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Mapping the Global Offshoring Network through the Panama Papers

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Abstract. This works maps the offshoring network between regions and countries worldwide through the Panama Papers. The Panama Papers 2016 divulgence is the largest leak of offshoring and tax avoidance documentation. The leaked documents contain 2.6 Terabytes of information involving more than two hundred thousands of enterprises in more than two hundreds countries. Using the Offshore leaks database we related entities around the world through different types of relationships. These relationships were used in order to build an offshoring network at countries and geographical regions scales. The network is characterized and described using chord diagrams to map the intra and interrelation between the countries and regions, discovering which of them are the more prominent in the worldwide offshoring scenario.

Keywords: Corruption network, Panama Papers, Offshore societies, Tax Havens.

1 Introduction

Recently, scandals related with tax havens and company offshoring have gained public interest. In this sense, tax havens are geographic areas which offer low or zero tax rates with the purpose of encouraging foreign investments [4]. This practice has quickly evolved in the last 25 years due to the increasing foreign investment in tax havens. The offshore financial economy is a corruption alternative to reinforce capital flight and tax evasion. Under this framework, natural persons and corporations non residents in tax havens, accumulate financial capital without strict regulations being all the information protected by a secret veil that prevents the transparency of operations and ownership [3]. The banking and commercial secrecy implies the unawareness of the identity of company owners, permission to designate second persons who act as nominated directors hiding

the real owners and the privilege to create accounts which are not registered publicly [12].

In the individuals case, which are in many circumstances corrupt autocratic officials, politicians, and even sportspeople and movie stars, they are interested to guard their assets in havens, due to this income comes from illegal bribery or for tax evasion purposes, the latter being the the principal motive in the firms' case [10]. This tax evasion, is frequently used to hide illegal activities like "market rigging, insider trading, illicit political donations, embezzlement, fraud, and payment of bribes and commission kickbacks" [3, p. 178].

In the quantitative order, about 15% of countries are tax havens, which are characterized by being small, under 1 million of population [4]. In 2014, the 71.6% of the Fortune 500 companies (358 enterprise) had as minimum 7,622 tax-haven subsidiaries [2]. With these subsidiaries, firms are evading around $90 USD billions in federal taxes. There are abut 50-60 tax havens, where are located more than the 30% of the global foreign direct investment [8]. Manufacturing companies from higher tax countries are more likely to have offshore operations than services industries [7], as well private firms have a greater tax reduction thanks tax havens than public companies [11]. There are several implications of the use of offshore [12], within which they are detected that tax-base of non-havens countries deteriorates since the amount collected from taxes decreases. Tax evasion generates at the same way, an additional control increasing regulation cost.

The Panama papers deal with the largest leak of documents in the history. These documents were in the Panamanian law firm Mossack Fonseca whose main function was to act as intermediary to create offshore societies. The documents reveal how thousands of people hid their assets in companies located in tax haven. The 2.6 Terabytes sized leaked documents containing information of 214,488 offshore entities which connect 208 different territories.

From the Offshore leak database data, which include the Panama papers, a network of connections between countries is built based on the relations that appear in the database. The network is characterized in the scale of countries and geographical regions, to discover the structure of the worldwide offshoring network. The rest of the article is organized as follows. In the following section 2 we describe the ensemble model. In section 3 we present the main results and section 4 concludes the paper discussing the implications of our findings.

2 The model

In this section the proposed methodology to build the offshoring Networks is described, starting with the data collection, the network construction from the data. Finally, the procedure to describe the network structure using chord diagrams is presented.

2.1 Data collection and organization

The data was obtained from the Panama Papers Offshore leaks Database (https://offshoreleaks.icij.org/), where the data can be downloaded as csv files. The data has information of entities, intermediaries, officers, addresses and edges between them.

Entities correspond to enterprises created in tax havens. There are 495,309 entities with the following attributes: name, original_name, former_name, jurisdiction, jurisdiction_description, company_type, address, Internal_id, incorporation_date, inactivation_date, struck_off_date, dorm_date, status, service_provider, ibcRUC, countr_codes, countries, note, valid_until, node_id, sourceID.

Intermediaries correspond to Law firms or other intermediaries that offer offshoring services. There are 24,183 intermediaries with the following attributes: name, internal_id, address, valid_until, country_codes, countries, status, node_id, sourceID, note.

