

Big Data Techniques for Measuring Global Flow of Funds*

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Abstract

Big data refers to the conventional software tools in a certain period to crawl the content management and the data set. Big Data Technology (BDT) refers to the various types of data, the ability to quickly obtain valuable information. It is suitable for big data technology, including database, data mining, distributed file system, distributed database, cloud computing platform, the Internet, and scalable storage system. BDT can also be used to compile monetary and financial statistics, especially to measure the Global Flow of Funds (GFF). This paper is focuses on building a statistical framework for measuring GFF, explore how to use BDT to integrates the data sources, and improve the timeliness of the existing data transmission. Applying BDT to measure GFF can provide important basis for policy authorities to guard against financial risks.

Keywords: Global Flow of Funds, Statistical Framework, Data Sources, Big Data, Data Gap

1. Introduction

Global Flow of Funds (GFF) is an extension of the domestic flow of funds. It connects domestic economies with the rest of the world. GFF data could provide valuable information for analyzing interconnectedness across borders, global liquidity flows, and global financial interdependencies. Corresponding to a sharp change in the financial market, a few researchers

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began looking at the GFF beginning in the 1990s. Ishida (1993) put forward the idea of GFF analysis, discussed the concept of GFF, and measured the international capital flows between Japan, the U.S., and Germany. He extended the scope of flow-of-funds analysis from the national to global level and suggested international capital flows should be included in the GFF.

In April 2009, the G20 Finance Ministers and Central Bank Governors Working Group on Reinforcing International Co-Operation and Promoting Integrity in Financial Markets called on the International Monetary Fund (IMF) and the Financial Stability Board (FSB) to identify information gaps and provide appropriate proposals for strengthening data collection and reporting back to the Finance Ministers and Central Bank Governors. As a result of this meeting, the IMF and FSB proposed maintenance and expansion of the existing statistics in October 2009. The principal focus was Recommendation 15, as financial and economic crises are characterized by abrupt revaluations or other changes in the capital positions of key sectors of the economy. Recommendation 15 states that, “the IAG, which includes all agencies represented in the Inter-Secretariat Working Group on National Accounts, to develop a strategy to promote the compilation and dissemination of the Balance Sheet Approach (BSA), Flow of Funds, and sectoral data more generally, starting with the G-20 economies. Data on nonbank financial institutions should be a particular priority,” etc.¹ Thus, Recommendation 15 also implies, through its reference to compiling “flow of funds” statistics, the compilation of breakdowns of financial positions and flows of each economic sector by its counterparty sectors. Datasets providing this kind of information are said to provide “from-whom-to-whom (W-to-W)” financial statistics. In such a situation, we also need to understand and measure the flow of funds between countries, namely the Global Flow of Funds (GFF).

Shrestha, Mink and Fassler (2012) described the importance of using an integrated approach for the compilation of financial flows and positions on a from-whom-to-whom (W-to-W) basis, one of the main components of Recommendation 15 of the G20 Data Gaps Initiative. The global financial crisis of 2008 highlighted the need to understand financial interconnectedness among the various sectors of an economy and their counterparties in the rest of the world. However, the application of this kind of analysis has been hampered due to inadequate data. This paper discusses the development of statistical methodologies and data availability, supporting the compilation of partial data on a W-to-W basis.

Stone (1966) set up the balance sheets of a closed economy in a standard matrix form, distinguishing between financial assets and real assets on the assets side and between liabilities to third parties and liabilities to self on the liabilities side. In Stone’s (1966) matrix, the first n row and column pairs relate to sectors; each row contains a sector’s assets, and the corresponding column contains its liabilities. The following m row and column pairs relate to financial claims; each row contains the holdings of a particular claim as a liability, and the corresponding column contains the holdings of the same claim as an asset. The penultimate row and column pair relate

¹ Financial Stability Board and International Monetary Fund (2009). The Financial Crisis and Information Gaps—Report to the G-20 Finance Ministers and Central Bank Governors, p.10.

to the real assets and accumulated saving in the various sectors, and the final row and column pair simply relate to totals. This paper considers that it was also a matrix based on the W-to-W format.

On the other hand, there is international awareness of the issue that existing statistical data do not describe the risks inherent in a financial system. Previous research has evolved into a discussion of the basic concept of GFF and a proposal to establish a statistical framework for GFF (Zhang, 2005; Tujimua, 2008). The recent global crisis showed how easily shocks in one country are transmitted and amplified as well as how liquidity in financial markets spread quickly across national borders. Therefore, the IMF's Statistics Department has already organized seven economies with systemically important financial centers to construct a GFF mapping domestic and external capital stocks, with a geographical break down (Luca et al., 2013). The main purpose of Luca et al. is to conceptually map the financial interlinkages reflected in the Balance of Payments (BOP) and the International Investment Position (IIP) statistics and in the "rest-of-the-world" (ROW) account of national accounts. The paper sets out the concepts and existing data sources. The Balance Sheet Approach is used to break down the rest of the world by IIP components. An external statistics' matrix (metadata) exercise shows what external-sector financial data are available by using IIP concept. The main outcome is a prototype template of stock and flow data, geographically broken down by national/regional economies.

