Abnormal Pricing in International Commodity Trading: Evidence from Ghana

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Ama A. Ahene-Codjoe[*]
Angela A. Alu[*]
Rahul Mehrotra[§]

ABSTRACT

Mispricing of international trade in natural resources contributes to significant tax base erosion from developing countries but is difficult to measure using aggregate trade statistics. In this paper, we apply a novel approach motivated by legal rules for trade and transfer mispricing to estimate abnormal pricing in gold and cocoa exports from Ghana, i.e. exports valued outside an assumed arm's length price range that indicates fair market values. Using daily frequency, transaction-level data from Ghana Customs, our results indicate abnormally undervalued exports of gold and cocoa from Ghana equalled USD 8.8 billion in constant prices (base year 2011) or USD 4.1 billion in current prices between 2011-17. Approximately 11% of gold doré exports, 1% of cocoa bean exports and 7.2% of cocoa paste exports appear abnormally undervalued. The implied corporate tax base erosion equals USD 2.2 billion in constant prices (base year 2011) corresponding to an average annual decrease of 0.3% in Ghana's tax-to-GDP ratio.

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[*]University of Ghana, Legon
[§] Graduate Institute of International and Development Studies, Geneva, Switzerland

Corresponding author: Rahul Mehrotra. Email: rahul.mehrotra@graduateinstitute.ch Address: Graduate Institute of International and Development Studies, Chemin Eugene-Rigot 2A, Geneva, Switzerland.

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1. INTRODUCTION

Illicit financial flows (IFFs) from developing countries represent a significant challenge for financing the 2030 Agenda for Sustainable Development (OECD, 2014; Reuter, 2012; United Nations, 2015). IFFs are broadly defined as cross-border financial flows that are illicit in their origin, method of transfer or eventual utilization. The most prominent channels of IFFs include mispricing of international trade, capital flight, international money laundering, tax evasion and aggressive tax avoidance by multinational firms and high net-worth individuals (Boyce & Ndikumana, 2017; Carbonnier & Mehrotra, 2018; Collin, 2020; Forstater, 2018). This flight of financial capital reduces domestic savings and investment while contributing to tax base erosion which limits the source countries' capacity to mobilize domestic financial resources to achieve the Sustainable Development Goals (SDGs). Tax revenues as a proportion of total economic activity remain significantly lower across developing countries compared to industrialized economies. However, the role of IFFs remains under-analysed due to an absence of robust data and methods to estimate the magnitude of prominent channels at the microeconomic level.[1] The resulting lack of policy focus disproportionately hurts developing countries' efforts to channel limited revenue sources to fund institutions and development programs (Besley & Persson, 2014; Gordon & Li, 2009; Pomeranz, 2015).

Resource-rich developing countries that rely on revenue from commodity exports are particularly susceptible to IFFs arising from trade mispricing (Guo, 2013; Mascagni et al., 2014; OECD, 2017, Vézina, 2015). Trade mispricing arises when one or both trading partners deliberately misreport the value, quantity or nature of goods or services in a commercial transaction. The economic motives for trade mispricing include tax-motivated profit shifting, evasion of Customs duties or restrictions and circumvention of capital controls. Exporting firms may under-invoice their exports to conceal international income from revenue authorities in the exporting country and hold these earnings abroad in low tax jurisdictions. Over-invoicing of exports may also be motivated by export incentives and subsidy schemes offered by developing countries to promote international trade (J. Bhagwati & Hansen, 1973; Boyce & Ndikumana, 2017; Fisman et al., 2008; Fisman & Wei, 2004, 2009; Mishra et al., 2007; Vézina, 2015).[2] Developing countries often lack the tax administration capacity and customs

[1] According to the OECD's Global Revenue Statistics Database, tax revenue-to-gross domestic product ratios in year 2015 displayed considerable heterogeneity between and within regions, between 10.8% to 30.3% in Africa and 12.4% to 38.6% in Latin America, compared to 16.2% to 45.9% in the OECD countries. See: Modica, Laudage, & Harding (2018).

[2] On the import side, firms may over-invoice their imports in order to obtain additional foreign exchange from central banks which can be used for illicit purposes or held abroad, especially in countries with controls over foreign exchange transactions. Similarly, import under-invoicing is motivated by desire to evade customs duties and restrictions on quantities.

valuation infrastructure to monitor transaction-level export valuations and complex financial transactions by sophisticated international firms motivated to reduce their global tax burdens (Beer et al, 2018; Crivelli et al, 2015).

Measuring the different channels of IFFs is not a straightforward task since it involves transactions which are either missing or misreported in official statistics. Previous literature has primarily focused on calculating country-level macroeconomic estimates of total capital flight, including trade mispricing, by using aggregate Balance of Payments (BoP) data which records a country's net position with respect to the rest of the world. Goods and services transactions appear in the BoP's Current Account, while financial transactions, including investment and debt flows are recorded in the Capital Account. Furthermore, official foreign exchange reserves are recorded as the balance between total receipts and uses of foreign currencies. Since all international transactions should be properly recorded in principle, the current account and capital account balances should be symmetrically equal after accounting for changes in official foreign exchange reserves. However, significant differences can be observed between these recorded balances which are termed 'net errors and omissions.' Large and systematically negative amounts of these 'net errors and omissions' are interpreted as total unrecorded capital flight (Boyce & Ndikumana, 2017; Cuddington, 1986). This basic framework has been further refined in the literature to improve the underlying data sources and measurements for debt, remittance and trade flows. Using the aggregate BoP framework with improved net debt flow measurements, Henry (2012) estimated that between 1970 and 2010, developing countries lost a total of USD 4 trillion to capital flight with Latin American and Asian countries accounting for two-thirds of total capital flight from developing countries. In a related study which contributed further improvements to underlying measurements of remittance and trade flows, Ndikumana, et al. (2015) estimated that developing countries in Africa alone lost approximately USD 1.3 trillion to capital flight between 1970 and 2010.

Similarly, evidence focusing on trade mispricing is limited to aggregate estimates of partner-country trade gaps which are estimated using the differences between aggregate export and import statistics of trading partners after adjusting for transportation costs (Bhagwati et al., 1974; Fisman & Wei, 2004; Global Financial Integrity, 2017; Kellenberg & Levinson, 2018; Ndikumana, 2016; Vézina, 2015). Based on the principle of mirror trade statistics, this method compares the source country's export

Overall, mispricing of imports is also an important channel for IFFs however in this paper, the analysis will focus on the export side in order to estimate outflows of financial capital from developing countries and the resulting tax base erosion.

statistics to the importing partner's corresponding import statistics adjusted for transportation costs. Researchers further assume that advanced countries' trade statistics are reliable and that any unexplained asymmetries in reported trade statistics between advanced and developing trading partners is evidence of trade misinvoicing in developing countries. In other words, the trade statistics of the advanced country represent the arm's length value for the exports and imports of developing countries. Existing global estimates using this method indicate that trade mispricing from developing countries could potentially equal USD 1 trillion annually (Global Financial Integrity, 2017). For developing countries in Africa, the Report of the High-Level Panel on Illicit Financial Flows from Africa estimated that Africa loses approximately USD 50 billion annually through trade misinvoicing (United Nations Economic Commission for Africa, 2015). While the underlying aggregate trade statistics and empirical method have been shown to have prominent limitations, this evidence has nonetheless triggered a significant push by national governments and international policy organizations to analyze the magnitude and channels for trade-related tax base erosion (Beer et al., 2018; Carbonnier & Mehrotra, 2018; Nitsch, 2016; OECD, 2014).

In this paper, we apply a novel empirical methodology for estimating the magnitude of abnormal pricing in commodity exports motivated by legal rules of customs valuation and transfer pricing analysis. Abnormal pricing is defined as the magnitude of trade valued outside an assumed arm's length price range which represents fair market value between unrelated buyers and sellers and is considered a reliable indicator for trade mispricing risks (Hong & Pak, 2017; World Customs Organization, 2018). Our baseline empirical approach, therefore, compares the valuation of transaction-level trade microdata with an appropriate market benchmark calculated using free-market prices adjusted for relevant product and market-specific factors identified by traders and regulators. This methodology is motivated by the World Trade Organization's Transaction Value methods for customs valuation, and the Comparable Uncontrolled Price (CUP) method for transfer pricing analysis of trade between related firms (Platform for Collaboration on Tax, 2017; United Nations, 2017).[3] These methods recommend the use of quoted, free-market prices as a starting point for identifying arm's length prices, subject to reasonable comparability adjustments.[4] We define the arm's length price range for our

[3] The use of prices from commodities exchanges for transfer pricing analysis is also referred to as the 'sixth method' in some countries. This is distinct from Comparable Uncontrolled Prices (CUP) method which relies on data from comparable transactions between related and unrelated parties. See Section 2.4.2, United Nations (2017) for a detailed discussion of the 'sixth method.'

[4] Our empirical approach is distinct from comprehensive case-by-case audits which are based on accurately delineating each transaction based on a fact-intensive transactional and functional analysis on a case-by-case basis. Case-specific

selected commodities based on their benchmark prices quoted by commodities exchanges, product characteristics, transportation costs and other relevant commodity-specific factors driving normal variation in observed prices, as indicated by additional data sources and fact-intensive interviews with commodity traders and regulators.

