UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

Towards a Statistical Framework for the measurement of tax and commercial illicit financial flows

Case studies

(Online document of case studies to accompany the UNTAD (2023) *publication Towards a Statistical Framework for the measurement of tax and commercial illicit financial flows.)*

Geneva, 30 October 2024

Preface

This document is to be understood as and read in conjunction with the Towards a Statistical Framework to measure tax and commercial illicit financial flows (UNCTAD, 2023). It provides examples of application of various methods and their elements to measure tax and commercial illicit financial flows (IFFs), as outlined in that document. As such, it primarily focuses on the six methods that have been proposed and tested in measurement exercises in various countries and their distinct national settings. The case studies highlight specific elements of application that aim to support national authorities in their exercise to apply specific method to compile official statistics on IFFs for their national reporting on SDG indicator 16.4.1 on inward and outward IFFs.

Case studies as such are listed broken down by each of the method, namely:

1. Method #1: Partner Country Method Plus (PCM+),
2. Method #2: Price Filter Method Plus (PFM+),
3. Method #3: Global distribution of MNEs' profits,
4. Method #4: MNE vs comparable non-MNE profit shifting,
5. Method #5: Undeclared offshore assets indicators, and
6. Method #6: Flows of offshore financial wealth by country.

Certain aspects, related to a specific method and developed or applied within other setting, e.g., for assessing IFFs risk, may also be included under respective methods. Additionally, section 7 lists some other, related and emerging case studies that may support measurement activities and compilation of official statistics on IFFs.

This is an online document, meaning that it remains updated as new information are being added, with the aim of providing an up-to-date basis to support practical implementation of the methods to measure IFFs.

Contents

Method #1: Partner Country Method Plus (PCM+)

Case study 1.1: Comparing bilateral trade statistics between national authorities

In 2016, Canada and China decided to conduct a joint study on the differences or asymmetries between their trade statistics. The objective was to explain and quantify the differences in the statistical data and to carry out an in-depth analysis of the origins of these differences. The exercise was carried out by the Chinese Ministry of Commerce and the General Administration of Customs, and the Global Affairs Canada and Statistics Canada. Over two years, the authorities exchanged and compared bilateral trade in goods and services data for reference years 2014 to 2016.

Indirect trade may result in increased value of goods, and even though the share of indirect trade has been declining in recent years in eastbound trade, it still accounted for over 90 per cent of the total asymmetry for goods. Shipments through Hong Kong and the United States had the greatest impact on the differences. Asymmetries also arise from differences in statistical methods and conceptual definitions in the processing of data, such as shipment time lag and China's re-exports, among others. In goods shipped from China to Canada directly, it seems possible that the same shipment of goods has a lower declared export value in China than the declared import value in Canada. In westbound trade, there is a lack of data on transshipments, shipment time lags and other sources of asymmetry.

The comparison of China's and Canada's bilateral trade in services statistics revealed that most of the asymmetries resided with travel and transport services while discrepancies for all other services remained relatively small and comparable. The following table provides a useful summary of issues that may be causing asymmetry in trade statistics.

Table 1. Comparison of statistical concepts and definitions in China's and Canada's merchandise trade statistics

Issue	China	Canada
Trade structure	Total trade structure	Total trade structure
Valuation methods	Exports: FOB Imports: CIF	Exports: FOB Imports: FOB
Partner countries	China applies the country of origin and country of destination principle to determine its trading partners. China Customs also records the countries where the shipment initiates as well as where it ends. Exports: Country of final destination/country of shipment ends Imports: Country of origin/country of shipment initiates	Canada applies the country of origin and country of destination principle to determine its trading partners. Exports: Country of final destination Imports: Country of origin/country of export
Frequency of data publication	Each month, China publishes its previous month's preliminary trade data on the 8th or 13th, and releases its official data on the 23rd.	For each reference month, Canada publishes official trade data about 35 days after the close of the calendar month.
Frequency of data adjustments or revisions	China adjusts the previous monthly data for the current year and publishes the adjusted results on the 23rd of each month. The final revisions to the previous year's data are published in October of each year.	Current year data are revised each month. Previous year data are revised in January and February, and on a quarterly basis. The previous two years

Issue	China	Canada
		of data are revised annually in February.
Commodity codes and descriptions	Goods are classified based on the Harmonized System classification. The first six digits of the HS codes are consistent with the Harmonized System, and the seventh and eighth digits are added according to the needs of China's tariff, statistics and trade management.	Goods are classified based on the Harmonized System classification. The first six digits of the HS codes are consistent with the Harmonized System, and the seventh and eighth digits for exports and imports and the ninth and tenth digits for imports are added for tariff and statistical purposes.
Special classifications	China classifies special traded goods, low-value simple customs clearance goods and unclassified goods into Chapter 98.	Canada classifies special trade, such as confidential trade and low value shipments, into chapters 98 and 99.
Re-export statistics	Re-export data are not included in China's customs statistics.	Re-exports are included in total exports and reported separately from domestic exports.
Special economic zones	Due to the preferential policies of trade and the need of customs supervision, China has a number of special regulatory areas, including: special economic zones, economic and technological development zones, high-tech development zones, bonded zones, bonded warehouses (including outbound supervision warehouses), export processing zones, bonded logistics zones, bonded port areas, bonded logistics centers (type A, type B), etc. When goods under these special zones are traded with foreign countries, these transactions are included in the customs statistics.	Goods stored in bonded warehouses are included in the customs statistics.
Freight and insurance costs	Freight and insurance premiums for imported goods are based on actual fees paid.	Freight and insurance premiums for imported goods are based on actual fees paid.

Source: Statistics Canada (2018)

Case study 1.2: Cost, insurance, freight by commodity

Schuster and Davis (2020) use the mirror trade gap method to estimate IFFs in Africa. They note that detection of IFFs with the mirror trade gap method has evolved from using total trade flows to reviewing commodity specific trade flows. This has given rise to the need for a better approximation of CIF due to heterogeneity between commodity groups.

The authors use the OECD ITIC database to match (56 354 out of 88 285) extra-African trade observations and (37 855 out of 48 513) intra-African trade observations for 17 selected commodity groups and 41 African countries from 2000 to 2018. The mean cost lies at 6.4 per cent of export value for extra-African trade and at 7 per cent for intra-African trade (see Table 2). The mean hides large commodity specific heterogeneities for extra-continental trade, for instance:

a. For high value commodities (gold, platinum and diamonds), CIF is around 2.5 per cent of export value;
b. Copper, aluminium and petroleum are close to the 6 per cent of CIF, as also recommended by IMF;
c. Manganese and iron are closer to 10 per cent, the amount of adjustment widely used in literature;
d. Standard deviations are very large.

Table 2. Summary of cost, insurance, freight (CIF) by commodity group; extra- and intra-African trade

	Extracontinental				Intra-African			
Commodity group	Mean CIF (%)	Standard deviation	Number of observations matched	Total number of observations	Mean CIF (%)	Standard deviation	Number of observations matched	Total number of observations
Gold	2.4	0.020	1421	2254	3.0	0.020	44	192
Platinum	2.6	0.016	348	572	2.3	0.021	87	155
Diamonds	2.4	0.019	1351	2803	2.8	0.023	145	328
Copper	5.2	0.021	8899	14351	5.7	0.026	4639	6403
Iron group	8.6	0.029	11155	18023	8.9	0.030	8352	10818
Aluminium	6.0	0.026	9756	14991	6.7	0.027	6711	8720
Petroleum	6.5	0.028	7084	13073	8.2	0.030	5416	7084
Manganese	10.7	0.043	1798	2805	10.8	0.034	428	660
Silver	3.6	0.021	448	810	4.1	0.024	181	255
Precious metal ores	6.1	0.025	283	720	6.3	0.024	139	224
Uranium	6.2	0.024	947	1536	7.3	0.027	416	642
Cobalt	3.5	0.016	1313	1986	3.0	0.023	298	449
Titanium	7.2	0.035	1275	1950	6.9	0.029	699	934
Chromium	10.9	0.051	1207	1827	9.1	0.046	448	555
Molybdenum	3.1	0.019	182	277	3.1	0.022	128	213
Rare-earth metals	5.4	0.030	454	962	6.0	0.029	759	1017
Conflict minerals	5.7	0.041	1231	2141	5.8	0.034	1014	1913
Total	**6.4**	**0.035**	**56354**	**88285**	**7.0**	**0.034**	**37855**	**48513**

Source: Schuster and Davis (2020)

The conclusion is that a more in-depth application of PCM by analysing commodity-based transactions, requires more precise estimates of CIF. Adding 10 per cent to the export value to account for the difference in valuation might be a good proxy when using total exports, but hides significant heterogeneity across commodity groups.

Case study 1.3: Country of consignment in mobile phone trade between Canada and China

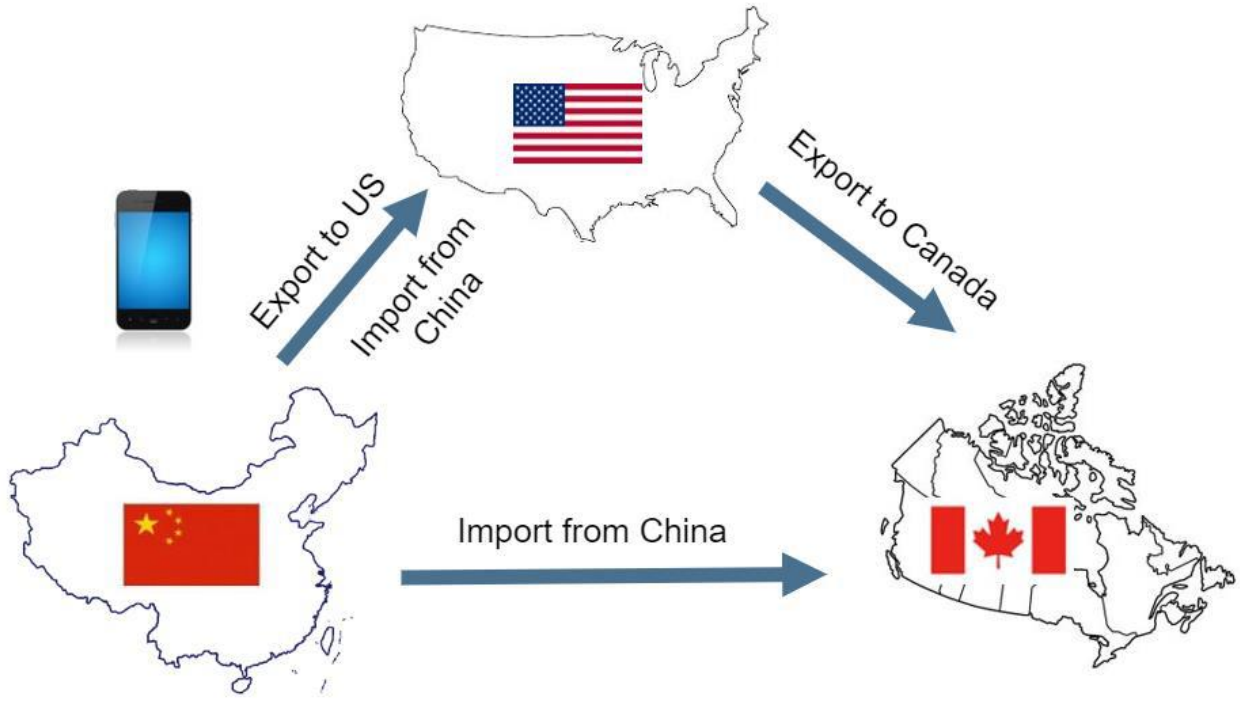
UNSD (2019) highlights the importance of proper partner country attribution. It refers to the trade of mobile phones between Canada and China with two possible ways:

The phone could be exported directly from China to Canada. Here, it is reported in China as an export to Canada and in Canada as an import from China.

The phone could also arrive in Canada via the United States of America. This trade could be reported as: in China, as export to the United States of America. In the United States of America, an import from China and an export to Canada. And in Canada, an import from the United States. However, such recording leads to imprecisions, and it should be reported as an import from China to Canada with the United States of America as a country of consignment.

This is best shown directly in the bilateral trade of mobile phones (Figure 1), revealing reported and adjusted values of Canadian imports and Chinese exports (Figure 2).

Figure 1. Trade flows of Chinese mobile phones from China to Canada, including through the United States of America



Source: UNSD (2019)

Figure 2. Bilateral inbound trade of mobile phones

Inbound Trade	CAN imports	CHN exports
Official data	3 329	1 362
Published asymmetry		**1 967**
Adjustment: *CAN imports of CHN goods from countries of export (consignment) other than CHN	1 280	
Adjusted official data	2 049	1 362
Remaining asymmetry		**687**

Source: UNSD (2019)

Case study 1.4: Multilateral study on bilateral trade asymmetries

Bilateral or multilateral studies on asymmetries in trade statistics are very useful before the analysis of IFFs based on trade asymmetry. Examples across the globe have led to considerable corrections to trade statistics which improves the analysis of remaining asymmetries (e.g., case study 1).

A programme called MEDSTAT II aimed to harmonise statistical methods between the EU and its Mediterranean partner countries in line with international statistical standards in order to improve the comparability of trade data between these countries. The programme included eight bilateral mirror studies on data from 2006 to 2009. One of these was a study with the Central Agency for Mobilisation and Statistics of Egypt (CAPMAS), which revealed substantial under-coverage of trade since statistics did not receive all Customs declarations. In addition, the strict definition of 'special trade system' was applied and the product nomenclature was based on the 1992 version of the HS classification. Egyptian free zones and bunkers were considered as separate countries and imports from them into the area of free circulation were recorded without product distinctions (European Commission, 2009)

A detailed analysis of asymmetries between the EU and the Mediterranean partner countries helped address many trade asymmetries by country and flow. The study found that Egypt exhibited significant asymmetries in trade with the EU in both directions.

Table 3. Overview of asymmetries between the EU and Mediterranean partner countries (MPCs)

	Mirror discrepancy							
	Northbound				Southbound			
	MPC exports to EU-25 (1000 euro)	EU-25 imports from MPC (1000 euro)	Northbound mirror discrepancy		EU-25 exports to MPC (1000 euro)	MPC imports from EU-25 (1000 euro)	Southbound mirror discrepancy	
			Value (1000 euro)	%			Value (1000 euro)	%
JORDAN	124 115	375 076	250 961	202.2	2 315 469	2 028 265	- 287 205	-12.4
EGYPT	2 217 471	4 191 972	1 974 500	89.0	7 398 116	3 059 961	-4 338 154	-58.6
ALGERIA	13 932 458	15 251 581	1 319 122	9.5	9 451 495	8 062 116	-1 389 379	-14.7
SYRIA	3 493 711	3 455 586	- 38 125	-1.1	2 902 799	1 698 860	-1 203 938	-41.5
MOROCCO	7 349 554	7 159 447	- 190 106	-2.6	10 387 890	9 882 012	- 505 877	-4.9
LEBANON	146 651	240 367	93 715	63.9	3 224 947	3 022 096	- 202 850	-6.3
ISRAEL	11 671 813	11 351 149	- 320 664	-2.8	14 286 886	13 645 370	- 641 516	-4.5
TUNISIA	8 782 949	8 975 115	192 165	2.2	9 503 610	9 052 109	- 451 500	-4.8

Note: Mirror discrepancy in value = Imports - Exports ; Mirror discrepancy in % = (Imports-Exports)/Exports

Source: European Commission (2009)

The study identified the following main reasons for discrepancies in trade statistics:

a. Confidentiality concerning the partner country in some EU countries (in particular for HS27);
b. Repairs of aircraft (HS88, HS84 and HS90);
c. Differences in the trade systems (impact on processing);

d. Difficulties with measuring trade involving Free Zones;
e. Non-use of registers to measure trade in vessels and aircraft (HS88 and HS89);
f. Difficulties with measuring trade in diamonds (HS71);
g. Registration of the country of origin for used cars in accordance with international recommendations; and
h. Possible under-declaration of values.

Case study 1.5: Weighting discrepancies in international goods trade volumes by ECLAC

In their study of IFFs in the countries of Latin America and the Caribbean, ECLAC (2016) focuses on gross outflows from misinvoicing, using data on international goods trade from the Comtrade and the International Trade Database (BACI) operated by the Centre for International Prospective Studies and Information (CEPII), at HS 6-digit level with exports valued at FOB and imports at CIF, using econometric modelling to adjust to FOB.

Asymmetries in bilateral statistics result in large discrepancies in international goods trade volumes at the partner and product level. To mitigate this, the discrepancies are weighted by the degree of concordance between the import and export volumes (*ImpVol* and *ExpVol*) reported by the two partners.