Another working paper on GFF was published by Luca et al. in 2014, which presents an approach to understanding the U.S. shadow banking system using a new GFF conceptual framework developed by the IMF's Statistics Department. The GFF uses external stock and flow matrices to map claims between sector–location pairs. Their findings highlight the large positions and gross flows of the U.S. banking sector (ODCs) and its interconnectedness with banking sectors in the Euro area and United Kingdom. European counterparties are large holders of U.S. other financial corporations (OFCs) debt securities. Luca et al. (2014) also explore the relationship between credit to domestic entities and the growth of non-core liabilities.

This means that observation of GFF has not remained mere theoretical research, but has entered the stage of experiment and statistical application. In order to measure financial stress and observe the spillover effect of systematic financial crises through GFF and to observe the situation triggering an international financial crisis, research on creation and analysis of GFF statistics is further needed.

Zhang (2016)'s paper reviewed the definition of GFF, clarified the integrated framework for measuring GFF, and attempted to carry out the compilation of the GFFS for external financial positions and flows on a from-whom-to-whom basis. In addition, it will potentially fill some important data gaps in currently available macroeconomic statistics. The paper elaborated on the main attributes of the integrated macroeconomic accounts and the GFF matrix, which allows it to serve as the framework for compiling sector accounts, including financial positions and flows on a from-whom-to-whom basis.

However, for GFF statistics creation, integration of data sources and timely collection of data are very important issues. This paper referenced "the report of the Financial Crisis and Information Gaps" that was prepared by the FSB and the IMF (2009) and BDT. The main purpose

of the paper is to measure GFF and apply the result to regular monitoring of the GFF. The composition of this paper is as follows. Firstly, according to the concept of GFF (Zhang, 2005), this paper will make an integrated framework for measuring GFF. Secondly, data sources and approach, is also very important. The paper sets out the concepts and existing data sources, and the BSA is used to break down the rest of the world by components of IMF data sources and BIS data sources. The third part, the paper will discuss how to use big data technology to resolve the integration of data sources, and to collect data timely for measuring GFF. The main outcomes and the issues which remain are summarized within the conclusion.

2. Statistical Framework of Global Flow of Funds

In order to measure financial stress and observe the spread effect of systematic financial crises through GFF, a new statistical framework is needed that corresponds to the operational structure of GFF. Especially, an integrated framework should be used as the foundation of a statistical monitoring system. When the flow of funds in financial markets is tied up with the balance of payments, the rest of the world sector will have an excess of outflowing funds (net capital outflows) if the current account is in surplus. Conversely, the domestic sector will have an excess of inflowing funds. Therefore, when the real economic side of the domestic and overseas economy is analyzed under an open economic system, the balance of savings-investment in the domestic economy corresponds to the current account balance. However, the outflow of domestic net funds corresponds to the capital account balance when we examine the financial relationship between domestic and external flows of funds. For this reason, relationships among the domestic savings-investment balance, financial surplus or deficit, current account, and external flow of funds should be expressed in an integrated framework to enable joint routine monitoring of GFF.

Table 1 is in accordance with IIP statistical standards and is based on a structure wherein the from-whom-to-whom data are used to establish the GFF statistical framework, and is keeping the double-entry principle. According to the statistical standards of IIP, which are based on Balance of Payments and sixth edition of the International Investment Position Manual (BPM6), the IIP can be set as the foreign financial assets and external debt. Each column corresponds to the balance sheet of a country in question, with country, assets, and liabilities then listed in rows by instrument with the counterparty country identified for each cell.

Table 1 provides a statistical framework for deriving the GFF matrix. Assets are subdivided into five parts: direct investment, portfolio investment, financial derivatives, other investments, and reserve assets; the liabilities are divided into four parts: direct investment, portfolio investment, financial derivatives, and other investments. The net financial position is external financial assets plus reserve assets minus liabilities. By this statistical framework, the GFF statistics can reflect stock information of financial assets and liabilities between the world and a region at a particular time. However, the GFF statistics remain consistent with IIP Statistics Standard, and also have its unique statistics establishment method, which can be summarized as follows:

Table 1. Global Flow of Funds Matrix for a Country

Holder of liability (creditor)	Financial Instruments	Rest of the World	Country A	Country B	...	All Other Economies	Total Liabilities of Financial Instruments	Total Liabilities
Issuer of liability (debtor)								
Rest of the World	Direct investment Portfolio investment Financial derivatives Other investment							1 2 3 4
Country A	Direct investment Portfolio investment Financial derivatives Other investment							5 6 7 8
Country B	Direct investment Portfolio investment Financial derivatives Other investment							9 10 11 12
.....							13
All other economies	Direct investment Portfolio investment Financial derivatives Other investment							14 15 16 17
Total Asset of Financial Instruments	Direct investment Portfolio investment Financial derivatives Other investment							18 19 20 21
Total Asset								22
Net Worth								23
Reserve assets								24
Monetary gold								25
Special drawing rights								26
Reserve position in the fund								27
Other reserve assets								28
Net error and omission								29
Net Financial Position								30