Furthermore, our analysis also considers commodities which are traded without reference to a unique benchmark price of which we are no longer able to estimate an arm's length price range based on product-specific factors. In this case, we apply a more limited approach in terms of using the interquartile range (IQR) of the observed prices to define the arm's length price range. The OECD Transfer Pricing Guidelines recommend using the interquartile range. Other percentiles can as well be used to help enhance the reliability of any transfer pricing analysis (paragraph 3.57, OECD, 2017). Since the IQR is calculated endogenously using the observed distribution of export prices, this method directly assumes the presence of under and over-valuation in the trade statistics. However, it provides useful insights from a risk analysis perspective by identifying exporters and trade partners who consistently appear in the extreme tails of the products' observed price distribution (Zdanowicz et al., 1999; Pak et al., 2003; De Boyrie et al., 2005; Hong & Pak, 2017). For our analysis, we introduce a methodological innovation compared to previous studies by calculating the interquartile range of unit prices (USD per kilogram) for each product using a rolling window of the previous 365 days. The price distribution accordingly updates on daily basis and takes into account the seasonal fluctuations over the previous year. All transactions valued in the top and bottom quartile of this rolling-window distribution are designated to be abnormally valued.

Finally, these price-filter estimates are compared to the asymmetries observed in annual, product-level trade data to contrast the micro-evidence with the more commonly used trade mispricing estimates based on partner-country trade gaps. This method relies on the principle of double counting in international trade statistics whereby the reported trade values of a country's trading partners are used as the arm's length value for the trade statistics of the exporting country (Bhagwati, 1964; Bhagwati, et al., 1974; Global Financial Integrity, 2017). We explore whether the estimates of trade mispricing are

transactional and functional analysis may include the specific contractual terms of the individual transaction; the functions performed by each of the parties to the transaction, their account assets used and risks assumed; the individual characteristics of the transacted good; the specific market conditions in which the parties operate, including their relative competitive position; and the business strategies pursued by the parties, etc. For the list of criteria used to delineate the economically relevant characteristics for transfer pricing analysis, see: Chapter 1-D1, OECD (2017).

consistent across methodologies and highlight the limitations of aggregated trade data compared to transaction-level trade microdata.

We focus our analysis on the case of gold doré and cocoa exports from Ghana— a resource-rich, developing country— which is the leading African producer of gold and the world's second largest producer of cocoa beans (Njini 2019; Peprah, 2019). However, its tax revenue collections remain low as the ratio of tax revenue to gross domestic product (including natural resources and oil sector revenue) equals only 17.6% (Bank of Ghana, 2018).[5] Our analysis of the commodity value chains indicates that the centralized and regulated trade in cocoa beans is exposed to fewer trade mispricing risks, relative to the more decentralized trade in gold doré and cocoa paste. Interviews with commodity traders and regulators help us identify the main risks for trade mispricing which include: 1) transfer pricing risks due to the nature of ownership of the firms operating in the sector; 2) the presence of artisanal, small-scale firms in the sector; 3) inadequate regulatory infrastructure for verifying customs valuation of exports; and 4) transit trade from neighbouring countries.

Our main empirical findings are as follows: first, we analyse gold doré exports from Ghana which incorporate an alloy of gold and silver, and minor impurities including lead and arsenic, whose composition can vary depending on the source mine. Therefore, we first use the exporters' identity to match the transaction-level export data with mine-level information on the gold and silver ratio in their doré production from the Metals Focus Gold & Silver Doré Flows Service. Next, we identify the London Bullion Market Association (LBMA) daily spot prices for refined gold and silver as the relevant benchmark price for Ghanaian exports. Combining the mine-level purity information with the commodity exchange prices for gold and silver allows us to calculate the relevant benchmark price for gold doré exports from Ghana.[6] Finally, we survey commodity experts to estimate variance in contractual pricing terms under normal business conditions to estimate the arm's length price range. Our results indicate that Ghanaian exports are undervalued by approximately USD 8.3 billion in constant prices (base year 2011), or USD 3.8 billion in current prices, equivalent to approximately 11% of the total gold exports between 2011-17. Total estimated tax base erosion from Ghana due to this

[5] This corresponds with the experience of other developing countries such as Cote d'Ivoire and Gabon where tax to GDP ratios remain at low levels, between 10% and 20%, compared to above 30% for OECD economies (Mascagni et al., 2014).
[6] For transactions where the exporters' identity cannot be matched with specific gold mines, we use a conservative approach that uses the maximum and minimum gold purity levels of all gold doré produced in Ghanaian gold mines to calculate the benchmark prices.

undervaluation of gold exports equals USD 2 billion in constant prices (base year 2011).[7] Overall, significant undervaluation in gold exports can be explained by the presence of international mining and trading firms in Ghana's liberalized gold sector. These firms are usually domiciled in foreign jurisdictions where they benefit from lower effective corporate tax rates relative to Ghana providing them with an incentive to under-report their taxable income. For example: one of the largest gold mining and exporting firm operating in Ghana is domiciled in Colorado, United States of America where corporate tax rate equals 4.5% compared to 25% in Ghana. Furthermore, the semi-processed gold doré production from Ghana is first exported to destinations with gold refineries which also usually also offer tax incentives, including reduced tax rates and complete tax exemptions for precious metal imports. For example: gold doré imports are exempt from Value Added Tax in Switzerland which is world's largest gold refining destination.

Next, we analyse the case of cocoa beans exports from Ghana that predominantly comprises superior quality fermented beans. Based on interviews with Cocoa Marketing Company (CMC) experts, we first identify that the benchmark price for these exports is the London International Financial Futures and Options Exchange (LIFFE) prices.[8] We trace information on the product-specific price premiums due to various certifications and transportation costs, which are normally included in reported Customs valuation, as well as expected variance in pricing terms under normal business conditions which allows us to estimate the arm's length price range. Our results indicate that Ghanaian cocoa beans exports are undervalued by USD 234.6 million in constant prices (base year 2011) or USD 126.6 million in current prices, which represents less than 1% of total exports between 2011-17. Estimated tax base erosion due to undervaluation of cocoa beans exports is USD 58.7 million in constant prices (base year 2011). The low magnitude of abnormal pricing in cocoa beans exports can be explained by the Government of Ghana's monopoly over cocoa bean exports from the country. Due to an absence of private actors in this partly liberalized cocoa sector of Ghana, the wholly state-owned Cocoa Marketing Company directly markets this commodity in the international markets and does not face economic incentives for trade mispricing.

[7] Our back-of-the-envelope estimate of tax base erosion, here defined as loss of revenue from corporate income tax, is calculated by multiplying the abnormally undervalued exports value for each commodity by Ghana's corporate tax rate of 25%. In Table A1 in the Appendix, we use data present Ghana's tax-to-GDP ratios with and without the inclusion of our estimates of tax revenue loss arising from abnormally under-valued exports.

[8] Ghana's cocoa is mainly sold on the futures market. These sales are used as collateral for the syndicated loan the state takes to finance the purchases of cocoa beans from farmers through the Licensed Buying Companies (Personal communication, Cocoa Marketing Company, 2019).

Next, we use the interquartile range price filter to estimate the arm's length price range for cocoa paste exports due to the absence of accurate benchmark prices and comparability criteria. Our results indicate that USD 306.5 million in constant prices (base year 2011), or USD 130.5 million in current prices, equivalent to 7.2% of the total exports was abnormally undervalued i.e. found below the 25th percentile of the per unit price distribution of the product. The resulting estimate for tax base erosion equals USD 76.6 million in constant prices (base year 2011). These magnitudes represent significant risks for illicit outflows and tax base erosion, however the precise estimates derived from interquartile range methodology are clearly limited since it is used to endogenously define a fixed proportion of transactions to be abnormally valued. Unlike the Ghanaian government monopoly control over cocoa bean exports, private traders and multinational firms are allowed to manufacture and export processed cocoa products, including cocoa paste, cocoa powder and cocoa butter. These exporting firms face economic incentives for tax-motivated profit shifting by engaging in export undervaluation of their international sales, usually to affiliated marketing firms operating under a common ownership structure. Accordingly, Customs Departments can use the interquartile range methodology to estimate risk indicators for trade mispricing in similar cases of processed export products traded without reference to an international benchmark price. This analysis is also useful to identify exporters and trading partners whose transactions are abnormally valued for further investigation.

Finally, we compare the above price filter estimates with the more commonly used partner-country trade gaps based on asymmetries between Ghana's exports and the imports reported by its trading partners in the rest of the world. Using annual product-level data from Ghana Customs and the United Nations Comtrade database, we find significant asymmetries in reported Ghanaian exports of gold, cocoa beans and cocoa paste compared to the reported imports by the rest of the world from Ghana. In the case of gold, the trade gaps indicate that reported Ghanaian exports exceed what the rest of the world reports as imports from Ghana between 2011-17, i.e. export over-valuation. This is contrary to our price filter estimates for the same period which indicate significant undervaluation in gold exports. However, an investigation of the aggregate trade data highlights that the observed trade gaps are primarily driven by missing imports data in the UN Comtrade database from significant destinations for Ghanaian gold, including South Africa, Switzerland and United Arab Emirates.

