1.1. Partner Country Method (PCM) +

**Concept and assumptions**
The PCM is a top-down method comparing import (or export) values reported by one country with the corresponding export (or import) values reported by its partner country. The concept of PCM is based on a trade gap, defined as discrepancy in the values of a trade transaction, independently reported by both trading partners. The main assumption behind PCM is that partner’s trade statistics are sufficiently accurate and comparable to treat differences in mirror statistics as misinvoicing, hence directly applicable to measuring tax and commercial IFFs as IFFs. This assumption is critical and highly unlikely, raising serious doubts about the reliability of this method.

Many factors contribute to trade asymmetry. Therefore, all measures must be taken to correct for other reasons before attributing a portion of asymmetry to IFFs or trade misinvoicing. According to UNSD (2019), three main and well-known reasons for asymmetries in bilateral merchandise trade are:

i. Application of different criteria of partner attribution in import and export statistics,

ii. Use of CIF-type values in import statistics and FOB-type values in export statistics,

iii. Application of different trade systems (General versus Special Trade System).

Reported exports of one country may not coincide with the reported imports of its partner country also due to (see UNSD, 2019):

- shipping time-lags across different accounting periods (quarters or years);
- goods entering Customs warehousing for several months;
- goods passing through third countries;
- lack of information or misspecification of re-exports and re-imports;
- improper declaration of product classification at the customs border, either entry or exit;
- differences in scope and coverage e.g., merchanting and trade value thresholds;
- statistical measurement differences and errors;
- variations in data compilation methods, and confidentiality among other reasons.

**Overcoming limitations**
Even the major drawbacks of PCM do not render it redundant. According to WCO (2018), any implementation of the PCM approach requires additional assumptions to be made and inferential techniques to be chosen. Most PCM applications use globally accessible data on bilateral trade flows from IMF DOTS or United Nations Comtrade databases (such as WCO, 2018 and GFI, 2019). National statistical authorities, in particular Customs, have more detailed data. We propose the PCM method to be used but enhanced with national data and bilateral data exchange to improve the quality of estimates. PCM methodology (hence, PCM +) can be enhanced with the following:

1. **Compare national data with trading partners** as it can significantly improve the accuracy of PCM estimates. Carry out mirror exercises to exchange and compare trade statistics data focusing on important trade partner countries with the largest trade flows and the largest observed asymmetries (see Case study 1).

2. **Use granular national data, including most detailed levels of the product classification by partner country, and available microdata**, to reduce uncertainty about the source of bilateral trade asymmetries. Apply PCM on the national data held by statistical authorities, in particular Customs, to improve the accuracy of PCM estimates. Focus corrections on trading flows or products with largest asymmetries and known prominent types of IFFs.
3. **Resolve CIF-FOB differences.** Exports are usually reported as FOB and imports as CIF. UNSD (2019) encourages countries to compile FOB values of imported goods as supplementary information. When these are not available, CIF/FOB ratios are needed to correct for the asymmetry caused by valuation differences. It is better to apply country and region-specific ratios rather than common ratios for all countries1. In some instances, commodity-specific CIF/FOB ratios are needed2. Precious metals are a good example where transportation and insurance costs constitute a lower share of the value of goods (see Case study 2).

4. **Analyse remaining bilateral asymmetries** after CIF-FOB differences have been accounted for. UNSD (2019) provides a step-by-step guide and tabular template to support the analysis of bilateral asymmetries, and this is applied to the following guidance on applying PCM.

5. **Apply the reliability weighting procedure.** In cases where gaps in mirror trade statistics are substantial, doubt may arise as to whether this is due to misinvoicing or other factors. A weighting procedure to address the issue (WCO, 2018) assigns a higher weight to trade gap the closer the associated matched volume reports are, i.e., the smaller the gap.

6. **Validate results with qualitative methods.** Mehrotra et. al. (2020) suggest complementing the above steps with qualitative research, interviews and consultations with Customs and trade experts to enhance the reliability of PCM results.

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**Case study 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>
<thead>
<tr>
<th>Comparison of statistical concepts and definitions in China’s and Canada’s merchandise trade statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Issue</strong></td>
</tr>
<tr>
<td>Trade structure</td>
</tr>
<tr>
<td>Valuation methods</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Partner countries</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

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1 GFI (2019) uses a 6 per cent fixed ratio, down from 10 per cent used in previous studies. WCO’s (2018) study of 2016 import data for the United States of America revealed that the average CIF is 2.2 per cent with Europe, 4.81 per cent with South America and 2.8 per cent with all other partner countries. The United States International Trade Commission (2013) apply different CIF/FOB ratios for east and westbound transport between China and Hong Kong, and the United States of America.

