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## Uses of Mirror Data: Estimation of Foreign Assets and Liabilities of Households<sup>1</sup>

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### Abstract

This paper estimates cross-border assets and liabilities of households in the form of bank deposits and bank loans and provides methodological guidance for users.<sup>2</sup> While banks' exposure to the households' sector are available in the BIS locational banking statistics, they are reported only on an encouraged basis from end-2013. The lack of information on household sector represents challenging issues to the compilers in particular. Moreover, analysis and interpretation of publicly available data are often misleading without taking care of gradual increase in coverage and data gaps.

First, we apply three alternative mirror data methods to deal with incomplete coverage and to provide estimate outstanding cross-border assets and liabilities of households in more than 200 countries around the world. Second, we demonstrate that the methods are suitable to improve estimates for other non-bank subsectors as well. Third, we apply the proposed methods to provide estimate data back to end-2006. Method-I can be applied to the publicly available data, while methods-II and -III use non-public data. These methods are also useful for compiling external statistics and national accounts.

### Keywords

Data gaps; cross-border assets/liabilities; households; international banking; mirror data.

### 1. Introduction

In a more globalized world of continuing economic and financial integration, policy makers, market participants and other users have an increasing demand for reliable and comparable data on economic developments. For the particular case of the household sector, there are statistical challenges in accurate measurement of exposures to this institutional sector. Due to the development in globalization, domestic entities, especially households use the global financial market for their financial investments as well as financing. The delimitation of the household sector is complex and very challenging to compile. In addition, the measurement of the households' sector implies the consistency between multiple dimensions – financial and non-financial perspective; counterparty countries and sectors, flows and stocks. Households' foreign assets and liabilities correspond to an important portion of many external operations both on the non-financial and financial part of the external statistics (Balance of Payments and International Investment Position) and rest of the world sector of the National Accounts.

Incomplete information and scarce data sources on the non-financial and financial cross-border operations may lead to the existence of data gaps. In this context, the BIS locational banking statistics (LBS) are very useful, because they provide information about the geographic and currency composition of banks' assets and liabilities (outstanding amounts) broken down by counterpart sector and instruments. The LBS data are consistent with the International Investment Position methodology, as they correspond to claims/liabilities of residents in one country vis-à-vis those of other countries. In the case of households' assets and liabilities, the LBS offer country location of counterparties and thus a full country coverage.

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<sup>2</sup> The household sector consists of private households as well as non-profit organisations serving households.

In this article, we focus on the outstanding amounts (stocks) to fill-in the data gaps, applying mirror-data methods to the LBS. The aim is to provide guidance on how to exploit available partial data and apply statistical methodology under reasonable assumptions to obtain consistent, comparable and reliable data for better analysis. This also provides more comprehensive and complete information of the external accounts – International Investment Position and, consequently, of the rest of the world counterparty in National Accounts.

## 2. Methodology

Although there are different data sources on the households’ foreign assets and liabilities, the sources of this information are scarce in terms of granularity, and do not permit a full breakdown by counterparty country.

We address the challenges by focusing on the LBS data as this is the main source to perform this empirical exercise. We apply the mirror data approach which refers to complementary sources that capture similar concepts (ie use the data reported from one side of the transaction to fill in missing observations for the other side of the transaction). This is a crucial statistical tool that helps complete the picture when data is sparse. Pradhan and Silva (2020) demonstrated the importance of mirror data to enhance statistical quality as well as coverage of data across comparable statistical domains. There are challenges when using the LBS data for this exercise. First, data on banks’ claims on and liabilities to households are collected only on an encouraged basis, which does not ensure full data coverage. Second, the coverage varies over time - only 15 out of 48 countries started reporting these data from end-2013, with another 18 countries starting to report in subsequent quarters. Third, confidentiality concerns mean that not all of the data are publicly available (though some are shared among reporting countries for internal analysis).