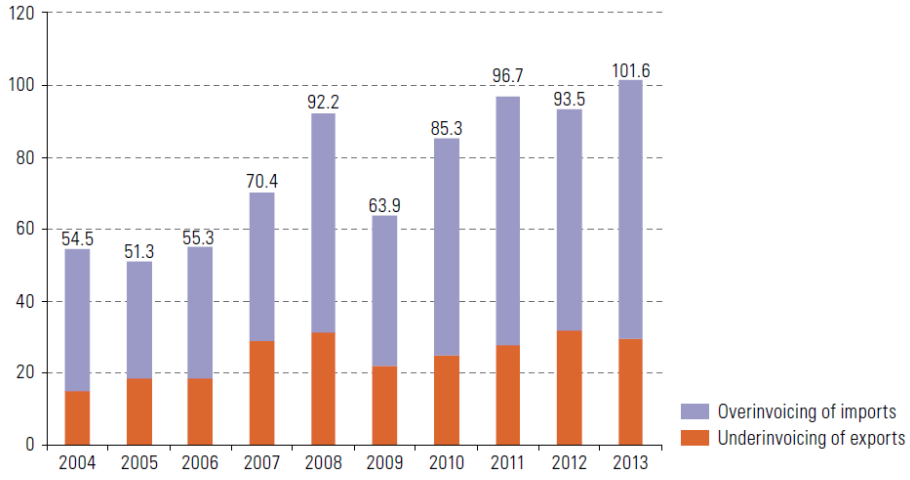
$$ExpDisc_{i,j,hs6,t} = (ImpVal_{j,i,hs6,t} - ExpVal_{i,j,hs6,t}) * (1 - \left(\frac{|\ ImpVol_{j,i,hs6,t} - ExpVol_{i,j,hs6,t}\ |}{\max(ImpVol_{j,i,hs6,t}, ExpVol_{i,j,hs6,t})}\right))$$

$$ImpDisc_{i,j,hs6,t} = (ImpVal_{i,j,hs6,t} - ExpVal_{j,i,hs6,t}) * (1 - \left(\frac{|\ ImpVol_{j,i,hs6,t} - ExpVol_{i,j,hs6,t}\ |}{\max(ImpVol_{j,i,hs6,t}, ExpVol_{i,j,hs6,t})}\right))$$

The analysis combines export under-invoicing (*ExpDisc*) and import over-invoicing (*ImpDisc*) as the gross outflows from misinvoicing, to produce a lower bound to the IFFs from the region:

$$Gross\ outflows\ from\ misinvoicing = \sum ExpDisc_{i,j,hs6} + \sum ImpDisc_{i,j,hs6}, for\ ExpDisc > 0\ and\ ImpDisc > 0$$

Figure 3. Estimated value of trade misinvoicing in Latin America and the Caribbean (US$ billions)



Source: UNECLAC (2016)

Case study 1.6: Trade Misinvoicing Estimation in the Arab Region Using Mirror Trade Statistics

An ESCWA (2018) study on IFFs conducted among Arab countries, examines the drivers of tax and commercial IFFs in the region and provides estimates on IFFs from trade-based misinvoicing.[1] The quantitative estimates in this report offer a low-end baseline for IFFs, capturing the measurable components.[2]

The report identifies different incentives to trade misinvoicing, which depend on distinct trade and fiscal profiles of different countries in the region. Such incentives are classified in four main categories: 1) Macroeconomic factors, such as exchange controls, export restrictions, trade bans and sanctions, and expenditure eligibility requirements; 2) Governance-related conditions, such as red tape, bureaucratic hurdles, weakness in regulatory oversight (deficient customs enforcement, for example), long judicial delays, bribery and kickbacks; 3) Structural drivers, such as income distribution, tax evasion and inequality, and; 4) Security and instability, including political instability, armed conflicts, terrorism, and criminal activities.

These factors affect the Arab region countries at different extent and are at the origin of different types of trade misinvoicing practices, namely: under-invoicing of exports (for example, to evade export restrictions and bans, or to circumvent sanction regimes or ceilings on the volume of oil that could be sold on the world market); over-invoicing of imports, allowing traders to shift value abroad by overpaying foreign exporters, for example for the purpose of circumventing capital controls or to reduce declared profits subject to corporate tax; over-invoicing of exports, occurring when exporters receive more for their exports than they are worth, so that firms may over-invoice exports if they wish to reclaim overpaid value-added tax (VAT) on over-invoiced imports of intermediate inputs or machinery; and under-invoicing of imports, which is a particularly pervasive form of illicit capital movement (inflow). Import under-invoicing is a form of tax evasion that adversely affects both direct and indirect taxes via underpayment of import duties and/or VAT. Beyond direct and indirect tax, and duty evasion, import under-invoicing represents a form of "technical smuggling".

The report finds that some commodities are more vulnerable to trade misinvoicing practices than others: the top six misinvoiced product categories in the Arab region are mineral fuels, machinery, electrical machinery, vehicles, plastics, precious stones and metals, and organic chemicals. It is estimated that these categories make up to 50 per cent of total misinvoicing between 2008 and 2015.

In particular, ESCWA (2018) estimates that, excluding trade in mineral fuels and derivative products (HS 27), between 2008 and 2015 around $60.3 billion per annum on average were estimated to be IFFs from trade misinvoicing, the equivalent of a fifth of the region's GDP in 2016. During this period, illicit financial outflows associated with misinvoicing amounted to $27.8 billion per annum on average and were mostly

[1] Including the illicit manipulation and/or movement of money across borders involving the misreporting of price (values), quantity (volumes) and quality of commodities.

[2] The paper recognises that there are other measurable components of IFFs such as hot money leakages from the balance of payments ("net errors and omissions", as labelled by the IMF). The implications of such unrecorded flows are complicated in some Arab countries by the presence of sovereign wealth funds. Mis-recording or uncoordinated data compilation of transfers to sovereign wealth funds can lead to unduly large net errors and omissions in the balance of payments. As such, in the interest of keeping the quantitative estimates as accurate and conservative as possible, these flows are not considered in this report.

dominated by import over-invoicing ($17.8 billion per year on average). Illicit inflows amounted annually to $32.5 billion and were, in turn, dominated by import under-invoicing practices ($25.1 billion per year on average). The top six countries adversely affected by IFFs in all sectors excluding mineral fuels and derivatives were Saudi Arabia, the United Arab Emirates, Egypt, Tunisia, Algeria and Jordan, accounting for 80 per cent of the region's IFFs associated with misinvoicing. In seven Arab economies, trade-based illicit financial outflows exceeded inflows.

The report finds in addition that, if mineral fuels are included in the estimate, they would be the largest commodity category for trade gaps within the region, in dollar levels and as a percentage of trade within the 2-digit commodity. When oil trade is included in the estimates, the total trade misinvoicing (oil and non-oil) for Arab economies between 2008 and 2015 would reach the amount of $77.5 billion on average per year.

The method relies on mirror trade statistics and takes from that adopted by the Economic Commission for Latin America and the Caribbean (ECLAC, 2016), by the High-Level Panel on Illicit Financial Flows from Africa (ECA, 2015) and IMF DOTS-based trade misinvoicing model (Kar and Freitas, 2012) , but departs from them in a number of aspects:

1) Two variations to capture the dynamics in intra- and extra-regional preferential and non-preferential trade misinvoicing are introduced.
2) A third variation involves estimating IFFs and misinvoicing in terms of gross values by supplementing illicit outflows with measures of inflows to capture the four conduits associated with over and under-invoicing of imports and exports. In other words, the methodology dismisses the application of net resource transfers or 'netting' IFFs for a given product and country, therefore aligning with the IFF definition of the *Conceptual Framework*.
3) A fourth variation relates to the consideration of product categories under the 6-digit HS 2007 coding system to avoid situations where overstated and understated misinvoicing cancel each other out, underestimating the true value of illicit trade-based capital movement.

Calculations were run at country level for 22 members countries of the League of Arab States. Estimations for commodity trade misinvoicing are based on the United Nations Comtrade database and capture export dynamics. Insurance, transport and freight mark-ups are discounted to derive actual mirror flows in terms of free on board (FOB) prices for each product category while accounting for distance and sectoral specialization. Data from the International Trade Database (BACI) are used to extract import values where, based on an econometric model, their values undergo reconciliation in terms of cost, insurance and freight/free on board values.

Discrepancies in mirror trade statistics are calculated for the reported exports and imports of Arab countries. Discrepancies are calculated for each Arab country with each partner country for each 6-digit HS product category for a number of observations each year. To mitigate the impact of trade value gaps where the trade volumes also do not match, the value gaps are weighted to give less prominence to those value gaps where wide volume gaps also exist. Discrepancies less than $1 million in value are excluded to avoid statistical noise.

Formulas used in the calculation are:

$$\Delta X_{ijkt} = \left(VM_{jikt} - VX_{ijkt}\right) * \left[1 - \frac{\left(\left|QM_{jikt} - QX_{ijkt}\right|\right)}{max\left(QM_{jikt}, QX_{ijkt}\right)}\right] \quad [1]$$

$$\Delta M_{ijkt} = \left(VM_{ijkt} - VX_{jikt}\right) * \left[1 - \frac{\left(\left|QM_{ijkt} - QX_{jikt}\right|\right)}{max\left(QM_{ijkt}, QX_{jikt}\right)}\right] \quad [2]$$

Where:

X = exports - M = imports - V = value - Q = quantity - Δ = difference - i = reporting country - j = partner country - k = commodity - t = time (year)

The methodology is subject to some limitations, some of which are common to other methodologies explored by other authors. The methodology is sensitive to data quality. It is difficult to quantify trade misinvoicing in cases of collusion or when both value and volume are misreported. Detailed statistics for services are unavailable to allow for estimating misinvoicing given by the four modes of services supply. Estimates remain a matter of faith without firm and transaction-level data.

Case study 1.7: Partner Country Method applications in South Africa, Arab region, Asia and the Pacific, and Africa

WCO (2018) analysed South African imports between 2010 and 2015 with PCM to identify trade misinvoicing, using bilateral trade data from the United Nations Comtrade database. In this period, United Nations Comtrade included approximately 628 000 records of South African imports. However, only matching entries for imports value and volume can be used, comprising only about 45 per cent of the total available. South Africa already reports imports on an FOB basis; therefore, no adjustment was needed in comparison to partners' exports. However, adjustment for Chinese re-exports via Hong Kong was done and reliability weights applied. The results reveal that import undervaluation (12 per cent of the value of imports in the sample) is a greater risk for South Africa than overvaluation of imports (9 per cent of imports).

An UNESCWA (2018) study on IFFs in the Arab region focused on all four conduits of trade misinvoicing, namely underinvoicing and overinvoicing of export and imports. The report finds that Arab economies fall prey to at least US$60.3 to US$77.5 billion per year in damages due to IFFs associated with trade misinvoicing (see case study 1.6). Misinvoicing appears more pervasive for non-resource-based economies and for non-oil product categories at the HS 6-digit level and follow a general upward trend. Variability in the scope of misinvoicing has also been found to permeate both preferential and nonpreferential trade. The UNESCWA report also compares the results of PCM without any enhancements and bilateral corrections, noting that *"until mirror data are supplemented and can be matched against data at firm and transaction levels, misinvoicing estimates will remain a matter of faith".*

A study by Kravchenko (2018) in Asia and the Pacific applies the PCM method to bilateral trade flows at HS 6-digit level and finds that in 2016 as much as 7.6 per cent of regional tax revenue may have been lost in the region due to fraudulent export and import value declarations. The study also addresses some of the method's shortcomings, noting that:

Not all available trade data can be used due to lack of matched data (at either side, i.e., import or exports). This could be due to erroneous or deliberate misdeclaration of product code or country of origin or destination, as well as time lag. The coverage of matching exports and imports varies significantly. Therefore, the assumption must be made that the estimated misinvoicing rates are the same also for the non-matching records.

Aggregated data on differences in declared exports and imports, do not identify cases where declaration is misvalued at both sides of the border. Kravchenko looks at relative export prices by source and destination and finds substantial differences. He further notes that aggregation is likely to mask variations in quality and brand-value addition and averaging across economies is also likely to cancel out variation where some products are over or underpriced for different reasons.

Schuster and Davis (2020) note that both intra- and extracontinental African mirror trade gaps should be analysed to obtain a full(er) picture of IFFs. They underline lack of information on how trade statistics are recorded as a major obstacle. The authors use PCM to study IFFs in Africa, noting that it is important to consider continental and country or commodity specific circumstances when conducting PCM analysis. For instance, a negative value of trade discrepancy cannot be directly linked to IFFs since: (a) illicit inflows in the context of extractive industries in Africa is counterintuitive; and (b) large negative trade gaps (i.e.,

larger exports than imports by partner country) are likely to be linked to specific primary commodities and their trade patterns, for example, copper storage in bonded warehouses, or upstream transformation in industrial free zones.

Their results confirm that new metals like manganese, chromium, molybdenum and other rare-earth metals have the largest trade gaps, more than 200 per cent for the rare-earth metal group (indium, cadmium, lithium). Imports by the rest of the world are three times larger than exports reported by the continent. The overall intra-African trade gap is relatively small with inconsistent trend and mainly negative, driven largely by West African gold exports to South Africa. These patterns cannot easily be attributed to errors in trade recording and systemic illicit behaviour.

Case study 1.8: Grey re-exports to estimated illicit financial flows in Kyrgyzstan

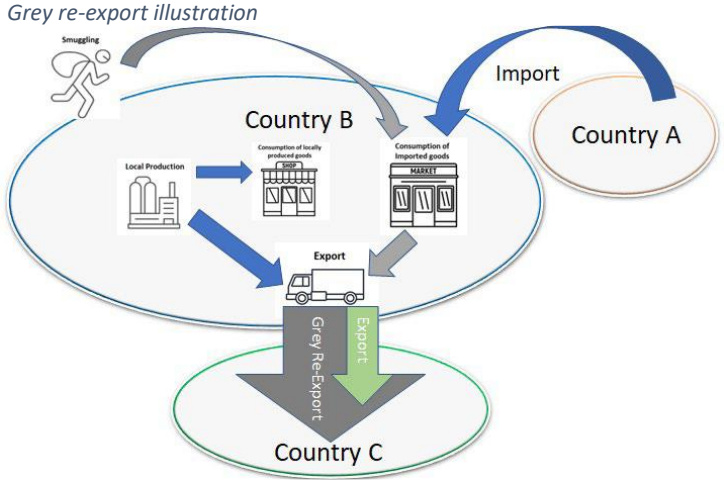
A special case of trade routing is the (ab)use of re-exports. This is a notable statistical challenge, whereby not all trading partners consistently report re-exports, i.e., export of goods by a country that have been previously imported from another country of origin. Rather, they sometimes report them simply as their exports, which may lead to mirror-trade discrepancies, but can carry along tax and commercial IFFs to some degree as well. While, when consistently and distinctly reporting on re-exports, the total value of exports needs to be adjusted (reduced) for the re-exports to arrive at a true value of (domestic) exports, this is easily said in theory and manuals, than actually implemented in practice. Maga et al. (2023) study the phenomenon of re-exports in Kyrgyzstan and link it directly to the IFFs through so-called grey re-exports: "*Grey re-exports refer to a scheme of misinvoicing which involves the importation and re-exportation of goods. Goods are imported to one country from another country and are then re-exported to a third country as exports from the second country rather than as re-exports. This scheme is seen in countries that have special trade agreements as part of a customs union*". More specifically, they identify massive underreported trade flows of textile from China (with no domestic production, yet significant consumption and exports as domestic goods to Kazakhstan and the Russian Federation, both within the customs union); or inverse flows of exports of tobacco products to China. Likely reasons for such misreporting lie in tariffs or duties associated with products with varying origin.

The authors note that grey re-exports can arise from various activities, among them:

- Misclassification and misreporting of goods (e.g., also to give the appearance that goods are of local origin when being exported to other countries for duty-free status) and falsification of customs documents;
- Abuse of customs regulations;
- Mispricing;
- Corruption, where a portion of goods crosses borders without accounting or registration;
- Smuggling.

The following scheme presents the method's premise.

Figure 4. Grey re-export illustration



Source: Maga et al. (2023)

Grey re-exports are defined to capture two components, as per the following equation:

$$Grey\ Reexports_{xbct} = Unreported\ reexports_{xbct} - Misreported\ Reexports_{xbct}$$

Using the following two and inserting:

$$Unreported\ Reexports_{xbct} = Imports_{xbat} - (1 - dom) * Consumption_{xbt}$$

$$Misreported\ Reexports_{xbct} = Exports_{xbct} - (Production_{xbt} - dom * Consumption_{xbt})$$

the final grey re-export model looks as (in absence of domestic *dom* consumption data):

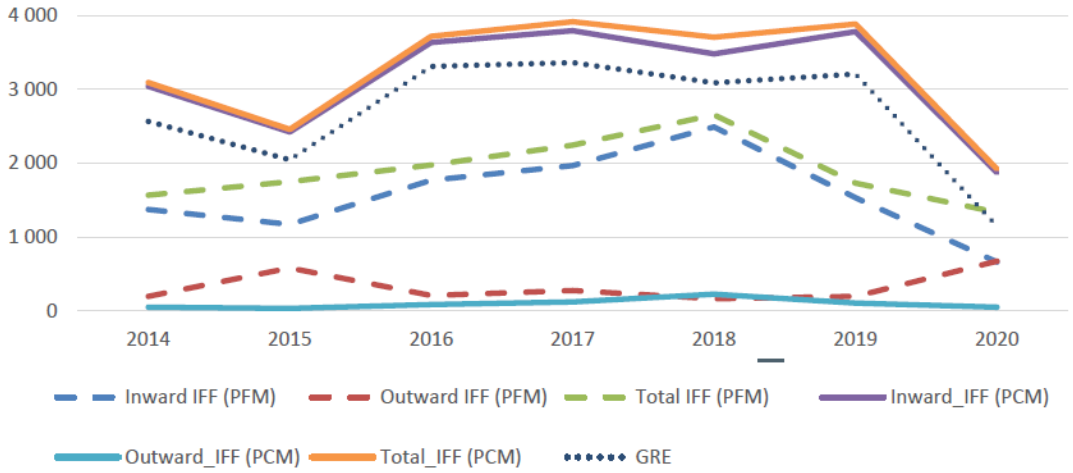
$$Grey\ Reexports_{xbct} = Imports_{xbat} - Exports_{xbct} + Production_{xbt} - Consumption_{xbt}$$

In the application of the method, authors (Maga et al., 2023: 16) note the following steps are to be taken:

1. *Risk assessment*: a qualitative approach using expert evaluation of the goods and/or trade routes/partners. It can be complemented conducting a quantitative observation of longitudinal imports and exports series.
2. *Obtaining access to the data*: combining publicly available data (e.g., UN Comtrade) with nationally available detailed customs data, including data from bilateral trade partners.
3. *Attribution of trade values and adjustments*: ideally done at a granular, 6-digit HS level, using experts' inputs to identify estimated values of respective categories required for the application of the model.
4. *Calculation*: run the above model.
5. *Estimation of IFFs from grey re-exports*: total value of IFFs from grey re-exports is calculated as the sum of the absolute value of misreported re-exports and the value of unreported re-exports.

