Exchange of Information



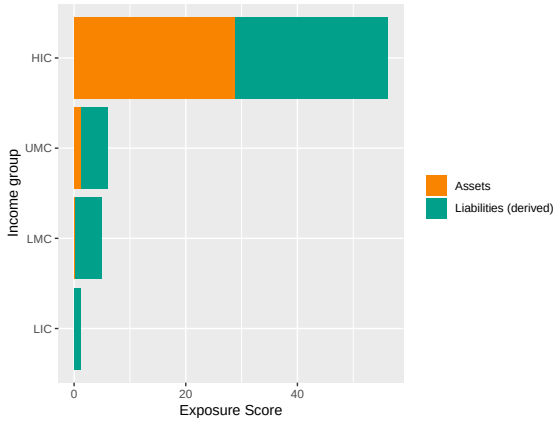
Exposure of Direct Investment

KFSIs 3 and 6: Company Ownership Registration and Publication



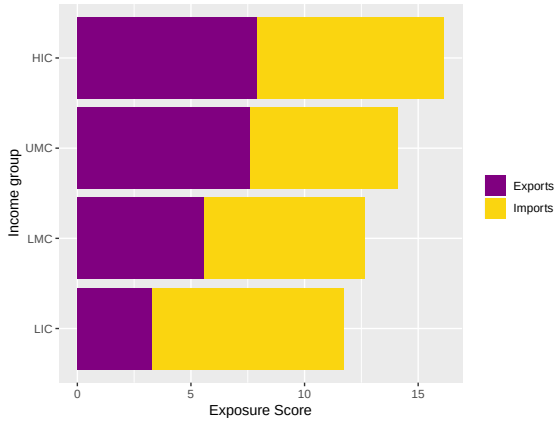
Exposure of Portfolio Investment

KFSIs 3 and 6: Company Ownership Registration and Publication



Exposure of Trade

KFSIs 3 and 6: Company Ownership Registration and Publication



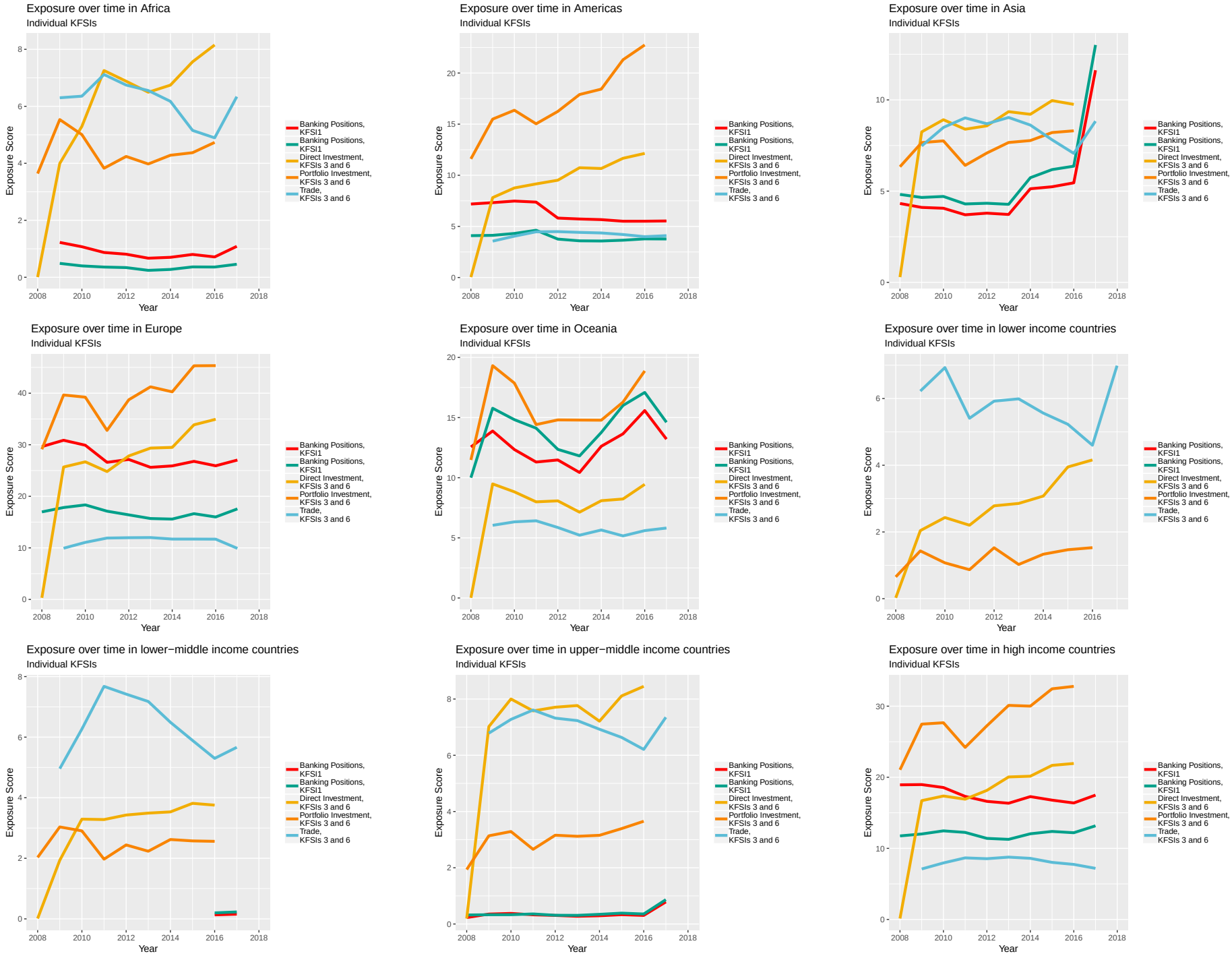


Figure 5: Figures of main results