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Foreign Branches of US Global Banks: Geography, Balance Sheet Structure and Contagion

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Abstract

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JEL: F33, F34, F36, F42, C23, C49
Keywords: US global banks; Foreign branches; Balance sheet structure; Contagion

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Foreign Branches of US Global Banks: Geography, Balance Sheet Structure and Contagion

CARMELA D'AVINO*

This paper contributes to the understanding of the international financial linkages created by US banks by looking at the geographical composition and structure of the balance sheet of foreign branches. The empirical investigation, which is based on a novel dataset containing balance sheet statistics of foreign branches by country of location, has a threefold objective. First, it provides geographical mapping and distribution of foreign activities of branches by host country by accounting also for those balance sheet items not included in the available international banking statistics, i.e. gross interoffice positions and transactions with third-countries. Secondly, this paper presents a classification of host countries by balance sheet structure of foreign offices. A partioning-based clustering analysis allows to identify 4 distinct types of foreign branches: liquidity importers, liquidity exporters, liquidity conduits and locally implanted. Lastly, the paper provides evidence in support of the fact that US branches' banking foreign operations are a good measure of financial integration with US as they can significantly explain business cycle synchronisation between the host country and the US during the Great Recession.

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I. Introduction

The global dimension of the latest financial crisis has highlighted the key role of banks in transmitting shocks across the borders through both common (indirect) exposure to a given asset class/counterparty and direct financial linkages established via banks' international operations. The latter can be established through cross-border lending and borrowing with unaffiliated foreigners and via foreign offices.

US global banks' foreign operations are primarily carried out by foreign-related offices, i.e. branches and subsidiaries, whose local claims make-up over 80% of all US foreign claims[1,2]. The international transmission of financial shocks for the US case is, thus, tightly linked to the operations of foreign offices located worldwide. Limited available data on the balance sheet by host country, however, hinders an accurate geographical mapping of the size and the scope of foreign offices in a given country.

The Country Exposure Lending Survey (CELS) published by the Federal Financial Institutions Examination Council (FFIEC) is the most comprehensive publicly available report on foreign office activities of US banks by host country comprising data on local claims and liabilities, collected on a consolidated basis, as well as net interoffice transactions. Data limitation within the CELS statistics does not allow comprehensive interpretation of geographical direct exposure of US banks for multiple reasons. Firstly, the reporting entities include foreign subsidiaries (other than own branches) on which parent banks have only a limited liability, confined to the capital invested in the subsidiary and net interoffice lending (Cerutti et al., 2011). This leads to an overestimation of the actual exposure, in the same fashion as in the Consolidated Banking Statistics (CBS) published by the Bank for International Settlements (BIS), to which the CELS are reported every quarter. Moreover, reported total liabilities refer exclusively to debt redeemable in the host country, underestimating the balance sheet size in those countries, such as international and Offshore Financial Centers (OFC), through which foreign offices borrow heavily from

1 Country Exposure Lending Survey published by the Federal Financial Institutions Examination Council (FFIEC), report of the 31st March 2015. The exposure of the banking sector of a given country is measured as the sum of cross-borde r claims on unaffiliated foreigners and
local claims of related-foreign offices.

2 Throughout the paper the term 'offices' refers to branches and subsidiaries together.

third countries and from related offices. Moreover, consolidated banking statistics[3] obscures the vulnerabilities that may arise at the foreign office level as local risks are masked by the netting out of internal funds transfers and by the (unreported) funding structure of the foreign offices (Fender and McGuire, 2009).

Given the above caveats, this paper aims to improve our understanding of the geography of the operations of US global banks by using a novel dataset, based on statistics disclosed in the FFIEC 030 reporting form, containing branches' balance sheet variables aggregated over by country of location. This dataset is particularly interesting from an international financial stability standpoint, as it allows to geographically disentangle the most pro-cyclical segment of the foreign operations of US banks.

The contribution of this study is threefold.

Firstly, it proposes a comprehensive geographical mapping of activities of branches of US banks taking into account some balance sheet items not looked at elsewhere, such as gross transactions with related offices and third countries.

The second aim of this paper is to provide a categorization of branches' balance sheet structures by host country, with the intent to capture the heterogeneity in local business models. A k-mean cluster analysis allows identification of 4 distinct balance sheet structures of foreign branches of US global banks, which can be grouped into *liquidity importers*, *liquidity exporters*, *liquidity conduits* and *locally implanted*. Moreover, the analysis highlights the structural instability observed in some host countries since the outburst of the Great Recession. For instance, it is found that branches located in many European countries and in Japan have moved from being liquidity exporters to liquidity importers due to disruptions in the dollar funding markets. The balance sheets in countries in which branches have the largest activities, that is, the UK and some OFC, on the other hand, have not experienced any significant changes to their structure, notwithstanding the large worldwide branch-level deleveraging observed since the Great Recession.

Lastly, this paper investigates whether the scale of activities of US foreign branches can significantly explain the crisis incidence in host countries. More specifically, it is here answered the question: can banking integration with the US, as measured by several US branches balance sheet variables, explain business cycle

[3] Fender and McGuire (2009) refer to the CBS.

synchronization with the US? The rationale behind this investigation lies in the surprising lack of strong empirical support in favor to the fact that countries with larger financial exposure to the US have experienced a more disruptive crisis (Kalemli-Ozcan et al., 2013b; and Rose and Spiegel, 2010). Contrary to other measures of bilateral exposure used in the literature, linkages measured by branch-related variables point to an unambiguous causation link between financial integration and crisis incidence. Indeed, results from a panel estimation point to the fact that US branches operations significantly explain business cycle synchronization between the US and host countries during the crisis.

The study is connected to several stands of literature. It is primarily related to those research paper that construct bilateral datasets to evaluate international financial linkages and cross-country exposure. Forbes and Chinn (2004) are among the first to propose a dataset for the largest five world economies on bilateral trade, bank lending, foreign investment and competition with which they show that international shocks in the late 1990s have been transmitted mainly via the trade channel. More recently, Milesi-Ferretti, et al. (2010) propose a novel cross-country dataset on bilateral external positions in various financial instruments with which they investigate the extent of global imbalances at the eve of the financial crisis. Lane and Milesi-Ferretti (2011), on the other hand, construct a dataset of external assets and liabilities focusing on bilateral cross-border transactions of many countries vis-à-vis small financial centers. Kubelec and Sa (2012) put forward a dataset on outstanding bilateral external assets and liabilities focusing on foreign direct investment, portfolio equity, debt and reserves. This paper is also closely related to the papers by Kalemi-Ozkan et al. (2013b) and Rose and Spiegel (2012) which examine whether direct financial linkages with the US, as measured by different metrics, can explain the incidence of the Great Recession in different countries.