(1) In order to reflect the relationship between W-to-W, GFF statistics use the parallel processing method wherein transaction and countries (sectors) are rows, namely, by putting the transaction items that direct investments, securities investments, financial derivatives, and other investments to countries (sectors) in the rows, whereas each country (sector) is in the columns. Accordingly, we can determine the dual relationship of a transaction item in countries (sectors), which can show the scale of the transaction item and reflect from-whom-to-whom-by-what relationships in a two-way format. For example, a5–a8 in the table show the rest of world transactions in a country in the columns by showing which financial instruments are used for transactions bringing how much funds to country A that in the row. As this can provide two-way

information about the financing structure of rest of world in a country with country A, we also can know the financing scale and corresponding information on counterparties. At the same time, we can also get the information of where country A is located in the row vectors from other countries to raise funds and total amount. We can also get relevant information on country B in the row vectors on its fundraising from the rest of the world, country A, etc.

(2) To reflect the actual situation of international capital in a country or a region, and in order to establish the GFF matrix table for the application analysis, we set countries (sectors) in rows and columns by the principle of W-to-W tabulating. We also designed an “All Other economies” sector (see the column e and row 9–12 that can be represented as e9, e10, e11, e12). The relationship of these “All Other economies” and the world total can be expressed as the follows: “Liabilities of All Other economies” = Total Liabilities – Liabilities of the total for specific countries. That is, $e9=f9-(a9+b9+c9+d9)$, ..., $e12=f12-(a12+b12+c12+d12)$.

(3) Each “column” shows a country how to use funds by transaction item, namely, who outputs how much funds by what item; each “row” represent how a country raises funds through four financial instruments, namely, who inputs how much funds by what item. The difference between the total of the row and column in row 23, which shows the balance between use of external funds financing for a certain country at a particular point in time, that is, the net output of funds. For instance, Country A's net worth equals country A's total asset minus its total liabilities, that is, $b23=b22-(g5+g6+g7+g8)$.

(4) Corresponding to the various transaction instruments of various countries, rows 24–28 show part of the reserve assets, specifically monetary gold, special drawing rights, reserve positions in the fund, and other reserve assets. Put reserve assets as an instrument in Table 1 is to show a balance relationship between net worth and net financial position, and also is can show its components. For example, country A's component of reserve assets, can show as $b24=b25+b26+b27+b28$.

(5) The bottom row in Table 1, namely row 30, reflects net international investment position. The data are gathered from IIP, in order to reflect overall equilibrium conditions of external financial position in a country, need to set the Net error and omission in row 29. Net financial position of each country is calculating using net worth that also can call as net financial investment plus the total reserve assets and the net error and omission, such as $a30 = a23 + a24 + a29$, ..., $e30 = e23 + e24 + e30$.

(6) Because the main purpose of preparing the GFF matrix table is to observe the cross-border capital positions and flows, so the diagonal line elements in GFF matrix are zero, namely, each transaction is a domestic to a foreign country and does not include a country's internal financial investments. In fact, as the data sources (CDIS, CPIS, and CBS) are also in accordance with observation of cross-border capital positions to the statistical classification, these data sources can fulfill the conditions that each diagonal line elements in the GFF matrix needs to become zero.

3. Data Sources for Measuring Global Flow of Funds

The GFF metadata should be based on existing statistical data and therefore share many similarities of approach with them. The GFF data sources include not only the “rest-of-the-world” account of national accounts, but also monetary and financial statistics, IIP statistics, and BIS international banking statistics. The prototype template for the main data is shown in Figure 1. There are two metadata sources for measuring GFF: (1) data sources for making the DAL matrix, and (2) data sources for establishing the EAL matrix. These two matrices thus cover the DAL and the EAL, and they could be extended to flow data. We will discuss the two data sources, which summarize the concepts, draw out what data are available, and identify the major data gaps.

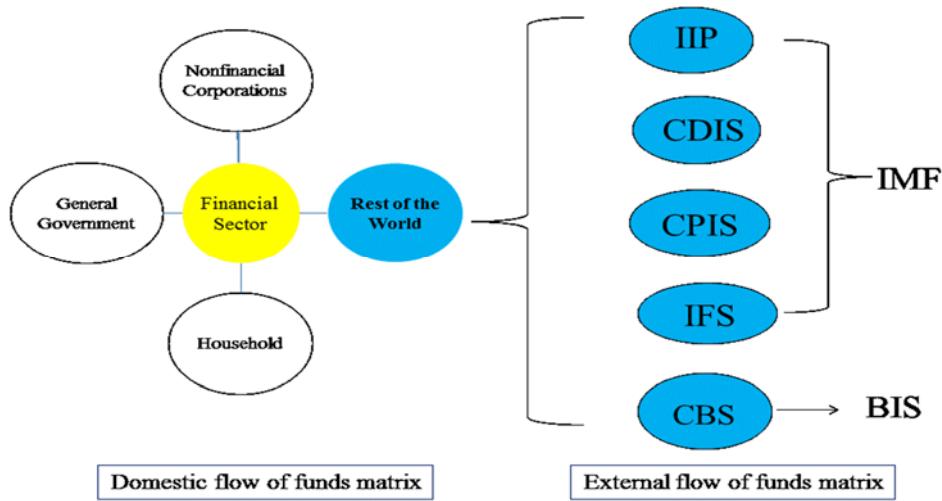


Figure 1. Prototype template for measuring GFF

The DAL matrix is based on the Balance Sheet Approach (BSA), with the rest of world sector data drawn from the national accounts and IIP. The EAL matrix presents metadata on whatever external sector financial stock data are available by IIP category, drawing on IMF and BIS data sources. The IIP is the link between domestic and external matrices. This paper will focus on the EAL data sources and integrate with the economic variables to establish the GFF matrix.