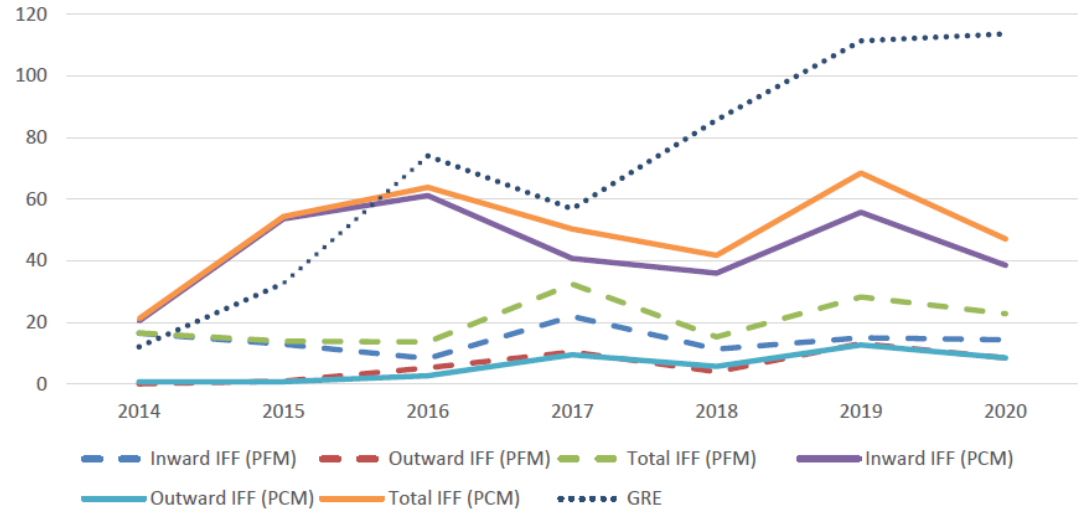
The authors process the calculations for textile and tobacco using both Kyrgyzstan data and data of partners (mirror trade statistics). Significant discrepancies were observed, i.e., for textile trade "*according to partner data, the estimated value of unreported re-exports is 8-10 times higher than that estimated with Kyrgyzstan's data*"(Maga et al., 2023: 26). They also take a step forward and compare results of the method (GRE) to other IFFs methodology (notably, methods #1 – PCM and #2 – PFM). The following figure presents results of such a comparison with ESCAP calculations for textile trade, and Figure 6 for tobacco.

Figure 5. Comparison of various models of IFF estimation for textile trade, millions USD



Source: Maga et al. (2023)

Figure 6. Comparison of PCM and PFM results for cigarettes containing tobacco, millions USD



Source: Maga et al. (2023)

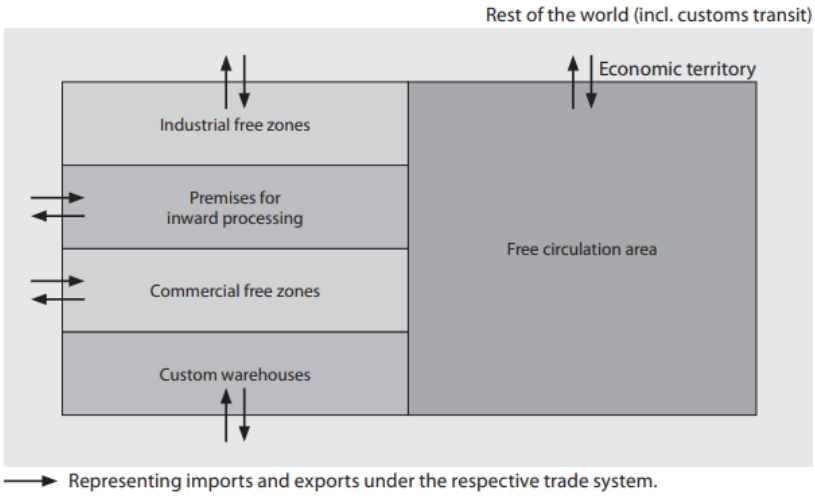
Case study 1.9: General and special trade systems

Analysing trade systems requires first the definition of the statistical territory of a country, which is "*the territory with respect to which trade data are being compiled*" (UNSD, 2011: 25). Several territorial elements of statistical territory exist:

a. Islands;
b. Territorial waters;
c. Continental shelf;
d. Offshore and outer space installations and apparatus;
e. Commercial free zones;
f. Industrial free zones;
g. Customs warehouses;
h. Premises for inward processing;
i. Territorial enclaves of the compiling country in other countries; and
j. Territorial exclaves, that is, enclaves of other countries in the compiling country.

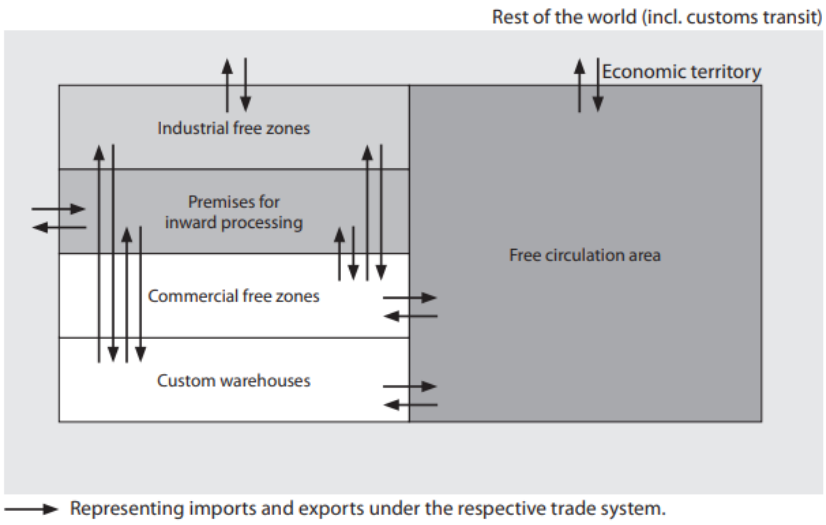
Some countries use the general trade system (where statistical and economic territories coincide), some others use the special trade system (when statistical territory comprises only some parts of the economic territory, hence not all flows are considered).

Figure 7. General trade system - territorial elements and potential imports and exports



Source: UNSD (2011)

Figure 8. Special trade system - territorial elements and potential imports and exports



Source: UNSD (2011)

When special trade system is used, lack of coverage may negatively impact usefulness of trade data and particularly in the application of PCM. Adjustment for the differences in trade system applied by trade partners is required, and they are processed by detailed bilateral comparison and using breakdowns, e.g., in the above figures, to eliminate elements of economic territory not present in both trading partners, therefore ensuring comparing like to like. UNSD (2011) encourages countries using special trade system to develop plans to introduce the general trade system. As this may be resource intensive, it is also recommended that those countries estimate the following statistics (unless such trade is insignificant):

a. When the strict definition is used, statistics on goods imported into and exported from premises for Customs warehousing, premises for inward processing, industrial free zones or commercial free zones;
b. When the relaxed definition is used, statistics on goods imported into and exported from premises for Customs warehousing or commercial free zones (ibid).

Case study 1.10: Adjusting imports of reporting and exports of partner country to calculate the remaining asymmetry

When applying the PCM+, all the identified corrections should be implemented leaving the remaining part of trade asymmetries. The UNSD template (2019) is useful for addressing these to come to a value of remaining asymmetry. A procedure for adapting imports of a reporting country and exports of a partner country is presented in Table 4.

Table 4. Adjusting imports of reporting and exports of partner country to calculate the remaining asymmetry

		R IMPORTS	P EXPORTS
ORIGINAL DATA	Official data	$\mathrm{IM}_{\mathrm{CIF,c,r,p,t}}$	$\mathrm{EX}_{\mathrm{FOB,c,r,p,t}}$
ADJUSTMENT	CIF-FOB	$\mathrm{A}_{\mathrm{CIF-FOB,c,r,p,t}}$	
	ADJUSTED DATA*	$\mathrm{IM}_{\mathrm{FOB,c,r,p,t}}$	
ADJUSTMENT	Trade system	$\mathrm{A}_{\mathrm{TS,c,r,p,t}}$	
	Indirect trade	$\mathrm{A}_{\mathrm{IT,c,r,p,t}}$	
	Re-exports		$\mathrm{B}_{\mathrm{Re-Ex,c,r,p,t}}$
	Merchanting	$\mathrm{A}_{\mathrm{M,c,r,p,t}}$	$\mathrm{B}_{\mathrm{M,c,r,p,t}}$
	Timing (time lags)	$\mathrm{A}_{\mathrm{T,c,r,p,t}}$	
ADJUSTED DATA		$\mathrm{IM}^{\mathrm{Adj}}_{\mathrm{FOB,c,r,p,t}} = \mathrm{IM}_{\mathrm{FOB,c,r,p,t}} - \mathrm{A}_{\mathrm{TS,c,r,p,t}} - \mathrm{A}_{\mathrm{IT,c,r,p,t}} - \mathrm{A}_{\mathrm{M,c,r,p,t}} - \mathrm{A}_{\mathrm{T,c,r,p,t}}$	$\mathrm{EX}^{\mathrm{Adj}}_{\mathrm{FOB,c,r,p,t}} = \mathrm{EX}_{\mathrm{FOB,c,r,p,t}} - \mathrm{B}_{\mathrm{Re-Ex,c,r,p,t}} - \mathrm{B}_{\mathrm{M,c,r,p,t}}$
REMAINING ASYMMETRY		$\mathrm{InboundRA} = \mathrm{IM}^{\mathrm{Adj}}_{\mathrm{FOB,c,r,p,t}} - \mathrm{EX}^{\mathrm{Adj}}_{\mathrm{FOB,c,r,p,t}}$	

Source: UNSD (2019)

** Depending on how CIF-FOB differences are dealt with, $IM_{FOB,c,r,p,t}$ can be calculated as $IM_{CIF,c,r,p,t} - A_{CIF-FOB,c,r,p,t}$, or, if CIF/FOB ratios are used, as in equation (1).*

Analogous adjustment is processed for exports of reporting country and partner country imports (to obtain *OutboundRA*). If any additional sources of asymmetries are detected at this point, they need to be considered.

Method #2: Price Filter Method Plus (PFM+)

Case study 2.1: The basic treatment of SARS data prior to applying the PFM

WCO (2018) applied PFM to South Africa's imports using transaction data by SARS. Basic treatment of these data before the application of PFM itself involved three passes through the data, with each applying standard statistical criteria to screen out extreme values. The PFM was, namely, applied to the SARS sample that required first elimination of outliers that could be the result of errors and would potentially exert undue influence on the results, if included. WCO (2018) notes that with a large sample, such as the SARS database, the potential for such overly influential observations is not negligible. It is also important to note that the PFM was implemented by organizing SARS price data into groups of similar trades, defined by the year of the transaction, commodity traded (8-digit SARS commodity classification) and the unit of measurement.

On the first pass to identify admissible groups of transactions, size of the group was checked. Groups with fewer than five observations were eliminated outright and those groups with five or more observations but limited variability in the prices were also eliminated from further analysis.

The second pass to identify admissible price observations within groups checked individual prices within the groups passing through first pass, removing the within-group outliers.

Third pass aimed at identifying admissible price observations across groups, whereby first standardizing remaining prices to allow comparison across groups. Outliers were removed.

The triple-pass treatment reduced the number of distinct groups from 40 737 to 36 487, and the number of admissible records in the SARS database to just over 7 million. The PFM procedure was then applied to each surviving record in the SARS sample.

Case study 2.2: Identifying national experts to support the application of the Price Filter Method

In their study of mispricing related to gold and cocoa exports from Ghana, Ahene-Codjoe et al. (2020) conducted extensive research to identify national experts for interviews during other statistical analyses.

Table 5. List of institutions contacted in Ghana

Cocoa Beans and Cocoa Paste	
Role of Institution	**Name of Institution**
Production	Ghana Cocoa Board (COCOBOD)
Transportation	
Export	Cocoa Marketing Company (CMC) (COCOBOD), Ghana Export Promotion Authority (GEPA)
Gold	
Role of Institution	**Name of Institution**
Regulator	Minerals Commission
Private Sector Organisation	Ghana Chamber of Mines, Freight Forwarding Agency, Gold Exporting Agencies 1, 2
Assaying/Valuation	Precious Minerals Marketing Company (PMMC)
Civil Society Organisations	Ghana Extractive Industries Transparency Initiative (GHEITI), Integrated Social Development Centre (ISODEC)
Natural Resource Sector Governance	
Purpose of Institution	**Name of Institution**
Regulator/Tax Authority	Customs Division (Ghana Revenue Authority)
Regulator/Central Bank	Bank of Ghana
Business Promotion	Ghana Investment Promotion Centre (GIPC)

Source: Ahene-Codjoe et al. (2020)

Case study 2.3: Calculating benchmark prices for gold

Gold is identified as a commodity with variations in its characteristic, the contents of gold, or other metals. In their application of PFM to gold imports to Switzerland, Carbonnier and Mehrotra (2020) use free market price to determine the arm's length price range, concretely the London Bullion Market Association (LBMA)'s daily spot price series for refined gold bars. As they note, according to the Metals Focus Gold Silver Dore Service database, gold doré bars produced and traded internally can contain between 2-95 per cent pure gold by weight, silver (ranging between 0-92% by weight) and other impurities (up to 5 per cent by weight). Consequently, they use the country-level gold and silver content in doré produced, and use formulas to calculate a maximum and minimum benchmark prices:

Maximum benchmark price =

*(daily price of gold * maximum gold content in doré) + (price of silver * minimum silver content)*

Minimum benchmark price =

*(daily price of silver * maximum silver content in doré) + (price of gold * minimum gold content)*

Case study 2.4: Price Filter Method for the Soya Bean exports in Brazil

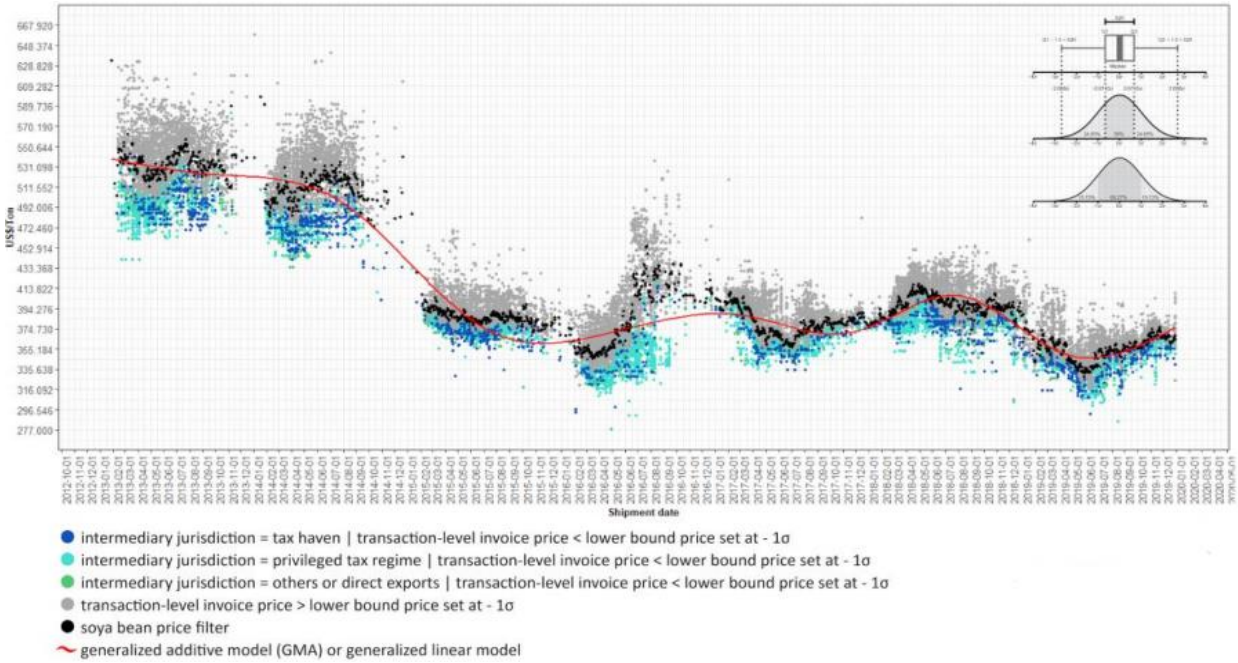
Amaral and Barcarolo (2020) applied the PFM to Brazilian soya bean exports. In Brazilian market the soya bean price is composed of the commodity future market quoted price and a premium basis, that is paid to the exporters. The soya bean price filter is therefore calculated as:

SOYA BEAN PRICE FILTER = [QUOTED PRICE + PREMIUM BASIS] +/- α (%)

Price filter was statistically estimated using a three-day weighted moving average price, based on the transaction-level data collected by the Customs Bureau. Outlier treatment was applied using IQR before estimating the weighted moving average price.