We propose three alternative methodologies to estimate bank assets and liabilities of the household sector in more than 200 countries. The first method uses published pooled (aggregated) data of banks in all reporting countries, the second method exploits unpublished bilateral data of banks in individual reporting countries, and the third method amends the second method by adding estimated bilateral data of 8 countries prior to start of their reporting LBS data to the BIS (we use their reported with incremental effect vis-à-vis individual countries to back cast data). We also demonstrate that depending on type of users to access the data (e.g. reporting countries have access to the unpublished bilateral data), these methods provide reasonably sound estimates for historical data, even for quarters prior Q4 2013. In addition, our proposed methods allow improved estimates for exposure of other non-bank subsectors, namely Non-Bank Financial Institutions (NBFI), Non-Financial Corporations (NFC) and General Government (GG) sectors. To clarify the linkages on the sector code/name between the LBS and the System of National Accounts (SNA), Table 1 shows the mapping of sector hierarchy between the SNA and BIS LBS.

**Table 1: Sector hierarchy between the SNA and BIS LBS**

LBS sector codes/names	SNA codes
<b>A: All sectors</b>	<b>S1</b>
<b>B: Banks, total (sub-sectors reported)</b>	S121+S122
<b>N: Non-banks, total</b>	(S123+S124+S125+S126+S127+S128+S129) + (S11+S13+S14+S15)
<b>F: Non-bank financial institutions-NBFIs</b>	S123+S124+S125+S126+S127+S128+S129
<b>P: Non-financial sectors-NFS</b>	S11+S13+(S14+S15)
<b>C: Non-financial Corporations-NFCs</b>	S11
<b>G: General Government-GG</b>	S13
<b>H: Households incl. NPISHs-HH</b>	<b>S14+S15</b>
<b>K: NFS, unallocated</b>	
<b>X: Non-banks, unallocated</b>	
<b>U: Unallocated by sector</b>	

The coverage of reported data differs across counterparty countries and sector. Estimation of positions for non-bank subsectors, especially for households is important because even after

8 years since Q4 2013, the coverage is still partial. Table 2 shows that more than 25% cross-border loan claims on non-bank aggregate remain unallocated by subsector for 108 of 217 counterparty countries and 56 counterparty countries for deposit liabilities.

**Table 2: Breakdown of non-bank subsectors incomplete<sup>1</sup>**

Unallocated non-bank (in % of total )	Q4 2013				Q4 2020			
	Loan claims		Deposit liabilities		Loan claims		Deposit liabilities	
	CPC count <sup>2</sup>	Cum. share of non-bank <sup>2</sup>	CPC count <sup>2</sup>	Cum. share of non-bank <sup>2</sup>	CPC count <sup>2</sup>	Cum. share of non-bank <sup>2</sup>	CPC count <sup>2</sup>	Cum. share of non-bank <sup>2</sup>
>=90%	13	0.04	11	22.81	15	0.6	0	-
>=70%	42	26.90	40	32.50	33	2.0	3	1.40
>=50%	108	60.92	101	53.94	68	17.0	17	9.74
<b>&gt;=25%</b>	<b>166</b>	<b>98.04</b>	<b>172</b>	<b>98.43</b>	<b>108</b>	<b>23.9</b>	<b>56</b>	<b>21.14</b>
>=15%	183	99.80	190	98.71	126	27.7	87	25.14
>=5%	199	99.90	211	99.99	151	69.8	143	44.13
>=0%	216	100	216	100	217	100	216	100
<b>Amount (\$bn)</b>								
<b>Non-bank, total<sup>3</sup></b>	-	<b>6,792.5</b>	-	<b>7,496.2</b>	-	<b>9,153.9</b>	-	<b>9,057.9</b>
o/w: Unallocated (% of non-bank)	-	3,941.4 (58.0%)	-	4,345.3 (58.0%)	-	1,520.6 (16.6%)	-	1,339.2 (14.8%)

<sup>1</sup> Excluding regional residuals, international organisations and unallocated by non-residents; CPC = Counterparty country. <sup>2</sup> Share in total non-bank amount; for example, 166 counterparty countries in Q4 2013 had at least 25% unallocated by non-bank subsectors and these 166 counterparty countries comprise 98.04% of total cross-border non-bank (aggregate). <sup>3</sup> The non-bank totals as published on the BIS website and include regional residents, international organisations and unallocated by non-residents.  
Source: BIS locational banking statistics (BIS Quarterly Review, June 2020 release); authors' calculations.