Additionally, this paper partly relates to those studies that focus on the operations, structure and organization of global banks. Cerutti et al. (2007) use bank-level data to investigate the factors that drive the choice of organizational structure of global banks, reporting that subsidiaries are preferred over branches whenever the scope of foreign activities is to engage in local retail operations. On the other hand, Fiechter et al. (2011) argue that the centralized model of global banks characterized by branches, rather than subsidiaries, allows banks to better absorb

localized liquidity shocks by freely reallocating liquidity across the banking group via internal capital markets.

The paper is organized as follows. Section 2 presents the different features of foreign-offices related variables available in the CELS and the FFIEC 030 report. Section 3 presents a classification of the balance sheet structure of branches by host country as well as an intra-class stability analysis. Section 4 reports the panel fixed-effect estimates aimed to evaluate whether host countries with larger presence of foreign branches and activities have aligned their business cycle to that of the US. Section 5 concludes.

II. Reconstruction of the balance sheet of foreign offices of US global banks by host country

II.I The Country Exposure Lending Survey (CELS)

Direct financial linkages established through banks' international operations have contributed to the global contagion of the financial crisis that originated in the US. However, available bilateral banking statistics are incomplete both at the aggregate and micro level, hindering a full understanding of the geographical composition of banks' foreign balance sheet positions and, thus, exposure (Herrero and Martinez Peira, 2007; Fender and McGuire, 2009; Cerutti et al., 2011).

The international operations of US banks are mainly carried out by foreign offices, that is, branches and subsidiaries, located in host countries. These offices are tightly linked to the US parent as witnessed by large reported interoffice positions. Residency based statistics from the Treasury International Capital System (TICS) indicate that US banks' claims due from own foreign offices constitute more than 60% of cross-border dollar claims on all foreigners since late 1990s, while the share of liabilities due to foreign-related offices ranges between 40% and 50%. In gross terms, this translates to $2.4 trillion of both banking claims and liabilities vis-à-vis foreign-related offices in the latest observed peak in August 2011.

The CELS published in the in the E.16 statistical release of the FFIEC reports a number of information on foreign activities of US banks and their foreign offices by host country. The bilateral foreign-office related variables contained in the CELS are: local claims (in local and non-local currency), liabilities redeemable locally (in local

and non-local currency) and *net* due to (or from) own related offices in other countries. Figure 1 shows a reconstruction of the balance sheet of foreign offices located in any given country *i* in which the variables in bold are available in the CELS on an aggregated basis for each country in which foreign offices of US banks are located.

Albeit the rich geographical and temporal coverage of the CELS, a comprehensive reconstruction of global banking activities of US banks via affiliated offices is hindered by a few drawbacks.

Most notably, the exact size of the balance sheet of foreign offices in country *i* cannot be established as claims on unaffiliated non-local residents and liabilities payable to third countries are not reported as well as gross figures of due to/from own related offices. Clearly, low claims on residents and payable liabilities in the host country do not imply that the activities of foreign offices of US banks located in *i* are negligible. For instance, banks located in OFC, which are mainly large branches or subsidiaries of global banks[4], have very little claims on local residents and liabilities payable in host countries. At the same time, these have large claims on unrelated and non-local residents and liabilities payable abroad since they are engaged in the intermediation of foreign funds which are in turn re-directed abroad[5] both to other countries and via internal capital markets.

Figure 1. CELS: Balance sheet of foreign branches of US banks located in country *i*

ASSETS	LIABILITIES
Claims on local residents	**Payable in the host country**
Claims on non-affiliated and non-local residents	Payable abroad
	Net due to related offices

Notes: The balance sheet of foreign offices of US banks by country of location above has been constructed according to the CELS available variables. In bold the variables which are available in the Survey.

Additionally, foreign offices related statistics in the CELS, in the same fashion of the Consolidated Banking Statistics (CBS) published by the Bank of International Settlements (BIS), do not distinguish between branches and subsidiaries.

4 In Cayman Island, for instance, at the beginning of 2013, 63% of banks were foreign branches and 27% subsidiaries, mostly of North American and European banks (Source: Cayman Island Monetary Authority).

5 As well as in structured finance and off balance sheet activities (i.e. via structured investment vehicles a nd conduits)

Disentangling the legal status of foreign affiliates in banking statistics would allow for a better monitoring of global financial stability. For instance, liquidity in foreign branches is centrally managed at the head office level and is reallocated freely worldwide within the banking group via internal capital markets[6]. Therefore, the degree of international shock transmission that occurs via branches can be potentially more important than in the subsidiary case (Fiechter et al., 2011); this is particularly true for the US, where interoffice transactions with subsidiaries are capped by the Federal Reserves[7]. Moreover, parent banks are fully-liable for their branches while the failure of a subsidiary would only incur the loss of invested capital and interoffice claims (Cerutti, 2013).

II.II Foreign Branch Report of Condition (FFIEC 030 form)

The foreign branch report of condition, reported in the FFIEC 030 form, allows the FFIEC to monitor the foreign operations of domestic commercial banks by collecting information on the structure and geographic distribution of foreign branches' assets and liabilities. Data is collected quarterly for large branches with total assets of at least $2 billion and annually for other branches with total assets more than $250 million[8]. Although branch-level data is confidential, aggregated data is available upon request; the customized dataset used in this research contains several balance sheet variables aggregated over by country of location of the branches. The unbalanced dataset considered spans from 2005q1 to 2014q4 and includes the following balance sheet items for branches located in 79 countries: total assets *(FORB2170),* total liabilities *(FOR2950),* balances due from US banks *(FORB0033),* balanced due from foreign banks *(FORB0034),* deposits of US banks *(FOR2623),* deposits of foreign banks *(FOR2625),* gross due from head office, U.S. branches, and other foreign branches *(FORBC482),* gross due from consolidated subsidiaries *(FORBC483),* gross due to head office, U.S. branches, and other foreign branches *(FORBC485),* gross due to consolidated subsidiaries *(FORBC486).*

Table 1 reports snapshots of total amounts outstanding of these series in 2005, 2008 and 2014, aggregated over host countries. Non-bank assets (liabilities) are

[6] In the US there is a high degree of heterogeneity on the choice of the organizational structure of global banks. Cerutti et al. (2007) find that in there is not a straight-cut preference of US banks to expand their foreign activities with either branches or subsidiaries.