In the case of cocoa beans, the estimated trade gaps indicate that reported Ghanaian exports are significantly lower than the reported imports by the rest of the world from Ghana. The estimated magnitude of undervaluation is significantly higher than what is estimated using transaction-level

export data. We hypothesize that these differences are driven by the entrepot trade effect in international trade statistics, whereby the exporting countries record the destination as the intermediate shipping hub from where commodities are then re-exported to final destination. This is a significant feature of the international trade in cocoa beans, which can be purchased and stored for multiple years before being marketed and shipped to the final destination. Finally, we observe significant data misreporting in product-level trade statistics for cocoa paste by Ghana Customs which does not allow us to estimate trade gaps. Ghana Customs records all export transactions for cocoa paste, cocoa butter and cocoa powder under the tariff category of cocoa paste, leading to incomparability with the import statistics of its trading partners. Overall, this comparison highlights the strong limitations of applying this methodology in the case of developing countries with poor statistical capacities and misreported trade data.

This paper makes significant contributions to the existing literature on trade-based IFFs and research methodologies. Firstly, we contribute a novel, data-intensive and interdisciplinary approach for establishing the arm's length price range for traded commodities. In previous studies using price filter analyses, arbitrary criteria are used to set arm's length price range in the absence of commodity sector research. Notable studies in this research area include Hong et al. (2014) who used the free-market price filter approach to assess abnormal pricing for the United States' banana trade with Latin American and Caribbean countries. The authors arbitrarily assume a 10% price filter around the benchmark price of bananas in the international agricultural commodity market to define the arm's length price range. By comparison, our approach incorporates insights from extensive qualitative research interviews with commodity experts and regulators in Ghana to identify the applicable benchmark price series and define the arm's length price range after accounting for expected level of price deviations. While our methodology is more precisely informed by commodity sector research, it still relies on these assumptions made to define the arm's length price range. Minor changes in these underlying assumptions indeed influence the quantitative estimates of abnormally priced exports, however they do not change the overall pattern of results and conclusions of our study.[9]

Secondly, we contribute new evidence based on administrative microdata to analyze the possible tax revenue losses due to abnormal pricing which could be indicative of the magnitude of IFFs in a country

[9] We conduct extensive sensitivity analysis to test whether the overall conclusions regarding over and under-valuation in exports of specific commodities are affected by minor changes in the assumed price filters used to calculate the arm's length price range. This analysis confirms that while there are minor changes in the quantitative estimates, the overall conclusions remain unchanged. The results from our sensitivity analysis are available upon request.

of interest. In recent years, the policy focus on IFFs and tax base erosion has increased across all developing countries, especially in Ghana. With the incumbent government's aim of steering Ghana out of an aid dependency era to one that is dependent on its domestic resources, there is, thus the need to examine the fiscal systems in place to prescribe appropriate policies to reduce IFFs in Ghana.[10] Indeed, it has been globally acknowledged that emphasis has to be laid on the need to build strong domestic fiscal and financial systems as well as improve on domestic revenue mobilization for financing the development agenda of African countries in a sustainable manner (African Economic Outlook, 2010; Andersson & Lazuka, 2019). Low to middle income countries do not only have to face the challenges of IFFs, but also deal with officials who are usually not equipped with the requisite skills to collect all the needed taxes as well as multinational companies that use sophisticated tax measures to evade taxes or negotiate deals that allow them to pay lower tax rates (Readhead et al., 2018).

The rest of the paper is organised as follows. Section 2 provides an overview of the natural resource sector in Ghana, presenting the value chains and the risks for IFFs in the specified commodities while section 3 is devoted to the empirical methodology the paper used. The data sources are outlined in section 4. This is followed by section 5 which reports the estimates of abnormal pricing. Section 6 presents the conclusion and recommendations.

2. GOLD AND COCOA SECTORS IN GHANA

To motivate our empirical research, we conduct expert interviews to first identify the risks for trade mispricing in the gold and cocoa sectors and triangulate relevant data sources to build the statistical methodology. This section presents the resulting analysis on the main risks and economic incentives for trade mispricing. Our research focused on the following main categories: 1) transfer pricing risks due to the nature of ownership of the firms operating in the sector; 2) the presence of artisanal, small-scale and informal firms in the sector; 3) regulatory infrastructure for verifying export valuation; and 4) transit trade from neighbouring countries. Overall, we determined significantly fewer risks for trade mispricing in the centralised cocoa beans sector, in comparison to the decentralised cocoa paste and gold sectors.

[10] This government is led by President Nana Akufo-Addo who launched the "Ghana Beyond Aid" agenda.

2.1. Gold Sector

Gold is the most important export commodity for Ghana, currently accounting for 49% of the country's total exports by value (Observatory of Economic Complexity (OEC), 2019). In 2017, gold accounted for 96.4% of total earnings from mineral exports from Ghana (Minerals Commission, 2018). In 2018, Ghana became the largest producer in Africa and extracted approximately 4.8 million ounces of gold, which surpassed the 4.2 million ounces produced by South Africa (Whitehouse, 2019). According to the Ghana Chamber of Mines 2018 report, the top four mines in Ghana in terms of production and revenue outturns were Goldfields Ghana Limited, Newmont Ghana Gold Limited-Ahafo, Newmont Golden Ridge Limited, Akyem and AngloGold Ashanti Iduapriem Limited (Ghana Chamber of Mines, 2019).

The mining sector is the largest contributor to Ghana's economy (Minerals Commission, 2018). Fiscal payments attributable to the mining sector amounted to GH₵ 2.36 billion in 2018 (Ghana Chamber of Mines, 2019). Contributions from gold mining to public finances are observed via general taxes on profit and labour borne by all companies as well as specific taxes such as mining royalties, license fees, property rates payments and export duties (Minerals Commission, 2018).

The risks for trade mispricing in Ghana's gold sector are as follows:

1. Transfer pricing risks arising from multinational firms' international operations: Many prominent mining companies in Ghana are affiliates of multinational firms with their headquarters based outside Ghana and several other international affiliates across different tax and legal jurisdictions (Oppong, 2013). This leads to significant economic incentives for transfer mispricing and tax optimization using the channels of intra-firm trade and financial transfers. Readhead (2016) argues that the contribution of the extractive sector to Ghana's economic growth could be much higher but for the tax avoidance by the companies operating in the sector through transfer mispricing, trade mispricing and thin capitalization. MNCs operating in the sector may have an incentive to under-declare their exports in order to reduce their tax liability to the state. This is because the revenue the state obtains from the sector is mainly through corporate and income taxes as well as royalties and withholding tax (Minerals Commission, 2018; Personal Communications, A. Tawiah; Aryee, 2018).

2. Artisanal, small-scale and informal firms: Artisanal, small-scale and informal mining in Ghana is characterised by labour-intensive local production of gold ore and doré bars by small mining concession owners (CSSM, 2009). Gold mining in this sector is allowed by individuals, small groups (of less than nine individuals) or a co-operative society with ten or more members (Parliament of Ghana, 1989). According to the Minerals and Mining Act of Ghana (Act 703), small scale mining is a prerogative of Ghanaian nationals who popularly refer to the sector as "*galamsey*."[11] However, inadequate availability of domestic capital and technological support incentivizes foreign businessmen and firms to capture small-scale mining concession sites through local frontmen. These foreign stakeholders' involvement can extend beyond provision of technological support to the complete operation of a mining site (Hausermann & Ferring, 2018). This sector is difficult to regulate because of its small-scale, geographically-dispersed and informal nature involving multiple middlemen. Furthermore, licensed gold exporters in Ghana are permitted to purchase gold from both licensed and non-licensed gold miners. This situation allows intermediate buyers and other persons to export undervalued and/or misreported gold doré bars and engage in trade-based money laundering (Hunter 2020; Personal Communications, K. Opare-Hammond).

3. Regulatory infrastructure for export valuation:

Before export, gold doré bars have to be tested or *assayed* to ascertain the purity levels of its contents. Large mining companies usually conduct their own assaying or use international pre-shipment inspection firms to independently certify the contents in each shipment. Dedicated customs officials are usually present during the stage where gold doré bars are fabricated for export, however, they are neither present nor qualified to determine how the gold is assayed.

The verification of the assay values is only conducted at a foreign refinery after the gold has been exported (Personal Communications, C. Nyarko). Any discrepancies in value noticed are likely to only be reported to the mining company and not to the state. These could potentially cause loss of revenue to the state if the company in question has under-declared the values of the gold doré bars exported. Furthermore, artisanal, small-scale and informal mining firms lacking their own assaying infrastructure are required to send their gold to a state-owned enterprise, Precious Minerals Marketing Company (PMMC), for assaying before shipment. However, the coverage of these assaying infrastructure remained limited until 2016 when a new legal regime was established in response to this loophole in

[11] An adulteration of the English phrase 'gather them and sell.'

gold exports valuation. Under the new regulation, both small and large-scale mining companies are now required to assay their gold shipments with the government regulator, PMMC.[12] Accordingly, a modern national assay laboratory has been constructed and equipped with trained personnel (Minerals Commission, 2018; Personal communications, K. Opare-Hammond).

