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ILLICIT FINANCIAL FLOWS AND TRADE MISPRICING: DECOMPOSING THE TRADE REPORTING GAP

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IES Working Paper 26/2021

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Bibliographic information:
Cobham A., Janský P., Mareš J. (2021): "Illicit Financial Flows and Trade Mispricing: Decomposing the Trade Reporting Gap" IES Working Papers 26/2021. IES FSV. Charles University.

Illicit Financial Flows and Trade Mispricing: Decomposing the Trade Reporting Gap

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July 2021

Abstract:
Despite a Sustainable Development Goals target to reduce trade mispricing and other illicit financial flows, it is not clear how to measure trade mispricing over time for countries worldwide. We aim to combine a broad coverage of countries by using UN Comtrade data and robustness by developing a new methodology that sheds new light on a potential scale of trade mispricing for many countries worldwide. Specifically, we provide new estimates of the trade reporting gap and, for the first time, we decompose it into seven individual components. Our explorative analysis reveals three main findings. We show, first, that trade reporting gap is large, in absolute values as well as relative to the overall trade. Second, conceptually well-defined components such as product and country misclassifications account only for a small share of trade reporting gap. The large remaining residual hints at the degree of imprecision in international trade reporting and calls for a significant improvement in data quality. Third, the low-income countries' trade reporting gap has the highest ratio relative to their GDP, which is consistent with existing literature that shows low-income countries to be more vulnerable to a variety of illicit financial flows.

JEL: F13, F14, H26
Keywords: international trade; trade reporting gap; trade mispricing; illicit financial flows; low-income countries; global development

Acknowledgements: This research was supported by the European Union's Horizon 2020 program through the COFFERS project (No. 727145).

1 Introduction

When money flows out of countries illicitly, their economies shrink, government revenues fall and institutions are weakened (Brandt, 2020). Growing appreciation of the threat of illicit financial flows (IFFs) is reflected in the inclusion of a target to reduce them in the United Nations' Sustainable Development Goals (UNODC & UNCTAD, 2020), which might be one of the few ones that are likelier to be achieved after COVID-19 due to the government's increased desire for more revenues (Barbier & Burgess, 2020). Trade mispricing is one channel for IFFs and, as documented by numerous case studies, a real phenomenon. What is less clear is the scale of these IFFs and how important trade mispricing in reality is for low-income countries in particular.

In this paper we critically review the existing estimation methodologies that attempt to overcome the challenges posed by the inherently illicit nature of the studied phenomenon (Nesvetailova et al., 2021). One the one hand, some studies provide estimates for many low- and middle-income countries, but they are not very reliable, as is the case with the estimates by the Global Financial Integrity (e.g. Spanjers & Salomon, 2017). On the other hand, a few recent studies using confidential customs data have succeeded in confirming the existence of trade mispricing (Wier, 2020), but it is unrealistic to expect estimates for many low- and middle-income countries any time soon. Both of these streams of literature are unsatisfactory since they do not provide us with a reliable answer to the question of the scale of trade mispricing for countries at different levels of economic development. This poses an opportunity to develop a new methodological approach, which would combine the strengths of both – country coverage and reliability.

With this objective in mind, we carry out an explorative analysis using the UN Comtrade data. This guarantees us a good coverage of countries of all income levels and the challenge is to quantify trade mispricing in a reliable way. While we ultimately do not succeed in isolating trade mispricing from other phenomena, we discuss several interesting observations that represent systematic pricing patterns in international trade. Specifically, we consider a concept of trade reporting gap. We decompose it into separate and additive components such as product misclassification and trade costs, some of which

have been studied individually and some not, but, as far as we know, so far not studied together in this way. We follow up on our conceptual framework with empirical methodology that estimates, more or less roughly, each of the components that sum up into the overall trade reporting gap. For this trade reporting gap approach we highlight the limitations as well as opportunities for future research.

With this new empirical approach, we arrive at three main findings. First, trade reporting gap is large, in absolute values as well as relative to the overall trade. Second, conceptually well-defined components such as product and country misclassifications account only for a small share of trade reporting gap, whereas most of the trade reporting gap consists of the unexplained residual component. Third, the low-income countries' trade reporting gap has the highest ratio relative to their GDP and consists relatively more of unmatched trade, country misclassification and product misclassification components. This latter finding is consistent with existing literature that shows low-income countries to be more vulnerable to a variety of IFFs (Picciotto, 2013, Johannesen et al., 2020, Janský et al., 2021) and IFFs more generally hurting many countries worldwide (Hampton & Christensen, 2002) and likely benefiting only few (Butkiewicz & Gordon, 2013), highlighting the need for international policy reforms that work, in particular, for low-income countries.

Overall, our paper's contribution is threefold. We put trade mispricing in the framework of IFFs from low- and middle-income countries in particular. IFFs are included in the Sustainable Development Goals and, as with other goals, we expect them to likely shape - and be shaped by - the wider research community (Fontana & Oldekop, 2020). Second, we review and critically evaluate the existing methodologies to estimate trade mispricing. Last, but not least, we provide new insights into the trade reporting gap by carrying out an explorative analysis with the objective of decomposing the gap for as many countries as possible, with the main findings discussed above, and in more detail below.

The rest of the paper is structured in the following way. Section 2 provides a discussion of related literature in two parts – first, a more general review of IFFs from low- and middle-income countries and, second, a critical overview of existing methodologies to estimate trade mispricing. Section 3 introduces our preferred data, UN Comtrade, which has information on international trade from most,

or, arguably, all countries worldwide. Section 4 develops a new conceptual framework and estimation methodology to decompose the trade reporting gap. Section 5 provides an explorative analysis decomposing the gap into several components that shed new light on the potential scale of trade mispricing and related IFFs. Section 6 concludes, including with ideas for extending our empirical approach.

2 Related literature

In this section we introduce trade mispricing in the framework of IFFs from low- and middle-income countries and then we critically evaluate the existing methodologies to estimate trade mispricing.

2.1 Review of illicit financial flows from low- and middle-income countries

IFFs from low- and middle-income countries, and particularly from Africa (relative to its economic weight in the world), are estimated to be substantial. There are at least three reasons why IFFs are detrimental to development in low-income countries in Africa and elsewhere. First, IFFs lower tax revenues. Second, IFFs erode the funds available for private investment on the continent. Third (and probably most importantly), IFFs and associated activities, such as corruption (Tajaddini & Gholipour, 2018), pose a threat to the legitimacy of government institutions, which in turn leads to a reduction in tax morale, among other negative effects. Clearly, IFFs are inherently harmful and their effects are likely to differ by type and characteristics.

In recent years, IFFs and trade mispricing in particular have assumed greater importance on African policy makers' agendas. This is partly due to initiatives by non- and inter-governmental organisations such as Global Economic Governance (GEG) Africa, the Tana High Level Forum on Peace and Security in Africa (Cobham, 2014) and the African Tax Administration Forum (ATAF), which have stressed the development threat posed by trade mispricing in Africa. An important milestone in the policy arena was the release of an African Union Commission/United Nations Economic Commission for Africa (AUC/ECA) report or, in short, ECA (2015), which names IFFs as one of Africa's biggest development challenges. The Report of the High Level Panel on Illicit Financial Flows from Africa,

chaired by former South African president Thabo Mbeki, assesses the volumes and sources of illicit financial outflows, provides case studies on how these outflows occur in Africa, and recommends certain actions "that should be taken both by Africa and by the rest of the world to effectively confront what is in fact a global challenge" (ECA, 2015, p. 2). ECA is perhaps the leading policy actor in Africa when it comes to IFFs, evidenced in the number of reports released recently (ECA, 2018a, 2018b).