[7] The Federal Reserves Act - Section 23A limits outstanding interoffice transactions of a US bank with its subsidiaries to 10% of its capital stock.

[8] Branches with total assets more than $50 million and less than $250 million file the FFIEC 030S report form.

calculated by subtracting from total assets (liabilities) the other four items in the assets (liabilities) side; they include primarily claims due from (to) the local private sector, the public sector and other non-bank financial institutions (both local and located in third countries). The most striking evidence is the large share of interoffice assets and liabilities of US foreign branches: as at 2008 claims due from and to related-offices (i.e. branches and subsidiaries altogether) represent 74% and 46% of total assets respectively. The main function of foreign-related branches of US banks, when looking at their balance sheet aggregated on a worldwide basis, is, thus, to channel liquidity (exporting, in particular) among the banking group. Total assets and liabilities of foreign branches of US banks located worldwide have reached their peak at the end of 2008 amounting to over $3 trillion, falling drastically, by about $1 trillion, by the end of 2014, but still depicting higher levels than those observed in 2005.

Table 1. Balance sheet of foreign branches of US banks, total amounts outstanding at year-end, $ millions

	2005	2008	2014
Total Assets	1,646,643	3,105,420	2,239,836
Non-bank assets	403,308	686,051	798,266
Balances due from foreign banks	60,031	114,102	168,087
Balances due from US banks	3,465	5,832	7,762
Gross due from consolidated subsidiaries	264,837	513,813	326,173
Gross due from head office and branches	915,002	1,785,622	939,548
Total liabilities	1,646,643	3,099,033	2,234,527
Non-bank liabilities	803,576	1,462,242	1,087,432
Deposits of foreign banks	71,994	128,818	106,774
Deposits of US banks	19,747	73,466	25,857
Gross due to consolidated subsidiaries	281,831	542,128	472,932
Gross due to head office and branches	469,495	892,379	541,532

Source: Author's computations based on FFIEC030.
Notes: The above amounts refer to foreign branches' balance sheet data aggregated on a worldwide basis.

Gross due from head offices and other branches constitutes the largest claim on the asset side of the balance sheet making up almost 60% of total assets as in 2008. This is also the item which has experienced the largest contraction in 2014, aligning to pre-crisis levels. Claims on foreign-related offices have decreased substantially after 2008, as also showed by the contraction in claims due from consolidated subsidiaries. Non-bank assets, as well as claims due to foreign and US

banks, on the other hand, have increased over the observed sample, implying a partial post-crisis move towards external claims.

On the liability side, non-bank liabilities represent an important source of debt followed from claims due to foreign-related offices, both of which have witnessed a post-crisis inflection, although less severe than the asset side equivalent items. It is interesting to note that deposits of US banks have reached as much as $73 billion in 2008.

The post-crisis retrenchment of US foreign branches operations, as reported in table 1, reflect the disruptions in international banking operations brought by the financial crisis observed elsewhere. Most notably, the International Monetary Fund (IMF, 2015) reports that the reduction of global banks' activities has particularly hit cross-border claims on unaffiliated foreigners rather than local lending extended by affiliates, which have kept rather stable. This is also observed in the FFIEC 030 dataset where non-bank assets of branches of US banks, made up of mostly local claims, have increased after the crisis (Table 1). However, FFIEC 030 data reveals that the retrenchment of some activities of the foreign branches of US banks has been more important than what observed for cross-border claims on unaffiliated foreigners. Indeed, if these latter have experienced their largest contraction equal to 13% on an ultimate-risk basis over the period 2010-2012[9], some US branches-related items, such as interoffice positions, have witnessed a much larger pro-cyclicality.

A closer look at the data reveals notable cross-country heterogeneities in the way the crisis has affected the activities of foreign branches of US banks. For instance, the financial crisis has lead to a remarkable reduction of operations in OFC, such as Cayman Islands and the Bahamas: assets in these two countries, which are almost entirely made up by claims due from the parent and other branches, have shrank substantially since 2011. In only 2 years total assets of US branches in these two locations have fallen by 55% and 78% respectively. In branches located in England[10], on the other hand, the deleveraging has been more contained during the crisis, with total assets still amounting to over $1 trillion since 2007. Branches located in Hong Kong and Singapore, on the other hand, have expended since 2006, experiencing a short-lived slowdown in 2012 and 2013. Lastly, branches located in Japan have experienced a very important fall in assets at the crisis outset:

[9] Source: CELS.
[10] In the FFIEC 030 form England is considered as a stand-alone country. Data for the rest of the UK is reported as UK (other than England).

in 2007q3 they fell to $31 billion down from $84 billion at the end of 2006. Moreover, in Japan the crisis has brought about a drastic reduction in inter-branch assets and an increase in inter-branch liabilities, implying that these branches have switched from supplying to receiving liquidity in the internal capital markets. As it will be further argued below, the large dollar funding gap featuring Japanese banks and Japanese-based US branches translated to massive dollar-denominated funding from internal capital markets as dollar funding markets froze during the crisis.

II.III Geographical reconstruction of branches' balance sheet

The FFIEC 030 report allows to reconstruct the balance sheet of foreign branches of US banks located in country *i* in the stylized structure reported in Figure 2.

Figure 2. Aggregated balance sheet of foreign branches located in country *i*

Assets	Liabilities
Non-bank claims	Non-bank liabilities
Due from US banks	Due to US banks
Due from foreign banks	Due to foreign banks
Inter-branch assets	Inter-branch liabilities
Due from subsidiaries	Due to subsidiaries

Table 2 reports the balance sheet size by host country and it can be noted that branches have largest presence in international and OFC. The largest share of activities of US banks branches take place in England: on average branches located there have total assets of over $1 trillion. Cayman Islands and Bahamas depict the second and the third largest presence of US banks branches reporting together an average of over $750 billion assets. Hong Kong and Singapore have become increasingly important host countries for US banks especially since the outburst of the financial crisis.