### Method-I: Estimates using aggregated published data

External users with access to public data only can run a mirror exercise on aggregated LBS data. Using aggregated published data the LBS allows, for example, each counterparty country to estimate bank deposits abroad by its resident sectors **F**, **P** and subsectors of **P** and in particular the household sector **H** (see Table 1 for codes). This method involves three sequential steps<sup>3</sup> to obtain the estimation for each counterparty country: 1) the aggregate sectors (**F** and **P**); 2) the sub-sectors (**C/G/H**); 3) non-reported (historical) data.

**Step 1: F, P and K** are estimated by assuming that the allocation of the reported amounts are representative for the unreported amounts (letter without “est” are the data as reported):

1. Estimated F:  $F^{est} = F + X \left[ \frac{F}{(F+P)} \right]$
2. Estimated P:  $P^{est} = P + X \left[ \frac{P}{(F+P)} \right]$
3. Derived K:  $K^{est} = P^{est} - (C + G + H)$

**Step 2:** Estimation for the sub-sectors: **C, G** and **H**, with a similar assumption as in step 1:

1. Estimated C:  $C^{est} = C + K^{est} \left[ \frac{C}{(C+G+H)} \right]$
2. Estimated G:  $G^{est} = G + K^{est} \left[ \frac{G}{(C+G+H)} \right]$
3. Estimated H:  $H^{est} = H + K^{est} \left[ \frac{H}{(C+G+H)} \right]$

<sup>3</sup> We propose proportional allocation of residual amounts to reportable subsectors. An improved alternative is to use moving average or average from the latest 4 or 8 quarters and apply the share to reported sector **N** amounts.

**Step 3:** To obtain estimates in periods before any data for these sector splits are available, compute a weighted average of the ratio of positions on sector **S** (ie **F, C, G, H**) relative to positions on the non-bank total over the reported quarters  $(\mathbf{S}/\mathbf{N})_w$  and apply that ratio to the reported non-bank position ( $\mathbf{N}_q$ ) in each of the previous quarters:  $N_q \left(\frac{\mathbf{F}}{\mathbf{N}}\right)_w, N_q \left(\frac{\mathbf{C}}{\mathbf{N}}\right)_w, N_q \left(\frac{\mathbf{H}}{\mathbf{N}}\right)_w$ .

### Method-II: Estimates using bilateral data

This estimation in Method-I can be made more precise by using the available bilateral data, including mirror data, to produce the estimate. In this process, we identify three different groups of reporting countries. The estimation for each reporting country vis-à-vis an individual counterparty country is done in multiple sequential steps. This set-up allows us to relax the assumption that claims/liabilities of banks in a reporting country vis-à-vis the counterparty sector in another country to follow a pattern that is different from the banks in another reporting country<sup>4</sup>. Over time, the share of NBFIs to the non-bank total remains stable for banks in respective countries. We exploit this trend in estimating data for non-reported quarters. The estimation is first carried for 33 countries (group 1) that report both required subsectors (**F** and **P**), and encouraged subsectors (**C, G** and **H**). We use complementary information from group 1 countries to estimate non-reported encouraged subsectors for 6 additional countries (group 2) that report the required subsectors (**F** and **P**). In the same way, we use complementary information from the combined 39 countries for 9 countries (group 3) that neither report required nor encouraged subsectors. For each group of countries vis-à-vis non-bank subsectors in individual counterparty countries, we apply backward estimation up to Q4 2006<sup>5</sup>. Once estimation is done for the 3 groups of countries, we aggregate quarterly bilateral data by sector to arrive at the estimated amount.

**Group 1:** For each of the 33 countries, unallocated amounts, if any, in **X** and **K** are reallocated to derive estimate amounts, following the first two steps of Method-I, but applying them country by country. In the third step, again along the lines of Method-I, we derive a weighted average of  $\frac{\mathbf{F}}{\mathbf{N}}$  and  $\frac{\mathbf{P}}{\mathbf{N}}$  from all reported quarters (only when sector **N** is reported) and derive estimated **F** and **P** for all prior quarters. In the fourth step, we similarly derive a weighted average of  $\frac{\mathbf{C}}{\mathbf{P}}, \frac{\mathbf{G}}{\mathbf{P}}$ , and  $\frac{\mathbf{H}}{\mathbf{P}}$ , from all reported quarters and derive estimated **C, G** and **H** for all prior quarters, using estimated sector **P** values from the third step.