A useful classification of IFFs is distinguishing between four groups according to the underlying motivation (ECA, 2015). The first group involves market or regulatory abuse. The second group involves tax abuse. For these first two groups we expect private actors to feature most prominently, namely individuals, businesses and multinational enterprises (MNEs). The third group involves abuse of power, including the theft of state funds and assets. For this group politicians and public employees are likely to be the key actors. The fourth group involves crime and proceeds of crime, and here the most obvious actors are criminals. Within this typology, we expect that a large proportion of trade mispricing is associated with or results into tax abuse, including trade tariffs. While the typology may be a useful means of categorisation, there are as yet no corresponding estimates for the volume of IFFs per motivating factor, nor any data on the importance of trade mispricing compared with other IFFs.

The relative importance of trade mispricing and other types of IFFs still needs to be determined using reliable empirical methods. While clearly desirable to compare the different types of IFFs, attempts at quantification or decomposition have been limited. As far as we know, only rough estimates have been produced, such as those of Baker (2005) who is among the few who have attempted to estimate the scale of various types of IIFs at the same time. Drawing from a survey of managers and estimates by Baker (2005, p. 172), global annual lower-bound estimates of more than USD 1 trillion into commercial IFFs (USD 700 billion) and criminal IFFs (with drugs being the single largest criminal subgroup estimated at USD 120 billion) are decomposed. Within commercial IFFs, he distinguishes between trade mispricing (between unrelated trade partners, estimated at USD 200 billion), transfer mispricing (between related trade partners, estimated at USD 300 billion) and fake transactions (no

trade actually taking place, estimated at USD 200 billion). According to these rough estimates trade transactions are responsible for most IFFs. Despite the anecdotal nature of the evidence, it highlights the potential prominence of trade mispricing in IFFs and supports the decision taken by Global Financial Integrity (GFI), an organisation that Baker founded, to base its estimates mostly on trade data. Although we discuss methodological limitations below, there are not many alternatives to estimating IFFs – and some of these, such as the UNECA methodology (ECA, 2015), build on the GFI approach. It is thus important to acknowledge the role of Baker and the GFI in shaping the public discussion on IFFs.

Trade mispricing is a well-known channel for IFFs. There are various definitions of trade mispricing (reviewed, for example, by Janský (2015). Trade mispricing (or mis-invoicing) is the deliberate over- or under-invoicing of exports or imports by businesses in a country, which results into avoiding or evading tax or levies in that country. Transfer pricing is used by multinational corporations to price transactions between affiliates in different countries. The practice of transfer mispricing, also known as transfer pricing manipulation or abusive transfer pricing, is a subgroup of trade mispricing. It involves the manipulation of transfer prices – namely, interest payments, licence fees or payments for goods and services transferred between subsidiaries of the same multinational operating in different countries with regard to transactions that might be otherwise correctly recorded.

There is anecdotal evidence of trade mispricing by news outlets and governmental and non-governmental organisations (NGOs), but systematic evidence of trade mispricing is scarce. Owing to data limitations and the illicit nature of IFFs, our knowledge of the extent and characteristics of IFFs is limited. The papers by the GFI and Ndikumana & Boyce (2001), who focus on African countries, and which are exemplified by the GFI's Spanjers & Salomon (2017) and Boyce & Ndikumana (2001), respectively, provide some of the most cited estimates of IFFs. The GFI methodology has some limitations but since it is widely used and there are no better estimates than those provided by the GFI, the authors of this paper have used them. Indeed, even the AUC/ECA (2015), which reports that Africa is estimated to be losing more than USD 50 billion annually in IFFs, argues that although these

estimates fall short of reality, they draw attention to the scale of IFFs in Africa. Wier (2020), while focusing on one African country only (South Africa), persuasively documents that the trade mispricing is present and he estimated tax loss for the country at less than 1% of total corporate tax revenue.

More research is needed to formulate policies that will effectively and decisively reduce IFFs. Policy measures aimed at reducing IFFs need to be better informed by new and more focused research. This will entail acquiring high-quality trade data, ideally at transaction-level, with detailed characteristics of each transaction. Such data are not likely to be readily available in most African countries, with the exception, according to the literature, of Madagascar (Chalendard, Raballand, & Rakotoarisoa, 2017) and South Africa (Wier, 2020). Furthermore, the preparation of such data, which requires high-level technical skills and capacity, might prove challenging. We discuss these challenges in Section 5.

Governments and international organisations worldwide share a commitment to combat IFFs. In 2015 governments throughout the world agreed on the United Nations Sustainable Development Goals (SDGs). Led by low- and middle-income countries and African countries in particular, including the G77 and the African, Caribbean and Pacific (ACP) states, a consensus emerged that the elimination of IFFs should feature in the SDGs. As a result, one of the SDG targets (16.4) specifically addresses IFFs:

> *By 2030, significantly reduce illicit financial and arms flows, strengthen the recovery and return of stolen assets and combat all forms of organized crime.*

Expert and political discussions on what indicators are suitable to follow up on this target are ongoing and it is not yet clear how progress will or should be measured. The selection of indicators could be crucial in obtaining more reliable data and a measure of IFFs. Cobham & Janský (2020) propose two indicators: first, how much profit multinational companies have shifted to achieve a tax-favourable misalignment with real activity; and second, offshore assets that are not declared to home country authorities. These two indicators focus on the inconsistencies resulting from IFFs rather than individual IFF channels, such as trade mispricing. Therefore, although the indicators do not explicitly

capture trade mispricing, they can expose the results of trade mispricing. If the intention was to use an explicit trade mispricing indicator, possible options would be indicators similar to those refined by ECA (2015) or developed by frontier of research methods, including those by Wier (2020) for South Africa.

2.2 Methodologies to estimate trade mispricing

It is important to have reliable estimates of the nature and scale of trade mispricing for effective policy making. However, as discussed earlier, reliable estimates of trade mispricing are few and far between. In this section we critically review the most widely used methodologies for estimating trade mispricing, organised in four groups:

1. Pioneering methods;
2. Partner country trade statistics (or mirror trade statistics) method;
3. Price filter (or abnormal prices) method;
4. Frontier of research methods.

Table 1 summarises the main characteristics of each of these groups.

Table 1: Four groups of methodologies used to estimate trade mispricing

Group	Prevailing level of data	Prevailing sources of data	The gist of the prevailing method	Recent examples	Robustness of the methodology	Availability and country coverage	Coverage of low- and middle-income countries
Pioneering methods	Country	Non-trade	Various	Oxfam (2000)	Not robust	Large share of the world	Covered
Partner country trade statistics method	Country	IMF	Comparing one country's exports with its partner country's imports	GFI's Spanjers & Salomon (2017)	Not robust, at the commodity level, useful as indicative information	Most of the world	Covered
Price filter method	Commodity	UN Comtrade	Identification of extremely priced trades	Chalendard, Raballand, & Rakotoarisoa (2017)	Not robust, at the commodity level, useful as indicative information	Most of the world	Covered
Frontier of research methods	Transaction	Country-specific	Systematic differences between intra-firm and arm's length prices	Davies, Martin, Parenti, & Toubal (2017)	Potentially robust, but only a few applications so far	Limited and only a few countries	Limited coverage

Source: Authors

Pioneering methods

The pioneering estimates (provided by a number of academics and NGOs, such as Baker, 2005) managed to put IFFs on research and policy agendas. For example, Oxfam (2000) argued that low- and middle-income countries suffered an annual tax revenue loss of USD 50 billion to tax havens, while Transparency International (2004) cited the billions of dollars in illicit financial flows that low- and middle-income country leaders were responsible for. Using the findings of Schneider (2005) and Murphy & Christensen (2005), Cobham (2005) estimated that low- and middle-income countries were losing USD 100 billion annually. Although pioneering estimates were important in attracting attention to topics closely related to IFFs in the past, they are of limited relevance today as they have largely been surpassed, in terms of credibility and coverage, by the methods discussed below.