Table 2. Total assets of foreign branches of US banks, 2005-2014 means, $ millions

Country	Total Assets	Country	Total Assets
ENGLAND	1,092,717	VIRGIN ISLANDS	312
CAYMAN ISL.	499,579	VENEZUELA	304
BAHAMAS	268,590	PAKISTAN	294
SINGAPORE	90,812	UK (Other)	263
HONG KONG	89,949	PANAMA	227
JAPAN	49,925	SAUDI ARABIA	182
AUSTRALIA	40,506	URUGUAY	176
CANADA	31,203	KENYA	176
BELGIUM	28,379	GABON	143
INDIA	25,206	BANGLADESH	136
PUERTO RICO	23,669	VIRGIN ISLANDS	122
TAIWAN	18,163	KUWAIT	120
CHANNEL ISL.	15,830	SENEGAL	117
KOREA, SOUTH	13,679	TUNISIA	115
GERMANY	10,911	MACAU	101
BAHRAIN	10,890	ECUADOR	92
SWITZERLAND	8,915	JORDAN	91
SOUTH AFRICA	8,150	BULGARIA	84
THAILAND	7,754	TURKEY	81
DUBAI	7,399	N. MARIANA ISLANDS	81
PHILIPPINES	5,374	DOMINICAN REPUBLIC	81
INDONESIA	5,308	SRI LANKA	81
ABU DHABI	4,364	JERSEY	79
CHINA	4,247	PARAGUAY	70
ARGENTINA	3,587	CAMEROON	59
FRANCE	3,385	GUATEMALA	54
ITALY	3,335	JAMAICA	52
SPAIN	2,254	LEBANON	47
IRELAND	1,907	PERU	44
CHILE	1,642	QATAR	43
NEW ZEALAND	1,441	EL SALVADOR	42
BRAZIL	1,440	GREECE	35
ISRAEL	1,284	HAITI	29
ALGERIA	1,082	BOLIVIA	27
EGYPT	1,059	PALAU	23
BRUNEI	651	MICRONESIA	23
NETHERLANDS	636	MARSHALL ISLANDS	23
VIETNAM	580	AMERICAN SAMOA	21
GUAM	385	MALAYSIA	20

Source: Author's computations based on total assets reported in the FFIEC030 report.

Table 3 shows the rankings of countries in which branches are located according to the liabilities as reported in the FFIEC 030 and the CELS separately. The top-20 countries ranked by size varies substantially across the two datasets as well as the outstanding reported liabilities, as discussed in section II.I. Most interestingly, in some countries the extent of foreign banking operations of US banks, when the totality of the branches' balance sheet size is considered, results to be much larger than what measured by the CELS. Indeed, international banking centers, such as England and offshore, are underestimated by the CELS as interoffice liabilities, which are not accounted for by the CELS constitute a large portion of their liabilities. This is particularly striking for the Cayman Islands whose liabilities in the FFIEC030 are more than double of those reported in the CELS. This holds also true for other countries, like Switzerland and Puerto Rico which do not appear in the CELS top-20 ranking because their liabilities are mainly due to related branches.

Table 3. Total liabilities FIIEC 030 versus CELS as at end-2014, millions $

	FFIEC030		**CELS**
ENGLAND	1,175,647	UK	1,027,371
CAYMAN ISL.	402,986	CAYMAN ISL.	181,464
HONG KONG	101,555	JAPAN	108,924
SINGAPORE	88,960	IRELAND	69,274
JAPAN	67,279	MEXICO	61,414
BAHAMAS	62,317	HONG KONG	61,100
CANADA	44,970	SINGAPORE	60,764
PUERTO RICO	43,377	AUSTRALIA	56,401
AUSTRALIA	42,268	CANADA	53,876
INDIA	30,142	BELGIUM	50,910
BELGIUM	25,096	GERMANY	43,652
SWITZERLAND	13,653	BAHAMAS	43,602
KOREA	13,653	KOREA	35,219
TAIWAN	11,032	LUXEMBOURG	33,151
PHILIPPINES	8,775	NETHERLANDS	32,516
THAILAND	8,700	OTH. BAN. CTR	32,320
GERMANY	8,398	CHINA	29,974
CHANNEL IS.	8,296	TAIWAN	20,940
DUBAI	7,853	BRAZIL	16,061
INDONESIA	7,778	POLAND	13,602

Notes: The above table shows the liabilities of foreign branches reported in the FFIEC 030 form (Federal Financial Institutions Examination Council) versus liabilities of foreign-related offices reported by the Country Exposure Lending Survey (E.16 Statistical Release of the Federal Reserves Board). The countries in the first and third columns are ranked in descending dollar value order. FFIEC 030 reporting institutions are foreign branches of US banks with assets in excess of $250 million. The reporting panel of CELS are both branches and consolidated subsidiaries. Liabilities reported in the CELS are limited to dues redeemable in the host country and exclude liabilities redeemable abroad and interoffice liabilities.

The outstanding amounts reported in the FFIEC030 also reveal that Hong Kong and Singapore are relatively more important than what is suggested by the CELS. Branches located in Japan, Canada, Belgium and Germany have larger size according to the CELS than in the FFIEC030, given a relatively larger presence of US subsidiaries in these countries. The same is true for the Netherlands, Brazil and Poland which are ranked further below the top-20 in the FFIEC ranking.

III. Balance sheet structure by host country

III.I Partioning-based clustering

This section aims at unveiling the geographical heterogeneity in the composition of assets and liabilities of branches of US banks across host countries by using of a *k-means clustering algorithm* (Hartigan and Wong, 1979). This partitioning-based algorithm searches the data space for k clusters in which the sum of squared errors, measured as distances from cluster means, are locally optimal within each cluster. The optimal cluster is found by first finding a cluster center, or *centroid*, and then allocating each observation to its closest partition. These two steps are reiterated until there are no further changes in the clusters.

After normalizing the balance sheet items by total assets, the Gower dissimilarity measure (Gower, 1971) is used as distance metric given the unbalanced nature of the panel arising from the difference in reporting frequency due to branch size. The measure for two p-dimensional observations x_i and x_j can be summarized as follows:

$$d_G(x_i, x_j) = \sqrt{\frac{1}{\sum w_{ijl}} \sum_{l=1}^{p} (x_{il} - x_{jl})^2 w_{ijl}} \qquad (1)$$

Where w_{ijl} is equal to zero if x_{il} and/ or x_{jl} are missing, zero or otherwise. The number of clusters is set equal to 4 and is determined by means of the Calinski–Harabasz pseudo-F index goodness of fit (Calinski and Harabasz, 1974)[11]. Table 4 reports the means of the variables by cluster.