Officers correspond to individuals or companies with a role in the offshore entity. There are 370,873 officers with the following attributes: name, icij_id, valid_until, country_codes, countries, node_id, sourceID, note.

Addresses corresponds to postal addresses of companies and individuals in the database. There are 151,665 addresses and the attributes are: address, icij_id, valid_until, country_codes, countries, node_id, sourceID, note.

The **edges** data contains the existing relations between all the above tables and is product of text mining the Panama Papers. The attributes available are node_1, rel_type, node_2, sourceID, valid_until, start_date, end_date. Here node_1 refers to the issuing entity and node_2 refers to the receiver entity. We use the relationship (rel_type) information to build the connectivity between node_1 and node_2. There are 19 types of relationships such as shareholder, beneficiary of, intermediary, president, secretary, director, to mention some of them.

A PostgreSQL database was built with the aforementioned tables, in order to facilitate the extraction of information through database queries.

2.2 Network construction

In order to build the network a set of database queries are performed in order to relate pairs of countries. The weight connection between pairs of countries is proportional to the number of appearances from the queries obtained for all possible relations according to **entities, intermediaries, officers, addresses and edges**. Inner join subqueries are performed in order to get all possible relations between each pair of countries. Finally, a high level query is done to aggregate all the results of similar tuples returned in the subqueries. In this way one gets a raw value for the total number of appearances a_{ij}^r of pairs of countries i, j for each type of relationship r. These values are normalized between 0 and 4 for each of type of the 19 types of relationships $r \in \{0, 1, \ldots, 19\}$ and for each

country i. The normalization T_r and the weight of the relationship R_{ij} between countries i and j is calculated as follows

$$R_{ij} = \sum_r T_r, \quad T_r = \frac{a_{ij}^r}{max(a^r)max(a_i)} \times 4, \ r \in \{0, 1, \ldots, 19\}. \tag{1}$$

Then the network connectivity matrix C_{ij} is built as follows:

$$C_{ij} = \begin{cases} 1, \text{ if } R_{ij} > \theta, \\ 0, \text{ otherwise.} \end{cases} \tag{2}$$

Here, θ is related to the value of the desired quantile used to build the mesoscopic networks obtained in the next Section 3.

Then, the offshoring network is described by the adjacency matrix $O_{ij} = C_{ij}R_{ij}$. This adjacency matrix $\boldsymbol{O}$ is used to characterize the offshoring network structure between countries using chord diagrams.

2.3 Characterizing the network

The network structure obtained in the previous subsection is characterized for countries and also in mesoscopic geographical relations. A chord diagram is used to display the intra- and inter-relationships between the blocks of the mesesocopic network and between countries (see Section 3). The blocks are arranged radially around a circle and the relationships are drawn as arcs that connect the blocks. A connection is represented as internal when it connects a country itself or in the case of geographical regions when connects countries belonging to the same regions. Chord diagrams are a very intuitive way to depict the structure of networks, and have been used to describe migration flows [1], and Enterprise Sustainability Reporting Maps [5, 6] to mention a few works.

To construct the chord diagrams that are presented in Figs. (1 and 2), the strength of these internal and external connections is measured. To determine the size of the connection, the chord diagram considers the number of links between enterprises among the regions/countries and the size (weighted degree) of of the region/country where the connections originated.

Table 1. Regions' acronyms

Region	Acronym	Region	Acronym
Maghreb Africa	AFM	Sub-Saharan Africa	AFS
America Antilles	AMA	Central America	AMC
North America	AMN	South America	AMS
South Asia	ASS	Eastern Asia	ASO
South East Asia	ASE	Slavic Europe	EUS
Germanic Europe	EUG	Latin Europe	EUL
Oceania	OCE	Middle East	ORM

Table 2. Countries' acronyms

Country	Acronym	Country	Acronym	Country	Acronym
Hong Kong	HKG	Guernsey	GGY	United Kingdom	GBR
Cyprus	CYP	Cayman Islands	CYM	Cook Islands	COK
China	CHN	Switzerland	CHE	Bahamas	BHS
Samoa	WSM	British Virgin Islands	VGB	Venezuela	VEN
United States	USA	Taiwan	TWN	Thailand	THA
Singapore	SGP	Russia	RUS	Panama	PAN
Malaysia	MYS	Jersey	JEY	India	IND
Indonesia	IDN				

3 Results: mapping offshoring networks

This section depicts the offshoring network obtained in the previous section and discuss the network structure in terms of countries and world geographical regions using chord diagrams.