Partner country trade statistics method

The partner country trade statistics method is likely the most frequently used method today. Its results have attracted the attention of policy makers to the reality and significance of IFFs, but its methodology is vulnerable to criticism. This method estimates the scale of IFFs by comparing the exports (imports) of a country (as reported by that country) with the corresponding import (export) figures supplied by the rest of the world in their trade dealings with the country. In this way it exploits the mirror nature of international trade data – that every flow is recorded twice.

The GFI regularly applies the partner country trade statistics method. The GFI focuses on low- and middle-income countries and provides estimates for African countries. Ndikumana & Boyce (2000, 2008) have frequently used the method to estimate capital flight from sub-Saharan African countries, while Nicolaou-Manias (2016) has applied the method to five African countries. A recent application of this method focused on trade-based money-laundering has been produced by Gara, Giammatteo & Tosti (2018) for Italy. We will concentrate on the GFI as its estimates have worldwide application and are likely to more credible. The most recent estimates by GFI (2019) for 148 countries for years 2006-2015 are based on the same methodology, the main change being the use of both Direction of Trade Statistics (DOTS) and Comtrade data to generate two sets of estimates.

The GFI results probably overestimate how much low- and middle-income countries lose in IFFs due to trade mispricing. This is mainly because of limitations in the partner country trade statistics method. It is not our goal to discuss the pitfalls of this method in detail, but a number of papers have criticised it, such as those of Nitsch (2012, 2016), Fuest & Riedel (2012), Hong & Pak (2016), Forstater (2016) and Nitsch (2017). Many of the method's limitations are linked to the availability of data. As it is difficult to obtain detailed trade data for many countries, the GFI relies on country-level data. As a consequence, it is necessary to make a number of assumptions which can make the estimates appear unreliable. Another limitation of the GFI's estimates is that they do not provide specific guidance on policy but constitute a general call to reduce IFFs.

The partner country trade statistics method has been refined over the years. ECA (2015) and other researchers have made improvements to this popular method, overcoming some of its earlier limitations. For example, instead of country-level data, ECA (2015) uses more detailed commodity-level data (although not as detailed or reliable as transaction-level data used by the frontier of research method discussed below). Whereas the method, as applied by the GFI, compares one country's trade with the rest of the world, Nicolaou-Manias (2016) uses bilateral data, which adds to the relevance thereof. With the GFI's application of the method it is assumed that there is no trade mispricing in partner (developed) countries. However, in reality, trade mispricing does occur to some extent, aimed at transferring funds from advanced economies as well (Hong & Pak, 2016). Indeed, Kellenberg & Levinson (2019) find evidence of trade misreporting for countries across all income groups.

Because of the dearth of detailed data, the GFI's Spanjers & Salomon (2017) assume that transportation costs are 10%, whereas in reality they differ across countries and even transactions. Nitsch (2016) criticises this assumption and Erskine (2018) finds that transaction costs are systematically higher for landlocked countries. To remedy this, ECA (2015) follows a country-specific approach.

While ECA (2015) and other researchers have improved the method and partially overcome certain problems of the partner country trade statistics method, other limitations persist. Of course, the

significance of the limitations depends on the research question to be answered. Where indicative or illustrative answers will suffice, the most improved versions of this method could prove useful, but for estimates of overall scale, the method remains unreliable.

Price filter method

The price filter method identifies extreme or abnormal prices in international trade, which signal IFFs. The method starts by estimating prices as unit values by dividing the financial values by kilograms. It then establishes what a normal price for a given commodity should be and labels any prices outside this filter as abnormal and the associated trade flows as illicit. This pivotal assumption implies that any abnormal prices are related to IFFs, which is likely to lead to overestimation. Consequently, we do not consider it a reliable method for estimating the scale of IFFs. Still, it can be useful for other, indicative purposes, such as identifying cases warranting a more detailed audit.

A number of academics have applied the method, notably Pak & Zdanowicz and their co-authors. These include De Boyrie, Pak, & Zdanowicz (2005), Pak (2007) and Zdanowicz (2009). In addition, NGOs such as Hogg et al. (2009, 2010) have used various versions of this method (including the example of Switzerland-Zambia trade in copper, an extractive industry for which Ponsford & Mwiinga (2019) document Zambia's government's request for financial models from companies). For example, De Boyrie, Pak, & Zdanowicz (2005) used transaction-level data for trade between the US and Russia and attributed the flows through trade mispricing to money laundering and tax evasion. They estimated that in 1995 the amount of capital shifted out of Russia in the form of abnormal prices was 3% of total exports and 6% of total imports, respectively.

A number of authors have criticised the price filter method, e.g. Carbonnier & Zweynert de Cadena (2015). We agree that the assumptions are too strong and the estimates are not particularly helpful in determining the overall scale of trade mispricing. However, we believe that the method is useful for highlighting the specific commodities and countries most vulnerable to trade mispricing and might become more reliable in the future if further developed and applied to the best available data.

In addition, the World Customs Organisation (2018) presented its study report on IFFs and trade-mis-invoicing to the Development Working Group of the G20 in July 2018. The multi-co-authored report argues that estimates of both partner country trade statistics and price filter methods are not sufficiently robust and should not be understood as a reliable quantitative measurement of the scale of IFFs, but rather as a risk indicator, which can be useful in comparing the risk of IFFs across commodities, countries and over a longer time period. The World Customs Organisation (2018) also makes the important point that rather than disputing the accuracy of individual assessment mechanisms, attention should instead focus on actions to combat IFFs, the existence of which is indisputable, the estimates of which, however, are dependent on the methodologies used.

Frontier of research methods

Frontier of research methods have so far provided the most rigorous evidence of trade mispricing. These methods are rigorous in their approach and are applied to detailed transaction-level data. To date they have provided some of the most convincing evidence of trade mispricing, mainly in developed countries. Studies for the United States have been conducted by Clausing (2003), Bernard, Jensen, & Schott (2006) and Flaaen (2017); for France by Davies, Martin, Parenti, & Toubal (2017) and Vicard (2015); for Denmark by Cristea & Nguyen (2016); and for the United Kingdom by Liu, Schmidt-Eisenlohr, & Guo (2017). The only directly comparable study for a low- or middle-income country is that by Wier (2020) for South Africa, which provides the first direct, systematic evidence of profit shifting through transfer mispricing in such a country.

There is also a clear recommendation emerging from the frontier of research papers: the tax authority should set up an automated flagging system. This digital system would automatically test for deviations in the pricing of related and unrelated transactions. Building on his experience of South Africa, Wier (2020) argues that this is a cost-effective way of curbing transfer mispricing as it uses information that is abundant but not efficiently exploited. He proposes that when a firm prices a product differently in related and unrelated transactions, this should prompt an automatic audit or, as a minimum, a flag should be raised and an email sent to the firm cautioning them to stop this behaviour.

He argues that the cost of doing this is in the thousands of dollars whereas the potential tax gain is in the tens of millions of dollars.

Overall, the evidence of trade mispricing is of relevance to policy makers, but it could be much improved. While the not-so-reliable partner country trade statistics and price filter methods remain the only ones that have produced results for many low- and middle-income countries, we argue that attention should be given to the application of new methods, such as frontier of research methods discussed. However, given the data requirements of the frontier of research methods that are unlikely to be met in many low- and middle-income countries, it is still worth seeing what can be done with the data is widely available, UN Comtrade data. We develop one such approach that combines some aspects of the partner country trade statistics and price filter methods.