2 Carbonnier and Mehrotra (2020) apply a 2 per cent ratio for trade of gold. Gaulier et al. (2008) provide insight into CIF/FOB ratios differences across activity sectors, noting that transport costs are higher for mining and quarrying than for manufacturing and that fresh goods and other commodities (agricultural, fishing) appear to have 2 percentage points higher transport costs than those of manufacturing.
<table>
<thead>
<tr>
<th>Exports: Country of final destination/country of shipment ends</th>
<th>Imports: Country of origin/country of export</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency of data publication</td>
<td>Each month, China publishes its previous month’s preliminary trade data on the 8th or 13th, and releases its official data on the 23rd.</td>
</tr>
<tr>
<td>Frequency of data adjustments or revisions</td>
<td>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.</td>
</tr>
<tr>
<td>Commodity codes and descriptions</td>
<td>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.</td>
</tr>
<tr>
<td>Special classifications</td>
<td>China classifies special traded goods, low-value simple customs clearance goods and unclassified goods into Chapter 98.</td>
</tr>
<tr>
<td>Re-export statistics</td>
<td>Re-export data are not included in China’s customs statistics.</td>
</tr>
<tr>
<td>Special economic zones</td>
<td>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.</td>
</tr>
<tr>
<td>Freight and insurance costs</td>
<td>Freight and insurance premiums for imported goods are based on actual fees paid.</td>
</tr>
</tbody>
</table>

**Source:** Statistics Canada (2018)

**Source data**

PCM requires bilateral trade statistics between reporting country and its trading partners, ideally by partner and not aggregated to the rest-of-the-world category. Source data include trade data collected nationally by the Customs or other relevant national authority. Data are preferably at the most granular level of product classification (at least 6-digit HS level with data on price, quantity, total value, CIF or FOB valuation, trading partner, country of origin or destination and type of flow, e.g., import/export or re-import/re-export). International data sources such as United Nations Comtrade or the IMF DOTS can be used in addition. The UNCTAD Global Transport Costs database for International Trade can be useful for resolving CIF-FOB discrepancy and the OECD’s ITIC database a source of CIF-FOB margins (see also Case study 2).

**Calculation**

Once source data are gathered and prepared, PCM is implemented in the following phases:
The analysis starts from a review of bilateral asymmetries, as outlined in UNSD (2019) – see Figure 1. It will be useful to start by assessing published asymmetries starting with total exports and imports and then moving to selected commodity groups looking at the main trading partners. As an alternative, observe discrepancy at HS chapters, and go deeper when significant discrepancy is detected. In observing the bilateral asymmetries, also consider the difference of HS editions.

Figure 1. Flow chart for analysing and reducing bilateral asymmetries

1. Adjusting for trade system differences

The first step examines the sources of differences for large asymmetries. First, check differences of trade systems used in reporting and partner countries based on information provided by United Nations Comtrade\(^3\) and adjust. Difference of trade systems may lead to trade asymmetries not attributable to IFFs. Box 1 illustrates how to deal with the differences caused by different trade systems.

Box 1. 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). 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;

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\(^3\) See https://comtrade.un.org/survey/Reports/byQuestion, Section 15: “Trade System”.
(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).

**General trade system - territorial elements and potential imports and exports**

![General trade system diagram](source: UNSD (2011))

**Special trade system - territorial elements and potential imports and exports**

![Special trade system diagram](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).
2. Valuation - converting import data to FOB

The second step is to review the difference in valuation of imports and exports. It should be checked which valuation is used by the trade partner countries of interest. And where imports use CIF valuation, these should be adjusted to FOB to match with exports. Otherwise, this discrepancy may lead to trade asymmetries not attributable to IFFs.

First, annual import data need to be converted to FOB valuation, if not already available\(^4\). Multiple ways of estimating the FOB values from CIF exist, apart from using fixed ratios. UNSD (2019) lists a few options, such as: extracting data from International Merchandise Trade Statistics (IMTS); collecting data on freight and insurance premiums from importers; analysing trade flows, freights, and insurance rates. Readers may consult the IMTS Compilers Manual, Chapter 14 on Valuation (UNSD, 2013) or Supplement to the Compiler’s Manual (UNSD, 2008). If FOB import values cannot be obtained directly, CIF/FOB ratio approach is applied:

\[
IM_{FOB,c,r,p,t} = \frac{IM_{CIF,c,r,p,t}}{CFr_{c,r,p,t}} \tag{1}
\]

where:

- \(IM\) ... import value
- \(CFr\) ... CIF/FOB ratio
- \(FOB\) ... FOB valuation
- \(CIF\) ... CIF valuation
- \(c\) ... commodity
- \(r\) ... reporter (country)
- \(p\) ... partner (country)
- \(t\) ... year.