Data from IMF's Monetary and Financial Statistics, IIP, and the national accounts are used to derive the BSA matrix. The BSA matrix can provide information about a country's or region's financial corporations' stock positions for residents and nonresidents. In the EAL matrix, the datasets with bilateral counterpart country details are collected by the IMF and BIS as Table 2

(1) Foreign direct investment: The Coordinated Direct Investment Survey (CDIS) provides bilateral counterpart country details on “inward” direct investment positions (i.e., direct investment into the reporting economy) cross-classified by the economy of immediate investors. It also provides data on “outward” direct investment positions (i.e., direct investment abroad by the reporting economy), cross-classified by the economy of immediate investment, as well as mirror data for all economies. The CDIS database contains breakdowns of direct investment position data, including, in most instances, separate data on net equity and net debt positions, as

well as tables that present “mirror” data².

(2) Portfolio investment: The Coordinated Portfolio Investment Survey (CPIS) provides bilateral counterpart country details covering holdings of asset stock positions by reporting economies and derived liabilities for all economies. The CPIS’s purpose is to improve statistics on holdings of portfolio investment assets in the form of equity, long-term debt, and short-term debt. It is also used to collect comprehensive information, including geographical detail on the issuer’s country of residence, stock of cross-border equities, long-term bonds and notes, and short-term debt instruments, for use in the compilation or improvement of IIP statistics on portfolio investment capital.

Table 2. Datasets for Measuring Global Flow of Funds

Items	Data source	Frequency	Geographic coverage	Latest update	Temporal coverage	Benchmark	Web address
Direct Investment	CDIS (IIP)	Annual	106 reporters on Inward 71 reporters on Outward Cross-classified	12/12/2016	beginning end-2009	BPM6	http://cdis.imf.org
Portfolio Investment	CPIS (IIP)	Annual Semi-annual Cross-classified	86 reporters 72 reporters	03/23/2017	beginning end-2001 beginning end-june 2013	BPM6	http://data.imf.org/
Financial Derivative	CPIS IIP	Annual & Quarterly Annual & Quarterly		03/31/2017 05/24/2017	beginning end-june 2013	BPM6	http://data.imf.org/
Other Investment	LBS by BIS	Quarterly	46 reporters by locational basis	04/20/2017	Q1.1999-Q4.2016	SNA, BPM6	http://stats.bis.org/stat
	CBS by BIS	Quarterly	31 reporters by ultimate risk basis	04/20/2017	Q2.1998-Q4.2016		http://stats.bis.org/stat
	IIP	Annual & Quarterly					
Reserve Assets	IFS	Annual, Quarterly Monthly	194 reporters	05/24/2017	beginning 1948	SNA, MFS, BPM6	http://data.imf.org/
	COFER	Quarterly	146 reporters	03/31/2017	beginning 1999	BPM6	http://data.imf.org/
	IIP	Annual Quarterly	152 reporters 152 reporters	05/24/2017	from 1945 onward from 2009 onward	BPM6	http://data.imf.org/

Notes: IMF, <http://data.imf.org/?sk=388DFA60-1D26-4ADE-B505-A05A558D9A42&sId=1469115547122>

BIS, <http://stats.bis.org/statx/toc/LBS.html>; <http://stats.bis.org/statx/toc/CBS.html>, June 1, 2017.

(3) Other investment: Other investment is a residual category that includes positions and transactions other than those included in direct investment, portfolio investment, financial derivatives and employee stock options, and reserve assets³. Other investment includes (a) other equity; (b) currency and deposits; (c) loans (including use of IMF credit and IMF loans); (d) nonlife insurance technical reserves, life insurance and annuity entitlements, pension entitlements, and provisions for calls under standardized guarantees; (e) trade credit and advances; (f) other accounts receivable/payable; and (g) SDR allocations (SDR holdings are included in reserve assets). In order to reflect the bilateral counterpart country for loans, deposits, and other assets

² The term “mirror” data refers to the tables in which data from the reporting economy are shown side-by-side with the data obtained from all other counterpart reporting economies.

³ IMF, *Balance of Payments Manual*, 6th edition (BPM6), 111, 2014.

and liabilities, this paper uses the related dataset with BIS International Banking Statistics (IBS) instead of IIP Statistics.