3 Data

We primarily rely on the UN Comtrade data, the most comprehensive database of international trade in goods. The database records annual bilateral trade on product-level by more than 150 countries. UN Statistical Division applies the Harmonized System (HS) product classification which at its most granular level (HS 6-digit) distinguishes about 5300 categories and contains roughly 15 million bilateral flows every year. In this paper, we employ the finest classification to explore trading and potential trade mispricing patterns. We mostly focus on 2015, the year with the best data availability at the time of the empirical analysis for majority of the reporting countries, but we also show the dynamics of trade gap components since 2010 capture the trade gap and its components over time. While we could potentially use even more recent years in UN Comtrade, the data is getting sparser as some of the countries lag on their reporting. We also follow the criterion of data availability in the choice of HS classification where we rely on the 2002 vintage. Not all the reporters offer data reports in the latest versions, which would limit our sample. Additionally, this vintage also ensures better backward compatibility of our estimates and enables extensions all to way to 2000s'. In the analysis, we combine the UN Comtrade data with the country classifications and other economic indicators

from the World Bank. We discuss descriptive statistics of the UN Comtrade data set in the Appendix 2.

One important consideration working with UN Comtrade is the fact that there is a difference in the prices reported on imports and exports. The export prices are generally declared as Free on Board (FOB) while the import prices as including Costs, Insurance, and Freight (CIF). The CIF prices should typically be higher than FOB prices with the difference range from 10 to 20% according to the World Bank (2010). Accounting for such differences is important when constructing mirror trade data or attempting to fully utilize the trade flows data collected by the reporting countries. The optimal approach towards reconciliation of import and export prices is unclear. Although the number of reporting countries has been growing, there are a lot of jurisdictions which do not provide data on their trade flows. In practice, around 150 countries report the data, but there are more than 200 partner jurisdictions reported in the database.

This presents us with further choices when analysing the data. One of the possibilities is the estimation of additional CIF costs and adjusting to their FOB equivalents. Gaulier and Zignago (2010) introduce such approach which results into BACI database of international flows. The average CIF estimated in BACI is around 3% which is somewhat lower than typically assumed (and lower than the price differential suggested by the UN). Although BACI offers a consistent database on mirror flows, the adjustment of mirror trade prices during its construction might mask some of the potential mispricing in the original data. We therefore stick with the original UN Comtrade data and use existing (WB trade cost data, CEPII, and also our own assumption of 5%) estimates of these factors and a sensitivity analysis to estimate the scale of this phenomenon in a separate component in the decomposition analysis below.

Differences in declared export and import values when using mirror data may also arise from other sources. The commodities can be classified into non-corresponding categories at HS 6-digit level by import and export customs administrations. Other discrepancies may arise, for example, due to the trades taking place around the turn of the year. The severity of these distortions cannot be precisely

investigated, but below we acknowledge and empirically isolate as many of these possible effects. Below we introduce a definition of trade reporting gap and methodology we apply to the UN Comtrade data to decompose it.

4 A simple economic model of trade misreporting incentives

We present in this section an economic model of firm-level traders' misreporting behaviours that takes into account the characteristics of bilateral, product-specific trade flows to guide our empirical analysis in the following sections. This model is the generalised version by Kellenberg & Levinson (2019) of the model in Ferrantino, Liu, & Wang (2012), which in turn builds on modelling the transfer pricing problem within multinational firms such as Swenson (2001) and Bernard et al. (2006).

We assume that for each product *i* and year *t*, there is a representative exporting firm in country *x*, and a representative importing firm in country *m*. The two firms arrive at the true value of free-on-board (FOB) exports, V^*_{xmit}, which is unknown to customs officials. Each exporting and importing firm decide how much of its exports to report to the customs, V^x_{xmit} and V^m_{xmit}, respectively. We let δ^x_{xmit} and δ^m_{xmit} be the proportional deviations from the true values of exports and imports byexporters and importers:

$V^x_{xmit} = \delta^x_{xmit} V^*_{xmit}$ and $V^m_{xmit} = \delta^m_{xmit} V^*_{xmit}$

Exporting firms may not report any exports at all ($\delta^x_{xmit} = 0$), underreport ($0 < \delta^x_{xmit} < 1$), report accurately ($\delta^x_{xmit} = 1$), or overreport ($\delta^x_{xmit} > 1$). Similarly, importing firms may not report any imports at all ($\delta^m_{xmit} = 0$), underreport ($0 < \delta^m_{xmit} < 1$), report accurately ($\delta^m_{xmit} = 1$), or overreport ($\delta^m_{xmit} > 1$). These deviations can be in the form of misreporting prices or quantities. There are a number of reasons why firms would misreport exports or imports and in the following we discuss how we distinguish between them and how we estimate their scale from the available data.

5 Conceptual framework and estimation methodology

In this section we develop a new conceptual framework that decomposes the trade reporting gap intro individual components and we introduce the methodology to estimate the scale of each of the components. The trade reporting gap (or misreported trade or reported trade gap or, simply, gap) has been studied in the literature, as reviewed above, most famously by the Global Financial Integrity and also recently by Kellenberg & Levinson (2019). However, none of the research has so far attempted such detailed analysis of the gap's various components as we do now and this requires to redefine the basic terms and develop a new conceptual framework that allows for the various components and the use of more detailed data than the previous research has used. We conceptually think of the gap and also empirically estimate it at the highest level of disaggregation possible (HS6 commodity groups in the UN Comtrade). In addition, we aggregate the results at higher levels (countries, regions, world) to be able to present the results and to provide further insight on the relative importance of individual misreporting categories as well as to relate the estimates to country characteristics.

We define the trade reporting gap as the overall absolute value of misreported trade between two trading partners. The fact we use the absolute value makes it more practicable for a decomposition, although it makes it less directly comparable with some of the existing literature. By construction, the seven components are additive and we sum up them in absolute values into an overall value of the trade reporting gap. In simple terms without detailed notation (for countries, years and products), the decomposition can be described as:

$$
\begin{aligned}
&Trade\ reporting\ gap \\
&\quad = |Country\ misclassification| + |Product\ misclassification| \\
&\quad + |Unmatched\ trade| + |Abnormal\ prices| + |Trade\ costs| + |Tariff\ costs| \\
&\quad + |Residual|
\end{aligned}
$$

For each of the seven components, we briefly explain the rationale for its existence and we outline how we estimate the scale of the components with the UN Comtrade data in Table 2.

In principle, the gap between the reported trade values can arise due to one of the trade partners not reporting the trade flow at all (unmatched data, corresponding to components 1-3), or due to the

difference in the declared value by the trade partners (matched data, corresponding to components 4-7).

Table 2. Decomposing the trade reporting gap: the seven components

Number	Component	Estimation strategy
1	Country misclassification (different partner, transit trade)	Assuming HS6/4 correct classification, unmatched exports from an exporter that overlap with unmatched imports from an exporter are a proxy for this misclassification (and a method for identification of the three-way transit trade, not visible but derivable from the data). This is the only common component for exports and imports.
2	Product misclassification (different HS6)	Misreported trade scale larger at the HS6 than the HS4 levels (and the difference is the scale of the misclassification difference). (Plus doing this only at the specific country-pair level and inputting the transit trade on the basis of the reported trade shares, which is an assumption.)
3	Unmatched trade (no corresponding at HS6, even after controlling for misclassifications)	HS6 exports not reported at all by importers.
4	Abnormal prices (includes also deliberate over and under pricing)	We estimate this as a residual for which there are extreme, abnormal prices (with an inevitably arbitrary cut-off guided by statistical literature, if the price is more than two standard deviations away from the world weighted average).
5	Trade costs (CIF, FOB, landlocked, as obvious, systematic reasons for differences in prices)	We use an assumption of 10%, which is in line with existing research. For example, the CIF prices should typically be higher than FOB prices with the difference range from 10 to 20% according to the World Bank (2010).
6	Tariff costs	Data on tariffs from WITS TRAINS database. We apply Most-Favoured-Nation (MFN) tariff rates of importing country against the countries

		globally on the import flows by HS6 category.
7	Residual	We estimate this as a residual, i.e. what cannot be explained by other components. This might include anything, including deliberate misreporting of amount or partially unmatched at transaction level (parts of the flow not reported by one partner). Any transit trade that we are unable to identify using the triangular trades.