3.1 Offshore maps relation for regions

The principal involved regions in the offshoring network are listed with their acronyms in Table 1. These regions are America Antilles, Central America, North America, South America, South Asia, Eastern Asia, South East Asia, Slavic Europe, Germanic Europe, Sub-Saharan Africa, Latin Europe, Oceania and Middle East.

Figure 1 shows the offshoring network relationship structure for the 80th (left) and 90th (right) percentiles of world geographical regions obtained from the mesoscopic configuration of the network defined in the previous section 2. The size of the segments in the chord diagram is proportional to the number of countries in the geographical block and their weighted importance in terms of R. The width of the links between segments indicates countries' connections that move from one region to another. Clearly, the links are thicker when they connect the largest blocks and according to the weighted relationship R between countries belonging the group. One should observe that, the chord diagrams represent the outgoing influences as connections that have a larger gap from the departing region/country, and the incoming influences are represented by a smaller gap from the arriving region/country.

For example, the relationship between ASO (East Asia) and AMA (America Antilles) indicates a strong relationship between entities belonging to the East Asia (ASO) countries offshoring to the Antilles. Similarly, the relationship between South-East Asia (ASE) and the Antilles (AMA). This means that the Antilles is receiving a lot of offshoring operations from these regions (ASO, ASE). On the other hand the Antilles is not exerting a big influence to other regions, but has a large self connections, which indicates a strong presence of relationship among the countries/entities inside the region. Likewise, East Asia has large offshore relationships with companies based in Oceania (OCE); and with other entities

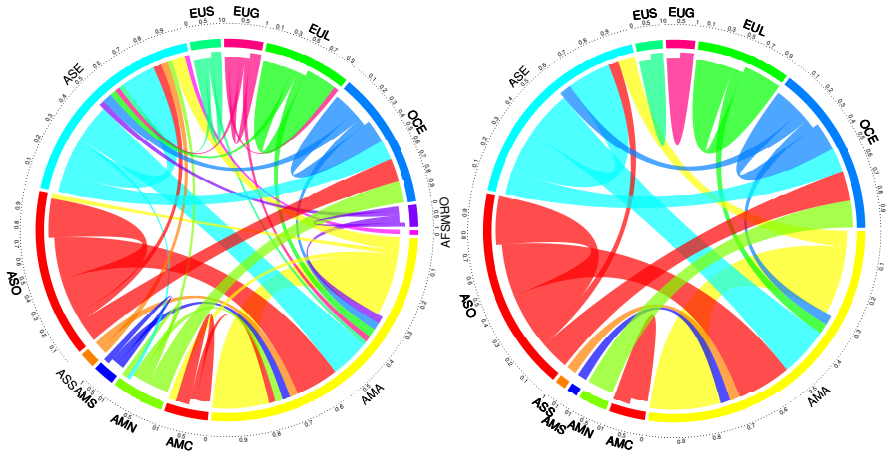

Fig. 1. Offshoring maps for world regions. Left: 80th percentile of regions. Right: 90th percentile of regions.

settled in the East Asia region. Analyzing South East Asia, their offshoring entities, in addition to be related to Antilles as was mentioned previously, are also related with Oceania and with companies from the region. In Slavic Europe (EUS), Germanic Europe (EUG) and Latin Europe (EUL) theirs offshore entities predominantly establish relations with firms from the same region. In Slavic Europe case, but in small amount, part of the relations are develop with entities from South East Asia and Antilles, prevailing the offshoring relationship inside this region. Germanic Europe in a smaller scale, also establish offshore relations with South East Asia, Antilles and Latin Europe.

Oceania is a region that mainly receives offshoring operations, about 70% in comparison with the emitted operations (30%). From this 70%, a smaller part corresponds to internal operations and the bigger one corresponds to external companies. This means, that the most parts of the offshoring entities are from regions like North America, South East Asia and Eastern Asia, with links to Oceania by relations based in address, intermediaries, officers, among others. On the other hand, Middle East (ORM) received operations from their owns entities, but also their entities establish relations with South East Asia and Antilles.