4. Transit trade from neighbouring countries: Trade flows can be categorized as exports, imports, re-exports and transit (Bensassi & Jarreau, 2019). The government of Ghana permits gold produced in neighboring countries to be brought into Ghana for assaying, documentation and onward shipment as transit gold. However, this introduces incentives for local actors to corrupt regulators and combine unrefined gold from different sources and misreport its true value and origin before shipping abroad (Rahman, 2018). The Head of Tax Policy Unit at the Ministry of Finance reported that Ghana Revenue Authority (GRA) has lost an accumulated revenue of GH¢4.5 billion over the past five years as a result of infractions by traders, importers and governmental agencies (Ocloo, 2018). The government of Ghana lost GH¢2 billion in revenue in 2018 through non-observance of rules governing transit trade and the probable complicity and collusion of Customs officials (Sarpong, 2019).

2.2. Cocoa Sector

Ghana is the world's second largest producer of cocoa beans. The export of cocoa beans contributes approximately a quarter of the overall export earnings (Peprah, 2019). The sector employs almost three million farmers, provides business for service providers via haulage, warehousing, insurance etc., and contributes to formal education through scholarships to mainly wards of farmers and the needy in cocoa farming communities. Cocoa is a primary source of livelihood to many rural communities in the southern part of the country where it is largely grown. This sector accounted for approximately 2.3% of Ghana's annual gross domestic product and 9.9% of annual agricultural output between 2010 and 2017.

Cocoa is by far the most important agricultural export commodity, contributing about 80.7% of average agricultural export earnings between 2014 and 2017 (ISSER, 2018). Contrary to the liberalised gold production sector, the Government of Ghana (GoG) plays a major role in the partly liberalised cocoa sector. The Ghana Cocoa Board (COCOBOD) regulates the sector with keen interest due to the socioeconomic importance of the commodity. About 70% – 80% of the cocoa produced (mainly

[12] Pursuant to Regulation (3) of the Minerals and Mining General Regulation 2012 (LI 2173).

the bigger beans from the main crop for the year) is exported. The rest of the beans (smaller beans) are mostly sold to local cocoa processing companies to make cocoa products such as cocoa paste, liquor, powder, cocoa husks and other cocoa waste for export. The cocoa paste sector is relatively decentralised with both the state-owned Cocoa Processing Company and multiple multinational firms present.

We identified the following risks for trade mispricing in this sector:

1. Transfer pricing risks due to multinational firms' international trade operations: Transfer mispricing is not a significant risk in Ghana's cocoa beans sector because the sector is dominated by COCOBOD on behalf of the government of Ghana. State-owned enterprises manage operations at every level of cocoa beans production. Prominent actors include Cocoa Research and Institute of Ghana (CRIG) which is in charge of agricultural research, Seed Production Division (SPD) which supplies seeds to farmers, Community Health and Extension Division (CHED) which provides support services for farmers, Quality Control Division (QCD) responsible for certifying the value of cocoa beans and most relevant for our analysis, Cocoa Marketing Company (CMC), the sole agency in charge of domestic and foreign sales of cocoa beans (David 2013; Personal Communications, COCOBOD Personnel). Since all but one of the subsidiaries of COCOBOD are state owned, it is taken that the bulk of proceeds from the export of cocoa revert to the state, thereby, creating a situation where transfer mispricing is not a significant issue (Bulir, 1998).[13] Furthermore, since 2018, an audit committee has been inaugurated to oversee the management of financial resources of the Board in line with financial management regulations governing state institutions. This is in line with the Public Financial Management Act 2016 (Ampofo, 2018). However, the cocoa paste sector has a number of multinational companies (MNCs) that introduces some incentives for transfer mispricing to reduce tax liabilities in Ghana (Kwaramba et al., 2016).

2. Artisanal, small-scale and informal firms: Artisanal, small-scale and informal firms operating in the cocoa paste sector are difficult to regulate which may create some risks for tax avoidance and non-compliance within the sector, potentially causing Ghana to lose tax revenue. For example, although multinational companies operating in the sector are required to register with the Ghana Investment Promotion Council (GIPC), the same requirements are not applicable to artisanal, small-scale and

[13] The Licensed Buying Company (LBC) sector which buys cocoa beans from farmers is the only liberalised arm of COCOBOD.

informal firms (Personal Communications, M. Acheampong). In addition, the cocoa paste sector is partially regulated by COCOBOD and Ghana Export Promotion Authority (GEPA) (Personal Communications, E. Quao). This situation creates loopholes within the sector that firms may take advantage of to reduce their tax liability to the state, especially when there is a lack of effective co-operation and information sharing between the state institutions which have oversight over them.

3. Regulatory infrastructure for verifying export valuation: Both the cocoa beans and paste for export are verified by the Quality Control Division of COCOBOD before sale. The main crop cocoa beans are directly exported by CMC while the light crop cocoa beans sold to the cocoa paste companies are processed for export and domestic consumption (Personal Communications, CMC Personnel). About 90% of all processed cocoa is exported while the remaining 10% is used in the production of confectionery products (Ashitey, 2012). Although the cocoa paste products are sold by CMC, the oversight is not as stringent as it is for cocoa beans because the companies are not directly owned by COCOBOD. In addition, because many of the companies operating in the sector are multinationals, they are under the oversight of Ghana Free Zones Authority (Personal Communications, M. Acheampong; Personal Communications, F. Mate-Kodjo). This creates a situation where there are multiple organisations with oversight over the same sector, thereby, creating some loopholes within the sector. Thus, the multinational companies operating in the sector have the incentive and opportunity to reduce their tax liability to the state.

4. Transit trade from neighbouring countries: Similar to gold, transit trade of cocoa products from neighbouring countries presents a risk to the sale of cocoa beans. There have been several identified cases of smuggling of cocoa beans between Cote d'Ivoire and Ghana based on the price differentials between the two countries (Bulir, 1998). In 2017, Reuters reported that about 100,000 to 200,000 tonnes of cocoa beans were smuggled into Ghana from neighbouring Ivory Coast for export because of the higher prices Ghana was offering farmers (Kpodo, 2017). However, since 2018, the two countries have decided to announce their prices together to eliminate this phenomenon (Bruce, 2018).

3. ABNORMAL PRICING ESTIMATION METHODS

In this section, we discuss two main methods used to estimate trade mispricing. First, we discuss the partner-country trade gap methodology introduced by Bhagwati (1964) and Bhagwati, et al. (1974). This method still represents the dominant approach used by trade economists to estimate trade

mispricing. Next, we discuss price-filter analysis methods which represent a data-intensive, methodological advancement. The main analysis presented in this paper applies price filter methods for the estimation of abnormal pricing in international trade from Ghana. This method has two approaches: the free market price filter and interquartile range price filter. The free market price filter is used in the analysis of gold and cocoa beans that have reliable international market reference prices whilst the interquartile price range is used for cocoa paste because it lacks a unique market reference price.

3.1. Partner-Country Trade Gap Analysis

Partner-country trade gap analysis is the predominant approach used in the economic literature for quantifying the extent of trade mispricing (Global Financial Integrity, 2017). Bhagwati (1964) and Bhagwati, et al. (1974) provided the first analysis based on partner-country trade gaps including a discussion on the incentives involved for trading firms, especially focusing on tax and customs duty evasion. This methodology is based on the principle of double-counting in international trade statistics, whereby the exporting country's statistics are compared to the importing partner's corresponding statistics, i.e. mirror statistics. It is further assumed that advanced countries' trade statistics are reliable and that any unexplained asymmetries in reported trade statistics between advanced and developing trading partners is evidence of trade misinvoicing in developing countries. In other words, the trade statistics of the advanced country represent the arm's length value for the exports and imports of developing countries.

This method is implemented as follows: first, annual export data (measured using free on board or f.o.b. method) are converted to the cost plus insurance and freight or c.i.f. basis using a standard factor of 10 percent, as calculated by the IMF's Direction of Trade Statistics (DOTS) database. Next, the trade gaps are calculated using the following formulae:

$$\textbf{Trade Gap}_{j,p,t} = \mathbf{I}_{p,t} - \mathbf{X}_{j,t} * \mathbf{r}$$

where:

Trade Gap $_{j,p,t}$= Trade gap between exporter country *j* and partner country *p* at time *t*

$\mathbf{I}_{p,t}$ = Partner country *p*'s imports from the country *j* at time *t*

$\mathbf{X}_{j,t}$ = Country *j*'s exports to partner country *p* at time *t*

r = Standard freight and insurance cost adjustment factor of 10 percent

These discrepancies or trade gaps are usually calculated at the aggregate level, including all traded product categories, but they can also be calculated at the product level (based on the Harmonized Commodity Description and Coding System or HS code) subject to availability of disaggregated data available from the UN Comtrade database. In this paper, we apply the above method to annual product-level exports data on gold, cocoa beans and cocoa paste from Ghana Customs which is compared to annual, product-level imports data reported by Ghana's trading partners in the rest of the world to UN Comtrade.