During this phase, CIF/FOB ratios are constructed at as detailed level(s) as possible with respect to commodities, reporting and partner countries (or regions), and years. Studying existent data on trade flows, freight and insurance premiums, distance between trading partners and similar provides basis for ratio calculation. Basic ratio can be calculated as:

\[
CFr_{c,r,p,t} = \frac{IM_{CIF,c,r,p,t}}{EX_{FOB,c,r,p,t}} = \frac{p_{CIF,c,r,p,t} * q_{IM,c,r,p,t}}{p_{FOB,c,r,p,t} * q_{EX,c,r,p,t}} \tag{2}
\]

where:

- \(EX\) ... export value
- \(p_{CIF}\) ... CIF price declared by importer
- \(p_{FOB}\) ... FOB price declared by exporter
- \(q_{IM}\) ... declared quantity by importer
- \(q_{EX}\) ... declared quantity by exporter.

---

Further considerations on data and methodology of estimating CIF/FOB ratios can be found in e.g., Gaioler et al. (2008) or Hummels and Lugovskyy (2003), and Case study 2 showcases the estimation of CIF for commodity-specific research (Schuster and Davis, 2020).

**Case study 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. 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.

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.

3. Partner country attribution

Goods are either shipped directly from one country to another or through third countries. Asymmetries can arise when the country of export may not know the final country of destination at the time of export. Similarly, importing country may not be able to identify the country of origin. This may lead to trade asymmetries not attributable to IFFs and should be corrected.

According to UNSD (2019), for imports, two categories of partner countries can be distinguished: **country of origin** and **country of consignment** (also called the country of exports). For exports, **country of final (known) destination** is important along with the identification of **re-export** flows. Identification of country of consignment is crucial for observing trade asymmetries.

There are three important considerations for partner country attribution: **consignments for imports**, **re-exports** and **merchanting**. In merchanting, a unit purchases goods from abroad and then sells them to another country without the goods entering the purchaser’s economy. Goods under merchanting are recommended to be excluded from trade statistics (UNSD, 2013), but countries may end up measuring the related flows differently thus leading to asymmetry.

Instead of direct shipment of goods to the destination country, they can be re-exported further or shipped via a consignment country\(^5\). This country is often mistakenly recorded as the destination or origin of the flow which causes trade asymmetry. Partner country attribution needs to be done for each trade partner country, and related flows studied carefully to make sure proper attributions are used (see Case study 3).

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\(^{5}\) A country of consignment is the country from which goods were dispatched to the importing country (or to which goods were dispatched from the exporting country), without any commercial transactions or other operations (UNSD, 2013).
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, revealing reported and adjusted values of Canadian imports and Chinese exports.

### Bilateral inbound trade of mobile phones

<table>
<thead>
<tr>
<th>Inbound Trade</th>
<th>CAN imports</th>
<th>CHN exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Official data</td>
<td>3 329</td>
<td>1 362</td>
</tr>
<tr>
<td>Published asymmetry</td>
<td></td>
<td>1 967</td>
</tr>
<tr>
<td>Adjustment:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;CAN imports of CHN goods from countries of export (consignment) other than CHN&quot;</td>
<td>1 280</td>
<td></td>
</tr>
<tr>
<td>Adjusted official data</td>
<td>2 049</td>
<td>1 362</td>
</tr>
<tr>
<td>Remaining asymmetry</td>
<td></td>
<td>687</td>
</tr>
</tbody>
</table>

Source: UNSD (2019)

### 4. Review remaining asymmetry

Trade asymmetries can arise from time lags in shipments or seasonal trade cycles, e.g., high trade at the end of the year. Generally, goods are recorded at the time of entering or leaving the economic territory of a country (UNSD, 2013). This may lead to some flows, or their parts, to be assigned to different years (or months) by each trading partner. Differences are often due to country-specific reasons and need to be addressed in a case-specific way. As UNSD (2019) point out, the method of estimating time lags depends on dominant mode of transport and can be obtained from transport documents (e.g., bill of lading for sea transport) or from transport operators. Required adjustments are netted, i.e., consolidated from reporter’s import or export perspective, and in the end subtracted to obtain adjusted value of imports, or exports.