The case is important also in the refining of the PFM analysis by considering economic substance. Particularly, this refers to observing high-risk transactions in terms of their exposure to BEPS and segregating transactions by country of acquisition into tax havens, privileged regimes, or other jurisdictions (following national regulation). Suspicious abnormally underpriced invoices are presented in the following chart.

Figure 9. Invoice prices at transactions level, by jurisdiction of acquisition and estimated risk exposure to BEPS, 2012-2020



Source: SISCOMEX Customs Database, Amaral and Barcarolo (2020)

The potential tax IFFs were estimated as follows:

$$(a)\ Weighted\ Average\ Price(t) = \sum_{i=1}^{n}[Invoice\ Price\ (t:i)\ x\ Quantity(t:i)]\ /\ \sum_{i=1}^{n}[Quantity(t:i)]$$

$$(b)\ Weighted\ Moving\ Average\ Price(t) = \sum_{t'=t-3}^{t}[Weighted\ Average\ Price(t')\ x\ TIN(t')\ x\ E(t')\ ]\ /\ \sum_{t'=t-3}^{t}[TIN(t')\ x\ E(t')]$$

$$(c)\ Price\ Filter\ Range(t)' = [Weighted\ Moving\ Average\ Price(t') \pm 1\sigma\ ]$$

$$(d)\ Total\ Estimated\ BEPS\text{-}related\ FF = \sum_{t=1}^{n}[Lower\ Bound\ Price(t)' - Invoice\ Price\ (t:i)]\ x\ Quantity(t:i)$$

Where:

Weighted Average Price (t): daily average price weighted by transaction-level invoice prices and quantity in tons.

Weighted Moving Average Price (t): three-day moving average price weighted by quantity of tax payers (exporters) and by quantity of exports transactions.

Price Filter Range (t): upper and lower bound prices set at the three-day weighted moving average price +/- 1σ (standard deviation).

Lower Bound Price (t): three-day weighted moving average price - 1σ (standard deviation).

Total Estimated BEPS-related FF: the sum of the differences between the lower bound prices and transaction-level invoice prices below the lower bound (potential underinvoiced exports) in the period from date *t=1* to *t=n*, wherein *1* represents the first and *n* the last day.

TIN (t'): quantity of taxpayers (exporters) in a date *t*.

E(t'): quantity of export transactions in a date *t*.

Invoice Price (i): transaction-level invoice price in a date *t*.

Quantity(i): weight in tons by transaction-level invoice price in a date *t*.

Estimated tax-related IFFs on export side amount to just below 1 per cent of total exports, around US$504 million. The authors further note that considering that around 99 per cent of export transactions happen between affiliated entities located in favoured taxation jurisdictions, the price filter for the soya bean trade market (estimated using transaction level trade data by the Customs) are likely biased down due to aggressive tax planning strategies. Applying a free-market rather than statistical price filter is required in such cases to guarantee reliability of the results in further applications of the method.

Table 6. Estimated BEPS-related financial flows

Estimated BEPS-related financial flows
Period: 2017 to 2019

country of acquisition	triangular transactions	Incoterms	total exports US$	quantity TON	estimated BEPS-related FFs US$
Art.1º - Tax Haven	Yes	FOB	18.128.478.967	47.964.971	162.298.531
Art.2º - Privileged Tax Regime	Yes	FOB	29.913.890.618	79.024.100	300.401.808
Other jurisdictions	Yes	FOB	5.552.651.496	14.590.957	38.643.608
Other jurisdictions	No	FOB	150.150.582	407.331	2.507.883
Total			**53.745.171.664**	**141.987.359**	**503.851.830**

Source: Amaral and Barcarolo (2020)

Case study 2.5: Determining the price filter using customs data in Uganda

Davies, McNabb, and Palanský (Forthcoming), in collaboration with Uganda Revenue Authority (URA), use customs data in Uganda to achieve two goals. First, they identify abnormal unit prices by constructing detailed price filters and comparing observed unit prices to them. Second, they study the impact of the implementation of cargo scanners at the Ugandan border on import values as well as tariff and VAT revenues, illustrating how the price filter methods and data can be utilized to examine causal effects of reforms aimed at reducing trade-related tax and tariff evasion.

Trade-related tax evasion, through transfer pricing or strategies such as underpricing, undercounting or misrepresenting imported goods, hinders tax collection in developing countries, affecting their tax capacity. In this study, the authors exploit transaction-level data and study the implementation of a technological improvement in a developing economy to quantify its impact on tax evasion and on tax capacity.

Cargo scanners increase the cost of tax evasion and should thus reduce evasion in high-tariff goods, as it diminishes the incentives to report high-tariff goods as low-tariff goods. In turn, an increase in declarations of high-tariff goods should increase tariff dues. However, tax evaders might stop trading entirely, leading to less imports overall and tariffs duties. On the other hand, a faster scanning process reduces trade costs, which could boost imports of both high-tariff and low-tariff goods – although there could be higher short-term trade costs resulting from the implementation of a new technology.

Combining transaction-level custom data with administrative firm-level data for Uganda from 2016 and 2021, the study suggests that scanners did reduce tax evasion while at the same time probably raising trade costs. The authors use a difference-in-difference estimation where they compare total imports, duties and VAT receipts before and after the introduction of scanners while controlling for other variables.

The study highlights two important results: firstly, following the implementation of scanners, the study observes a decline in imports for low-tariff products and an increase in imports of high-tariff products. This is consistent with a decrease in the misrepresentation (misclassification) of high-tariff goods as low-tariff goods prior to the implementation of the scanners, suggesting that the scanners are successful in reducing tax evasion. However, product unit values increased both for high- and low-tariff goods. This result, together with the decline in imports for low-tariff goods could indicate higher trade costs in the short term. Secondly, the study finds that for low-tariff goods, both tariff duties and VAT are estimated to fall, while for high-tariff goods, both tariff duties and VAT are estimated to rise. Both sets of results suggest a reduction in evasion, together with an increase in trade costs and a decrease in imports.

The study exemplifies the realities of fighting tax evasion in developing countries. At least in the short-term, the results suggest that while stronger border enforcement stops some illicit activities, it may increase trade costs to such a degree that losses from non-evaders outweigh the gains from reducing trade-related tax evasion. Regardless, long-term gains in fight against the IFFs are expected to outweigh any short-term losses, especially in a broader, regionally and globally harmonized approach to fend off IFFs.

Case study 2.6: Identifying MNEs and their affiliates in low-tax jurisdictions: data sources

The price filter method requires, as its first step, determining the price filter, which brings about a series of challenges. For the case of focusing on transfer mispricing by multinational corporations, one major challenge lies in identifying incentives of companies to misprice transactions. This includes, crucially, determining whether the transaction takes place between unrelated parties or related parties that form part of a multinational corporation, the multinational enterprise group (MNE) – and if they are related parties, whether the MNE has affiliates in low-tax jurisdictions in which it reports significant shares of its global profit.

There is no comprehensive database of MNEs and their affiliates, so we have to rely on partial sources. We list these sources here and discuss their advantages and limitations.

1. *Domestic business registers.* Information about company ownership may be readily available within domestic business registers, although this is often only at the immediate level of legal ownership. This is a limitation because companies may be structured in multiple layers – a company can be owned by another company, which is in turn owned by another company. With some additional work, it is thus possible to look through the vertical chain of ownership and reconstruct full ownership structures within a country, however, a major limitation arises at the first step at which the company's ownership structure tree continues beyond the domestic jurisdiction. For example, when Uganda's business register states that company X (registered in Uganda) is fully owned by company Y which is registered in Kenya, we only know that companies X and Y are part of a MNE Z, however, we do not easily see the rest of the MNE's structure.
2. *International business databases*. The main limitation of domestic business registers – that they do not contain foreign information – can be overcome by using databases compiled from multiple business registers. The most prominent such database, often used by academics for international firm-level analyses, is the Orbis database, maintained by Bureau van Dijk, which compiles "information on more than 489 million companies across the globe … [by combining] … data from more than 170 different sources and treats it so it's standardized and comparable" (Moody's, 2024). There are two major limitations of Orbis. First, it is a private database and charges a relatively high cost for its use. Second, it is incomplete, with some of the most important information missing (primarily on affiliates in secretive jurisdictions and tax havens (Tørsløv et al., 2023)).

   There are other private international data sets that contain ownership information for companies, such as Standard & Poor's Capital IQ, Eikon, Bloomberg, or WRDS, each with a different scope, features, and pricing. Depending on the specific purpose or geographical focus, a different data set may be the most suitable option.

   One important effort in the direction of providing global, comprehensive, and free data on company ownership is the Global Legal Entity Identifier (LEI) Index, which is database of companies using identifiers and reporting standards developed by the International Organization for Standardization. The coverage and adoption of LEI is so far not very comprehensive: as of 13 March 2024, 2.58 million companies have had an LEI issued. However, since large companies are more likely to have an LEI (and also more likely to be responsible for a larger share of IFFs), the Global LEI Index may prove to be a valuable resource to identify company ownership structures.

3. *Country-by-Country Reporting (CbCR) company-level data*. CbCR data is reported since 2016 by most large multinationals with annual revenue over EUR 750 million (or similar thresholds in various currencies) as part of the OECD's Base Erosion and Profit Shifting (BEPS) initiative. It requires multinational companies to report annually, separately for each jurisdiction where they do business, information on their revenue, profit, taxes paid, and other measures of economic activity. It also includes information on all entities that form each MNE, and thus allow to construct an ownership network.

   There are at least three important limitations of this data. The first is its coverage – since there is a minimum revenue threshold for reporting, smaller MNEs are not included in the dataset despite being potentially very important players in a country's economy, especially for smaller and less developed countries. A second limitation of CbCR data is its accessibility: in its current form, it is only accessible for tax authorities that engage in information exchange as part of the OECD framework. Within this framework, companies submit their CbCR to the tax authorities of their headquarter country, which then share this data with all the countries in which that particular MNE operates. As of 13 March 2024, there are 6,649 bilateral exchange relationships of this data, however, some regions' coverage is relatively small: in Africa, for example, only Kenya, Mauritius, Nigeria, Seychelles, and South Africa receive this data. The CbCR data is planned in a number of countries, including European Union countries, to be publicly available starting with the 2024 financial year. A third limitation of the current form of CbCR data is the reporting standard, which falls short of some of the features of the Global Reporting Initiative's GRI 207: Tax 2019 standard, which includes additional reporting related to tax strategy, including the governance, control frameworks, and risk management processes related to taxation.
4. *OECD-UNSD Multinational Enterprise Information Platform*. A joint initiative of the OECD and the United Nations Statistics Division provides publicly available data on the top 500 largest MNEs' ownership structure. As of 13 March 2024, the database includes over 124 thousand affiliates that these MNEs own in 222 jurisdictions around the world. Depending on the country, setting and objectives of work, this can represent a substantial share of the necessary coverage.

Once we have identified affiliates of MNEs involved in imports and exports, we need to determine the scale of the incentives for profit shifting that the companies face. This exercise considers the characteristics of jurisdictions in which the MNEs operate, including factors like tax rates, loopholes and exemptions, and other factors that determine the potential for regulatory arbitrage.

Method #3: Global distribution of MNEs' profits

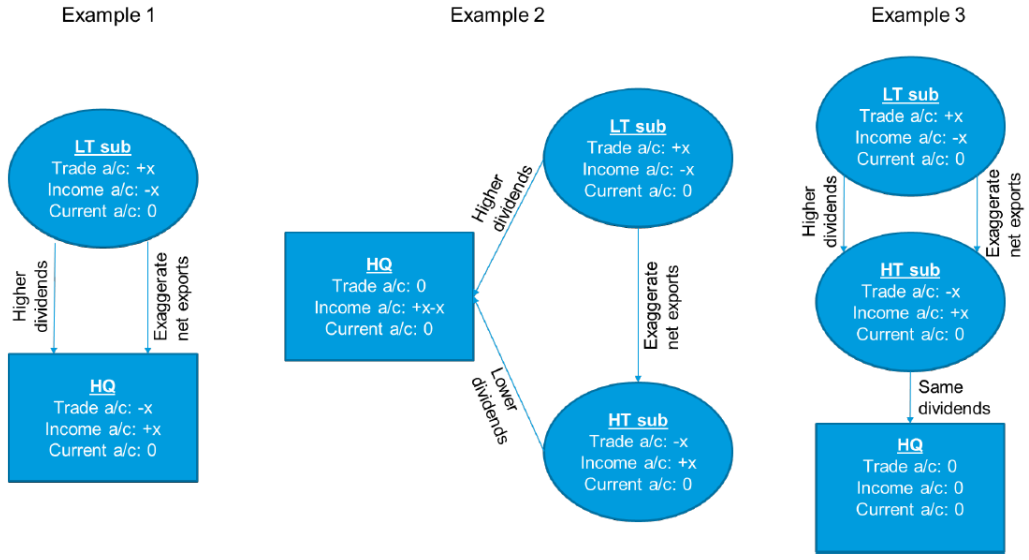
Case study 3.1: How does profit shifting reflect on the balance of payments?

Hebous et al. (2001) studied how tax strategies of MNEs shifting profits to jurisdictions with lower tax rates reflect on international flows. Using a panel of 81 countries for a period from 1990 to 2018, they find that the current account balance is not affected by statutory corporate tax rate, yet higher tax rates are associated with lower trade balances and higher income balances. Transfer mispricing flows (F3) affect import and export statistics; debt shifting (F4) and assets and intellectual property shifting (F5) affect international flows of interests, royalties and licence fees. Thus, profit shifting affects various components of the BoP.

Examples of how (1) transfer price manipulation and (2) profit shifting via intragroup lending impact the BoP are presented in figures below. The authors note that transfer price manipulation can affect bilateral current account balances, but not the aggregate level (except indirectly through changes in tax liabilities). With debt shifting, on the other hand, no impact is observed in the trade balance, yet credits and debits do occur in the income account.

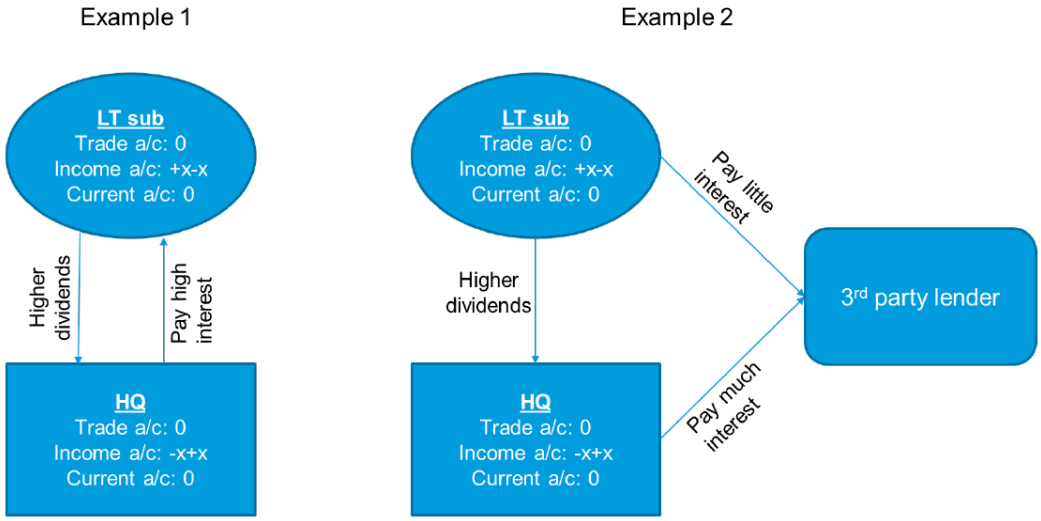
Figure 10. Graphical representation of BoP impact of

(1) transfer price manipulation



Notes: An amount x is shifted. LT indicates a low-tax jurisdiction, HT a high-tax jurisdiction. HQ denotes the country of the headquarters' location, which also has high taxes. Instead of higher dividends, there could also be an increase in liabilities through retained earnings with the same impact.

(2) profit shifting via intragroup lending



Notes: An amount x is shifted. LT indicates a low-tax jurisdiction, HT a high-tax jurisdiction. HQ denotes the country of the headquarters' location, which also has high taxes. Instead of higher dividends, there could also be an increase in liabilities through retained earnings with the same impact.

Source: Hebous et al. (2001)

Cobham et al. (2021) provide an overview of how specific profit shifting flows (as defined in Table 1 of UNCTAD (2023)) can be linked to the BoP.