Source: Authors

Country misclassification

An important reason why unmatched data may occur in the database is the transit trade. By convention, exporting countries declare the next country where the trade flow is directed. However, this might not be the terminal stop, but merely a trading hub, through which the goods flow (either physically or "on paper") to another country. Nevertheless, at the destination country, such trade flow gets reported with the origin jurisdiction as a trade partner. This way of recording the trades implicitly introduces mismatches into the data. We try to partially account for this transit trade by mapping the unmatched exports to unmatched imports and netting them off. Unmatched import is any trade flow that a country reports as an import, but the trade partner declared for this flow does not report it as an export. Similarly, unmatched export is an export, where the declared trade partner does not report the flow as an import.

We first identify all the exports going out of a country which do not have a corresponding reported import (same HS6 category and trade partner), since these flows might be unmatched due to transit trade. Then we identify unmatched imports to all the jurisdictions and sum them across importing jurisdictions for all partners (exporters) and HS6 commodity codes. This is the potential "end" side of the transit trade. We join the latter sums with the exporters' data on unmatched exports by commodity categories and lessen the unmatched export flows proportionally to the potential transit trade and the share of specific trade flow on the overall unmatched exports within individual HS6 commodity category. We then sum up absolute differences for a country pair with the adjusted trade value. We

follow the equivalent procedure for the imports. Estimating the trade gap with and without accounting for transit trade serves as an estimate of the amount of trade misreporting arising due to existence of transit trade (component 1). Admittedly, this allowance for transit trade is not perfect as the unmatched flows do not net off perfectly and nonnegligible volumes of trade remain unmatched.

Product misclassification

Since we look at the most granular level of the database and HS6 commodity categories, it might be the case that the trade flow is reported in different 6-digit categories (this might be, for example, either as a consequence of an error, the two countries' customs officials disagreement, or deliberate attempt to evade tariffs by the trader's misclassification from high- to low-tariff category). We estimate the size of this reporting gap by computing the difference of our baseline unmatched trade volume with the volume of unmatched trade when using 4-digit level classification of the data. In theory, it can happen that the customs of two countries categorize a trade flow in non-corresponding HS6 categories, but it is much less likely that they will categorize the same trade flow in different HS4 categories which tend to be much broader. The unmatched trade at the higher level of aggregation must always be lower by definition and the difference between the estimates captures the volume of misreported trade due to misclassification at HS6 level (component 2).

Unmatched trade

The third component and category accounting for unmatched data are the *true* unmatched flows, which we label as unmatched trade (component 3) and which we estimate as the overall unmatched flows less the mismatches due to misclassifications in the data caused either by transit trade (component 1) or different HS6 classification (component 2).

Abnormal prices

We distinguish between four components of trade misreporting in the matched data and the first category which we can empirically capture is the misreporting of trade through extreme pricing (component 4). We use the matched trade flows to compute the average prices for commodities at HS6 level along with their standard deviations. We then compare the prices of individual flows with these

reference prices and classify the trade into extreme prices category if the price is more than two standard deviations away from the world average (a rule of thumb for statistical significance). This choice is arbitrary, and the definition of abnormal prices naturally affects our results. The sum of differences between trading volumes declared by corresponding trading partners is the misreported trade in this category. After accounting for extreme pricing, the remaining misreported trade falls in three categories. The value that captures the costs of trade which are only recorded by one side of the transaction (component 5), tariff costs (component 6) and the residual misreported trade we cannot explicitly classify (component 7).

Trade costs

The former, trade costs, arises not only due to the different recording standards (CIF vs. FOB), but also due to differences in transaction costs of international trade, which might include systematic factors related to country characteristics (countries that are landlocked or members of a free trade area are likely to have higher import prices relative to countries that have access to the sea and low tariffs with their trading partners) as well as goods characteristics (country importing goods with higher than average weight will have high transaction costs), but also some non-systematic, random factors. One way to account for trade costs and one that we use for headline results is to assume a fixed proportion of trade flow values to be trade costs.

To estimate the volume of the misreported trade of this nature we assume fixed costs of trade of 10% of the value declared by the exporter – FOB (technically, we net off the categories detected as abnormal in prices). The assumed 10% is on the lower bound of the World Bank (2010), but higher than Gaulier and Zignago (2010). The United Nations Economic Commission for Africa & African Union's (2015, page 95) ECA model uses the BACI database, which provides reconciled bilateral trade flows using Comtrade data at the HS6 level of product disaggregation, explained in detail by Gaulier and Zignago (2010). They contrast this their Trade Mispricing Model, which uses a fixed CIF/FOB ratio of 1.1 for assessing the value of CIF. The GFI's Spanjers & Salomon (2017) used to assume 10%, but the most report by GFI (2019, page 3) assumes 6% for the IMF DOTS data and in this

follows the IMF researchers working on DOTS data, who newly use it to produce CIF/FOB-adjusted values for non-reporting countries (Marini, Dippelsman, & Stanger, 2018, page 11). In turn, IMF researchers explain their assumption by using a cross-country average coming from OECD's Miao & Fortanier (2017), who prepare the bilateral, product level international trade and insurance costs for more than 180 countries and partners, over 1 000 individual products, for the 1995-2014 time period. Similarly, Duval, Saggu, & Utoktham (2016) estimate trade costs using a regression model.

Tariff costs

To estimate tariff costs, we use data on tariffs from a leading database WITS TRAINS, discussed, for example, by Anderson and van Wincoop (2004) or Shepherd (2010), and sourced from UNCTAD and the World Bank. We apply Most-Favoured-Nation (MFN) tariff rates of importing country against the countries globally on the import flows by HS6 category to estimate the scale of this component.

Residual

What we are left with is the residual misreported trade which contains the misalignment at the level of individual transactions, unintended reporting errors, and the transit trade we are not able to account for using the mapping between unmatched imports and exports.

6 Results

We decompose the overall trade gap to seven components described in the section on methodology. After identifying the trade gap components on bilateral basis, we aggregate the results on country level. For the ease of exposition, we also aggregate the country level data by income levels and geographic regions following the classification of the World Bank as this allows us to show patterns in trade gap components across otherwise heterogenous country observations. Table 3 presents the estimated decomposition of the misreported trade summed up across countries for 2015. With the important exception of the unexplained residual of 63%, we ascribe the highest share of the differentials to trade costs. Our estimates suggest that the trade costs might make up nearly 15% of misreported trade. To some extent, this share is driven by our choice of fixed costs. We only account

for the costs when analyzing matched trade flows, as we treat the we treat the unmatched trade as strictly misreported. Along with the higher share of trade gap resulting from matched trade flows than the unmatched in the overall misreported trade, this explains why the share of costs on the reported trade gap is higher than assumed fixed costs of 10%.

Table 3. Decomposing the trade reporting gap, world totals, 2015

	Component	Estimated scale (billion USD)	Share (% of trade reporting gap)
-	Total trade reporting gap	9507	100
1	Country misclassification	168	1.8
2	Product misclassification	656	6.9
3	Unmatched trade	837	8.8
4	Abnormal prices	70	0.7
5	Trade costs	1409	14.8
6	Tariff costs	380	4
7	Residual	5987	63.0

Source: Authors

The remaining notable components of the gap are unmatched trades, product misclassification and tariff costs. Unmatched trade represents 8.8% of the world trade gap. It is important to note that we only partially address the transit trade and some of it might still be hidden in this component (some of the transit trade may also appear in the commodity categories and country pairs we identify as matched and in these we do not make any adjustments). This number should thus serve as an upper bound for the "true" unmatched trade. Product misclassification constitutes 7% of the world trade gap. It is likely that this share would increase if we accounted for misclassification at higher HS levels of aggregation at the expense of unmatched trade. The tariff costs are estimated to account for 4% of the trade reporting gap. The remaining components, abnormally priced trade flows and country misclassification, together account for less than 3% of the trade gap. Overall, conceptually well-

defined components such as product and country misclassifications account only for a small share of trade reporting gap and most of the trade reporting gap consists of the unexplained residual component.