(4) The BIS compiles and publishes two sets of statistics on international banking activity, namely the Locational Banking Statistics (LBS) and Consolidated Banking Statistics (CBS). LBS provide information about the currency composition of banks' balance sheets and the geographical breakdown of their counterparties. They capture outstanding claims and liabilities of banks located in 46 reporting countries⁴, including intragroup positions between offices of the same banking group. The locational statistics are compiled following principles that are consistent with balance of payments. CBS measure banks' country risk exposures. They capture the worldwide consolidated claims of internationally active banks headquartered in BIS reporting countries which include 31 countries. The consolidated statistics include the claims of banks' foreign affiliates but exclude intragroup positions, similarly to the consolidation approach followed by banking supervisors. They detail the transfer of credit risk from the immediate counterparty to the country of ultimate risk (where the guarantor of a claim resides). This paper utilizes CBS⁵ in the dataset because it measures banks' country risk exposures. The CBS data capture the worldwide consolidated claims of internationally active banks headquartered in BIS-reporting countries. The consolidated statistics include claims of banks' foreign affiliates but exclude intragroup positions, similar to the consolidation approach followed by banking supervisors. They detail the transfer of credit risk from the immediate counterparty to the country of ultimate risk (where the claim guarantor resides). In addition, CBS data provide quarterly information on claims and liabilities of banks vis-à-vis banks and nonbanks in other countries worldwide based on the country of ultimate risk or residence of the creditor bank and can also be used to mirror data for non-reporting countries. The CBS data can be used in the external statistics' matrix.

(5) For data on reserve assets, we obtained the data template from the IIP, and the Currency Composition of Official Foreign Exchange Reserves (COFER) provide country-level data, while the Survey of Securities Held as Foreign Exchange Reserves (SEFER) provides counterpart country data for all SEFER reporters as a group. To supplement data on reserve assets, International Financial Statistics (IFS), which includes World Total Reserves, World Gold, World Reserve Position in the Fund, World SDR Holdings, and World Foreign Exchange, can also be used.

But no matter what kind of reserves assets data are not counterparty information, it cannot constitute a matrix form, and neither can it reflect the relationship between countries based on W-to-W form. Therefore, in order to observe the balance of a country's external assets and overall liabilities; as a reference, IIP data alone can be used to fill the cell on reserve assets.

⁴ Countries reporting the international banking statistics are shown by
http://www.bis.org/statistics/rep_countries.htm

⁵ A BIS-organized data collection that measures banks' country risk exposures. It captures the worldwide consolidated positions of banks headquartered in BIS reporting countries, including positions of their foreign affiliates but excluding intragroup positions. Central banks or other national authorities collect data from internationally active banks headquartered in their jurisdiction, compile national aggregate data, and then report these to the BIS to calculate global aggregates.

In order to observe the overall net position, in this paper, IIP data have been used to supplement the data for constructing the EAL matrix. The IIP is a subset of a national balance sheet, the net IIP plus the value of nonfinancial assets equaling the net worth of the economy, which is the balancing item of the national balance sheet. The IIP relates to a point in time, usually at the beginning (opening value) or the end (closing value) of the period.

GFFS can provide a statistical framework if concepts, definitions, and classifications underlying these statistics are standardized across economies. Fortunately, these standards can be obtained from 2008SNA, the IMF's Monetary and financial statistics manual and compilation guide (2016) and Balance of Payments Manual (BPM6), and the BIS's Guidelines for Reporting the BIS International Banking Statistics. Based on the statistical framework and data sources described above, we tried to compile the GFF statistics matrix, as shown in Table 3. Confined to the length of the paper, we omit the description of Table 3, which will discuss it in other paper.

4. Big Data in Global Flow of Funds

When we read Table 3, we can know that it is not easy to compile this table. It needs to use many different data sources with different statistical criteria, and some of which had a long lag time. Through the above research of constructing statistical framework and arranging data sources, we can conclude that the key problem for establishing GFF statistics is the benchmark of data sources and timeliness of data reporting. Some data that are compiled by IMF and BIS which both based on the BPM6, but some parts of the data are overlapping. For example, CPIS is compiled by IMF, which mainly consists of securities statistics, while banking statistics are made by BIS, but banking credit business also include some securities trading. That is, data collected from different sources have some overlapping and omitted. If we can make a same benchmark for data sources, it will facilitate in data collection and improve the quality of data. If we improve the timeliness of reporting data, it will be easy to data compilation, thereby ensure the timeliness of data publication.

4.1 Way Need to Use Big Data Technology for Measuring GFF

Therefore, we need to solve two issues for establishing GFF. One is to clear benchmarks on data source; and another is to use Big Data techniques to solve the standardization of data transmission, reduce statistical errors, and improve the timeliness of data publication to reflect the changes of financial risk. As shown in Table 2, the lag of the data published by CDIS is more than one year, and the lag period of CPIS publication is 6 months, which cannot meet the needs of financial regulation. In the following sections, we will focus on applying big data technologies to solve the standardization of data transmission and to improve data timeliness.

Big data is a term for data sets that are so large or complex that traditional data processing application software is inadequate to deal with them. Challenges include capture, storage, analysis, data curation, search, sharing, transfer, visualization, querying, and updating and information privacy. Big data can be described by the following five basic characteristics.