Table 7. Overview of the variables in the Balance of Payments Statistics that are related to flows of profit shifting by multinational companies

Profit shifting method	Corresponding concept in BPM	Reasoning
Strategic location of intangible assets (F5)	Primary income account / Investment income / Direct investment / Income on equity and investment fund shares	Profit shifting made possible by the mobility of intangible capital
Strategic location of liabilities (F4)	Primary income account / Investment income / Direct investment / Interest	Profit shifting made possible by debt shifting (earning stripping)
Transfer mispricing in trade in goods (F3)	Goods and services account / Total goods	Profit shifting made possible by the vagueness of arm's length pricing rules
Transfer mispricing in trade in services (F3)	Goods and services account / Other business services Goods and services account / Financial services Goods and services account / Charges for the use of intellectual property n.i.e.	Profit shifting made possible by the mobility of intangible capital

Source: Cobham et al. (2021)

Case study 3.2: Estimating profit shifting in South Africa using firm-level tax returns

Reynolds and Wier (2016) use firm tax returns from Tax authority in South Africa for the period from 2009 to 2014 to analyse variables, including labour costs, fixed capital, accounting profits and taxable profits. The analysis includes MNE units in South Africa with sales of over 1 million South African Rand (ZAR) that are at least 70 per cent owned by a foreign parent. All other MNE units are excluded due to data limitations, including cases where South African unit is the parent of the MNE. With about 2 000 MNE units, only a small number compared to nearly one million firms in South Africa, these subsidiaries are markedly larger than the average South African firm. The observed average parent tax rate is similar to domestic corporate tax rate. The authors estimate the following specification:

$$\log(taxable\ income_{it}) = \alpha_{Ind,t} + \beta_1 \log(fixed\ capital_{it}) + \beta_2 \log(labour\ expenses_{it}) + \beta_3 \cdot parent\ tax\ rate_{it} + \varepsilon_i \quad (1)$$

The semi-elasticity of taxable income with respect to the parent tax rate is estimated to be 1.7, meaning that a 10 percentage points lower parent tax rate is associated with a 17 per cent lower taxable income in the South African unit of that MNE. Accordingly, they estimate the loss of MNE units profits due to profit shifting at 7 per cent of these units' income, or 1 per cent of the total corporate tax base in South Africa.

In another study, Wier and Reynolds (2018) investigate the link between firm size and profit shifting. They find that the major portion of profit shifting takes place with the largest of MNEs, with the majority of firms shifting only very limited amount of profits. By not considering heterogeneities in profit shifting across firms of different sizes may lead to significant underestimation of profit shifting. Accordingly, the authors account for differences in size by dividing the sample into ten groups according to wage bills and run regressions within each of these groups. They show that in larger MNE units, the estimated impact on profitability is significantly larger and also statistically significant. Alternative way to account for the size of firms is to apply a weighted regression using wage bill as the weight.

Results are significantly larger when properly accounting for firm size. Authors also note that combining high profits with aggressive tax avoidance implies that the largest 10 per cent of foreign-owned firms account for as much as 98 per cent of all profits shifted. As these findings are not unique to South Africa, authors note the findings can help in explaining the gap between micro and macro estimates of profit shifting often observed in studies.

Case study 3.3: Profit shifting in Germany using Country-by-Country Reporting data

Fuest et al. (2021) analyse CbCR data for German-headquartered MNEs at the level of each MNE unit. They estimate tax-induced profit shifting using the quadratic specification (to account for non-linearity of tax sensitivity):

$$y_{ict} = \dot{\alpha}_i + \dot{\beta}_1 \tau_{ct} + \dot{\beta}_2 \tau_{ct}^2 + \dot{\gamma}' Firm_{ict} + \dot{\delta}' Country_{ct} + \dot{\theta}_t + \dot{\epsilon}_{ict}$$

The authors use two alternatives for dependent variable: statutory tax rate and effective tax rate to show that statutory tax rate is an inaccurate measure of the actual tax burden in a country. In the vector Firm, they also use the unrelated revenues. Given the granularity and richness of their dataset, they further use dummy variables to test whether tax havens (divided into European and non-European) play a key role in profit shifting by German MNEs – and show this is the case, whereby confirm the bivariate graphical analysis conducted at the beginning of their study revealing that MNE units in non-haven countries have smaller profits per employee, whereas effective average tax rates are higher in non-havens (with just above 20 per cent) than in both European and non-European tax havens (10 and 11 per cent, respectively).

Fuest et al. (2021) further test whether tax sensitivity varies depending on the size of the MNE, whereby they break down the entire sample into four sub-samples based on the quartiles of MNEs' consolidated revenues. The findings confirm that larger MNEs shift more profits. Results of the regression model (with only a linear tax sensitivity) are presented in the following table.

Table 8. Semi-elasticities by firm size

Dependent Variable	log(profits)							
	1st quartile		2nd quartile		3rd quartile		4th quartile	
Statutory tax rate	-0.535		0.849		0.926		0.950	
	(0.525)		(0.480)		(0.571)		(0.494)	
Effective tax rate		0.015		-0.359		-0.306		-0.271
		(0.359)		(0.303)		(0.324)		(0.365)
European tax havens	0.433**	0.452**	0.584***	0.540***	0.780***	0.738***	0.872***	0.815***
	(0.139)	(0.137)	(0.153)	(0.147)	(0.149)	(0.148)	(0.152)	(0.162)
Non-Eur. tax havens	0.345	0.373	0.228	0.141	0.662***	0.605***	0.476**	0.418**
	(0.215)	(0.214)	(0.210)	(0.212)	(0.170)	(0.175)	(0.139)	(0.133)
Dependent Variable	log(intra-firm revenues)							
	1st quartile		2nd quartile		3rd quartile		4th quartile	
Statutory tax rate	1.765*		1.699		0.658		1.198	
	(0.890)		(1.024)		(0.836)		(0.651)	
Effective tax rate		-0.666		-1.413		-0.101		-1.072**
		(0.795)		(0.797)		(0.453)		(0.371)
European tax havens	0.192	0.074	0.807**	0.725*	1.060***	1.025***	1.155***	1.050***
	(0.242)	(0.240)	(0.295)	(0.283)	(0.206)	(0.204)	(0.189)	(0.180)
Non-Eur. tax havens	0.898**	0.704**	1.277***	1.139***	1.287***	1.232***	0.962***	0.907**
	(0.280)	(0.256)	(0.349)	(0.325)	(0.300)	(0.296)	(0.254)	(0.259)

Notes: Results are based on OLS regression. Coefficients of control variables are omitted to conserve space. All specifications include corporate group fixed effects. Standard errors shown in parentheses are clustered at the corporate group level. */**/*** indicate significance at the 5%/1%/0.1% level.

Source: Fuest et al. (2021)

In the last step, the authors estimated the total of profits shifted to tax havens by large German MNEs to amount to approximately €18.3 billion for 2016 and 2017 combined, roughly 40 per cent of total profits reported by MNEs in tax havens. With this estimate, the authors also note that profits shifted by German subsidiaries of foreign MNEs are excluded, as well as the ones by domestic MNEs with revenues below the threshold €750 million to be included in CbCR. To account for those, scaling-up is processed assuming, first, that the three groups (German MNEs, domestic MNEs with revenues below threshold, and German subsidiaries of foreign MNEs) contribute to the total profits reported in the same way as they contribute to gross operating surplus (for which the distribution is available); and second, that the latter two groups shift the same share profits to tax havens as German MNEs covered in CbCR. The resulting figure is €19.1 billion on average per year.

Case study 3.4: Profit shifting in Italy using Country-by-Country Reporting data

Bratta et al. (2021) study profit shifting in the case of Italy (Italian MNEs and foreign MNEs operating in Italy) using cubic specification:

$$ln(\pi_{c,m}) = \beta_0 + \delta_1 \ln(\mathrm{K_{c,m}}) + \delta_2 \ln(L_{c,m}) + \delta_3 \ln(R_{c,m}) + \beta_1 \mathrm{T_{c,m}} + \beta_2 \mathrm{T^2_{c,m}} + \beta_3 \mathrm{T^3_{c,m}} + \boldsymbol{X}_m + \boldsymbol{\Psi}_c + \epsilon_{c,m}$$

Authors study scenarios differing based on what tax rate they use (statutory corporate income tax rate or effective average tax rate) and whether they use the tax rate itself or the rate differential, i.e., the difference between the tax rate of the country where the MNE unit is located and the average rate faced by other units of the same group operating in all other countries. Based on the results of different specifications, they show how semi-elasticity and marginal effects differ: the table shows the percentage change in profit in a country due to an increase of tax rate by one percentage point, and how, in their case, cubic function performs intuitively correct (always a negative marginal effect).

Table 9. Semi-elasticities of statutory CIT rates and tax rate differential in linear, quadratic and cubic formulation

Changes in tax rates	Semi-elasticity		
	Linear	Quadratic	Cubic
From 1% to 2%	-0.7	-1.84254	-4.24371
From 24% to 25%	-0.7	-0.77396	-0.24516
From 35% to 36%	-0.7	-0.2629	-0.31875

Changes in difference between tax rates	Semi-elasticity		
	Linear	Quadratic	Cubic
From -30% to -29%	-0.684	-2.1856	-5.5903
From 1% to 2%	-0.684	-0.69698	-0.27885
From 16% to 17%	-0.684	+0.02332	-0.588168

Source: Bratta et al. (2021)

Bratta et al. (2021) estimate profits shifted using the following formula:

$$S_{m,c} = \frac{\pi_{m,c}\widehat{\beta}\, f(C_{m,c})}{1 + \widehat{\beta}\, f(C_{m,c})} = \frac{\pi_{m,c}(\widehat{\beta_1} C_{m,c} + \widehat{\beta_2} C^2_{m,c} + \widehat{\beta_3} C^3_{m,c})}{1 + (\widehat{\beta_1} C_{m,c} + \widehat{\beta_2} C^2_{m,c} + \widehat{\beta_3} C^3_{m,c})}$$

Since they use a larger data base than Fuest et al. (2021), i.e., they also take into account other MNEs in Italy, their results provide for the global level of profit shifting. Adjustments need to be made for coverage (MNEs below €750 mio and MNEs not having a unit in Italy) and the authors estimate that in 2017 a total amount of €887 billion of profits was shifted due to differences in tax rates (Bratta et al., 2021).

Case study 3.5: Misalignment in Slovakia using Country-by-Country Reporting data and corporate tax returns

Boukal, Janský and Palanský (Forthcoming) analyse the behaviour of MNEs that operate in Slovakia by exploiting a rare combination of datasets encompassing firm-level CbCR data, corporate tax returns, balance sheets, the beneficial ownership register, and the business register.

Specifically, they run a quadratic and a logarithmic specification of the semi-elasticity model as follows:

$$log(\pi_{i,j}) = \beta_0 + \beta_1 \times \log(K_{ij}) + \beta_2 \times \log(L_{ij}) + \beta_3 \times \tau_i + \beta_4 \times \tau_i^2 + \beta_x \times \chi + \epsilon$$

Where j represents an MNEs' subsidiary in country j, τ_i is the tax rate faced by the subsidiary (calculated as the effective tax rate weighted by profits), and χ is a vector of controls at the country level including population and GDP per capita. The results from the model are presented below.

Table 10. Results of the linear, quadratic and logarithmic semi-elasticity model in Slovakia

	Linear		Quadratic		Logarithmic	
	y = Log(Profit)					
Log(Assets)	0.361***	*(72.68)*	0.360***	*(72.33)*	0.359***	*(72.54)*
Log(Labor)	0.411***	*(54.52)*	0.414***	*(54.84)*	0.412***	*(55.00)*
ETR	-0.377**	*(-2.22)*	-2.971***	*(-5.70)*	4.656***	*(11.93)*
ETR Quadratic			7.837***	*(6.40)*		
ETR Logarithmic					-0.880***	*(-14.31)*
Log (GDP per cap	0.303***	*(26.73)*	0.332***	*(29.03)*	0.337***	*(29.23)*
Log(Population)	0.0589***	*(7.68)*	0.0704***	*(8.51)*	0.0933***	*(11.65)*
Constant	3.257***	*(17.51)*	2.947***	*(15.63)*	-0.123	*(-0.41)*
N	21813		21813		21813	

Source: Boukal, Janský and Palanský (Forthcoming)

Next, Boukal, Janský and Palanský (Forthcoming) estimate the profit shifting for Slovakia by attributing the real profits to where the activity taxes place, following García-Bernardo and Janský (2021). They calculate the underlying profits without profit shifting for Slovakia as:

$$\widehat{p_i} = \pi_i \times \frac{e^{(\beta_3(0.25)+\beta_4 \log(t+0.25))}}{e^{(\beta_3(\tau_i)+\beta_4 \log(t+\tau_i))}}$$

Subsequently, they redistribute shifted profits to where real economic activity takes place:

$$\Delta P_i = -\widehat{S_i} + \left(\sum_i \widehat{S_i}\right) \times R_i$$

$$R_{ij} = \frac{1}{3} \times \frac{Employees_{ij}}{\sum_j Employees_j} + \frac{1}{3} \times \frac{Assets_{ij}}{\sum_j Assets_j} + \frac{1}{3} \times \frac{Unrelated\ revenue_{ij}}{\sum_j Unrelated\ revenue_j}$$

where R is operationalising real economic activity. They find that, using the logarithmic specification, the total amount of profit shifting out of Slovakia amounts to 1.9 billion EUR (and 0.53 billion EUR using the quadratic specification).

They check for the robustness of their method by the misalignment model, which compares the reported profits in the given country with the recorded activity. In this method, the MNE profits for the whole group are summed up and then multiplied by R. The obtained real activity profits are then subtracted from the recorded profits. If the value is negative, they assume that there is profit shifting out of the country. This method yields an estimate of 1.2 billion EUR shifted profits from Slovakia.

As a next step, they calculate the potential tax revenue under the unitary taxation. That is, they redistribute the shifted profits based on the multinational activity share in Slovakia to individual countries. For each of the country-firm pair they calculate an effective tax rate. If the effective tax rate is below statutory tax rate, they replace it either by 15% rate (in case of global minimum tax) or 21% rate (the statutory tax rate in Slovakia). They project that MNEs paying below 15% in other countries which act as profit origin (higher number of profits than what would the real activity predict) could increase their tax payments from the current 56 million EUR to 195 million EUR. If the shifted profits would be taxed by 21% (above what is taxed currently) the projected increase would be from 105 million EUR to 330 million EUR.

Case study 3.6: Using Transfer Pricing Disclosure Forms in Nigeria

Gabanatlhong et al (2024) use novel administrative data from Transfer Pricing Disclosure Forms (TPDFs) to identify transactions which are most often used by MNEs to shift profits out of Nigeria and estimate their relative importance. TPDFs cover intra-group transactions of MNEs operating in Nigeria vis-a-vis related parties in other jurisdictions. The data provides a breakdown of these intra-group transactions into seven categories: (1) tangible goods, (2) services and fees, (3) royalties, (4) interest, (5) dividends, (6) reimbursements, and (7) other. To identify the most important transactions, their specification starts by calculating the hypothetical total tax paid:

$$T_{i,x} = \sum_{x,c} \tau_{x,c} \times X_{i,x,c}$$

The hypothetical tax paid is thus the sum across x and c of the products of the applicable tax rate on the particular transaction category, $\tau_{x,c}$, and the value of the transactions in that category, $X_{i,x,c}$.

The approach then moves from transaction-level data to the affiliate-level and use the following baseline specification to estimate the semi-elasticity of reported profits to the hypothetical tax paid on intra-group transactions:

$$\log(\pi_i) = \beta_0 + \beta_x \times \log(T_{i,x}) + \gamma_x \times \log(V_{i,x}) + \delta_x \times \chi_i + \epsilon,$$

where $T_{i,x}$ is a vector of hypothetical taxes applicable to transaction x; $V_{i,x}$ is the value of transaction x; χ_i company's revenue; and ϵ is the error term. The authors then use the coefficients obtained from these regression models to estimate the scale of corporate profit shifting and the resulting tax losses.

Using this transaction level data, Gabanatlhong et al. (2024) find that a 1 per cent increase in the hypothetical tax on outgoing transactions (i.e., costs) is associated with a 0.38 per cent increase in reported profits in Nigeria. In a back of the envelope calculation, they find that Nigeria loses $6.96 billion in corporate tax revenues due to profit shifting. The results further show that interest payments and payments for services and fees are the most important channels used by the multinationals operating in Nigeria to shift profits. The Netherlands, United Kingdom, Mauritius, and the Bahamas emerge as top destinations of these categories of transactions.

In the context of developing economies, notably in Nigeria, where corporate revenue plays a pivotal role, substantial revenue losses such as these pose significant negative impacts on economic development.

Method #4: MNE vs comparable non-MNE profit shifting

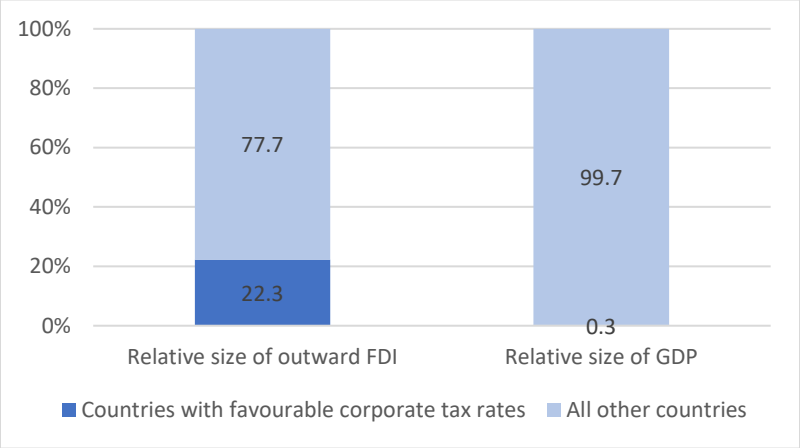
Case study 4.1: Indicators of profit shifting by multinational enterprises operating in Canada

Indicators of profit shifting by MNEs in Canada have been studied by Fortier-Labonté and Schaffter (2019), whereby they apply the BEPS indicators of OECD (2015) to identify whether Canada experiences MNEs performing BEPS activities. Specifically, they look for mismatches between financial and real economic activity using macroeconomic data from Statistics Canada and the World Bank. The mismatch may indicate income not being reported, and therefore not taxed, where it was earned.