We show the extent to which estimates of trade reporting gap are downward biased at higher levels of aggregation. Figure 1 shows the comparison of overall trade gap when we compute at different levels of HS aggregation. The misreported trade decreases continuously all the way to HS0, where we compare the trade flows summed across all commodity categories for mirror country-pairs. The value of the trade gap shrinks down to 4089 bn. – less than half of the trade gap estimated at the HS6 level. While the trade reporting gap estimated at various levels of aggregation reveals that the gap substantially increases the more detailed the aggregation is, we consider the most detailed aggregation preferable and why we use it in our decomposition results. In any case, trade reporting gap is large, in absolute values as well as relative to the overall trade. For an illustrative comparison, we note that the total sum of all exports and imports in 2015 is 29707 billion USD, but this sum is double counting most of the flows, which appear as both exports and imports. Our indicators of trade reporting gap are designed to be largely without this kind of double counting and thus these two are not directly comparable. As a more comparable total trade value could be considered the sum of all exports or imports or half of the combined total.

Our estimates allow us to explore the importance of trade gap components for individual countries. Table 4 presents the list of top country standings in each of the decomposition categories. We compute the shares of individual components on the overall trade gap and then reorder the countries in each component. In addition, Table 5 then introduces a straightforward indicator of trading hubs based on dollar value of unmatched exports, i.e. only a part of the unmatched trade component. The values of unmatched exports are net off product misclassification and transit trade and capture only the unmatched trade for partner countries declared in identified unmatched exports. In other words, the countries in this table are often declared as partners in trade which is only reported by the exporter. Essentially, such countries might either be transit countries (which might be considered trade hubs), or deliberately not report trade for other reasons.

There are substantial differences across income groups: high-income countries account for much of the trade reporting gap in the absolute values, while tiny low-income countries' gap has the highest ratio relative to their GDP. Figure 2 presents trade reporting gap and its components as shares overall trade gap (%) for each of the income groups for 2015 (other figures, with estimates over time and across regions as well as across income groups in absolute values and relatively to GDP, are included in the Appendix 1). Interestingly, the low-income countries' gap consists relatively more of country misclassification, product misclassification and unmatched trade (although for this latter one, the upper-middle income countries have a larger share) components.

We now turn to discussing the interpretation of our results and methodology and their inherent limitations that provide opportunities for future research.

The seven components are distinct in their interpretation as well as a way of estimation. They also likely differ in how likely they are reflecting the presence of any IFFs. It is not straightforward to discuss the possible presence of IFFs, or trade mispricing as understood by the existing literature, in the seven components, which partly depends on the preferred definition of IFFs. Nevertheless, we suggest that trade costs are not likely to be related to IFFs, whereas abnormal prices and the residual are likely to partly reflect some IFFs. The other components might but need not include IFFs. Across all components, it is impossible to determine with precision the share for which IFFs were responsible, if any. Still, we believe this decomposition sheds new light into the likely scale and potential channels of IFFs and, in this respect, our methodology improves on the previously researched aggregate trade reporting gaps. Similarly, with regard to trade mispricing, it is also impossible to approximate the scale with our methodology. While there is other existing evidence of transfer mispricing between related parties, there is not much evidence on trade mispricing between unrelated parties. This is important since only around one third of international trade is estimated to happen within MNEs (Shaxson, 2019). These estimates mostly rely on the US data only, but they provide us with approximate understanding of how large share of the overall global trade can be vulnerable to transfer and trade mispricing, respectively.

In interpreting our results we call for a caution since, as any researchers working on IFFs, we are faced with significant data and methodology challenges. Some of them are related to the detailed nature of the data we use. For some components (4, 5, 6 and 7, but not so for 1, 2, 3, where all the gaps have the same sign), we need to combine negative and positive values of estimated gaps at the disaggregated levels. When aggregating the detailed component results across commodities and countries, we sum them up as absolute values. This is a preferred way of aggregation and it enables us to preserve the consistency from the lower up to the highest levels of aggregation. This approach of adding absolute values of estimated gaps does not suffer from summing the potential cases of summing negative and positive gaps resulting into a zero estimated gap at higher levels of estimation (this reflects our argument that there is no such thing as net trade reporting gap). While most previous research, such as Kellenberg & Levinson (2019), usually lets any misreporting at the lower levels of aggregation to be netted out by using the aggregate at the country level only and thus label their estimates as conservative, we investigate the various reasons behind misreporting at the most disaggregated level as carefully as the available data allows us. In this way we believe we thus improve on previous approaches and provide more realistic estimates, however approximate they still are. But it also implies that our estimates at the aggregate levels are not directly comparable with previous research. Another remaining challenge, well-known in the existing literature, is that even the most detailed HS6 trade classification codes are too wide and include a range of products within one of the more than 5000 product categories. Except for using the most detailed categorisation, there is not much we can do about it, but we do acknowledge its potential confounding effects on our estimates.

There is also a number of research questions and extensions that naturally follow up from our paper. Some of them should improve the robustness of the methodology. For example, a variety of assumptions could be used in the case of trade costs or abnormal prices. We could also first adjust the prices for trade costs and tariff costs and only then for abnormal prices. Unmatched exports could be attributed not only to importers, but also to exporters and possibilities could be explored as to how the unmatched data could be decomposed in a similar way to the matched data. The role of matched trades of tiny value might be investigated. We could use the leftover transit flows from the country

misclassification component to adjust the matched trade flows and capture the volumes of transit trade more precisely. In addition, the results could be extended beyond the current period of 2010-2015 (possible since 2002 and even earlier, 1998 or so, with an earlier classification). We could also study the heterogeneity across goods and identify the trading partners and products for audit purposes by customs or other authorities (e.g. which products and trading partners have disproportionately larger trade reporting gap components). Last but not least, we could analyse the country-level characteristics' determinants of the individual gap components, perhaps similarly to the more aggregate approach of Kellenberg & Levinson (2019). All these future avenues have a good research potential and policy relevance.

Figure 1. Comparison of overall trade reporting gap on different levels of aggregation, 2015

Source: Authors on the basis of UN Comtrade.

Figure 2. Trade reporting gap and its components as shares overall trade gap (%) by income groups, 2015

Source: Authors on the basis of UN Comtrade.

Table 4. Top 15 countries in each decomposition category, share of total trade gap, 2015

	Country misclassification	Product misclassification	Unmatched	Abnormal prices	Trade costs	Residual
1	Greenland	Kiribati	Kuwait	Georgia	Botswana	Ethiopia
2	Cape Verde	Afghanistan	Bahamas	Lesotho	Italy	Dominican rep.
3	Central African Rep.	Lesotho	Bermuda	Botswana	USA	Palestinian terr.
4	Swaziland	Aruba	St. Lucia	Jordan	Canada	Czech Republic
5	New Caledonia	Greenland	Saudi Arabia	Cameroon	Romania	Poland
6	St. Vincent	Gambia	Zambia	Azerbaijan	Hong Kong	Mexico
7	Samoa	Australia	St. Vincent	Philippines	Portugal	Slovakia
8	Sierra Leone	Myanmar	Azerbaijan	Sierra Leone	Spain	Malaysia
9	Gambia	Solomon Island	Antigua & Barbuda	Sao Tomé & Principe	Croatia	Bangladesh
10	Afghanistan	Qatar	Aruba	Switzerland	Belgium	Brunei
11	Seychelles	Honduras	Niger	Macau	United Kingdom	Hong Kong
12	Burundi	Cambodia	Panama	Zambia	South Korea	Serbia
13	Mozambique	Yemen	Malta	Kyrgyzstan	Japan	Tanzania
14	Bahamas	Denmark	South Africa	Japan	Peru	Kyrgyzstan
15	Kiribati	Seychelles	St. Kitts & Nevis	Bermuda	Belarus	Malawi