Central America (AMC) establish operations with their own entities and with Antilles, in both directions, as a receiver and as a transmitter. In North America (AMN), more than a half of the offshoring operations are between their entities and regions like Oceania, Antilles and South Easts Asia, which means that is a region where large offshored entities are generated; where connections like intermediaries, officers and address are established with firms or persons from the aforementioned regions.

There are three remaining regions to be included in the analysis: South America (AMS), Africa Sub-Saharan (AFS) and South Asia (ASS), which in spite of having few relationships compared to the other analyzed regions, it is

worth studying their behavior. South America are linked basically with their own entities and with Antilles, Africa Sub-Saharan are only linked it with South East Asia; and South Asia are connected with Antilles and South East Asia.

Up to this point, is valid to highlight that from the thirteen regions involved, only four account for the major offshored operations: Antilles (the big one), Eastern Asia, South East Asia and Oceania. Of all the studied regions, the predominant behavior is that these regions contain offshored entities, which establish relationships with other companies or people from the same region or from other regions. Only Antilles and Oceania are shown as regions where they predominantly receive operations, based on connections with intermediaries, officers, address, among others. These internal relationships can be seen as the network of entities to cover the trace of the receiving offshoring operations from other regions.

3.2 Offshore maps relation for countries

Figure 2 shows the offshoring relationship for the top 0.1 (left) and top 0.05 (right) percent of countries in the network. The countries involved are Hong Kong, Guernsey, United Kingdom, Cyprus, Cayman Islands, Cook Islands, China, Switzerland, Bahamas, Samoa, British Virgin Islands, Venezuela, United States, Taiwan, Thailand, Singapore, Russia, Panama, Malaysia, Jersey, India and Indonesia (see Table 2).

Taiwan (TWN) offshore entities establish relations predominantly with Samoa (WSM) and British Virgin Island (VGB). Samoa is an offshore finance center since 1987 and the sixth most popular tax havens in the Panama Papers, which is focused in the provision of international business companies, being their principal market the countries from South East Asia [15]. In the Offshore Leaks Database it is possible to confirm the existence of 265 offshore entities in Samoa jurisdiction linked to Taiwan [14]. British Virgin Island occupies in the representation of the offshoring map the greater portion, and it is recognized by Mossack Fonseca's files as the favorite tax haven, where about 113,000 entities are registered, 1819 of which, are linked with Taiwan. Likewise, British Virgin Island has an important volume of operations with countries like Singapore, Malaysia, India, Indonesia, Hong Kong and China.

Singapore (SGP), despite having a business friendly tax regime, maintains a higher connection with British Virgin Island, as was previously mentioned, and with Cook Island (COK) both of which are no tax territories. There are 4027 registered entities in VGB related with Singapore and 48 registered in COK. Similarly, Singapore has reported 706 offshore own entities related with itself, by operations that are supported by flexible tax politics.

Panama (PAN) is known as a popular tax haven, having predominantly internal relationships and in a minor scale with Bahamas (BHS), with 1120 offshore entities with jurisdiction in BHS linked with PAN. Malaysia (MYS), although having a lower weight compared to the other countries analyzed, it is possible to reflect that their principal operations are with British Virgin Island and Indonesia (IDN). Jersey (JEY) is another hosts of offshore finance centers,

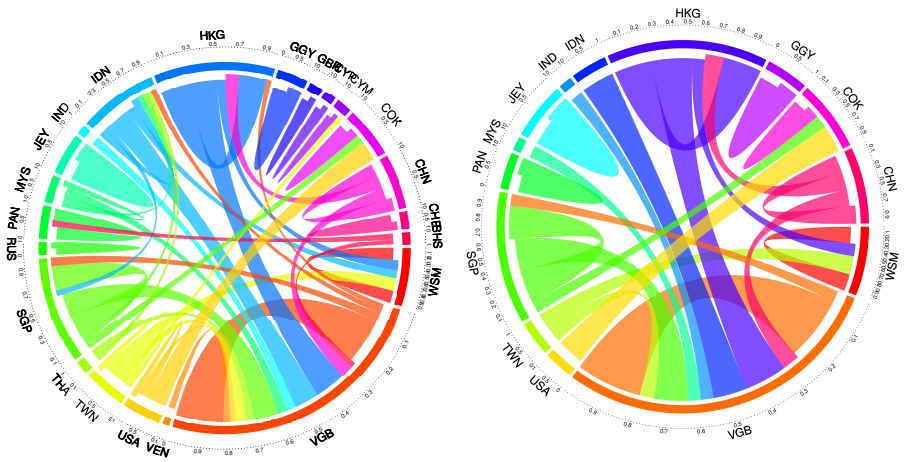

Fig. 2. Offshoring maps for countries. Left: Top 0.1 percent (quantile(0.999)) of countries. Right: Top 0.05 percent (quantile(0.9995)) of countries.

where the operations coming from this activities represent 90% of its government revenues [9]. Their principal operations are related with other entities or person from the same country.