The data are from Statistics Canada's Balance of Payments program, specifically the outward foreign direct investment statistics and the activities of Canadian majority-owned affiliates abroad. Two indicators are studied:

BEPS Indicator 1A: Mismatches between stocks of Canadian outward FDI and GDP of recipient countries for countries with favourable corporate income tax rates, revealing that a high level of Canadian outward FDI was directed to countries with favourable corporate tax rates.

Figure 11. Relative size of Canadian outward FDI and of GDP for ten countries with highest stocks of Canadian FDI, 2016



Source: Fortier-Labonté and Schaffter (2019), based on Statistics Canada (NDM table 36-10-0008-01) and the World Development Indicators.

BEPS Indicator 1B: Mismatches between assets, employment and sales for countries with favourable corporate tax rates. Results showed that in 2016, in countries with favourable corporate tax rates, foreign subsidiaries reported having 23 employees per billion dollars of assets. For the other countries, foreign subsidiaries reported having 270 employees per billion of assets. These results suggest that investment in countries with favourable corporate tax rates by the subsidiaries of MNEs operating in Canada is not driven by real economic factors.

Overall, using these indicators, Canada can be interpreted as an outward IFFs country.

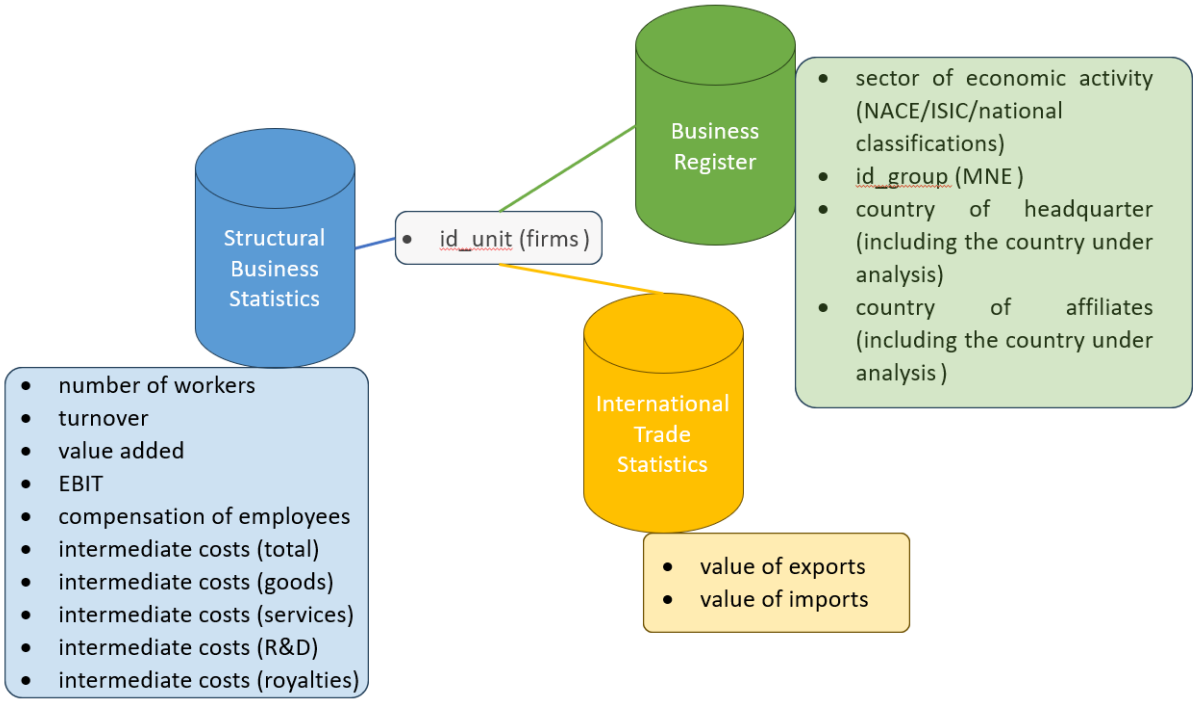
Case study 4.2: Measuring profit shifting in Italy

A PS-ROC method to measure BEPS is described in Sallusti (2021) for the case of Italian MNEs. The case uses firm-level data collected by Istat and referred to 2015. For each Italian firm (MNEs and non-MNEs), Sallusti (2021) integrates three databases:

- The archive Frame-SBS (Structural Business Statistics), which includes the information about the structure and economic variables for the whole set of 4.4 million of firms.
- The archive COE-TEC (Integrated International Trade Database), which includes the information about imports and exports (by product and origin/destination Country) for the whole set of firms.
- The archive ASIA-Groups (Italian version of European EGR), which includes the information about firms involved in domestic and foreign groups.

Schematically, the three databases used and interlinked are presented in the following figure.

Figure 12. The three databases used and interlinked to estimate IFFs in Italy



Source: Authors deliberations based on Sallusti (2021)

A final database for the analysis contains 3.6 million firms, where about 400 thousand are internationalized (export and/or import) and 61.706 belong to MNEs. Initial cleaning of the database included also removing firms with negative or zero value added or turnover, or employing less than 1 worker, as well as business units operating in industries characterized by regulated markets such as tobacco, coke and refined petroleum products, and financial intermediaries.

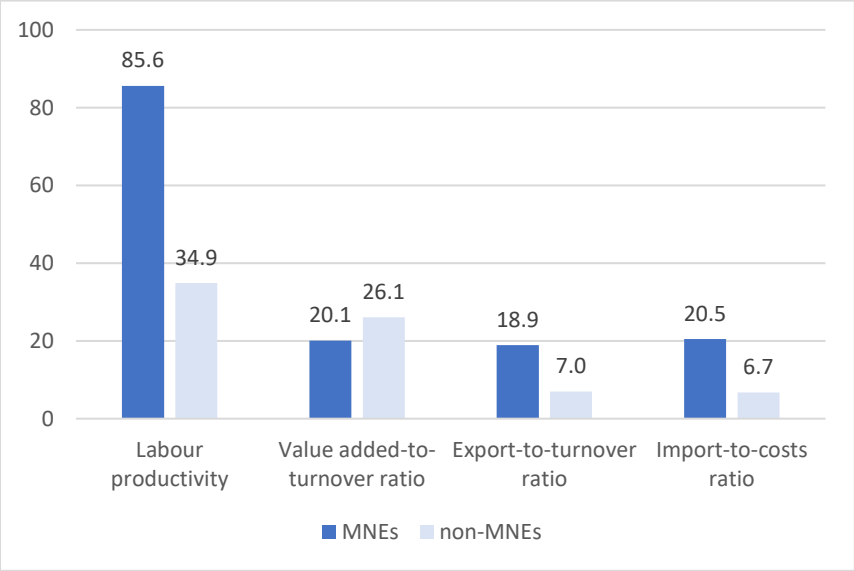
The method's identification phase first looks at "between" comparison. Domestic firms were characterized by nine variables which are used for the PS matching:

- region (NUTS2)
- industry (3-digit NACE rev. 2)
- per-capita turnover
- persons employed
- share of goods and services on total costs
- export-to-turnover ratio
- import-to-total costs ratio
- share of salaries on total costs
- share of services on turnover

The matching, however, is carried out in clusters of domestic companies in control groups, comprised of 10 non-MNEs with the highest level of similarity with respect to region, industry, size class (1-2, 2-5, 5-10, 10-20, 20-50, 50-100, 100-250, 250-500, more than 500 workers).

Differences between MNEs and non-MNEs (domestic firms) exist specifically in labour productivity, but also export-to-turnover ratios and import-to-costs ratio.

Figure 13. Multinational enterprises vs. non-multinational enterprises, 2015 (percentage)



Source: Sallusti (2021)

The within comparison of the identification phase assumes the equal weights assigned to manage the trade-off between true and false positives, therefore *h=0.5*.

A "vertical" strategy has been chosen to measure BEPS. In this strategy, analysing possible incoherencies between the given MNE and others MNEs (with similar characteristics) in the same country assesses BEPS. Obvious constraint for choosing this strategy are availability and reliability of data related to foreign business units belonging to MNE in which Italian business units are involved.

Analyzing 61 191 MNEs in 2015, the PS-ROC methods reveals that tax avoiding units represent 60.1 per cent of Italian MNEs, strongly differing by sectors: incidence of tax avoiding units ranges from 43.3 per cent in real estate activities to 78.8 per cent in informatics. Results also show that BEPS amounts to €32.3 billion, accounting for about 2 per cent of the Italian GDP at current prices. Results also confirm that, generally speaking, tax avoiding MNEs are smaller (26.5 vs 94.2 workers on average) and less productive (€77.0 vs. €89.9 thousands) than non-tax avoiding ones. They also generate higher turnover (€26.3 vs. €17.9 million on average), value added (€8.5 vs. €2.0 million) and, particularly, EBIT (€8.2 vs. €1.4 million). Consequently, tax avoiding MNEs are characterized by lower levels of EBIT-to-turnover ratio (7.9 per cent vs. 31.2 per cent).

Case study 4.3: Comparing corporate tax returns of MNE affiliates and domestic companies in the UK

Bilicka (2019) studies the differences in taxable profits between subsidiaries of foreign MNEs and domestic standalone firms in the UK. Using confidential corporate tax returns data for the period 2000 - 2014 the paper calculates differences in the ratio of taxable profits to total assets across comparable companies.

The following datasets are used to construct the final sample:

- Universe of the unconsolidated corporate tax returns for years 2000 - 2014 (CT600). This is where the taxable profits information comes from.
- BvD FAME dataset to obtain balance sheet information and ownership. This is where the information on total assets and industry for each unconsolidated subsidiary of foreign MNE and domestic standalones comes from. This is also where ownership information is obtained.

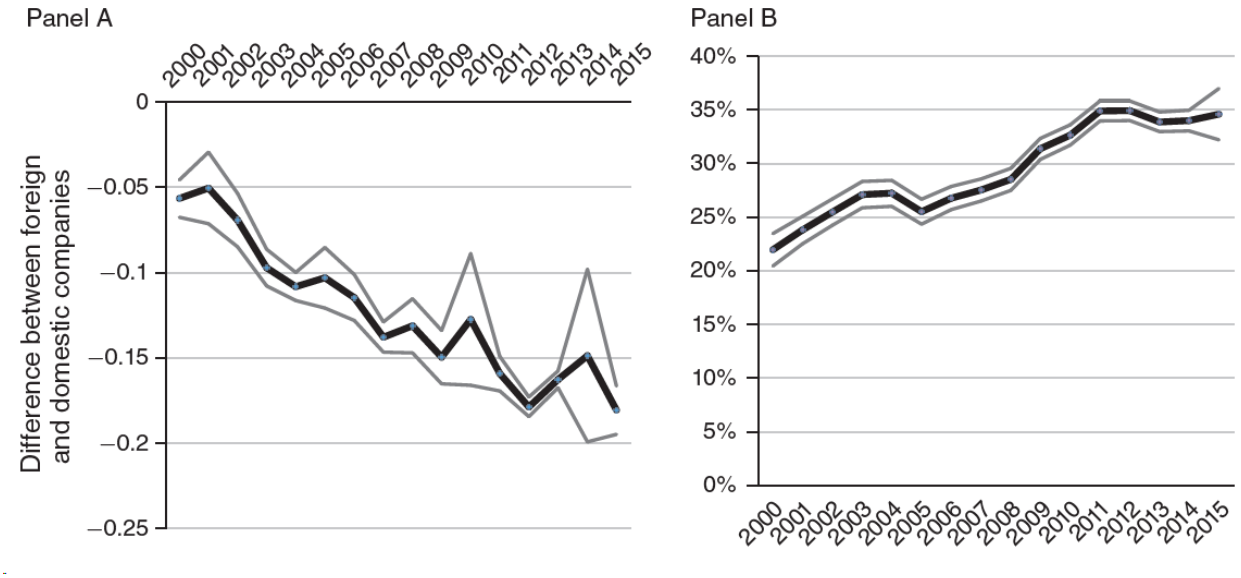
Using ownership information from FAME, the author classifies firms into subsidiaries of foreign MNEs – those are subsidiaries that report having a foreign parent in FAME – and UK domestic standalone – those are independent companies with no affiliates either abroad or in the UK. Subsidiaries of foreign MNEs are used because information on just their unconsolidated assets is available. In FAME, only information on UK MNEs consolidated assets is available.

Further, the sample of subsidiaries of foreign MNEs is limited in the following ways: they need to have no affiliates of their own and have positive turnover. The first criterion is to eliminate firms that may report the value of total assets of their subsidiaries on their balance sheets. The second criterion is to exclude holding companies.

To compare domestic firms with MNE subsidiaries, Bilicka (2019) uses propensity-score matching (PSM). The matching variables are size of total assets and industry in which firms operate in the baseline specification. PSM method used is nearest neighbour matching within 0.1 caliper radius without replacement and with common support for total assets. This means that no company larger than the largest domestic standalone and no company smaller than the smallest foreign multinational is in the sample. To test the robustness of these estimates various additional matching strategies as well as matching variables are utilized.

The author finds that subsidiaries of foreign MNEs report 50% lower ratios of taxable profits to total assets than comparable domestic firms. Across the entire time period, domestic firms report these ratios to be 0.238 while subsidiaries of foreign MNEs report these to be 0.12, with the difference being 0.119. Figure 14 presents the evolution of this difference across years. Using the estimated differences between these ratios Bilicka (2019) uses back of the envelope calculations to show potential revenue gains from equalizing tax treatment of domestic standalones and foreign MNE subsidiaries. These gains are calculated by multiplying the average difference in taxable profits between these two groups by the number of subsidiaries of foreign MNEs in the UK. These numbers vary between 3 billion GBP in 2000 to 25 billion GBP in 2014.

Figure 14: Difference between domestic firms and subsidiaries of foreign MNEs



Source: Bilicka (2019)

Note: Results from the Propensity Score Matching estimated year by year. PSM using total assets and within each industry. Panel A: the outcome variable is the ratio of taxable profits to total assets. Panel B: the outcome variable is zero taxable profits dummy. The estimated coefficients for each year are significant. Selected sample, 2000-2014.

Case study 4.4: Comparing ratios of economic activity and reported profit for domestic companies vs. MNEs

Tørsløv et al. (2023) develop a methodology to infer the amount of profit shifting by multinationals to low-tax countries, a statistic for which we lack comprehensive estimates. They adopt a global and bilateral approach, highlighting what happens *within* tax havens, and producing replicable estimates of profit shifting that can be tracked by policymakers annually.

The methodology is straightforward: the authors estimate the profitability of foreign vs. local firms within each tax haven, with profitability defined as the profits-to-wage ratio. The ratios are obtained using a combination of national accounts data for local firms and foreign affiliate statistics for foreign firms.

Their results reveal that foreign firms are hugely more profitable than local firms in tax havens, even when controlling for true economic differences, such as research and development expenditures, or real capital expenditures, such as property and equipment. Only a small fraction of the higher ratios of foreign firms in tax havens turns out to be attributable to true economic differences with local haven firms. As two striking examples, the authors show that Ireland has a profits-to-wage ratio equivalent to 800%, and 1,625% in Puerto Rico. On average, foreign firms in havens have a profits-to-wage ratio eight times larger than local firms in havens. Strikingly, the opposite is true in high-tax countries: in the UK the profits-to-wage ratio is 26% for foreign firms vs. 48% for local firms, suggesting further evidence that profit shifting is the reason why foreign firms are relatively less profitable than local firms in high-tax countries.

Importantly, they also estimate the amount of profits shifted to tax havens globally by computing the aggregate amount of profit that foreign firms in e.g. Ireland would make if they were as profitable as local Irish firms, and similarly in each other tax havens. With this methodology, they find that 36% of multinational profits, equivalent to $616billion, were shifted to tax havens globally in 2015.

Furthermore, they re-allocate the shifted profits to the countries where they have been made, or to the countries where the multinationals ultimate parents are headquartered using bilateral balance of payments data and following the origin of intra-group interest received by tax havens, as well as the destination of the exports that have been found to be conducive to profit shifting.

They find that US multinationals shift comparatively more profits, with more than half of their multinational profits shifted to tax havens; however, the prime losers of global profit shifting are high-tax European Union countries, with a reduction in domestic profit of about 20%. Furthermore, a key pattern they highlight is large profit shifting out of EU high-tax countries, often by US multinational, first to European tax havens such as Luxembourg or the Netherlands and eventually to non-EU offshore centres.

All in all, the paper offers a key methodological contribution to the estimation of profit shifting into tax havens, by combining three data sources: national accounts data, foreign affiliate statistics and bilateral balance of payments. Crucially, their methodology for estimating the differences in profitability between local and foreign firms in tax havens is replicable, and easy to observe and track annually.

Case study 4.5: Inward IFFs in MNE vs comparable non-MNE profit shifting

The procedure described above in section 4.2 of UNCTAD (2023) is intended to identify and measure the amount of BEPS generated by tax avoiding MNEs in a given country, which in turn represents outward IFFs. However, the method can also be used to account for the symmetric case, in which BEPS (outward IFFs in Country A) are collected by an MNE unit in Country B, where it represents an inward IFFs.