**Group 2:** The estimation for each of 6 additional reporting countries is carried out again in 4 similar steps. Unallocated amount, if any, in **X** are reallocated to derive estimated **F** and **P** (step1 mentioned above). In the second step, weighted average of  $\frac{\mathbf{F}}{\mathbf{N}}$  and  $\frac{\mathbf{P}}{\mathbf{N}}$  from all reported quarters are used to estimate **F** and **P** for all prior quarters (only sector **N** reported). In the third step, we derive quarterly weighted average of  $\frac{\mathbf{C}}{\mathbf{P}}, \frac{\mathbf{G}}{\mathbf{P}}$ , and  $\frac{\mathbf{H}}{\mathbf{P}}$  from the 33 countries in group 1 and derive estimated **C, G** and **H** for all prior quarters, using estimated sector **P** values in the step 2.

**Group 3:** Nine additional countries in this group report only Sector **N** (total non-bank) and no subsectors. In this case, we derive quarterly weighted average of  $\frac{\mathbf{F}}{\mathbf{N}}, \frac{\mathbf{P}}{\mathbf{N}}, \frac{\mathbf{C}}{\mathbf{N}}, \frac{\mathbf{G}}{\mathbf{N}}$  and  $\frac{\mathbf{H}}{\mathbf{N}}$  from 39 countries in group 1 and group 2. In the second step, we apply quarterly weighted average ratios to reported **N** and derive estimated values for **F, P, C, G** and **H**.

<sup>4</sup> For example, claims on NBFIs in KY by banks in the US follow a specific profile than those by banks in Portugal.

<sup>5</sup> The estimated amounts for quarters prior to Q4 2013 could be improved using moving average or another alternative algorithm. However, we find that the estimated amounts are reasonable within acceptable limit (about 10%) of variation.

### Method-III: Complementing Method II with estimated data for new reporting countries prior their joining the LBS

The estimated amounts mentioned above are based on reported bilateral data, with availability of sector **N** and full or partial availability of its subsectors. However, the previous two methods did not take into account the impact of 8 new reporting countries prior to their joining the LBS reporting system. These 8 countries joined in different years during the period from Q4 2006 to Q4 2017<sup>6</sup>. While analysing bilateral reported and estimated data, we noticed strong impact on certain counterparty countries due to addition of new reporting countries over time. The additional reporting countries, by contributing more data, increases the accuracy of the estimated shares. Hence, using the most recent data where everything is well reported can help improve the shares constructed<sup>7</sup>.

Cerutti, Casanova and Pradhan (2020) highlighted a significant increase in bilateral positions of Chinese banks, mainly after China joined reporting system in Q4 2015. Taking into consideration of such worldwide and regional influence of new 8 reporting countries since Q4 2006, we estimated these countries' bilateral positions vis-à-vis non-bank sector (aggregate) for all periods prior to their joining the BIS LBS reporting system. We treated quarterly estimates in the same way as in group 3 (method-II) but only for quarters prior to start period of their LBS reporting<sup>8</sup>. It is recognised that the estimation of data for these 8 countries is exploratory and could be improved but we are the first ever to attempt in such bilateral estimates and resulted in better estimates.

### 3. Results

Table 3 illustrates the results of method-I from published data for each of the non-bank subsectors **F**, **P**, **C**, **G** and **H** and the published data. Step 1 and Step 2 of Method-I are used. It evidences how the unallocated amounts are distributed to the sectors/subsectors.