Table 3. Example GFF Matrix (millions of US dollars, End-December 2015)

Holder of claim (creditor)	Financial Instruments	Canada	China	France	Germany	Italy	Japan	Korea	Netherlands	Switzerland	United Kingdom	United States	All Other Economies	Total of Financial Instruments	Total Liabilities	
Issuer of liability (debtor)																
Canada	Direct investment		14871	5705	9749	1155	15896	2329	64350	8857	24759	280124	127457	555251	2868691	
	Portfolio investment		3710	18658	38808	3676	55607	3294	18489	34680	37483	703300	306614	1224319		
	Financial derivatives															
	Other investment		11281	20239	24742	1200	34277	2330	12307	3910	104664	833856	40315	1089121		
China	Direct investment		11313		23292	66637	7430	151926	61239	31459	12142	18912	78490	2116724	2579564	4299674
	Portfolio investment		19396		10317	5265	418	16630	13955	11795	5417	47982	113816	531419	776410	
	Financial derivatives															
	Other investment		79959	141343	123646	36008	40545	6457	52540	80254	139802	139157	103988	943700		
France	Direct investment		3391	2022		63414	15126	15802	1077	80190	76958	71696	71504	258925	660107	5501960
	Portfolio investment		35265	4906		359091	141637	222314	10593	187006	82509	302137	469625	1101541	2916625	
	Financial derivatives															
	Other investment		27403	37845		148282	278091	150090	13980	94151	66414	233868	434245	440859	1925228	
Germany	Direct investment		1737	1963	45145		36931	20946	4961	151506	52333	68035	78123	325262	786941	5271823
	Portfolio investment		29426	4999	231018		74816	128649	5155	225401	82766	288405	378630	1351440	2800704	
	Financial derivatives															
	Other investment		29232	26464	169935		91573	34615	11617	114185	70935	358785	433362	343475	1684178	
Italy	Direct investment		334	107	59058	23765		3009	399	68319	17731	39444	7565	117352	337083	2123958
	Portfolio investment		6990	1164	263595	183564		53713	1159	45932	9945	131576	106171	492602	1296410	
	Financial derivatives															
	Other investment		2472	2924	39867	178185		6253	120	17984	12394	41511	36403	152352	490465	
Japan	Direct investment		1160	655	24865	2332	930		3190	24719	8966	13173	51573	39136	170698	4523993
	Portfolio investment		53301	10691	109160	27305	5147		11665	41081	26431	213004	806703	547489	1851976	
	Financial derivatives															
	Other investment		61351	70127	153031	98373	29588		47952	84598	26539	188349	1414069	327341	2501318	
Korea	Direct investment		1500	4669	5315	6921	198	44767		15428	3492	13112	33034	41222	169659	685145
	Portfolio investment		13865	3251	7350	8296	776	25196		10491	10864	37311	171011	139122	427533	
	Financial derivatives															
	Other investment		2411	21656	1065	3051	573	9706	865	1546	4046	25431	17603	87953		
Netherlands	Direct investment		8406	22460	131413	170863	88976	50684	2628		256832	364574	790385	2052195	3939415	6546057
	Portfolio investment		16909	2647	259375	228784	47253	118160	4055		70714	177752	412984	552359	1890991	
	Financial derivatives															
	Other investment		14625		73721	150700	28230	10542		24716	97160	172686	143271	715651		
Switzerland	Direct investment		-311		40662	25506	4374	5765		183523		38968	93969	470170	862624	2856086
	Portfolio investment		25486	4105	27053	47986	9867	28919	4320	23601		85498	431068	212426	900329	
	Financial derivatives															
	Other investment		20890	15749	70221	69085	20603	20283	7239	32133	218338	514360	104232	1093133		
United Kingdom	Direct investment		34399	2707	109080	82782	9520	67729	3614	231565	61917		432987	518003	1554303	6807677
	Portfolio investment		77623	12452	239845	198978	67767	171104	16509	114334	78949		1244554	1127021	3349136	
	Financial derivatives															
	Other investment		83674	151375	146114	143197	31916	98754	59704	93539	52227		740268	303470	1904238	
United States	Direct investment		268972	14838	233844	255471	28648	411201	40130	282525	257859	483841	856870	3134199	15265593	
	Portfolio investment		748521	111144	245894	320482	84124	1369423	98555	425217	272133	968186	5592270	10235949		
	Financial derivatives															
	Other investment		102148	86309	153752	157067	50224	284545	71222	79299	54901	414491	441487	1895445		
All other economies	Direct investment		307177	452526	381373	423680	113543	374340	51444	1729565	357084	1089795	2140655		13655760	34571254
	Portfolio investment		188559	121761	111771	1487060	774606	1321977	66613	606882	558235	1489395	4609854		18555376	
	Financial derivatives															
	Other investment		22283	297870	111441	117499	67564	55210	9654	73136	34837	764622	588178	2360118		
Total Asset of Financial Instruments	Direct investment		638078	516818	1059751	1131120	306831	1162065	171011	2863149	1114170	2226308	4058409	13157896	28405605	91321910
	Portfolio investment		1215340	280830	2530037	2905617	1210087	3511692	235872	1710229	1232641	3778730	9447716	18166966	46225757	
	Financial derivatives															
	Other investment		446448	721600	1080729	1213827	635570	744820	230275	654737	428673	2565636	5332015	2636217	16690548	
Total Asset			2299866	1519248	4670517	5250564	2152488	5418577	637158	5228115	2775483	8570674	18838140	33961079	91321910	
Net Worth			-568824	-2780426	-831443	-21259	28530	894585	-47987	-1317942	-80603	1762998	3572547	-610174		
Reserve assets			79753	3406112	138163	173684	130770	1232756	367944	38260	606109	129536	383601			
Monetary gold			58	60191	82963	115176	83736	26116	4795	20917	35749	10593	277189			
Special drawing rights			7899	10284	13058	16533	8307	18047	3239	6535	4716	13238	49688			
Reserve position in the fund			2719	4547	4113	5588	3014	9471	1397	1970	1611	4197	17609			
Other reserve assets			69077	3331089	38020	36387	35714	1179122	358514	8836	564032	101509	39115			
Net error and omissions			839496	970767	278953	1461025	-589991	688062	-124695	1727524	88025	-2291506	-11236785			
Net Financial Position			350425	1596453	-414327	1613450	-430691	2815402	195262	447841	613531	-398972	-7280637			