Following the conceptual framework proposed for the case of BEPS generation (outward IFFs), in the case of BEPS collection (inward IFFs) the assumption is that BEPS-collecting MNEs should have a level of profits higher than the "normal" level of similar non-MNEs in the same Country. Accordingly, the shape of structural, economic, and behavioural variables should be different with respect to the case of BEPS generation. In particular, the structure of revenues, instead of the structure of costs should be focused on. Other characteristics (such as the international tax framework and the participation in international markets) are the same, but they need be modified to account for the symmetric behaviour (e.g., the tax differential should in case of BEPS-collecting MNEs have an inverse relationship with the "suspect").

To identify and measure BEPS collection (and the related inward IFFs), all the steps in the procedure are modified according to the different context of analysis. In particular:

The first step of the identification phase (PS matching) is modified to provide a coherent proxy of "suspect". Indeed, it relates to a level of EBIT-to-turnover ratio for the given MNE that is higher (instead of lower) than the average of the control group. In this context, however, the definition of the control group (method, confounding variables, and constraints) is the same as in the case of BEPS generation. Similarly as in procedure described for identifying outward IFFs, also here comparison of MNE units to domestic firms can be adjusted to meet national statistical capacity, i.e., when comparable domestic firms cannot be identified, comparison can be made to an average of certain size or industry class, or, eventually, simply comparing all MNE units to all domestic firms.

In the second step of the identification phase (ROC analysis) the set of considered variables changes to account for structural and behavioural indicators that signal the presence of a MNE that collects eroded profits from MNEs residing in other Countries. In this case the following set of variables should be considered (take into account that variables should be positively correlated with the proxy of "suspect", which, in case of BEPS collection, is represented by higher profits with respect to the average of the control group of non-MNEs):

- EBIT-to-turnover ratio (reversed with respect to the case of BEPS generation)
- Value added-to-turnover ratio (reversed with respect to the case of BEPS generation)
- R&D spending with respect to turnover
- share of royalties on turnover
- share of salaries on total costs
- share of services on turnover
- export-to-turnover ratio
- import-to-total cost ratio
- average differential in income taxation among (related) countries (reversed with respect to the case of BEPS generation)

Given the change in the second step of identification, the measurement phase of BEPS-collecting MNEs (inward IFFs) is analogous as in the case of BEPS-generating MNEs (outward IFFs). Indeed, the definition of the threshold does not conceptually change. In this case, however, $x_{j,i}$ for MNEs that are considered as collecting BEPS from other countries should be higher than $\tilde{x}_{h,i}$, which is the level of the EBIT-to-turnover ratio representing the threshold. This produces the reversed sign with respect to the case of outward IFFs (BEPS generating MNEs), meaning that the total level of EBIT for these MNEs has to be reduced with respect to the one they have declared. Therefore, the amount of EBIT connected with BEPS-collecting, termed inward IFFs here, is calculated, for each BEPS-colleting MNE *i*, with a negative sign to account for the reversal:

$$InwardIFFs_i = -\left(\tilde{x}_{h,i} - x_{j,i}\right) * Turnover_i \qquad \textit{Equation (4.5.1)}$$

At national level and for a given year, the aggregate value of inward IFFs is obtained by aggregating over all MNEs in a country:

$$InwardIFFs = \sum_i InwardIFFs_i \qquad \textit{Equation (4.5.2)}$$

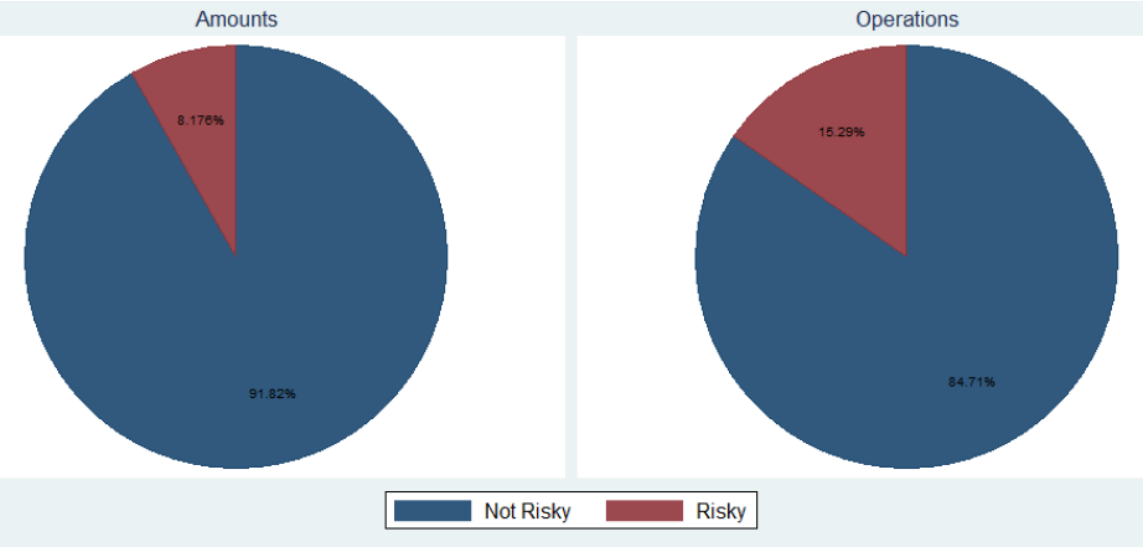
Similar as for outward IFFs, once the country is classified as inward or outward IFFs prone, its value of total IFFs will equal that category, here $IFFs = InwardIFFs$.

Method #5: Undeclared offshore assets indicators

Case study 5.1: Italian cross-border bank transfers using gravity model

Studying the Italian cross-border bank transfers between 2007 and 2010, Cassetta et al. (2014) use the gravity model to identify flows appearing to be abnormally above the predicted values by the model itself. Only cross border wire transfers made by private customers of Italian banks are considered in the study. National financial intelligence unit (FIU) classified destination countries as risky or not risky.

Figure 15. Destinations of cross-border financial flows



Source: Cassetta et al. (2014)

Using the original dataset by the FIU and adding a set of socio-economic and demographic variables for province of origin and country of destination (e.g., GDP per capita, average firm-level taxation, FDI per capita, dummy variable of shared border as a proxy for distance between areas, employment rate, personal taxable income, etc.), authors reveal the positive correlation between financial flows and foreign GDP and population, FDI and proximity to Italian provinces; and a negative correlation with firm-level tax rate.

The study is important not only for the application of gravity model to observe cross-border risky financial flows, but also to complement empirical analysis by contextual interpretation, shedding important light on the (illicit) financial flows in terms of, if not measuring IFFs directly, their risk assessment.

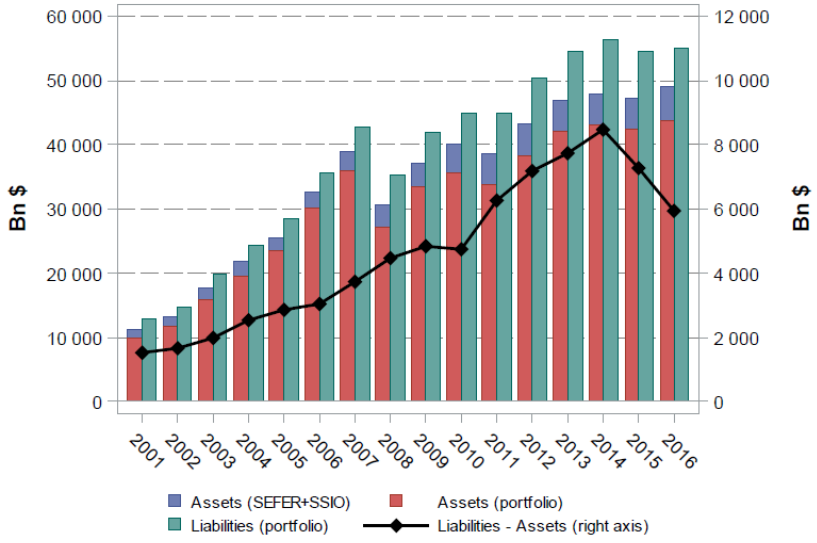
Method #6: Flows of offshore financial wealth by country

Case study 6.1: Identifying hidden assets in the Balance of Payments by Bank of France

The Bank of France analysed how the discrepancy between assets and liability in international investment positions statistics can be attributed to hidden investments. Authors do, however, point out that caution is needed in using this methodology for statistical purposes (Gervais and Quang, 2018).

The below figure presents the global discrepancy between assets and liabilities in international securities statistics. Different coverage of participating countries in surveys and the inability of BoP compilers to collect data on resident portfolios held in other jurisdictions contribute to the discrepancy.

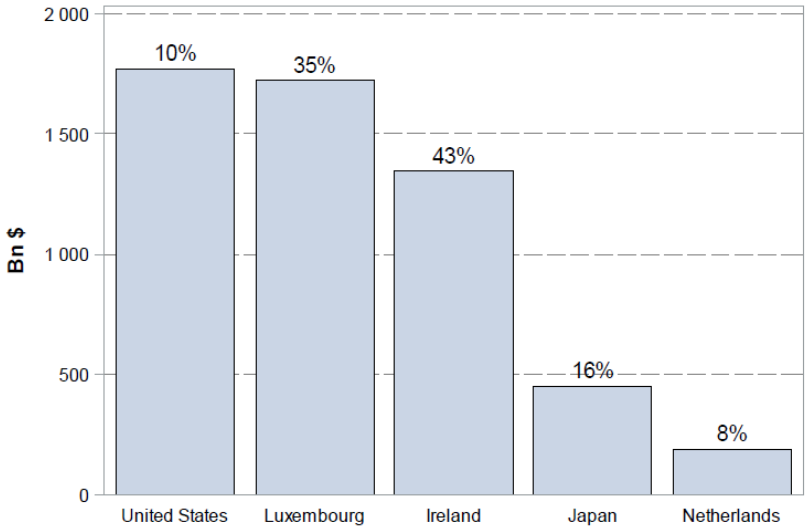
Figure 16. Global discrepancy between assets and liabilities in international securities statistics



Source: Gervais and Quang (2018).

The authors assume that financial assets are well collected except for the part that is owned by households in offshore centres. They plot top five countries in differences between liabilities as reported by national compilers and liabilities derived from assets in other sources.

Figure 17. Differences between nationally-compiled liabilities and liabilities derived from counterparts assets



Source: Gervais and Quang (2018).

European regulation requires financial corporations to report directly to national compilers, whereas non-financial corporations and households are not. Hence, one can assume that "hidden assets" are held by these two sectors.

Gervais and Quang (2018) conclude that academic findings cannot be directly used in BoP statistics since:

1. Adjustment to statistical methodologies and concept may be required prior to their use in statistics compilation.
2. Data limitations prevent establishing longer time series.
3. It is not natural to assume inconsistencies are explained by a single source, i.e., households' hidden assets.

According to authors, sharing data on third-party holdings can solve the problem, i.e., requiring participating or contributing countries to provide data, bringing in various stakeholders, also investment companies and private banks.

Case study 6.2: Using foreign direct investment data to identify cross-border deposits from individuals

Statistics on deposits by non-financial institutions, as provided by the BIS, do not distinguish between individuals and corporations – but we need to get as close as possible to cross-borders deposits of individuals. Recognising that the share of cross-border deposits by corporations is positively correlated with the level of FDI, a correction is applied to the BIS statistics. Outgoing cross-border deposits by a given country *i* in a year *t* are given by the following formula:

$$d_{i,t} = w_{i,t} * d_{i,t}^{bis},$$

where

$$w_{i,t} = \frac{\frac{3}{2}\frac{gdp_{i,t}}{\sum gdp_{i,t}} + \frac{1}{2}\frac{fdi_{i,t}}{\sum fdi_{i,t}}}{\frac{gdp_{i,t}}{\sum gdp_{i,t}} + \frac{fdi_{i,t}}{\sum fdi_{i,t}}}$$

The weight $w_{i,t}$ is applied to $d_{i,t}^{bis}$, the outgoing deposits of country i in year t. It is decreasing with the share of FDI by country i with respect to the total world FDI and increasing with its share of GDP. It has been specified to be equal to 1 for countries with a share of FDI equal to their share of GDP.[172] The FDI statistics used for the computation of these weights are taken from the United Nations Conference on Trade and Development.

(see European Commission, 2019)

Case study 6.3: Gravity model to estimate total foreign securities owned by the Cayman Islands

Estimating international tax evasion by individuals requires global offshore wealth to be, first, estimated, and second, distributed among countries. Applying the gravity model to estimate total foreign securities owned by the Cayman Islands stems from available data by the United States Treasury: information on the value of United States securities held by the Cayman Islands, $A_{KY,US,t}$. It is then estimated with the following gravity-like model of bilateral cross-border portfolio holdings (European Commission, 2019):

$$\log(1 + A_{i,j,t}) = \phi_j + \theta_t + \beta Z_{i,j,t} + \gamma X_{i,t} + \epsilon_{i,j,t},$$

where $A_{i,j,t}$ denotes the portfolio holdings of country i in country j in year t (as declared in the CPIS database), ϕ_j denotes host-country fixed effects, θ_t year fixed-effects, $Z_{i,j,t}$ is a vector of bilateral controls (distance, GDP gap, dummies for common language, etc.), and $X_{i,t}$ a vector of source-level controls (population, GDP per capita, etc.).

From the predicted bilateral claims $A^p_{i,j,t}$, one can compute the predicted share of each country j in i's portfolio at time t as:

$$\omega^p_{i,j,t} = \frac{A^p_{i,j,t}}{\sum_k A^p_{i,k,t}}.$$

The estimated value of total foreign securities owned by the Cayman Islands is then equal to $A_{KY,US,t}/\omega^p_{KY,US,t}$.

Results of the estimation are presented in the following table.

Table 11. Gravity Model Estimation

	(1) Log equities b/se	(2) Log debt b/se
Log distance	-0.676***	-0.746***
	(0.015)	(0.012)
Common language	1.396***	0.542***
	(0.036)	(0.030)
Colony dummy	0.942***	0.582***
	(0.063)	(0.054)
Industrial pair du~y	2.059***	1.963***
	(0.046)	(0.037)
Log of GDP gap	0.112***	0.193***
	(0.010)	(0.008)
Log of GDP p.c. gap	-0.120***	-0.037***
	(0.011)	(0.009)
Sce ctry OFC	0.883***	1.609***
	(0.175)	(0.146)
Latitude of source~y	-0.000	0.007***
	(0.001)	(0.000)
Sce ctry landlocked	-0.645***	-0.263***
	(0.035)	(0.028)
Log of sce ctry po~n	0.600***	0.565***
	(0.009)	(0.007)
Log of sce ct..c.	0.000***	0.000***
	(0.000)	(0.000)
Observations	56857	61878
Adjusted R-squared	0.561	0.575

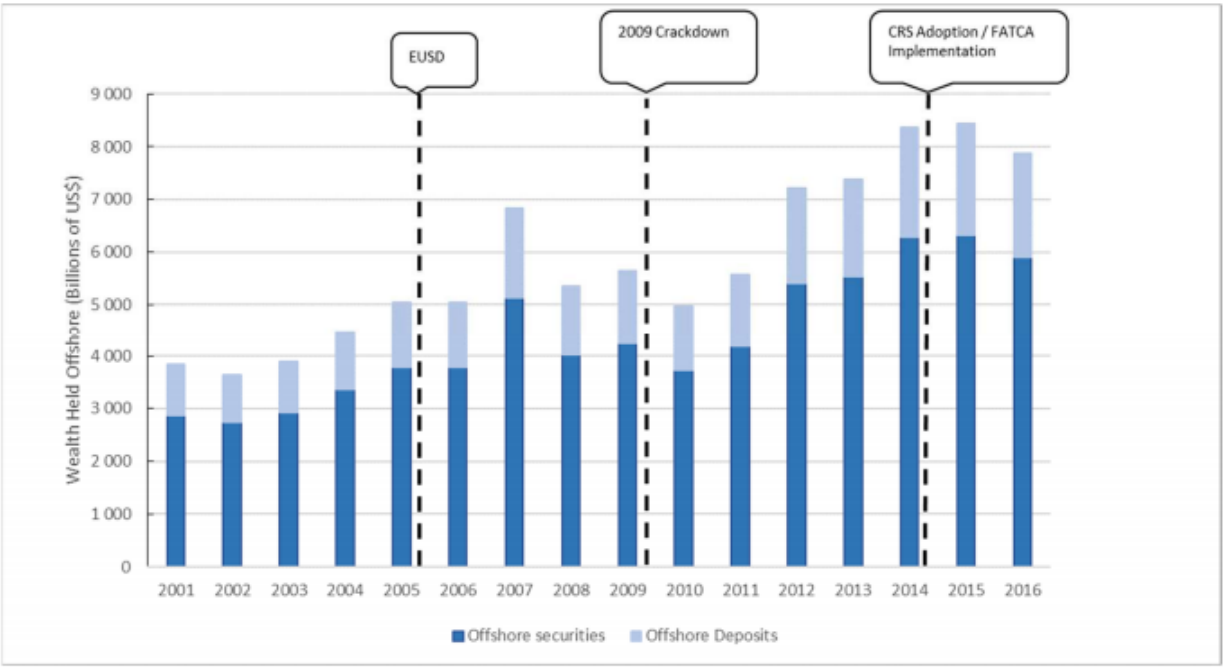
* p<0.05, ** p<0.01, *** p<0.001

Source: European Commission (2019)

Case study 6.4: International tax evasion for the EU-28

The European Commission (2019) applies this method for 28 EU member states. Their results estimate global offshore wealth at US$7.8 trillion in 2016 (€7.5 trillion), or 10.4 per cent of global GDP. Dynamics and breakdown by offshore securities and deposits is depicted in the following chart.