**Table 3: Banks' cross-border claims/liabilities: published vs estimated**

As of end-2020, Amount outstanding, in USD billion

Sectors (# of reporting countries)	Loan claims		Deposit liabilities	
	Published	Estimated	Published	Estimated
<b>N: Non-banks, total (48)</b>	<b>9,153.9</b>	<b>9,153.9</b>	<b>9,057.9</b>	<b>9,057.9</b>
<b>F: NBFIs (39)</b>	4,526.9	4,900.0	4,930.0	5,184.6
<b>P: NFS (39)</b>	3,929.9	4,253.8	3,683.1	3,873.3
<b>X: Non-banks, unallocated</b>	697.1	-	444.8	-
<b>C: NFCs (33)</b>	2,554.7	3,498.2	1,886.2	2,619.8
<b>G: GG (32)</b>	242.3	331.9	107.3	149.0
<b>H: Households (32)</b>	<b>309.5</b>	<b>423.8</b>	<b>795.1</b>	<b>1,104.4</b>
<b>K: Unallocated NFS</b>	823.5		894.5	
<b>K<sup>est</sup>: derived after allocating X to F &amp; P</b>	1,147.4		1,084.6	

Sources: BIS locational banking statistics (Quarterly Review, June 2020 release); authors' calculations.

In addition, Graph 1 shows reported/published amounts by non-bank subsector including unallocated amounts (left panel) and estimated amounts derived in three steps of Method-I (right panel) since Q4 2006. The reported figures do not identify the breakdown between sectors/subsectors, whereas the estimated figures show the amounts by sector/subsector and its evolution over time. Thus, this estimation can be incorporated on both

<sup>6</sup> Malaysia in Q4 2007, Cyprus in Q4 2009, South Africa in Q3 2009, Indonesia in Q4 2010, China and Russia in Q4 2015, Philippines in Q4 2016 and Saudi Arabia in Q4 2017.

<sup>7</sup> It is true that these shares can change over time, especially for growing banking sectors like CN.

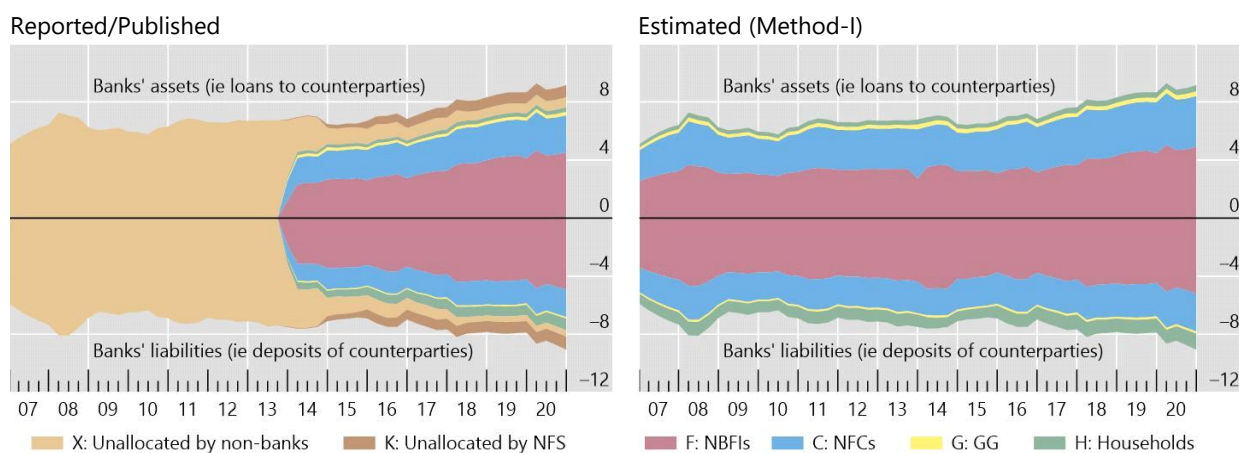
<sup>8</sup> While details of this estimation method is out of scope of this paper, we made use of incremental contribution (share) by each of their countries since their joining and global trends to estimate their bilateral data backwards.

external statistics and rest-of-the-world accounts to complement the existing national data sources, on an aggregate basis.

### Banks' cross-border loans and deposits by non-bank subsectors<sup>1</sup>

Amounts outstanding, in USD trillion

Graph 1



<sup>1</sup> Positive amounts relate to claims and negative to liabilities; Claims of banks on a counterparty sector are the liabilities of counterparty sector to the reporting banks.