There are also other sources of discrepancies, such as those listed at the start of this chapter, for instance coverage issues, misclassification, under valuation, difficulties in recording trade by change of ownership and measurement errors. Correcting for these asymmetries requires close collaboration of national authorities, such as the NSOs and Customs, within and across countries (Case study 4).

### Case study 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.

### Overview of asymmetries between the EU and Mediterranean partner countries (MPCs)

<table>
<thead>
<tr>
<th>MPC</th>
<th>Northbound mirror discrepancy</th>
<th>Southbound mirror discrepancy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Value (1000 euro)</td>
<td>%</td>
</tr>
<tr>
<td>JORDAN</td>
<td>124 115</td>
<td>375 076</td>
</tr>
<tr>
<td>EGYPT</td>
<td>2 217 471</td>
<td>4 191 972</td>
</tr>
<tr>
<td>ALGERIA</td>
<td>13 932 458</td>
<td>15 251 561</td>
</tr>
<tr>
<td>SYRIA</td>
<td>3 493 711</td>
<td>3 455 654</td>
</tr>
<tr>
<td>MOROCCO</td>
<td>7 349 554</td>
<td>19 159 447</td>
</tr>
<tr>
<td>LEBANON</td>
<td>146 651</td>
<td>240 367</td>
</tr>
<tr>
<td>ISRAEL</td>
<td>11 671 813</td>
<td>11 351 149</td>
</tr>
<tr>
<td>TUNISIA</td>
<td>8 782 949</td>
<td>8 975 116</td>
</tr>
</tbody>
</table>

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.

Finally, all the identified corrections should be implemented leaving the remaining part of trade asymmetries. The UNSD template (2019a) 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 1.

### Table 1. Adjusting imports of reporting and exports of partner country to calculate the remaining asymmetry

<table>
<thead>
<tr>
<th>ORIGINAL DATA</th>
<th>R IMPORTS</th>
<th>P EXPORTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADJUSTMENT</td>
<td>CIF-FOB</td>
<td>A&lt;sub&gt;CIF-FOB&lt;/sub&gt;</td>
</tr>
<tr>
<td>ADJUSTED DATA*</td>
<td>IM&lt;sub&gt;CIF-FOB&lt;/sub&gt;,&lt;sub&gt;r,p,t&lt;/sub&gt;</td>
<td></td>
</tr>
</tbody>
</table>

R IMPORTS | P EXPORTS
Original data | IM<sub>CIF-FOB</sub>,<sub>r,p,t</sub> | EX<sub>FOB</sub>,<sub>r,p,t</sub>

Finally, all the identified corrections should be implemented leaving the remaining part of trade asymmetries. The UNSD template (2019a) 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 1.
### Case study 5. Weighting discrepancies in international goods trade volumes by UNECLAC

In their study of IFFs in the countries of Latin America and the Caribbean, UNECLAC (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.

### Adjusted Data

<table>
<thead>
<tr>
<th>Adjustment</th>
<th>R Imports</th>
<th>P Exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade system</td>
<td>$A_{TS,c,r,p,t}$</td>
<td></td>
</tr>
<tr>
<td>Indirect trade</td>
<td>$A_{IT,c,r,p,t}$</td>
<td></td>
</tr>
<tr>
<td>Re-exports</td>
<td></td>
<td>$B_{Re-Ex,c,r,p,t}$</td>
</tr>
<tr>
<td>Merchanting</td>
<td>$A_{M,c,r,p,t}$</td>
<td>$B_{M,c,r,p,t}$</td>
</tr>
<tr>
<td>Timing (time lags)</td>
<td>$A_{T,c,r,p,t}$</td>
<td></td>
</tr>
</tbody>
</table>

### Remaining Asymmetry

$$\text{InboundRA} = IM_{\text{Adj}}^{FOB,c,r,p,t} - EX_{\text{Adj}}^{FOB,c,r,p,t}$$

### Adjusted Data Equations

<table>
<thead>
<tr>
<th>Equation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equation (3)</td>
<td>[ w = 1 - \frac{</td>
</tr>
<tr>
<td>Equation (4)</td>
<td>[ \text{Inbound}<em>{c,r,p,t} = w \ast (IM</em>{\text{Adj}}^{FOB,c,r,p,t} - EX_{\text{Adj}}^{FOB,c,r,p,t}) ]</td>
</tr>
<tr>
<td>Equation (5)</td>
<td>[ \text{Outbound}<em>{c,r,p,t} = w \ast (EX</em>{\text{Adj}}^{FOB,c,r,p,t} - IM_{\text{Adj}}^{FOB,c,r,p,t}) ]</td>
</tr>
</tbody>
</table>

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.