3.2. Free Market Price Filter

The free market price filter methodology is motivated by a simplified application of the Comparable Uncontrolled Price (CUP) method for establishing the arm's length price range for commodities using commodities exchange prices, as per global transfer pricing guidelines (OECD, 2017; Platform for Collaboration on Tax, 2017; United Nations, 2017). This method relies on transaction level trade micro data on product type, quantity and unit value based on the Harmonized Commodity Description and Coding System (HS code) used internationally for classifying internationally traded products (Hong et al., 2014). This framework compares actual transaction level unit prices (price per kilogram) for a particular commodity (HS code) with an arm's length price range defined using the contemporaneous free market price, plus or minus a reasonable filter to account for normal price volatility, commodity heterogeneity or purity, transportation costs and other relevant product-country level factors. Transactions which deviate significantly from this arm's length price range are declared as abnormally valued.

The abnormally overvalued amount is estimated as the deviation from the upper bound of the arm's length price range ($\mathbf{P_{High}}$) and the abnormally undervalued amount as the deviation from the lower bound of the range ($\mathbf{P_{Low}}$). Specifically, the mispriced amount for each transaction is calculated as follows:

$$\textbf{Undervalued exports} = \textbf{Quantity} \times \textbf{MAX}(0, P_{Low} - P)$$

$$\textbf{Overvalued exports} = \textbf{Quantity} \times \textbf{MAX}(0, P - P_{High})$$

where:

$\mathbf{P}$ = Declared price (unit value implied in the quantity and value in each declared export record)

$\mathbf{P_{Low}}$ = Lower bound of the arm's length price range

$\mathbf{P_{High}}$ = Upper bound of the arm's length price range

3.2.1. Arm's Length Price Range for Gold Exports

Gold doré produced in Ghana ranges from between 67:33 and 100:0 gold – silver split (after accounting for a maximum of 5% of impurities like lead, copper and arsenic). Accordingly, we first calculate the relevant benchmark prices for the various proportions of gold and silver found in the gold doré bars produced in Ghana. Secondly, we assess the commodity-specific factors which result in further variation of observed export values to deviate from the free market reference prices. Finally, we combine this information to estimate the arm's length price range between $\mathbf{P_{Low}}$ and $\mathbf{P_{High}}$.

Benchmark Price for Gold: In order to establish the benchmark prices for different levels of gold-silver mix, we merge the firm names in our exports data from Ghana Revenue Authority with mine-level production information from Metal Focus Gold-Silver Doré Service database. However, not all the exporters can be matched to individual gold mines due to the presence of intermediate buyers and logistical firms in the GRA export data. In these cases, we conservatively use minimum and maximum gold purity levels observed across all gold mines to estimate the benchmark prices. Accordingly, we calculated the benchmarks as follows:

Case 1 - GRA exports data matched with mine-level gold-silver content:[14]

$$\textit{Benchmark price} = \textit{(price of gold*gold content)} + \textit{(price of silver * silver content)}$$

Case 2 - GRA exports data which cannot be matched with mine-level gold-silver content. In this case, we calculate a minimum and maximum range for benchmark prices as follows:

$$\textit{Maximum benchmark price} = \textit{(price of gold * maximum gold content)} + \textit{(price of silver * minimum silver content)}$$

$$\textit{Minimum benchmark price} = \textit{(price of silver * maximum silver content)} + \textit{(price of gold * minimum gold content)}$$

[14] In all cases, we adjust the gold and silver content to account for a maximum of 5% permitted impurities in the doré using the following adjustment: (gold/silver purity*0.95)/100.

Upper bound of arm's length price range (P_{High}): Next, we estimate the arm's length price range by first calculating the upper bound using the following commodity-specific factors based on estimations by interviewed gold sector experts:

> **1. Transport, storage and insurance costs (negligible impact):** These costs are included in all export transactions, however, their impact on the total value of precious metals like gold are negligible i.e. maximum 2% of total value. This decreases further for larger volume transactions (Personal Communications, A. Tawiah).[15]
>
> **2. Market conditions and contract terms (up to 10%):** Export prices also fluctuate due to the terms of underlying contracts which include different types of transactions (spot and futures contracts). This also reflects differences in price bargaining power between trading companies. Favourable forward/futures sales can determine gains of the doré exports against spot prices used as benchmark. Also, Ghanaian Cedi – US Dollar exchange rates and prevailing interest rates affect export prices of gold from Ghana (Personal communications, C. Nyarko).

As a result, we conservatively use an estimate of 10% above the previously calculated benchmark prices as the upper bound of our arm's length price range for gold:

*Upper bound of arm's length price range = (Benchmark price*1.10)*

Lower bound of arm's length price range (P_{Low}): Finally, we can estimate the lower bound of the arm's length price range as follows:

> **1. Market conditions and contract terms (up to 10%):** Same as above, contract types and market conditions also have a negative impact in terms of reducing the observed export prices below our calculated benchmark prices. Therefore, we conservatively assume the total downward impact of 10% to calculate the lower bound of the arm's length price range as follows:

*Lower bound of arm's length price range = (Benchmark price*0.90)*

[15] This information was gathered from two gold exporting agencies and a conversation with a contact at a freight forwarding agency.

Declared export values falling above the upper bound arm's length range indicate overvaluation while those below the lower bound arm's length range indicate undervaluation of exported gold.

3.2.2. Arm's Length Price Range for Cocoa Beans

Unlike gold, our empirical methodology for estimating abnormally priced cocoa beans exports does not require detailed information on different types or purity levels. This is because Ghana exports only Grade I and Grade II cocoa beans which are generally considered as high-quality beans, even above standards set by the international market, hence, attract premiums in addition to the international market reference prices (Quarmine et. al., 2012; Abbott, 2013).[16] In order to ensure maintenance of this internationally recognised high-quality cocoa beans standards set by COCOBOD, Cocoa Marketing Company (CMC), a subsidiary of COCOBOD, has (by law) been given the sole right to sell and export cocoa beans from Ghana as well as perform the take-over function within the internal marketing system.[17]

The cocoa marketing procedure in Ghana is unique with its partly liberalised system where internal marketing undertaken by LBCs are privatised, albeit with strict oversight by CMC (a parastatal with keen government interest). COCOBOD/Government of Ghana show particular interest and control the marketing of cocoa beans because of the potential revenue increase to, foremost, finance syndicated loans (receivables-backed trade finance facility) taken by COCOBOD. The loans are used for purchasing cocoa beans from local farmers through LBCs and providing research and extension services to farmers as well as funds for the general administration of all the cocoa institutions. They are also used for rural community development in the country (Personal Communications, CMC Personnel). Furthermore, increased income of farming households improves rural livelihood and subsequently aids some developmental targets of the government. In effect, prompt payment of the loans ensures reliability and continuous subscription that translates into consistent cocoa beans production of prescribed quality and standards set by COCOBOD.

[16] This grading standard is set and enforced by COCOBOD. It indicates the physical quality of the cocoa beans in relation to moisture content, disease infestation, defectiveness of the beans, mouldiness, saltiness and the presence of foreign matter. Specifically, Grade I beans are well fermented with moisture content not higher than 7.5% and the maximum defect levels of beans allowed are mouldiness level (3%), saltiness (3%) and other defects (3%); while Grade II beans do not have more than 8.5% moisture content with maximum defect levels allowed are mouldiness level (4%), saltiness (8%) and other defects (6%). In addition to these indicators, COCOBOD ensures all cocoa bags contain cocoa beans of uniform size (Quarmine et. al., 2012; Personal communications, CMC/COCOBOD personnel).

[17] The take-over function involves CMC performing the final quality checks of cocoa beans for dryness, mouldiness, saltiness and other defects at their take-over centres, after quality checks and delivery by LBCs, before acceptance and warehousing for shipment.

To ensure guaranteed funds for the next cocoa season's business, CMC trades most of the main crops which they describe as relatively more stable in terms of yield as well as attract higher prices in the futures sales (Personal Communications, CMC/COCOBOD Personnel). Hence, COCOBOD's presence at every stage of the cocoa value chain to ensure the required production size for the season. Also, to this end, COCOBOD, with support of Bank of Ghana, forecasts prices and exchange rates to assess total revenue and industry costs to determine the annual producer price of cocoa in Ghana. The Producer Price Review Committee (PPRC) deliberates and decides on the producer price as well as shares of other stakeholders such COCOBOD, LBCs, haulers and GoG.[18] The aim is to incentivise cocoa farmers to produce more with stable income (Laven and Boomsma, 2012; Vigneri and Lolavalli, 2018; and Bangmarigu and Artan, 2018). Basically, cocoa beans' external marketing is based on volume and reliability because, usually, quality is given and already attracts a premium. Two seasonal produce of cocoa beans are exported— main and light crops— and the ability to make external sales depends on experience, intuition and timing on the futures' market as well as a quest to secure enough sales to fund the syndicated loans.