Figure 18. Estimated global offshore wealth (US$ billions)



Source: The European Commission (2019) based on computations by the European Commission and World Bank Indicators for global GDP

Offshore wealth held by EU residents is estimated at US$1.6 trillion (€1.5 trillion) in 2016, leading to the estimated €46 billion or 0.32 per cent of GDP of revenue lost to international tax evasions for the EU-28 in 2016.

Case study 6.5: Estimating illicit financial flows from offshore tax evasion by individuals in Kyrgyzstan and Uzbekistan

Maga et al. (Forthcoming) have followed the method #6 as guided by the original study (European Commission, 2019), with a notable focus on the countries in Asia and the Pacific. The authors introduce adjustments to the process streamlining their implementation based on publicly available data. The authors first provided a thorough update of data using suggested data sources. International Monetary Fund's Coordinated Portfolio Investment Survey (CPIS) and the External Wealth of Nations Mark II database (EWN) have been used; where country data was missing from CPIS and EWN, additional information has to be sourced elsewhere, including national sources. In 2022 CPIS reported data on 82 countries, EWN reported data on 195 countries, meaning that the total coverage after supplementing CPIS data with EWN is consistent with EWN coverage. Overall, the jurisdictions missing from both databases over the period are the following twelve: Central African Republic, Chad, Comoros, Djibouti, Eritrea, Gambia, Haiti, Malawi, Mauritania, Somalia, South Sudan, and Turkmenistan. There is an assumption that these countries due to low-income status don't contribute significantly to the global offshore financial wealth (as the first step in estimation as per method).

A specific innovation in this paper is the process of identifying wealth-collecting and wealth-channelling international financial centres (IFCs) and introducing adjustments to country wealth by the values of indirect wealth held in the IFCs and rechannelled to other destinations. The main source of data in this step is the Bank of International Settlements (BIS) locational statistics. The authors also validate the data by comparing mirror values for the countries reporting to BIS.

Finally, the authors arrive at country values of IFFs from offshore wealth for the period of 2001-2022 and provide discussion as to the implications of these flows, especially to national tax authorities in oversight over the cross-border movement of flows with regard to tax evasion. According to the method of observing year-on-year changes to arrive at flows estimates based on stock measures in subsequent years, and applying the rate of variation of market prices (using MSCI World price index) and a rate of compliance of 0.75.

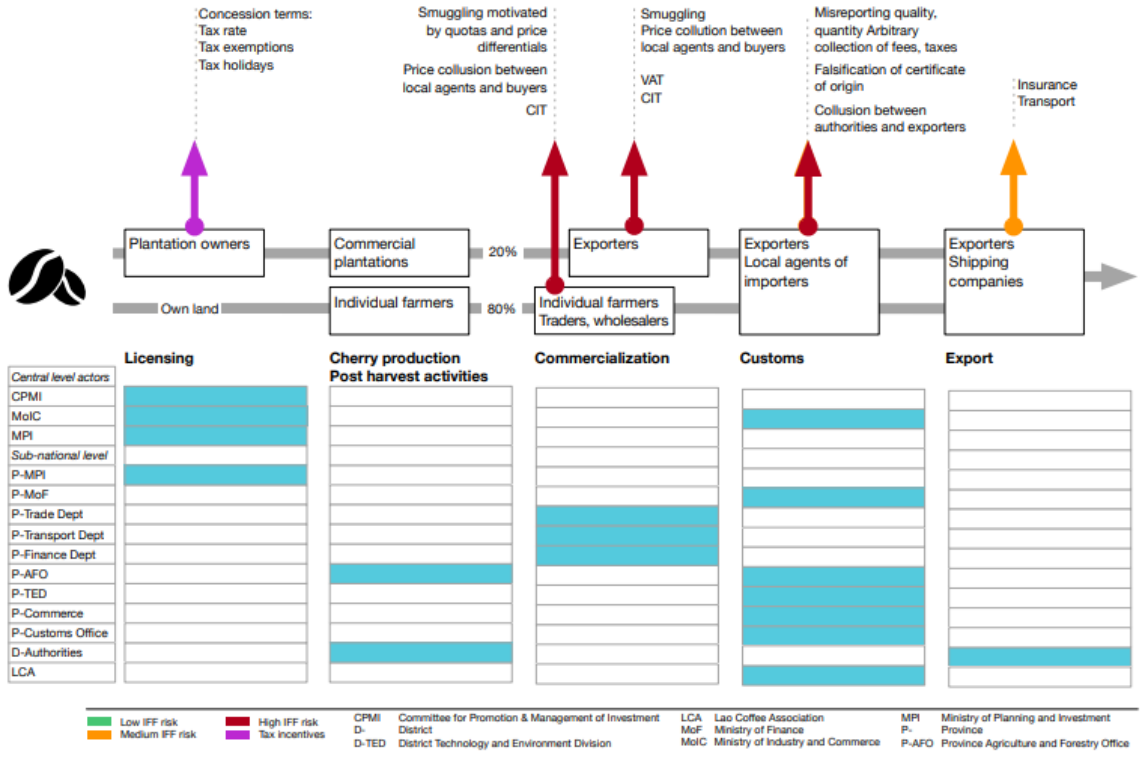
The preliminary results indicate that the total annual IFFs are strongly correlated from this study and the original one (European Commission, 2019), from and converge by the end of observation period; annual IFFs also drop during the financial crisis of 2009 after peaking in 2008, and after 2014 IFFs seem to develop a trend for decrease (more details, including by country, in the paper: Maga et al. (Forthcoming)).

Other case studies and topics, related to measurement of tax and commercial illicit financial flows

Case study 7.1: Value chain risk map as a risk assessment tool

Using the value chain risk maps, Nolintha et al. (2020) illustrate how stakeholders in the coffee value chain in Lao contribute to IFFs. Specifically, local agents of importers are considered at high risk for IFFs in the value chain. This involves misreporting quality, quantity arbitrary, collection of fees and taxes, falsification of a certificate of origin, and the collusion between authorities and exporters. For this reason, the function of local agents is attributed as a significant risk for trade mispricing from the Lao coffee sector.

Figure 19. Illicit financial flow risks in Lao's coffee value chain

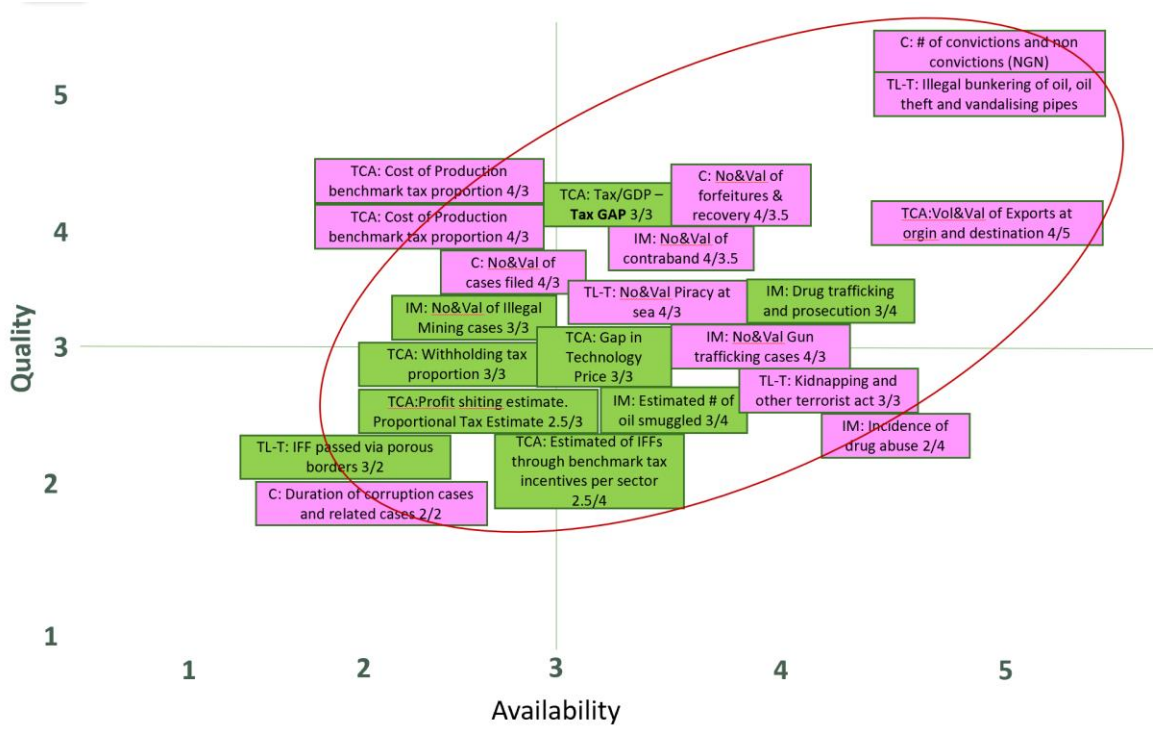


Source: Brugger and Engebretsen (2019)

Case study 7.2: Mapping of the quality and availability of IFF-related indicators in Nigeria

Nigeria was the first African pilot country to bring together relevant agencies and review data availability. The pilot mission under auspices of UNECA took place in 2019 and noted that the bulk of IFFs in Nigeria emerge in tax and commercial practices, and corruption. A preliminary exploration into potential indicators of IFFs and related issues was carried out, including indicators of profit shifting, cost of production (commercial transactions with offshore companies), tax-GDP ratio, volume of tax incentives, revenue to GDP ratio etc. The indicators were further assessed in terms of quality and availability (see findings in the below chart).

Figure 20. Quality and availability of indicators related to illicit financial flows in Nigeria



Source: UNECA briefing on the pilot mission with Nigeria.

Note: TCA refers to tax and commercial practices; C refers to corruption; TL-T refers to theft-like and terrorism; and IM refers to illegal markets. Green is for macro data sets or ones that rely on estimations; and Cerise is for transactional data sets.

References

Ahene-Codjoe A, Alu A and Mehrotra R (2020). Abnormal Pricing in International Commodity Trading: Evidence from Ghana. Available at https://curbingiffsdotorg.files.wordpress.com/2020/06/r4d_ghana_trademispricing_june2020-1.pdf (accessed 22 October 2020).

Amaral LR and Barcarolo L (2020). Statistical methodology to estimate BEPS-related financial flows or tax-related illicit financial flows channelled via "phantom trade." UNCTAD Research Paper No. No. 57. UNCTAD. (accessed 1 August 2021).

Bilicka KA (2019). Comparing UK Tax Returns of Foreign Multinationals to Matched Domestic Firms. *American Economic Review*. 109(8):2921–2953.

Boukal T, Janský P and Palanský M (Forthcoming). Global Minimum Tax and Profit Shifting. *IES Working Paper*. Charles University. Prague, Czechia.

Bratta B, Santomartino V and Acciar P (2021). Assessing profit shifting using Country-byCountry Reports: a non-linear response to tax rate differentials. No. DF WP n.11 February 2021. Ministry of Economy and Finance, Department of Finance. Rome. (accessed 20 April 2021).

Brugger F and Engebretsen R (2019). Value Chain Risk Maps. Curbing IFFs. (accessed 12 December 2020).

Carbonnier G and Mehrotra R (2020). Abnormal Pricing in International Commodity Trade: Empirical Evidence from Switzerland. (accessed 22 October 2020).

Cassetta A, Pauselli C, Rizzica L and Tonello M (2014). Financial flows to tax havens: Determinants and anomalies. Quaderni dell'antiriciclaggio No. 1. Banca d'Italia. (accessed 2 July 2021).

Cobham A, Garcia-Bernardo J, Janský P and Palanský M (2021). Statistical Measurement of Illicit Financial Flows in the Sustainable Development Goals: Tax Avoidance by Multinational Corporations. Background paper. UNCTAD.

Davies R, McNabb K and Palanský M (Forthcoming). You Can't Tax What You Can't See: Using Fixed Cargo Scanners to Combat Tax Evasion. *Tax Justice Network Working Paper*. Tax Justice Network. London, United Kingdom.

ECA (2015). Illicit financial flows: Report of the High Level Panel on Illicit Financial Flows from Africa. United Nations Economic Commission for Africa. Addis Ababa.

ECLAC (2016). Economic Survey of Latin America and the Carribean. The 2030 Agenda for Sustainable Development and the challenges of financing for development. United Nations Economic Commission for Latin America and the Carribean. Santiago. (accessed 28 November 2020).

ESCWA (2018). Illicit Financial Flows in the Arab Region. Beirut. (accessed 3 July 2021).

European Commission (2009). *MEDSTAT II: Asymmetry in Foreign Trade Statistics in Mediterranean Partner Countries*. Office for Official Publications of the European Communities. Luxembourg.

European Commission (2019). Estimating International Tax Evasion by Individuals. Luxembourg. (accessed 21 September 2020).

Fortier-Labonté A and Schaffter C (2019). Indicators of profit shifting by multinational enterprises operating in Canada. Analysis in Brief No. 11-621–M. Statistics Canada. Ottawa. (accessed 15 December 2020).

Fuest C, Hugger F and Neumeier F (2021). Corporate Profit Shifting and the Role of Tax Havens: Evidence from German Country-By-Country Reporting Data. CESifo Working Papers 8838-2021. Munich Society for the Promotion of Economic Research.

Gabanatlhong B, Garcia-Bernardo J, Iyika P and Palanský M (2024). Profit shifting by multinational corporations: Evidence from transaction-level data in Nigeria. *Tax Justice Network Working Paper*. Tax Justice Network. London, United Kingdom.

Garcia-Bernardo J and Janský P (2021). Profit Shifting of Multinational Corporations Worldwide. ICTD Working Paper No. 119. Institute of Development Studies. Brighton. (accessed 24 March 2021).

Gervais E and Quang PB (2018). How to identify "hidden securities assets" in the Balance of Payments: methods of Bank of France. Ninth IFC Conference "Are post-crisis statistical initiatives completed?" BIS. Basel. (accessed 6 February 2021).

Hebous S, Klemm A and Wu Y (2001). How Does Profit Shifting Affect the Balance of Payments? IMF Working Paper No. WP/21/41. IMF. (accessed 21 February 2021).

Kar D and Freitas S (2012). Illicit Financial Flows from Developing Countries: 2001-2010. GFI. Washington D.C. (accessed 31 March 2021).

Kravchenko A (2018). Where and how to dodge taxes and shift money abroad using trade misinvoicing: A beginner's guide. Working Paper. ESCAP. Bangkok. (accessed 3 July 2021).

Maga A, Marshall A, Nyasulu AM and Kerdlapphon A (Forthcoming). Estimating illicit financial flows from offshore wealth and tax evasion implications. No. ESCAP Working Paper Series. ESCAP.

Maga A, Nyasulu AM, Marshall A and Bekenov C (2023). Estimating illicit financial flows from trade misinvoicing: introducing the 'Grey Re-exports' method (The case of Kyrgyzstan). No. ESCAP Working Paper Series April 2023. ESCAP. (accessed 21 April 2023).

Moody's (2024). Orbis. Available at https://www.moodys.com/web/en/us/capabilities/company-reference-data/orbis.html (accessed 6 August 2024).

Nolintha V, Sayavong V and Mehrotra R (2020). Abnormal Pricing in International Commodity Trade: Evidence from Lao P.D.R. Available at https://curbing-iffs.org/2020/03/03/abnormal-pricing-in-international-commodity-trade-evidence-from-lao-p-d-r/ (accessed 22 October 2020).

OECD (2015). Measuring and Monitoring BEPS, Action 11 - 2015 Final Report. OECD/G20 Base Erosion and Profit Shifting Project. OECD. Paris.

Reynolds H and Wier L (2016). Estimating profit shifting in South Africa using firm-level tax returns. No. WIDER Working Paper 2016/128. United Nations University World Institute for Development Economics Research.

Sallusti F (2021). Measuring profit shifting in Italy with propensity score matching and receiver operating characteristics analysis (PS-ROC) method. UNCTAD Research Paper No. 64. UNCTAD. (accessed 19 April 2021).

Schuster C and Davis J (2020). Old dog, new tricks? The fitness of mirror trade analysis to detect illicit financial outflows from Africa. Background Paper: Economic development in Africa Report. UNCTAD. Geneva. (accessed 30 March 2023).

Statistics Canada (2018). Comparing Canada's and China's bilateral trade data. China-Canada Joint Working Group on Trade Statistics Reconciliation. Statistics Canada. Ottawa. (accessed 3 April 2021).

Tørsløv T, Wier L and Zucman G (2023). The Missing Profits of Nations. *The Review of Economic Studies*. 90(3):1499–1534.

UNCTAD (2023). Towards a statistical framework for the measurement of tax and commercial illicit financial flows. Available at https://unctad.org/publication/towards-statistical-framework-measurement-tax-and-commercial-illicit-financial-flows (accessed 5 January 2024).

UNSD (2011). *International Merchandise Trade Statistics: Concepts and Definitions 2010*. United Nations publication. Sales No. E.10.XVII.13. New York.

UNSD (2019). *IMTS Bilateral Asymmetries - How to Measure, Analyze, Reduce and Way Forward*. United Nations Publications. New York.

WCO (2018). Illicit Financial Flows via Trade Mis-invoicing. Study Report. World Customs Organization. Brussels. (accessed 20 October 2020).

Wier L and Reynolds H (2018). Big and 'unprofitable' - How 10 per cent of multinational firms do 98 per cent of profit shifting. No. WIDER Working Paper 2018/111. United Nations University World Institute for Development Economics Research.