[11] The highest pseudo F-Scores were obtained for k=3 and k=4 groups. K=4 is chosen to better capture the heterogeneity of balance sheet structures across the sample.

Table 4. Clusters means

	Cluster			
Variables are divided by total assets	**1**	**2**	**3**	**4**
Non-banking assets	0.11	0.27	0.64	0.55
Balances due from US banks	0.00	0.00	0.00	0.00
Balances due from foreign banks	0.04	0.07	0.17	0.17
Gross due from subsidiaries	0.07	0.41	0.05	0.03
Gross due from branches	0.78	0.25	0.14	0.25
Non-banking liabilities	0.56	0.43	0.70	0.21
Deposits of US banks	0.01	0.00	0.00	0.00
Deposits of foreign banks	0.03	0.03	0.04	0.02
Gross due to subsidiaries	0.12	0.24	0.02	0.07
Gross due to branches	0.27	0.29	0.23	0.69
Number of observations	313	181	613	300

Notes: Table 4 reports the results of the K-means cluster analysis (Gower distance measure). The Calinski–Harabasz pseudo F-scores are equal to 433.76, 638.63, 625.40, 574.18, 485.23 for k=2,...,6 respectively.

The four clusters have very distinguishable features.

Branches located in countries that fall in cluster 1 raise a substantial amount of non-bank liabilities locally (almost 60% on average) with very little non-bank assets. Liquidity is mainly channeled to related branches: gross due from head office and branches constitutes on average almost 80% of branches' activities. This cluster, thus, features those host countries in which branches are *liquidity exporters,* as liquidity is raised locally and redistributed to the rest of the banking group.

In cluster 2 are grouped those branches that have limited non-bank assets and liabilities in the host country, with non-bank assets being on average only 27% of the branches' activities. Transactions via internal capital markets are very important for these branches, constituting on average more than 50% of their assets and liabilities (related-branches and subsidiaries confounded); in particular, this group features the highest share of assets and liabilities vis-à-vis related subsidiaries. Given the large and somewhat balanced level of interoffice assets and liabilities, branches that fall in this cluster can be defined as *liquidity conduits*, as they both import and export liquidity to the rest of the banking group.

Branches in the third cluster have a large share of local non-banking assets and liabilities. Transactions with both subsidiaries and other related-branches are limited,

especially with the former ones, while balances due from non-US banks are relatively important and are likely to be mainly due from resident banks[12]. These branches can be defined as *locally implanted* given their limited scope of interoffice and cross-border banking transactions.

Lastly, branches in cluster 4 have more non-banks and non-US banks assets than non-bank liabilities which constitute a mere 22% of their activities. Non-bank assets are largely financed by the parent and related branches which finance almost 70% of the branches' total assets. Given the latter evidence, branches in this cluster can be identified *as liquidity importers*.

Locally-implanted branches feature the highest frequency, however, as shown in Table 1, the gross dollar amount of their activities is rather small. The relatively large share of observations falling in clusters 1 and 4, around 300 each, witnesses the global interdependence between US parent offices and their foreign branches. Liquidity conduits branches only feature 181 observations, implying that this function is limited to branches located in few branches only.

Table A1 in the Appendix reports the frequencies by cluster and by host country. In some countries the balance sheet structure of foreign branches of US banks has not changed dramatically, with all the observations falling in the same cluster over the observed sample. In other countries, the Great Recession has brought about considerable volatility in the balance sheet structure of branches, as it will be shown in the next section. The cluster of liquidity exporters features branches located in many OFC (the Bahamas, Cayman Islands) and countries such as Ireland, the Netherlands and Puerto Rico, which have depicted a consistently stable balance sheet structure over the whole sample. Branches located in Belgium, Channel Islands, Hong Kong and Japan, on the other hand, were liquidity exporters during most of the sample considered.

Branches located in England are liquidity-conduits with a stable balance sheet structure over the whole sample, while those in Australia, Belgium, Germany and Singapore are liquidity-conduits over most of the sample.

Locally-implanted branches are located mainly in Africa, Asia and South America: Australia, Canada and South Africa are among the host countries in which all or almost all the balance sheet observations fall into the third cluster.

Liquidity importers are those branches located in some European countries

[12] Unfortunately, the data disclosed by branches to the FFIEC does not allow to disentangle balances due to/from lo cal banks from other banks.

such as France, Spain and Switzerland whose observations all fall in this cluster. Branches located in countries such as Germany, Italy, Japan, Korea, New Zealand, Bahrain, Chile and Taiwan depict a large portion of observations in which the structure of their balance sheet is better described by this group.

III.II Within-cluster stability analysis

Frequencies by cluster and by country showed in Table A1 imply a certain degree of within-cluster instability for branches located in some countries over the observed sample.

Table A2 provides a within-cluster stability analysis by country of location of US banks' foreign branches. The balance sheet structure can be either *stable* (all or most of the observations falling in the same cluster), *regime-switching* (changing cluster at some break point either temporarily or permanently) or *volatile* (no clear pattern).

Branches located in 37 out of 77 countries depict a stable balance sheet structure. This is the case in those host countries in which branches have the largest size: England, Cayman Islands and Bahamas, implying that their role of liquidity-conduits and liquidity-exporters has not been disrupted by the crisis.

A limited number of host locations feature branches with a very volatile balance sheet structure; this is the case for those located in Macau, New Zealand, Sri Lanka, Tunisia, Virgin Island and Bahrain.

Lastly, branches that experienced a regime-shift in their balance sheet structure depict heterogeneous patterns.

In Italy, there is evidence of both volatility and regime switching: the balance sheet structure was volatile up to end-2010 where it stabilizes in the liquidity-importers cluster. Branches in Australia and Israel depict a cluster change only during a limited regime: Australian branches move from being locally-implanted to liquidity-conduit only during 2007q4-2011q2 and Israeli branches move from being locally-implanted to liquidity-importers during 2010q3-2012q2. Then, there are branches that change cluster after a brief volatile period; this is the case for Japan and Taiwan-based branches which in 2010 become liquidity importers after being liquidity exporters and locally implanted respectively. Branches located in other

countries such as Belgium, Germany, Hong Kong, Korea and Singapore, depict a one-off regime-change in their balance-sheet structure, i.e. without being preceded by a volatility period. In this latter group are found some host countries in which branches have a large volume of activities such as Hong Kong and Singapore, both moving from being liquidity exporters to liquidity importers and liquidity conduit respectively. Branches located in Singapore, in particular, have depicted the cluster change early in 2007. Branches located in Germany have moved away from being liquidity-conduits to liquidity-importers.