India (IND) establish their principal offshore relations with British Virgin Island, and it has been studied that Indian entities related with to tax havens, pay 30% less tax than another firms without these connections [13]. Indonesia also are linked with British Virgin Island, with small relationships with another countries like Singapore and Samoa. Likewise, Indonesia is related, as an operation receiver, from Singapore and Thailand (THA).

Hong Kong (HKG) is considered as another trendy tax haven in the Panama Papers where the companies are looking for tax avoidance/evasion [13]. The 90% of Hong Kong gross domestic product (GDP) comes from the service industries, being the financial services included one of the five most important industry services. The principal relations detected are with British Virgin Island, in lesser extent with Samoa and with companies and persons from the same country. It has been found that such evaded tax origin are related with money laundering and financing of terrorist activities, with about 500 entities connected with Hong Kong [17].

Guernsey (GGY), a Britain's crown dependencies, is another international financial center which have larger operations with itself. Cook Island (COK) is a Pacific island, which "concentrates on forming trusts to protect assets from seizure by courts, wives, husbands or creditors" [16, p.652]. Their principal relations are with companies from the same country, and are also linked it as an operations receiver with Singapore and United Stated (USA); been the connection with USA the larger. It is worth noting that USA maintains its largest volume of offshore operations with Cook Island, and in a lesser extent with the Virgin Islands.

China (CHN) has links with Hong Kong, being their first investor, followed by British Virgin Island [18]. China, like India, has propitiated zones with special economic regulations with attractive tax systems in order to attract offshoring investors.

There are another countries contemplated in the Figure 2 left, which contain minority operations compared to the rest of the ones analyzed. One of them is Venezuela (VEN) linked with Virgin Islands as well as Thailand (THA), which also is connected with Indonesia. Russia(RUS), Cyprus (CYP), Switzerland (CHE) and United Kingdom (GBR) have mainly small connections with themselves. Caymand Island (CYM) is linked as a receiver with Taiwan and with it self, and Bahamas (BHS) is connected with Panama and Virgin Island. Again, the self connections can be interpreted as the internal network to cover the offshoring operations from their external investors. This internal operations are highlighted in the left panel of Figure 2, in contrast to the right panel where a larger variety of external relations still can be appreciated.

Its is interesting to highlight that of the 22 countries analyzed, there are three that cover the greater proportion of offshore relationships: Virgin Island (1st place), Hong Kong (2nd) and Singapore (3rd). It has been remarked the high participation of Virgin Islands within the world of tax havens, being an area highly welcomed by countries of different regions as a financial center. It is also noted that most of the countries studied have relations not only with other regions, but also with companies and entities from the same country.

4 Conclusions

We have studied the offshoring relations for the principal countries and world geographical regions. The network was built from the different relations appearing between emitting and receiving entities from where we have traced their corresponding countries. The network of entities has been represented mesoscopically by countries and geographical regions and their intra and inter relationships have been mapped.

As commented before, we have identified the main offshoring regions/countries and how they are related to the rest of the world. The major offshoring receiving regions by operations are Antilles, Eastern Asia, South East Asia and Oceania. And the major offshoring receiving countries are Virgin Island, Hong Kong and Singapore. Also, the dimension of internal relationships is important, since can give a measurement of the internal network used by the countries in order to hinder the tracking of money in tax havens.

Building a network from socio-economic data, and discribing it in a mesoscopic scale, in this case by countries and geographical regions can give interesting insights to these systems. Using this approach in order to tackle socio-economic problems is of interest in order to get a plausible description of the structure and intra/inter relationships of the system components. As a further work, we can apply clustering analysis to this network in order to get relationships that can be linked not only to the geographical analysis done in this work. Also, we can

apply this analysis to gender equality, LGBT, corruption data, among others, which are of current interest in socio-physics.

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