Data Source: IMF, Coordinated Direct Investment Survey (CDIS), Coordinated Portfolio Investment Survey (CPIS), <http://www.imf.org/external/data.htm>, and International Investment Position Statistics (BOP/IIP) <http://data.imf.org/?sk=7A51304B-6426-40C0-83DD-CA473CA1FD52> on 4/17/2017;
BIS international banking statistics, <http://www.bis.org/statistics/consstats.htm> on 4/20/2017.

The first is Volume. The quantity of generated and stored data. The size of the data determines the value and potential insight- and whether it can actually be considered big data or not. The second is Variety. The type and nature of the data. This helps people who analyze it to effectively use the resulting insight. The third is Velocity. In this context, the speed at which the data is generated and processed to meet the demands and challenges that lie in the path of growth and development. The fourth is Variability. Inconsistency of the data set can hamper processes to handle and manage it. The fifth is Veracity. The quality of captured data can vary greatly, affecting accurate analysis.

Through the above general interpretation on big data, we can know that the preparation of GFF data as well as the monetary and financial statistics also have the characteristics of big data, big data technology can be used to handle GFF data and application analysis.

We think that it can be put forward by the international institutions, such as the IMF, to put forward a proposal to the member of countries for establishing a network data transfer agreement concerning the submission of direct investment, securities investment, financial derivative products, and international banking. In this way, some international institutions can popularize the standardization of data transmission, and it can improve the timeliness of data transmission. Through the timely monitoring of GFF, we can track massive behavioral data on international capital flows from the Internet, mining analysis, reveal the regularity of GFF, and put forward the research conclusion and countermeasures.

4.2 How to Use Big Data Technology for Measuring GFF

In the big data era of financial, a large number of financial products and trading to show through the network, including fixed network and mobile network. Among them, the mobile network will gradually become a major channel of big data financial transactions. With the law and the regulatory policy are improved, and the continuous development of big data technology, there will be more and more rich the financial products and transactions, and gathering financial information through the network is also becoming more and more convenient.

4.2.1 Integrate the data sources of CDIS, CPIS and IIP

Application of BDT in finance field including GFF, which have three levels. The first is to integrate the internet data source, the second is to make the common statistical standard of different data sources, and the third is to establish the subject classification and coding standard system. As noted above, the data source of GFF is mainly from IMF and BIS. IMF data source can be divided into CDIS, CPIS, IIP, but the statistical methods of CDIS and CPIS are different with IIP. CDIS and CPIS are the same stock data, including cross-border matrix, which can reflect

the situation of counterparties. IIP is the stock data too, provides the data about of direct investment, securities investment, financial derivatives, other investment, and reserve assets. However, IIP's data only reflects each countries' respective external financial positions, and does not include the information of counterparties. Therefore, we need to integrate the data source of CDIS, CPIS and IIP, that make an instrument of a country in IIP consistent with CDIS and CPIS. For instance, make that the total assets of direct investment of Country A in table 1 is equal to the assets of direct investment of the same country in IIP, and the total liabilities of direct investment of Country A in table 1 is equal to the liabilities of direct investment of the same country in IIP. This can ensure that IIP is in the same statistical range with CDIS and CPIS, and it can avoid double calculations and omissions.

4.2.2 Consistency of statistical standards: Treatment of Other Investments

In the third section of this paper, as a conceptual introduction, we explain concept of other investment instrument and its data source. Other investment covers other equity; currency and deposits; loans; insurance, pension and standardized guarantee schemes; trade credit and advances; other accounts receivable/payable-other; and special drawing rights (SDRs)⁶. However, other investment has not compiled as a matrix form, as CDIS or CPIS. Therefore, as an alternative method and data acquisition possibility, we adopt the data of CBS, which belongs to the BIS statistics. In this way, we need to solve the issue of statistical standard consistency of different data sources.