Overall, the evidence presented in Table A2 suggests that those branches which experienced a regime-shift during the crisis moved mainly to being liquidity-importers. This is particularly true for branches located in European countries which are, by sample-end, mostly all liquidity importers. This is, in all probabilities, due to the large dollar funding gap featuring banks in these countries at the crisis outburst (Fender and McGuire, 2010): branches had to increase their interoffice dollar borrowings either to repay their dollar-denominated debt or to lend to local banks. The same argument applies to branches located in Japan, which at the end of 2010 became liquidity importers (McGuire and von Peter, 2009). Furthermore, branches located in Hong Kong and Singapore, which as discussed earlier, have been the least affected by the crisis, have moved away from being liquidity exporters to increasing substantially their liabilities to US parents and related branches.

IV. Banking integration via branches: can it explain the international contagion of the Great Recession?

The contagion of the US-originated Great Recession to many countries worldwide was partly due to the global scope of banking operations. Yet, there is a lack of conclusive evidence that links direct financial exposure to the US to cross-border crisis transmission.

Rose and Spiegel (2010) could not find a significant relationship between financial linkages to the US and crisis incidence in a panel of 85 countries using a variety of bilateral exposure data[13]. In a similar fashion, (Rose, 2012) fails to find conclusive evidence in support of the fact the fact that a greater financial exposure

[13] Three measures of financial linkages are used are: US assets holdings, foreign assets and public guaranteed debt denominated in US dollars and Yen.

to the US, as measured among several measures by consolidated bilateral BIS claims, has resulted in a more severe crisis incidence.

Kalemi-Ozkan et al. (2013b) analyze whether banking exposure to the US, measured by locational banking assets and liabilities by the BIS, have increased output synchronization between country-pairs. The authors could not find a significant direct effect of US exposure on cycle synchronization; however, this relation becomes significant (and negative during normal times and positive during the crisis) when the exposure is considered in a broader sense by augmenting it with the positions vis-à-vis the Cayman Island.

This section of the paper aims to explore whether financial exposure to the US as measured by branches' balance sheet selected variables constitute a direct channel of international crisis transmission. The underlying rationale of this investigation is that the centralized organizational structure of global banks renders transactions with branches highly pro-cyclical with the cycle of the country of the head office. It can then be expected that those countries more exposed to US branches' operations have experienced a heightened cycle synchronization with that of the US.

To this extent, it is here tested whether synchronization of a country *i*'s output with that of the US is explained by US branches located in *i*'s total assets and intra-branch and interoffice gross positions. Following Kalemi-Ozkan et al. (2013b), output synchronization is measured by:

$$syncr_{i,US} = -\left|\left(log\ y_{i,t} - log\ y_{i,t-1}\right) - \left(log\ y_{US,t} - log\ y_{US,t-1}\right)\right| \qquad (2)$$

So that the higher (less negative) value corresponds to higher output synchronization of country *i* with the US. Output *y* is measured as quarterly real GDP and is collected from the OECD and the IMF World Economic Outlook Databases (see data appendix*)*. There are 26 countries included in the panel, i.e. i=1, …, 26 which constitute the *core* host locations, that is, those countries in which US branches are large enough to report for most quarters over the considered sample[14]. Those countries for which variables are available on mostly an annual basis are *secondary* locations in which on aggregate branches' activities are less pronounced; as it can be noticed, in most of these secondary locations branches are locally implanted (see *Table A3* for details).

The empirical framework is based on the baseline fixed-effect panel regression

[14] In only a few countries some missing observations-variables are encountered, to which a linear interpolation is applied.

of the following form:

$$syncr_{i,US,t} = \alpha_{i,US} + \gamma_t + \beta_1 CB_{i,US,t} + \beta_1 Trade_{i,US,t} + \beta_3 US\ branch\ variable_{i,t} + \boldsymbol{X}'_{i,US,t}\boldsymbol{\delta} + \varepsilon_{i,US,t} \quad (3)$$

Where $\alpha_{i,US}$ is the fixed effect dummy variable which accounts for all time-invariant country *i*-US unobserved characteristics and γ_t is the time dummy which accounts for those common/global factors which affect all countries cycle synchronisation with the US simultaneously. $CB_{i,US,t}$ represents consolidated cross-border claims of US banks on country i, collected from the CELS and $Trade_{i,US,t}$ accounts for trade inter-dependence between country i and the US[15]. $US\ branch\ variable_{i,t}$ accounts for balance sheet variables relating to US branches located in country i included in different specifications of the empirical estimation. These are: total assets in country *i*, gross due from head office and other branches of branches in country i, gross due to head office and other branches of branches in country i, interoffice assets and liabilities of branches in country i (i.e. gross due to/from head office and other branches plus due to/from consolidated subsidiaries). All balance sheet variables are divided by the real GDP of country i and transformed in logarithms. The vector $\boldsymbol{X}'_{i,US,t}$ includes interaction variables with crisis and clusters dummies and local claims of US affiliates as reported by the CELS, included in only one of the specifications. Table 5 reports the estimates of (3) for different specifications.

All specifications include bilateral trade interdependence with the US and US consolidated cross-border claims vis-à-vis country *i*. Trade interdependence is negative and weakly significant different from zero in only three specifications. Cross-border claims, on the other hand, are positive during tranquil times and negative during crisis[16], being significantly different from zero in most of the specifications mostly at 10% significance level. That is, cross-border claims are associated with high synchronization during normal times and can be then considered as a good measure of financial integration. However, the important retrenchment of cross-border claims of US banks observed during the crisis is

[15] Two trade measures are used in the empirical analysis: US-country *i* imports plus exports to GDP of country i and US exports to i to GDP of country i. The reported estimates of the regression refer to specifications with US exports to i to GDP of country i.

[16] The crisis dummy takes the value of one from 2007q4 until sample-end 2014q4 given the persistent disruptions in global banking that have been observed beyond 2009.

associated with a divergence in business cycle with the US in the panel of countries considered. On the other hand, the opposite effect is observed when considering branch-related variables. Branch-related variable are all strongly significant and negative during normal times. This result is similar to what found in Kalemi-Ozkan et al. (2013b) for their measure of financial integration[17].