Benchmark Price for Cocoa Beans exports: We use the London Futures Prices as our benchmark prices for the analysis of the abnormal pricing of cocoa beans. This is because export prices of the beans are negotiated as differentials based on these prices. The Intercontinental Exchange (ICE), London, particularly represents delivery in Northern Europe and serves as reference prices for West African cocoa; hence, CMC's trading of cocoa beans, especially to foreign buyers, is based on these prices. In the agreement outlined, buyers and sellers present the futures contract as a reference price and then negotiations are undertaken in relation to differential premium or discount depending on quality, default and counterparty risks in delivering the quantities for which prices are fixed. Ghana's institutional reputation with regard to quality and counterparty risk, for instance, allow for sales that are usually conducted six to 12 months (or sometimes 15 to 18 months) prior to delivery. The main reason for the futures sales is that the sales serve as collateral for the syndicated loans acquired to pay LBCs for their cocoa beans, provide research and extension services to farmers as well as funds for the general administration of all cocoa institutions in the country (Tröster et al., 2019; Personal Communications, CMC Personnel). Based on assumptions guided by our communications with experts in the industry and desktop research, an arm's length price range is subsequently estimated by

[18] A committee made up of COCOBOD, government officials, representatives of LBCs and transport/haulers, the national cocoa farmers' association, and chaired by the Ministry of Finance.

focusing on market conditions and contract types as well as transport and insurance costs. The upper and lower bounds arm's length price ranges are set as follows:

Upper bound of arm's length price range (P_{High}): We use the following considerations to estimate P_{High} for cocoa beans exports from Ghana:

1. **Market conditions and contract terms:** With the peculiar cocoa supply chain in Ghana, varied sales strategies undertaken by the traders based on instinct with experience, plausible portions of estimated abnormal pricing are assumed to be a reflection of premiums earned as a result of a combination of an established guaranteed delivery of sold cocoa beans on time, quality of beans, market power and counterparty premium. For example, CMC/COCOBOD selects top-grade quality and size of cocoa beans for export that attract roughly 3 – 5% price premium on the world markets. Certifications such as Organic, Fairtrade, UTZ and traceability also attract price premium of 150 USD per tonne which is about 5.4% of the average value of the London's Futures Prices for the period 2011 – 2017 (Gilbert, 2009 in Kolavalli and Vigneri, 2011; Dand, 2011). Some reasons given for the premiums include slightly higher-than-average fat content, low levels of debris that results in higher cocoa butter yields and low levels of bean defects that generate cocoa liquor flavour preferred by some end users (Kolavalli and Vigneri, 2011). Indeed, premiums have been known to go as high as 16.5% of the market reference (Personal Communications, CMC/COCOBOD Personnel; Stakeholder Meeting at COCOBOD).

2. **Transport, storage and insurance costs:** According to CMC, cocoa beans are sometimes exported with pre-financed shipments by COCOBOD upon customers' request. On these occasions, the beans are exported under Cost, Insurance and Freight (CIF) terms, which usually cost around USD 100 per tonne or 10% of export value (Dand, 2011; Personal Communications, CMC/COCOBOD Personnel). Also, using the world market price in 1999, Pedersen (2001) estimated transport cost of cocoa exported from Tema to Rotterdam to be around 13% of the market price.

Overall, we conservatively use a 30% increase above the benchmark price (i.e the futures market reference prices) to set the upper bound for the arm's length range beyond which export values are considered overvalued (abnormally overpriced).

Lower bound of arm's length price range (P_{Low}):

Market conditions and contract terms: We deduce that based on market conditions and contract terms that fix majority of export values ahead of the season in forward sales, risks such as exchange rates, lower than expected estimated volumes due to crop failures and smuggling can lead to sales that fall short of the expected prices due to defaults (Tröster et al., 2019). Also, CMC exports about 20 – 30% of cocoa beans at spot prices (mostly light crops of relatively small sizes (Quarmine et al., 2012)) that are subject to same risks, especially smuggling and speculations. Discounts due to non-delivery or default of the expected quality (which hardly occurs) and size can result in export values below the benchmark market reference prices.[19] We, thus, similarly approximate 20% deviations from the benchmark to constitute the lower bound arm's length price range. Consequently, cocoa beans export values falling below this lower bound are considered undervalued.

3.2 Interquartile Range Price Filter Analysis

The inter-quartile range price filter method assumes that values between the 25th and 75th percentile of the observed distribution of unit prices for a specific commodity denotes the arm's length price range. Any transaction that falls above or below this price range is categorised as abnormally valued. Traditionally, this method relies on the inter-quartile range being calculated for each calendar year. However, in a methodological innovation from previous studies (for example, Hong and Pak, 2017), we implement a dynamic version of the previous method by updating our calculation of the inter-quartile range on a daily basis using the price distribution observed over the previous 365 days i.e. a 365-day rolling window estimate of the interquartile range. The main advantage is to make our definition of the arm's length price range more responsive to pricing dynamics observed over the course of the year. For example, in the case of agricultural commodities, the observed trade prices may be affected by planting seasons, climactic variation and market conditions which do not directly correspond to calendar years used by previous studies to calculate the arm's length price range.

Accordingly, any transaction value which exceeds the 75th percentile or fall below the 25th percentile of the observed price distribution is designated to be abnormally priced. The under or overvalued amounts for each transaction is then calculated as follows:

[19] According to Quarmine et al., 2012 cocoa beans from Ghana, on two occasions, have been rejected by Japanese and American markets due to chemical residues that exceeded the maximum requirements.

Undervalued amount = Quantity x MAX(0, LoQ - P)

Overvalued amount = Quantity x MAX(0, P - UpQ)

where:

P = Declared price (unit value implied in quantity and value in each trade record)

LoQ = Lower-quartile price calculated using price distribution over previous 365 days

UpQ = Upper-quartile price calculated using price distribution over previous 365 days

It is relatively straightforward to observe that since the interquartile price range is endogenously estimated using the observed price distribution, this hypothesis will be rejected by design for a certain proportion of transactions. Therefore, these estimates of trade mispricing should be interpreted carefully and supplemented with further discussion regarding product, price and individual market characteristics. For example, contemporaneous political, economic or environmental shocks may play a key role in determining whether the observed transaction price falls within the interquartile price range during a given period.

3.2.1. Arm's Length Price Range for Cocoa Paste

Due to the lack of commonly acknowledged market reference prices for cocoa paste exports from Ghana, the interquartile range method is used to calculate its abnormal estimates. Furthermore, we observe a high degree of export price rigidity in the cocoa paste exports data which suggests advance pricing agreements at constant prices between trading partners which do not respond to observed prices from relevant commodities exchanges. Therefore, we apply the rolling-interquartile range price filter method as described above to approximate the arm's length price range for cocoa paste exports.

Upper bound of arm's length price range (P_{High}): We use the 75th percentile to set the P_{High} for cocoa paste exports from Ghana. Thus, export values that are found above the 75th percentile are estimated as the overvalued amount of cocoa paste.

Lower bound of arm's length price range (P_{Low}): Similarly, we set the 25th percentile as the P_{Low} for cocoa paste exports from Ghana. Calculated values below this boundary are declared as undervalued amount of cocoa paste.

4. DATA SOURCES

4.1. Gold and Cocoa Exports: 2011 – 2017

Ghana Revenue Authority's Customs Division provided us with daily, transaction level gold and cocoa exports microdata for this analysis. This database covers all exports from 2011 – 2017 and includes all relevant information including transaction value, weight (net and gross, including packaging), detailed description of the commodity type, tariff classification code as per the global Harmonized System for Classification (HS System), trading partners (importer and exporter names) and the receiving country.

For gold, our analysis focuses on two main categories of exports from Ghana: gold bullion (7108.13.1000) and unwrought, non-monetary gold (7108.12.0000) corresponding to gold smelted into doré bars.[20] This firm level transactions data show that Ghana exported gold worth USD 35.6 billion to 47 countries between 2011-17. Significant trading partners include South Africa, Switzerland, United Arab Emirates and India.

Similarly, Ghana Customs used a 10 – digit HS code to classify the nine types of cocoa exported within the study period. Two of these types — cocoa beans, superior quality raw beans (1801.00.1100) and cocoa paste, wholly or partly defatted (1803.20.0000) — are examined in this study. In the data, cocoa beans refer to superior quality raw beans. It is also known as well-fermented cocoa beans. The specific descriptions in the Ghana Customs data include main crop raw cocoa beans (*abrabopa*; *kuapa kooko*; *certified*; *traceable* and *UTZ certified*) and light crop raw cocoa beans. These descriptions signify the various types of raw cocoa beans exported. For example, some of the cocoa exported are certified as organic (bought from farmers who do not use child labour in cocoa production and also from farmers' associations that ensure sustainable production of cocoa). Ghana exported about 4.3 million tonnes of cocoa beans worth USD 12.6 billion over the study period. The top four destination countries of Ghana's cocoa are The Netherlands, Malaysia, United States of America and Belgium.