The BIS publishes two sets of statistics on the activity of internationally active banks: Locational statistics: detail the currency and geographical composition of banks' balance sheets according to the location of banks' offices (LBS). Consolidated statistics: detail banks' country risk exposures according to the nationality of banking groups (CBS). The BIS also publishes three sets of statistics on issuance in money and bond markets: international debt securities (IDS), domestic debt securities (DDS) and total debt securities (TDS). These statistics are harmonised with the Handbook on Securities Statistics⁷, an internationally agreed framework for classifying debt securities issues. That is, the data that we want to use are come from different data sources and different publishing agencies. Therefore, it is necessary to coordinate international agencies to develop common benchmarks and statistical ranges to avoid double calculation and omission.

By the uniform international statistical benchmark, we can use BDT to measure GFF, namely use Internet technology, the Internet of Things technology and statistical techniques to collect data, compile GFF statistics and release relevant information. To achieve this goal, we need to improve the environment of data transmission and prepare for three aspects. The first is the creation of a new international agreement on data transmission. It should be in conjunction with the relevant countries and international organizations formulate relevant international agreements about data transmission. The second is to improve the data transmission based on the uniform statistical benchmark. According to the relevant international agreements and the uniform statistical

⁶ IMF, Balance of payments and international investment position compilation guide, 2017.

⁷ IMF, BIS and ECB, 2015, Handbook on securities statistics.

benchmark, the participating countries timely report relevant data to the IMF and other international organizations. The third is to strengthen the IMF's coordination and leadership in data transmission management. The international organizations collect and collate data by the procedures, and publish all kinds of data that meet the statistical benchmark in the online by the time limit.

4.3 The Expected Effect by Applying the BDT for Measuring GFF

Compared with the traditional statistics, the innovation of using BDT is based on intelligent sensor, information acquisition technology such as software device, in accordance with the requirements for large systems interconnection, build a system of information standardization, which include data transmission, statistics processing, and an information official announcement such a statistical information standardization. This will have the following effect for establishing GFF statistics.

4.3.1 Will enhance Data quality and financial supervision

The rapid development of the Internet has not only made it easier for countries to report their data to international organizations such as IMF, but also greatly expanded the amount of data held by international organizations. In addition, makes the IMF and other international organizations can be collated information and timely feedback to the world, to meet the demand for statistical information at all levels. By using BDT the statistical error of data transmission and processing can be reduced and the data quality can be improved. The application of high-quality GFF statistics can increase the controllability of financial risks, and timely discover and solve possible financial risk points. It is more accurate to grasp the regularity of financial risk and improve the financial supervision level of policy authorities.

4.3.2 Will reduce the asymmetry of the financial transaction information

So far, in the international financial market, due to the time, place and the borders of physical and institutional constraints, the transmission of financial data were slow; the demand of financial information is far greater than the supply. However, in the era of network financial, financial data transmission will be improved, and data processing will be more quickly, it will be able to meet the balance of the financial information needs and supply.

4.3.3 High efficiency for Measuring GFF.

Using the BDT to compile financial data is efficient, many processes and actions have completed in the online, and some action is automatic. At the right time, the right place, provide the necessary financial information to the appropriate information users in the appropriate manner. At present, the lag period of some financial information disclosure is too long, such as the CDIS data released the lag period of about 1 years, the CPIS and FD data released lag period of about 6 months. If we use BDT into the compilation of financial statistics will undoubtedly improve the efficiency of data transmission and consolidation. At the same time, strong data analysis ability

can do high efficiency analysis of financial transactions and the market.

5. Concluding Remarks

This paper discussed how to establish the GFF statistical framework, data collection sources, compared and integrated different data sources, and analyzed the possibility of using BDT to compile GFF statistics. In particular, the paper also discussed how to use BDT in financial statistics including GFF statistics, and its effects.

The paper has explored the following issues which are statistical agencies such as IMF and BIS how to measure CDIS, CPIS, FD, CBS and Reserve Assets which in National Accounts, Balance of Payments statistics, International Investment Position and financial statistics. Put forward the idea of applying BDT to compile GFF statistics. There are also need to address the innovations in data collection, compilation or reporting, and how are Big Data techniques being used to build a new statistical benchmark to measure the global flow of funds in macroeconomic and financial statistics. The policy recommendations for this paper are as follows.

(1) With the development of Internet technology, international financial transactions will become more and more rapid and the volume of transactions will become more and larger. In order to prevent financial risks, it is necessary to establish a GFF statistical system.

(2) To this end, we need to establish data transmission standards for the use big data technologies between international organizations such as the IMF and BIS and the participating countries.

(3) Based on the common statistical benchmarks, establish a network data transmission agreement for measuring GFF between the Member States and international organizations such as the IMF, which including direct investment, portfolio investment, financial derivatives, other investment and foreign currency reserve assets, etc.. It also should be clarified the deadline of reporting national data and the timing of the release of the IMF data; in the form of W-to-W; implement the system of information sharing.

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