Interaction variables with country clusters yield a better understanding of the effect of banking integration via branches of US banks on cycle synchronization with the US. Most notably, the negative and significant effect of the branch-related variable is mainly driven by countries in which US branches are locally implanted. Indeed, the interaction variable with cluster 3 is negative and significant, at different confidence levels, in all specifications (1)-(5). In those countries in which US branches act as liquidity conduits and liquidity exporters, on the other hand, higher interoffice liabilities and total assets respectively lead to more output synchronization over the whole sample. In other words, in those host locations in which US banks' branches are liquidity conduits, the more interoffice liabilities of these branches the more business cycle synchronisation with the US. Similarly, in those host locations in which US banks' branches are liquidity exporters, the more total assets of these branches the more business cycle synchronisation with the US.

Branch-related variables during the crisis are, on the other hand, positive and strongly significant in specifications (1)-(5), which differ in terms of the type of branch-related variable used. This evidence implies that countries in with large US branches' operations witnessed more synchronization with the US cycle during the crisis. In particular, this result is very robust across specification and the estimated coefficient of the branch-related variable post-crisis is about 0.1 in all cases.

[17] Kalemi-Ozkan et al. (2013b) argue that the negative and significant estimated coefficients of banking integration might be due to endogeneity issues. However, in Kalemi-Ozkan et al. (2013a) it is found that addressing the endogeneity issue with the use of instrumental variables does not lead to quantitatively important effects of synchronization of banking integration. The endogeneity might well arise from the fact that banks diversify risk during normal rimes by expanding their activities in countries which are on a different phase of business cycle.

Table 5: Fixed-effects panel estimation

	Dependent variable: GDP synchronization with the US					
Explanatory variables	**1**	**2**	**3**	**4**	**5**	**6**
Trade	-0.174**	-0.150	-0.166*	-0.158*	-0.131	-0.148
	(-1.967)	(-1.543)	(-1.642)	(-1.782)	(-1.463)	(-1.565)
CELS Cross-border claims	0.162*	0.178**	0.157*	0.168*	0.154*	0.132
	(1.861)	(1.961)	(1.802)	(1.867)	(1.781)	(1.550)
CELS Cross-border claims*crisis	-0.096*	-0.144**	-0.107*	-0.113**	-0.086*	-0.069
	(-1.869)	(-2.130)	(-1.765)	(-2.037)	(-1.646)	(-1.237)
Branch-related variables						
Due to head office and other branches	-0.120***					
	(-3.961)					
Due from head office and other branches		-0.086***				
		(-3.167)				
Interoffice assets			-0.108***			
			(-3.400)			
Interoffice liabilities				-0.119***		
				(-4.273)		
Branch assets					-0.131***	
					(-3.777)	
Branch-related variable*crisis	0.092***	0.104***	0.091***	0.098***	0.103***	
	(3.052)	(3.340)	(3.167)	(2.991)	(3.091)	
Other variables						
branch-related variable*cluster 1	-0.024	-0.097	-0.118	0.044	0.754**	
	(-0.179)	(-0.492)	(-0.552)	(0.259)	(2.141)	
branch-related variable*cluster 2	0.106*	0.083	0.000	0.152**	0.138	
	(1.670)	(1.130)	(0.004)	(3.303)	(0.980)	
branch-related variable*cluster 3	-0.100*	-0.102**	-0.124**	-0.105*	-0.241***	
	(-1.756)	(-2.116)	(-2.261)	(-1.680)	(-2.849)	
CELS Local claims						-0.124**
						(-2.498)
CELS Local claims*crisis						0.049
						(1.010)
Countries	26	26	26	26	26	26
Observations	1040	1040	1040	1040	1040	1040
R-squared	0.48	0.49	0.48	0.48	0.48	0.47

Notes: The table reports panel fixed-effect estimates of regression 3. Each model includes a time dummy. The dependent variable is expressed in percentage terms. All the explanatory variables are dived by GDP of branches' resident country and are in logarithms. Interoffice assets and liabilities refer to positions of US branches located in county i with head offices, related branches and consolidated subsidiaries altogether. The crisis dummy takes the value of 1 from 2007q4 and zero otherwise. Cluster dummies refer to the type of balance sheet structure of US branches by country of location. Cluster 1 is equal to one if branches are liquidity exporters, zero otherwise; Cluster 2 is equal to one if branches are liquidity channelling, zero otherwise; Cluster 3 is equal to one if branches are locally implanted, zero otherwise; Cluster 4 is equal to one if branches are liquidity importers, zero otherwise; t statistics are in parentheses. ***, **, * indicate statistical significance at 1, 5, and 10 percent levels, respectively. A constant (unreported) is added to each specification. Local claims refer to the local claims reported in the CELS of both branches and affiliates located in country i.

Specification (6), considers as measure of banking integration local claims of all US offices, that is, branches and subsidiaries, as reported by the CELS. During the crisis, this measure is positive but not significant, implying that the branch-related measure of banking integration outperforms the related but broader measure reported by the CELS. In tranquil times, on the other hand, local claims by the CELS are negative and significant at 5% confidence level.

V. Conclusions

This paper has attempted to unveil the geographical map and the balance sheet structure of foreign branches of US global banks with the intent to gain further understanding of the international financial linkages created by US banks. The empirical analysis is centred on a customised dataset including balance sheet statistics based on data disclosed by foreign branches of US banks to the FFIEC.

Evidence shows that the main scope of branches on a worldwide basis is to channel liquidity across the banking group and that the crisis has brought about a considerable reduction of interoffice transactions. The geographical pattern, which takes into account gross interoffice positions and transactions with third-countries, reveal considerable gaps with the consolidated CELS statistics, mainly due to large interoffice transactions of branches located in England and in OFC which are not accounted for by the latter.

A portioning-based clustering analysis allows for the grouping of branches by balance sheet structure and by host country. Four distinct clusters classify foreign branches as *liquidity importers*, *liquidity exporters*, *liquidity conduits* and *locally implanted*. A within-cluster stability analysis reveals that the structure of the branches' balance sheet in those countries with the highest activities, such as England, Cayman Island and the Bahamas, has not been disrupted by the crisis. On the other hand, branches located in some European countries and in major Asian International financial Centers have become liquidity importers from internal capital markets probably due to the disruptions in dollar funding market.

While other bilateral measures of direct financial exposure to the US, used in other studies, have failed to link financial integration to crisis contagion, the last part of the empirical analysis shows that the operations of US banks' foreign branches can significantly explain the contagion from the US to the rest of the world of the Great Depression.