Ghana Customs also describes cocoa paste as either wholly or partly defatted; it is generally made up of refined cocoa liquor, cocoa mass, unrefined cocoa nibs, non-deodorised filtered cocoa butter, fine alkalised cocoa liquor, coarse alkalised cocoa cake, natural coarse cocoa cake, defatted cocoa cake and cocoa powder. The value of processed cocoa paste exports from Ghana within the study period

[20] Upon cleaning the data to remove errors such as the listing of diamonds, gold dust, tar, soil samples, and silver as well as extremely large per unit prices outliers, 20,933 transaction level observations were left for the analysis; from an original 21,261 observations.

totalled USD 1.8 billion. The top four countries that bought some of these cocoa paste products are The Netherlands, France, Belgium and Switzerland. Table 1 gives the summary statistics of the three commodities used in our assessment of abnormal pricing in Ghana.

Table 1: Summary Statistics of Selected Commodities

HS: 7108.13.1000 & 7108.12.0000	**Gold**				
	Transactions	**Mean**	**Standard Dev.**	**Max.**	**Min.**
Quantity (kg)	20,933	49.1	265.8	30,646.0	0.03
Transaction value (USD)	20,933	1,699,228	3,373,144	46,200,000	135.0
Price per Kg (USD)	20,933	40,522.8	8,622.8	60,690.0	6.3
HS: 1801.00.1100	**Cocoa Beans (Superior Quality Raw Beans)**				
	Transactions	**Mean**	**Standard Dev.**	**Max.**	**Min.**
Quantity (kg)	13,210	323,435.2	508,272.7	23,100,000	646
Transaction value (USD)	13,210	954,661	1,415,084	19,100,000	2,485
Price per Kg (USD)	13,210	3.03	1.5	31.8	0.002
HS: 1803.20.0000	**Cocoa Paste (Wholly or Partly Defatted)**				
	Transactions	**Mean**	**Standard Dev.**	**Max.**	**Min.**
Quantity (kg)	5,889	90,340	86,875	1,400,000	19.0
Transaction value (USD)	5,889	309,551	315,601	3,019,378	20.0
Price per Kg (USD)	5,889	3.5	0.9	7.2	0.07

Source: Ghana Revenue Authority – Customs Division

For our partner country trade gap analysis, we use annual product-level trade statistics on Ghana's exports of gold, cocoa beans and cocoa paste from the United Nations Comtrade database. The summary statistics are reported in Table 2. For our product-level analysis, we use data on Ghana's exports and its trading partners' imports for the same product categories described above.

Table 2: Aggregate Trade Data for Selected Commodities, 2011-17

	Gold (HS Category: 7108.13.1000 and 7108.12.0000)		Cocoa Beans: (HS Category: 1801.00.1100)		Cocoa Paste: (HS Category: 1803.20.0000)	
Year	**Ghana Exports (Current USD, Million)**	**RoW Imports (Current USD, Million)**	**Ghana Exports (Current USD, Million)**	**RoW Imports (Current USD, Million)**	**Ghana Exports (Current USD, Million)**	**RoW Imports (Current USD, Million)**
2011	4,833	172	2,072	2,782	8.82	58
2012	7,093	3,687	1,968	2,504	-	53
2013	5,356	3,881	1,381	1,880	0.22	26
2014	4,686	3,708	2,008	2,348	391.95	30
2015	4,370	4,949	2,730	2,088	377.66	23
2016	4,428	5,780	1,886	2,336	-	31
2017	5,858	5,132	1,642	1,820	282.22	53
Mean	**5,232**	**3,901**	**1,955**	**2,251**	**212.17**	**39**
Total	**36,624**	**27,310**	**13,686**	**15,758**	**1,060.87**	**274**

Source: United Nations Comtrade Database (accessed: December 2020). Missing data fields are indicated by the symbol '-'.

4.2. Free-Market Commodity Price Data: 2011–2017

Daily market price data is from Thomson Reuters Datastream, a database of global financial markets and economic indicators. The commodity exchanges' data used as free market reference prices for the analyses are: the London Bullion Market Association (LBMA) for Gold Bullion LBM (US dollars per troy ounce) with 99.5% to 99.9% purity levels and London International Financial Futures and Options Exchange (LIFFE) prices for the assessment of the raw cocoa beans (US Dollars per metric tonne).

4.3. Metal Focus Gold Doré Flows Service Database: 2019

This database provides mine-level information on historical, current and forecasted doré production (up to 2030) by company and country. It also contains information on current refining location, historic production costs, current mineral reserves and resources as well as the gold – silver split of doré production. This information covers 652 mining companies in 77 countries. Specifically, the database has information on 16 mines in Ghana owned by Newmont Goldcorp Corporation, Golden Star Resources, Kinross Gold, Gold Fields, Perseus Mining, AngloGold Ashanti, BCM International,

Asanko Gold/Gold Fields and Golden Star Resources. Except for Newmont Goldcorp Corporation and AngloGold Ashanti, all the mines listed are co-owned by the Government of Ghana (GoG).[21]

This study primarily used the gold – silver split information from this database for companies that exported gold doré within the study period. The gold – silver split recorded are 100 – 0%, 97 – 3%, 96 – 4%, 86 – 14%, 81 – 19% and 67 – 33% (Table 3).[22] Since the data is merged on company level with the GRA dataset where companies have differing gold – silver splits from different mines, the lowest gold – silver split is used for the analysis of that company. Of the gold – silver split recorded, up to 5% constitutes impurities such as copper, lead and bismuth, which is permissible by refineries; and mines are paid based on gold and silver in doré (Metal Focus Report, 2019).

Table 3: Main Gold Mines in Ghana, Ownership and Gold – Silver Content in Production

Mine Name	Mine Ownership	Gold:Silver Split (%)
Ahafo	Newmont Goldcorp Corporation	100:0
Akyem	Newmont Goldcorp Corporation	86:14
Bogoso Prestea	Golden Star Resources / Government of Ghana	100:0
Chirano	Kinross Gold Corporation / Government of Ghana	67:33
Damang	Gold Fields / Government of Ghana	97:3
Edikan	Perseus Mining / Government of Ghana	100:0
Iduapriem	AngloGold Ashanti	100:0
Obotan	Asanko Gold / Gold Fields / Government of Ghana	81:19
Tarkwa	Gold Fields / Government of Ghana	96:4
Wassa	Golden Star Resources / Government of Ghana	100:0

Source: Metal Focus Gold Doré Flows Services Database, 2019

5. ESTIMATES OF ABNORMAL PRICING

We will now present the annual and total estimates of abnormal pricing for the selected gold and cocoa exports using the methodologies and data explained above. The analyses presented in this section are based on export trade between Ghana and various partners, hence, the abnormal price estimates are

[21] The government owns 10% of each mining company.

[22] Records from other sources have also shown that some mines, in rare cases, produce gold dorés of purity levels as low as 50% (Personal Communications, C. Nyarko).

general rather than specific to a particular trading partner. Overall, our estimates show economically significant undervaluation of some of the commodities.

5.1. Gold (Semi-Manufactured) (HS Code: 7108.13.1000 &7108.12.0000)

Table 4 gives the calculated annual and total under and overvaluations of gold exported within the study period.

Table 4: Undervalued and Overvalued Exports – Gold (HS Code: 7108.13.1000 &7108.12.0000)

Year	Abnormal Undervaluation (2011 Constant USD, Million)	Abnormal Overvaluation (2011 Constant USD, Million)	Abnormal Undervaluation (Current USD, Million)	Abnormal Overvaluation (Current USD, Million)	Partner Country Trade Gaps (Current USD, Million)
2011	225.7	2.0	222.8	2.0	-5,145
2012	662.0	17.7	544.5	14.5	-4,115
2013	673.4	29.9	514.7	23.1	-2,010
2014	373.5	25.2	205.5	13.4	-1,447
2015	192.9	17.7	78.9	7.4	142
2016	3,084.9	5.0	1,195.4	1.9	909
2017	3,071.1	12.0	1,067.4	4.2	-1,312
Mean	**1,183.4**	**15.6**	**547.0**	**9.5**	**-1,854**
Total	**8,283.5**	**109.5**	**3,829.1**	**66.6**	**-12,977**

Data Source: Ghana Revenue Authority (GRA); Metal Focus Limited; United Nations Comtrade Database (accessed: December 2020)
Notes: Constant prices in USD are calculated using the average annual Ghana Cedi-US Dollar exchange rate for the base year 2011. Current prices are based on the daily Ghana Cedi-US Dollar exchange rate during the sample period.

Estimates for abnormally undervalued exports: Using the lower bound of the arm's length price range as described under sub-section 3.1.1, we estimate that abnormally undervalued exports equalled USD 8.3 billion in constant prices (base year 2011) or USD 3.8 billion in current prices. This constitutes approximately 11% of the total value of gold exported during this period. The top five destination countries of these undervalued gold exports include major gold refining destinations including India, South Africa, United Arab Emirates, Switzerland and Portugal representing major gold refining, trading and manufacturing destinations. The estimated tax base erosion from Ghana due to the undervaluation of gold exports equals USD 2.1 billion in constant prices (base year 2011) or USD 957.3 million in current prices (see Table A.1 in appendix).

Estimates for abnormally overvalued exports: Similarly, using the upper bound arm's length range, we estimate an economically insignificant magnitude of abnormally overvalued gold exports between 2011-17 equalling USD 109.5 million in constant prices (base year 2011) or USD 66.6 million in current prices (Table 4). Relative to the total value of gold exports, overvaluation seems negligible; representing approximately 0.2% of total exports during the study period.