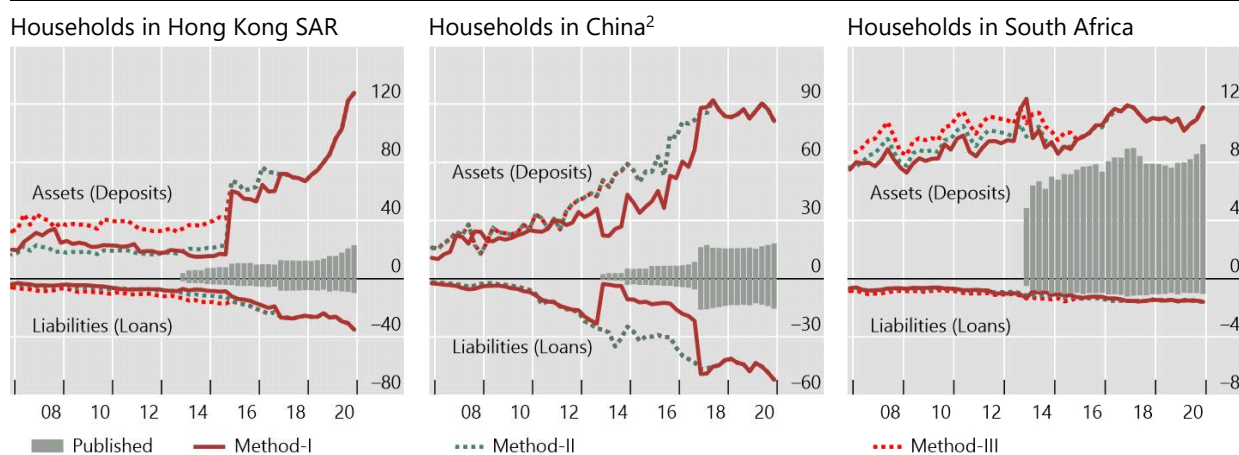
Sources: BIS locational banking statistics (by residence), authors' calculations.

Moreover, the results of the three methodologies for households' foreign bank claims and liabilities are obtained for all counterparty countries. In Graph 2 below, we show results for three selected jurisdictions. Reported/published figures are shown in bars and estimated figures from all three methods are in lines. The difference between the reported (published) and estimated amounts during the period from Q4 2013 is due to reallocation of unallocated amounts (Method-I and -II), and estimated positions for new reporting countries (Method-III).

### Households' foreign assets and liabilities<sup>1</sup>

Amounts outstanding, in billions of US dollars

Graph 2



<sup>1</sup> Method-I estimates using published aggregates; Method-II uses non-published bilateral data; Method-III=Figures from Method-II plus estimated amounts for new reporting countries prior to their joining. <sup>2</sup> Visibly no impact due to new reporting countries (Method-III).

Sources: BIS locational banking statistics (by residence); Authors' estimate.

The rationale for selection of three jurisdictions are: (a) Hong Kong SAR is representative of offshore centre, with relatively largest gap between published and estimated figures (mainly due to non-reporting of household sector by China and Japan); (b) China and South Africa, are representatives of EMDEs, China with largest gap between published and estimated figures, whereas South Africa with lesser gaps; and (c) gap for advanced economies is smaller and not considered for this shorter version of the paper.

#### 4. Conclusions

Mirror data analysis ensures consistency and enhances statistical coverage and quality standards, which is crucial for economists, analysts and policy makers. The effectiveness of these exercises depends on the availability of granular information. We apply mirror data concepts to develop the methodological framework on uses of reported data, and to provide estimates for non-reported data with an aim to provide users with more complete information. We discuss methodological aspects and offer guidance on derivation of household assets/liabilities abroad in the form of bank deposits/loans, for more than 200 individual countries around the world.

Any user can easily adopt Method-I exploiting published data from the BIS website. We recommend the BIS to consider adopting Method-II to publish estimated data not only for households' sector but also for other non-financial sectors (NBFIs, NFCs and GG). This would be similar to the new database for total credit to the private non-financial sector following method proposed by Dembiermont and Mukusakunratna (2013). Method-III is exploratory in nature providing estimated figures for the complete reporting population of banks in 48 countries. Our results for three specific jurisdictions show the importance of back data estimations to a more consistent comprehensive and complete time-series information. These methods are also applicable for the compilation of external statistics and rest of world sector accounts, and may be possible to extend for other flows (exchange rate, price and volume changes and other adjustments). Furthermore, this short version of the paper for the conference does not include additional details due to limitation of length.

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