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Appendix

Table A1. Cluster frequency by host country

Country	Cluster 1	Cluster 2	Cluster 3	Cluster 4
ABU DHABI	1		30	
ALGERIA			20	
AMERICAN SAMOA			1	
ARGENTINA			37	
ARUBA		1		
AUSTRALIA		15	25	
BAHAMAS	40			
BAHRAIN	6		1	22
BANGLADESH			9	
BELGIUM	18	22		
BRAZIL		18		
BRITISH VIRGIN ISLANDS	2		8	
BRUNEI	11			
BULGARIA			7	
CAMEROON			1	
CANADA		1	38	1
CAYMAN ISLANDS	40			
CHANNEL ISLANDS	36	4		
CHILE			16	18
CHINA			28	4
DOMINICAN REPUBLIC			8	
DUBAI			7	
ECUADOR			7	
EGYPT			18	
EL SALVADOR			1	
ENGLAND		40		
FRANCE				36
GABON	2			
GERMANY		27		13
GREECE	1			
GUAM			9	
GUATEMALA		1	1	
HAITI			1	
HONG KONG	24	1	1	14
INDIA			40	
INDONESIA			40	
IRELAND	33			
ISRAEL	1		14	7

Notes: The table reports the frequencies of each group by country of location of the foreign

branches. Groups are assigned by means of clustering k-means analysis with the Gower distance measure.

Table A1 (continued). Cluster frequency by host country

Country	Cluster 1	Cluster 2	Cluster 3	Cluster 4
ITALY	2	6	1	27
JAMAICA			1	
JAPAN	17	4	2	17
JERSEY	1			
JORDAN			9	
KENYA			9	
KOREA, SOUTH			6	34
KUWAIT	3		4	
LEBANON			1	
MACAU	3		5	
MALAYSIA		1		
NETHERLANDS	11			
NEW ZEALAND	1	4	4	14
N. MARIANA ISLANDS	1			
PAKISTAN			9	
PALAU			1	
PANAMA			9	
PARAGUAY			8	
PERU				1
PHILIPPINES			40	
PUERTO RICO	40			
QATAR			1	1
SAUDI ARABIA				3
SENEGAL			1	
SINGAPORE	8	32		
SOUTH AFRICA	2		38	
SPAIN				29
SRI LANKA			4	2
SWITZERLAND				25
TAIWAN	1	4	14	21
THAILAND			40	
TUNISIA			5	4
TURKEY				3
UK (other than ENGLAND)	1			1
URUGUAY			9	
VENEZUELA			9	
VIETNAM	6		7	

VIRGIN ISLANDS	8	2

Notes: The table reports the frequencies of each group by country of location of the foreign branches. Groups are assigned by means of clustering k-means analysis with the Gower distance measure.

Table A2: Within-group stability analysis, by country

Country	Country-level group stability classification	Main break/ regime period	Clusters instability details
AUSTRALIA	Regime-shifting	07q4 11q2	From 3 to 2 only during the regime period
BAHRAIN	Volatile		From 4 to volatile after 2011
BELGIUM	Regime-shifting	09q1	From 1 to 2
BRITISH VIRGIN ISLANDS	Regime-shifting	13q4	From 3 to 1
CHILE	Regime-shifting	10q4	From 3 to 4
GERMANY	Regime-shifting	11q2	From 2 to 4
HONG KONG	Regime-shifting	11q1	From 1 to 4
ISRAEL	Regime-shifting	10q3 12q2	From 3 to 4 only during the regime period
ITALY	Volatile/Reg.-shifting		Stabilising at 4 in 2010q4
JAPAN	Regime-shifting	10q4	From 1 to 4 and volatile during regime period
KOREA, SOUTH	Regime-shifting	06q4	From 3 to 4
KUWAIT	Regime-shifting	11q4	From 1 to 3
MACAU	Volatile		
NEW ZEALAND	Volatile		
SINGAPORE	Regime-shifting	07q1	From 1 to 2
SRI LANKA	Volatile		
TAIWAN	Regime-shifting	08q1 10q1	From 3 to 4 and volatile during regime period
TUNISIA	Volatile		
VIETNAM	Regime-shifting	12q4	From 3 to 1
VIRGIN ISLANDS	Volatile		

Notes: The classifications are attributed according to the following criteria: Regime-Switching: changing cluster at some break point either temporarily or permanently, Volatile: no clear pattern is detected. Clusters numbers in the last columns refer to branches balance sheet structure in the host country: 1 for liquidity exporters, 2 for liquidity conduits, 3 for locally implanted and 4 for liquidity importers.

TABLE A3: Core host locations used in the estimation

ABU DHABI	INDONESIA
ARGENTINA	IRELAND
AUSTRALIA	ISRAEL
BAHRAIN	ITALY
BELGIUM	JAPAN
CANADA	KOREA
CHILE	PHILIPPINES
CHINA	SINGAPORE
ENGLAND	SOUTH AFRICA
FRANCE	SPAIN
GERMANY	SWITZERLAND
HONG KONG	TAIWAN
INDIA	THAILAND

Notes: Cayman Islands, the Bahamas and Channel Islands are also core locations but are excluded in the regression.

Data Appendix

Real GDP

The main source is Real GDP from the OECD National Accounts.

Real GDP from the World Economic Outlook (WEO) database from the International Monetary Fund is used for the following countries only: Abu Dhabi, Bahamas, Bahrain, China, Hong Kong, Philippines, Singapore, Taiwan, Thailand. Data from the WEO database is annual and is transformed in quarterly basis via the quadratic match average method. Real GDP for Abu Dhabi is unavailable and the variable for United Arabic Emirates is used instead.

Bilateral Trade

Two measures are used in order to evaluate trade interdependence of country i with the US.

Measure 1. Exports of i to US to Real GDP of i

Measure 2: Exports of i to US plus imports of i from US to Real GDP of i.

Source: US Census, imports and exports. Data for United Arabic Emirates is used for Abu Dhabi (unavailable) and for England the variables refer to the UK.

CELS/FFIEC009

Two series are used in the empirical analysis from the Country Exposure Lending Survey (CELS, report E.16 of the FFIEC): cross-border claims and local claims of foreign affiliates (branches and subsidiaries). Data is available from the FFIEC website: https://www.ffiec.gov/e16.htm.

Data for United Arabic Emirates is used for Abu Dhabi (unavailable) and for England the variables refer to the UK.