### 5. The reliability weighting procedure

The next phase brings in the reliability weighting procedure to mitigate risk of unproportionally privileging large trade gaps, which have higher potential of not indicating mispricing. The weights are applied to records of inbound flows from reporter’s side using the weights:

$$w = 1 - \frac{|q_{IM,c,r,p,t} - q_{EX,c,r,p,t}|}{\max(q_{IM,c,r,p,t}, q_{EX,c,r,p,t})} \quad \text{Equation (3)}$$

In an analogous fashion, weights are applied to outbound flows, i.e., exports of reporter. By applying these weights, the inbound (imports) and outbound (exports) flows are expressed as:

$$\text{Inbound}_{c,r,p,t} = w \ast (IM_{\text{Adj}}^{FOB,c,r,p,t} - EX_{\text{Adj}}^{FOB,c,r,p,t}) \quad \text{Equation (4)}$$

$$\text{Outbound}_{c,r,p,t} = w \ast (EX_{\text{Adj}}^{FOB,c,r,p,t} - IM_{\text{Adj}}^{FOB,c,r,p,t}) \quad \text{Equation (5)}$$

Case study 5. Weighting discrepancies in international goods trade volumes by UNECLAC

In their study of IFFs in the countries of Latin America and the Caribbean, UNECLAC (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.
The analysis combines export underinvoicing (ExpDisc) and import overinvoicing (ImpDisc) as the gross outflows from misinvoicing, to produce a lower bound to the IFFs from the region:

\[
\text{Gross outflows from misinvoicing} = \sum \text{ExpDisc}_{i,j,k,t} + \sum \text{ImpDisc}_{i,j,k,t}, \text{ for ExpDisc} > 0 \text{ and ImpDisc} > 0
\]

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

![Bar chart showing estimated value of trade misinvoicing in Latin America and the Caribbean](chart1.png)

Source: UNECLAC (2016)

### 6. Calculate inward and outward IFFs

The final phase is to calculate inward and outward IFFs. Inward IFFs refer to over-invoiced exports and/or under-invoiced imports; and outward IFFs refer to under-invoiced exports and/or over-invoiced imports, as in:

\[
\begin{align*}
\text{Overinvoiced } IM_{c,r,p,t} &= \max(0, \text{Inbound}_{c,r,p,t}) & \text{Equation (6)} \\
\text{Underinvoiced } IM_{c,r,p,t} &= -1 \times \min(0, \text{Inbound}_{c,r,p,t}) & \text{Equation (7)} \\
\text{Overinvoiced } EX_{c,r,p,t} &= \max(0, \text{Outbound}_{c,r,p,t}) & \text{Equation (8)} \\
\text{Underinvoiced } EX_{c,r,p,t} &= -1 \times \min(0, \text{Outbound}_{c,r,p,t}) & \text{Equation (9)}
\end{align*}
\]

To compile inward and outward IFFs the following equations are used:

\[
\begin{align*}
\text{InwardIFFs}_{c,r,p,t} &= \text{Overinvoiced } EX_{c,r,p,t} + \text{Underinvoiced } IM_{c,r,p,t} & \text{Equation (10)} \\
\text{OutwardIFFs}_{c,r,p,t} &= \text{Underinvoiced } EX_{c,r,p,t} + \text{Overinvoiced } IM_{c,r,p,t} & \text{Equation (11)}
\end{align*}
\]
Finally, aggregation at national level is obtained by:

\[ IFFs_{r,t} = \sum_{c,p} InwardIFFs_{c,r,p,t} \]

**Equation (12)**

\[ OutwardIFFs_{r,t} = \sum_{c,p} OutwardIFFs_{c,r,p,t} \]

**Equation (13)**

There are many applications of PCM covering different countries or regions. Case study 6 showcases an application of PCM for South African imports, a study by the UNESCWA in the Arab region, a study in Asia and the Pacific, and a recent application for African continent paying particular attention to continental circumstances and the characteristics of commodities.

**Case study 6. 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 (2016) 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. 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:

1. 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.

2. 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

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6 For a single measure of IFFs in a country, the inflows and outflows can be summed, not netted, as per:

\[ IFFs_{r,t} = InwardIFFs_{r,t} + OutwardIFFs_{r,t} \]

Subtracting outflows from inflows of IFFs would indicate the net effect of IFFs on the country. However, in a case that inflows and outflows balance out, the country may be perceived as if no threat or danger from IFFs are present, whereas each flow, inward and outward, may be of significant scale. Therefore, their sum would be used to indicate the overall IFFs in a country, if relevant.
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.