Source: Authors

Table 5. A tentative indicator of trading hubs based on dollar value of unmatched exports, world, top 20 countries, 2015

Country	Total reported trade (bn. USD)	Unmatched exports (bn. USD)	Ratio of the two previous columns (%)
China	1483.6	13.8	0.9
Panama	10.2	11.1	109.3
South Korea	413.4	11.1	2.7
Singapore	269.1	10.5	3.9
United States	2247.1	7.4	0.3
Saudi Arabia	160.3	7.0	4.4
United Kingdom	616.9	6.6	1.1
Switzerland	245.4	5.7	2.3
Vietnam	152.4	5.3	3.5
Thailand	193.5	5.2	2.7
Japan	592.1	5.0	0.8
Bahamas	3.0	4.9	164.9
Malta	6.5	4.9	76.0
Russia	174.4	4.7	2.7
United Arab Emirates	171.8	4.6	2.7
Hong Kong	522.4	4.5	0.9
Brazil	163.1	4.5	2.8
Chile	60.4	3.9	6.5
Oman	24.3	3.5	14.6
Malaysia	163.9	3.0	1.8

Source: Authors

7 Conclusion

Trade mispricing is a real phenomenon, but the scale of these illicit financial outflows countries at all income levels is unclear. In this paper we shed more light on this by critically reviewing the existing methodologies to estimate trade mispricing and by carrying out an explorative analysis using the most extensive cross-country international trade data set. While our empirical results are not able to provide estimates of IFFs or trade mispricing, they do decompose the nominally large trade reporting gap into seven distinct components. Only further research will show how much IFFs might be responsible for each, if any, of these, but the already these results confirm the hypothesis of some of the existing literature that the potential for trade mispricing is large and visible in the data. However, since we cannot speak with our methodology about the realisation of this potential, we at least point to avenues for further research, as discussed in specific terms at the end of the results section. Still, we believe that the empirical decomposition of trade reporting gap that we develop in this paper, while somewhat orthogonal to the literature estimating IFFs and trade mispricing, can spur a new research area that might ultimately inform the question of the scale of IFFs as well.

There are at least three tentative conclusions we can preliminarily draw from our existing estimates. While these estimates would benefit from further research and they should thus be interpreted with caution, we hope even in their current form our results and the associated conclusions can usefully inform the future research. First, trade reporting gap is large, in absolute values as well as relative to the overall trade. Also, the trade reporting gap estimated at various levels of aggregation reveals that the gap substantially increases the more detailed the aggregation is. We consider the most detailed aggregation preferable and use it in our decomposition results. Second, conceptually well-defined components such as product and country misclassifications account only for a small share of trade reporting gap and most of the trade reporting gap consists of the explicitly unexplained residual component.

Third, there are substantial differences across income groups: high-income countries account for much of the trade reporting gap, while the in absolute values tiny low-income countries' gap has the highest

ratio relative to their GDP. More surprisingly, the low-income countries' gap consists relatively more of unmatched trade, country misclassification and product misclassification components. Why is it so and what it implies is beyond the possibilities of this paper and warrants further research. Additionally, we observe that the empirical estimates are sensitive to the choice of assumptions and future research should provide a robustness check analysis. More generally, we consider our paper as hopefully initiating a new area of research focused on decomposition rather than on individual components only and presented empirical results should thus be considered as preliminary with follow-up research focused on validating and extending our findings.

We conclude with a brief discussion of related policy recommendations, although they are not directly related to our empirical estimates. Various global standards and actions to combat IFFs are in force or under discussion. Some relate to general policy improvements in tax, transparency and international cooperation, such as more widespread implementation of public beneficial ownership registers for companies, trusts and foundations or country-by-country reporting by multinational companies, disclosed publicly. These recommendations have been widely embraced in recent years, for example by ECA (2018). Conventionally, there are other policy initiatives more directly applied to trade mispricing. These include the transfer pricing rules prescribed by the OECD, such as the recent G20-mandated Base Erosion and Profit Shifting plan, that has been able to prolong the life of the rules further, despite calls for a more substantial reform from increasing number of individual countries and to a growing extent by the UN (FACTI, 2021).

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9 Appendix 1: Additional results

Table A1. Decomposing the trade reporting gap, imports, country-level results, 2015

The large table is available from the authors upon request.

Source: Authors on the basis of UN Comtrade.

Figure A1. Trade gap and its components, world, 2010 - 2015

Source: Authors on the basis of UN Comtrade.

Figure A2. Trade gap and its components as shares of GDP (%) by income groups, 2015

Source: Authors on the basis of UN Comtrade.

Figure A3. Trade gap and its components by income groups, 2015

Source: Authors on the basis of UN Comtrade.

Figure A4. Trade gap and its components by regions, 2015

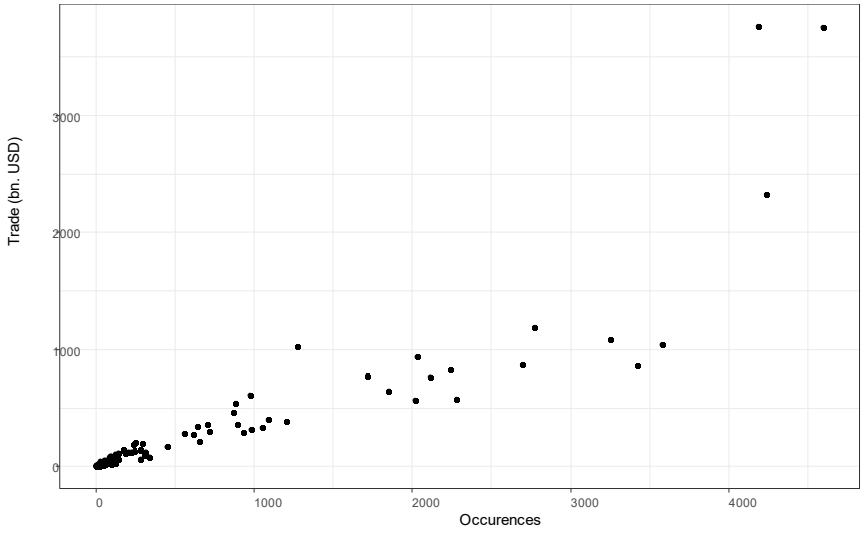
Source: Authors on the basis of UN Comtrade.

10 Appendix 2: Descriptive statistics

To get a general perspective on the contents of the database, we explore the statistics for individual reporters. Table A2 shows all the reporting jurisdictions ordered by trade openness (overall trade / GDP). Except for a few small and very open economies in Central Europe and Baltics, the table offers expected pattern with the world large trading hubs in the top. Hong Kong, Singapore, Belgium, and Netherlands all occur in the top 15 most open economies. When we group the countries by geographic regions (Table A3) and levels of per capita income (Table A4) as defined by the World Bank, we get more general perspective on where the trade takes place. Europe, Central and East Asia nominally account for more than 70% or the world commodity trade, while Africa, Middle East, and South Asia together only add up to 14%. Table A4 documents that the dominant share of trade takes place in upper-middle and high-income countries. The intensity of trade relative to GDP, however, fluctuates around 0.4 in all the income country groups.

Next, we have a look at the variety of the trade by countries. We order the countries based on their shares in the world trade of individual HS 6-digit level and count their occurrences in top 20% of traders and top 5 most important traders. There are three countries which stand out in these statistics and these are, United States, China, and Germany. While these countries export or import almost 80% of the monitored categories, there is a huge gap in the occurrences thereafter. This drop is somewhat mitigated when we consider top 20% quantile of the traders instead, but the US, China, and Germany still stand out. The picture is quite similar for another check where we count occurrences of trade by a country in a category representing more than 10% of the world trade with this commodity. It turns out that all these measures correlate almost one to one with the total volume of trade in the countries (see Figure A5).

Figure A5. Number categories where the country ranks in top 5 by the share of the world trade within a category vs. overall trade volume



Source: Authors on the basis of UN Comtrade.

Table A2. Commodity trade openness (commodity trade as a share of GDP) and total commodity trade values by country. Trade values in bn. USD (2015)

Country	Trade	Open.	Country	Trade	Open.	Country	Trade	Open.
Hong Kong SAR, China	1024.5	331.2	Qatar	106.9	66.1	Philippines	121.1	41.4
Singapore	604.3	198.7	Mexico	768.9	65.7	Bangladesh	77.6	39.8
Belgium	762.8	167.6	Fiji	2.8	64.2	Ecuador	39.4	39.7
Slovak Republic	141.0	161.1	Portugal	120.6	60.5	Aruba	1.1	39.5
Vietnam	310.7	160.8	Honduras	12.4	58.9	Turkey	335.0	39.0
Czech Republic	295.7	158.3	Iceland	10.0	58.9	New Zealand	69.0	38.9
Hungary	190.2	154.8	Morocco	59.1	58.4	Ethiopia	25.0	38.7
Austria	568.9	148.9	Togo	2.4	58.3	Azerbaijan	20.5	38.6
Lithuania	53.3	128.5	Mauritius	6.8	58.3	Greece	75.1	38.4
Estonia	28.7	127.2	Montenegro	2.4	58.3	Israel	114.2	38.2
Malaysia	359.4	121.1	Bolivia	18.4	55.9	Greenland	1.0	37.9
Slovenia	52.0	120.6	Denmark	167.1	55.4	United Kingdom	1081.0	37.5
Netherlands	869.3	114.7	Sweden	273.1	54.8	Panama	20.2	37.3
Macedonia, FYR	10.8	107.5	Albania	6.2	54.7	Benin	3.1	37.3
Bulgaria	53.9	107.3	Malawi	3.4	53.1	Cyprus	7.3	37.2
Seychelles	1.4	104.9	Cote d'Ivoire	20.9	52.8	Peru	70.5	37.1
Bahrain	32.6	104.8	Canada	823.1	52.8	Dominican Republic	25.5	37.1
Namibia	12.1	104.0	Luxembourg	30.3	52.5	Sri Lanka	28.8	35.7
Cambodia	18.5	102.8	Algeria	86.3	52.0	Central African Republic	0.6	34.9
Thailand	401.2	100.0	Paraguay	18.5	51.1	China	3763.8	34.0
Belarus	55.4	98.0	St. Vincent and the Grenadines	0.4	50.0	Russian Federation	464.2	33.9
Malta	10.0	95.0	Palau	0.1	49.8	Nepal	7.3	33.9
Botswana	13.5	93.5	Chile	120.9	49.6	Indonesia	284.8	33.1
Latvia	25.2	93.5	Madagascar	4.8	49.4	Kuwait	37.7	32.9
Moldova	5.9	90.7	Maldives	2.0	49.4	Cameroon	10.1	32.6
Bosnia and Herzegovina	13.8	85.1	Burkina Faso	5.1	49.4	Saudi Arabia	209.4	32.0
Serbia	31.5	84.9	West Bank and Gaza	6.2	48.7	India	639.7	30.4
Ukraine	75.3	82.8	Myanmar	29.1	48.7	Antigua and Barbuda	0.4	30.2
Nicaragua	10.4	82.6	Sao Tome & Principe	0.2	47.9	Bahamas	3.5	29.7
Kyrgyz Republic	5.5	82.4	Spain	572.9	47.8	Colombia	86.9	29.6
Trinidad and Tobago	19.9	81.7	Lao PDR	6.8	46.9	Rwanda	2.4	29.4

Poland	381.2	79.9	Cabo Verde	0.7	46.9	Uruguay	15.6	29.2
Switzerland	542.1	79.8	Norway	181.2	46.9	Egypt, Arab Rep.	95.3	28.6
United Arab Emirates	278.9	77.9	Italy	855.8	46.7	Uganda	7.7	28.2
Tunisia	33.1	76.7	South Africa	144.1	45.4	Japan	1190.2	27.1
Mozambique	11.1	74.8	St. Lucia	0.7	45.2	Australia	342.9	25.4
Solomon Islands	0.9	74.4	Senegal	8.0	45.1	Macao SAR,	11.0	24.2
Belize	1.3	74.0	Tanzania	20.5	44.9	Pakistan	65.1	24.1
Oman	50.6	73.5	Costa Rica	24.6	44.9	Burundi	0.7	21.7
Romania	130.1	73.1	Niger	3.2	44.7	United States	3747.0	20.7
Zambia	15.4	72.7	Armenia	4.7	44.6	Brazil	356.4	19.8
Mongolia	8.5	72.0	Guatemala	28.1	44.1	Argentina	114.2	19.2
Jordan	26.9	71.6	Barbados	2.0	44.0	Yemen, Rep.	6.7	14.8
Brunei Darussalam	9.1	70.3	Sierra Leone	1.9	43.9	Sudan	14.0	14.4
Germany	2319.5	68.7	Zimbabwe	8.7	43.4	New Caledonia	3.6	-
Ireland	197.4	67.9	Jamaica	6.1	43.4	French Polynesia	1.6	-
El Salvador	15.7	67.8	France	1041.9	42.7	Bermuda	0.9	-
Korea, Rep.	934.2	67.6	Afghanistan	8.3	41.6	Iraq	-	-
Georgia	9.4	67.4	Kazakhstan	76.5	41.5	Cayman Islands	-	-
Croatia	33.1	67.0	Angola	48.1	41.4			

Source: Authors on the basis of UN Comtrade.

Table A3. Trade openness by regions, 2015

Region	**Trade (bn. USD)**	**GDP (bn. USD)**	**Openness**
East Asia & Pacific	9498	21195	0.45
Europe & Central Asia	12179	19988	0.61
Latin America & Caribbean	1782	4878	0.37
Middle East & North Africa	1154	2615	0.44
North America	4571	19680	0.23
South Asia	829	2694	0.31
Sub-Saharan Africa	396	917	0.43

Source: Authors on the basis of UN Comtrade.

Table A4. Trade openness by income groups, 2015

Income group	Trade (bn. USD)	GDP (bn. USD)	Openness
High	20644	46729	0.44
Upper-middle	7610	19849	0.38
Lower-middle	2030	5095	0.40
Low	124	294	0.42

Source: Authors on the basis of UN Comtrade.

We are interested in the prices of international trade flow both on export and import side. To learn how relatively expensive the exports are on average for a country, we construct a measure where we compare the prices of the commodity categories relative to the price of the commodity weighted by traded quantities. We then average the ranking across all the commodity categories and order the countries by their average rank. We then do the same exercise for import. The main observation for the ranking is that these country standings are highly correlated (close to 0.7), i. e. the countries which typically export for higher than average world price also import for higher prices. Interestingly, there are several countries (about 10% of the sample) which occur off diagonal in Figure A6 which plots export price ranking against the import price ranking.

Additionally, about half of these tend to have relatively high export prices and low import prices (Jamaica, Sri Lanka, Netherlands, Sweden, Vietnam) while the opposite is true for the other half (UAE, Belarus, China, Kuwait, Qatar, Turkey). Although these specific examples seem diverse, we search for a factor driving these systematic differences in pricing between countries. As we mostly see rich and developed countries in the top, we plot the ranking against GDP per capita for individual countries in Figure A7. While the correlation is far from perfect (around 0.5 in absolute value), per capita income level of countries partially explains the pricing differences.

Figure A6. Country ranking on export and import prices

Source: Authors on the basis of UN Comtrade.

Figure A7. Country ranking on export and import prices and GDP per capita

Source: Authors on the basis of UN Comtrade.

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