Comparison with partner country trade gap estimates: Next, we estimate the more commonly used partner-country trade gaps based on asymmetries between Ghana's exports and the imports reported by its trading partners in the rest of the world using annual product-level data from the Comtrade database. The overall results indicate that reported Ghanaian exports exceed what the rest of the world reported as imports from Ghana between 2011-17, i.e. export over-valuation, which is contrary to our price filter estimates for the same period. Upon investigating the aggregate trade data series, we find that these conflicting results are primarily driven by non-reporting of imports data by important destinations for Ghanaian gold, including South Africa, Switzerland and United Arab Emirates. For example: according to the UN Comtrade database, South Africa reported zero imports of gold doré from Ghana between 2011-17. However in the data provided by Ghana Customs, it is reported that Ghana exported USD 4.4 billion of gold to South Africa during this period. This highlights the challenges of estimating trade mispricing using poor quality aggregate trade data voluntarily reported by countries to the global databases.

5.2. Cocoa Beans (HS Code: 1801.00.1100)

Table 5 gives the estimated magnitudes of undervaluation and overvaluation of cocoa beans for the period 2011 – 2017.

Estimates for abnormally undervalued exports: In spite of the unique marketing characteristics of Ghana cocoa beans exports, it is estimated that about abnormally undervalued exports equalled USD 234.6 million in constant prices (base year 2011) or USD 126.6 million in current prices between 2011-17 (Table 5). This represents approximately 1% of the total value of cocoa beans exported during this period, with the most significant destinations including Estonia, Netherlands, Germany, China and Belgium representing major cocoa product manufacturing and trading destinations. Although undervaluation in percentages appears small, the magnitude of tax base erosion is potentially significant

equalling USD 58.7 million in constant prices (base year 2011) or USD 31.6 million in current prices (see Table A.1 in appendix).

Table 5: Undervalued and Overvalued Exports – Cocoa Beans (HS: 1801.00.1100)

Year	Abnormal Undervaluation (2011 Constant USD, Million)	Abnormal Overvaluation (2011 Constant USD, Million)	Abnormal Undervaluation (Current USD, Million)	Abnormal Overvaluation (Current USD, Million)	Partner Country Trade Gaps (Current USD, Million)
2011	24.6	3.9	24.4	3.8	503
2012	10.0	9.9	8.5	7.9	339
2013	1.8	28.3	1.4	21.6	361
2014	101.9	23.6	57.4	12.0	139
2015	5.5	17.3	2.2	7.0	-915
2016	23.4	122.0	9.0	47.0	262
2017	67.4	43.7	23.8	15.4	13
Mean	**33.5**	**35.5**	**18.1**	**16.4**	**100**
Total	**234.6**	**248.6**	**126.6**	**114.7**	**703**

Data Source: Ghana Revenue Authority (GRA); United Nations Comtrade Database (accessed: December 2020)
Notes: Constant prices in USD are calculated using the average annual Ghana Cedi-US Dollar exchange rate for the base year 2011. Current prices are based on the daily Ghana Cedi-US Dollar exchange rate during the sample period.

Estimates for abnormally overvalued exports: The estimates of abnormally overvalued cocoa beans exports are quite similar to the undervaluation estimates. For example, the estimated overvalued amount of cocoa beans is USD 248.6 million in constant prices (base year 2011) corresponding to approximately 0.9% of total exports over the entire study period (Table 5). The top five destination countries that overvalued cocoa beans from Ghana are Malaysia, Netherlands, Brazil, United States of America and Japan.[23]

Comparison with partner country trade gap estimates: Next, we estimate partner-country trade gaps between Ghana's reported exports of cocoa beans and its trading partners' reported imports from Ghana. Overall, our findings indicate that reported Ghanaian exports are significantly lower than the reported imports by the rest of the world from Ghana, i.e. export under-valuation. These estimates of

[23] The abnormal pricing results for cocoa beans imply that the estimated revenue gains from taxing the income earned due to abnormally overvalued cocoa bean exports are approximately equal to the tax base erosion due to the corresponding undervalued exports.

undervaluation are significantly higher than what we find using transaction-level export data. We hypothesize that these differences are primarily driven by the entrepot trade effect in international trade statistics, whereby the exporting country records an intermediate transit country or shipping hub as the final destination of their exports. However, the products are re-exported from the transit country to final destination which reports them as imports from the original source country. This is a significant feature of the international trade in cocoa beans, which are usually purchased and stored for multiple years before being shipped to their final destination.

5.3. Cocoa Paste (HS Code: 1803.20.0000)

The annual and total undervaluation and overvaluation estimates of cocoa paste are given in Table 6.

Estimates for abnormally undervalued exports: Our estimations indicate that the amount of undervalued cocoa paste is USD 306.5 in constant prices (base year 2011) or USD 130.5 million in current prices, corresponding to 7.2% of the total exports between 2011-17. Although endogenously determined, the interquartile range filter is applied for products where it is not feasible to estimate the arm's length price range using internationally recognized commodity exchange prices. As discussed previously, the magnitude of the resulting estimates can be interpreted as risk indicators for trade mispricing of processed cocoa paste exports, i.e. proportion of exports valued in the tails of the unit price distribution.

A large number of multinationals operate in the processed cocoa sector in Ghana which increases risks for trade and transfer mispricing (Kwaramba et al., 2016). The top five imports for undervalued cocoa paste from Ghana are Spain, Bulgaria, Netherlands, Turkey and Russia representing major cocoa product manufacturing and shipping destinations. The total tax base erosion due to the estimated magnitude of abnormal undervaluation equals USD 76.6 million in constant prices (base year 2011) or USD 32.6 million in current prices.

Estimates for abnormally overvalued exports: Overvaluation of cocoa paste is approximately USD 59.1 million, constituting roughly 3.2% of the total value of cocoa paste exported (Table 6). The first five countries that overvalued the cocoa paste are Netherlands, Turkey, Bulgaria, United States of America and United Kingdom.

Table 6: Undervalued and Overvalued Exports – Cocoa Paste (HS: 1803.20.0000)

Year	Abnormal Undervaluation (2011 Constant USD, Million)	Abnormal Overvaluation (2011 Constant USD, Million)	Abnormal Undervaluation (Current USD, Million)	Abnormal Overvaluation (Current USD Million)	Partner Country Trade Gaps (Current USD Million)
2011	3.7	0.2	2.7	0.2	48
2012	12.5	7.0	7.7	4.1	-
2013	17.4	5.9	11.8	4.5	26
2014	68.8	37.4	33.7	19.1	-401
2015	61.9	39.2	24.9	14.9	-393
2016	49.1	23.3	18.4	7.7	-
2017	93.0	26.4	31.3	8.6	-258
Mean	**43.8**	**19.9**	**18.6**	**8.4**	**-195**
Total	**306.5**	**139.4**	**130.5**	**59.1**	**-977**

Data Source: Ghana Revenue Authority (GRA); United Nations Comtrade Database (accessed: December 2020)
Notes: Constant prices in USD are calculated using the average annual Ghana Cedi-US Dollar exchange rate for the base year 2011. Current prices are based on the daily Ghana Cedi-US Dollar exchange rate during the sample period.

Comparison with partner country trade gap estimates: Finally, we estimate partner-country trade gaps for cocoa paste exports from Ghana and the results are reported in Table 6. We observe significant data misreporting in product-level trade statistics for cocoa paste by Ghana Customs which does not allow us to reliably interpret the observed trade gaps. Transaction-level data from Ghana Customs shows that all export transactions for cocoa paste, cocoa butter and cocoa powder have been recorded under the tariff category of cocoa paste despite being allocated to distinct tariff categories. This leads to incomparability with the import statistics of its trading partners. Overall, this case highlights the strong limitations of estimating trade mispricing using aggregate trade data in the case of developing countries which limited statistical capacity and misreporting.

6. CONCLUSIONS AND POLICY IMPLICATIONS

As a resource-rich, developing country, Ghana expects to leverage the production and marketing of its natural resources for financing socio-economic development. However, trade mispricing can significantly erode the potential of its natural resource sector to contribute to development as it leads to tax base erosion from the economy. This study accordingly aims to provide novel evidence of

abnormal pricing of Ghana's most economically significant exports (gold and cocoa) using a robust, interdisciplinary method involving statistical analysis informed by industry experts. We postulate that our estimates represent useful, new evidence to inform policymakers, especially, since these estimates rely on transaction level microdata rather than the aggregate trade statistics used in existing studies.

Overall, our findings confirm that commodity trade mispricing is an urgent concern for Ghana. Policymakers accordingly need to prioritize the establishment of institutional expertise to track, monitor and block the sources of the resulting tax base erosion. In recent years, Government of Ghana has already put in some measures to monitor illicit operations. Such measures include the setting up of a transfer pricing unit and anti-money laundering unit within the revenue authority. Other measures include designating a national assayer (PMMC) to assay all gold to be exported and agreeing with neighbouring countries, especially Cote d'Ivoire, to announce the producer price of cocoa at the same time in a bid to curb smuggling of cocoa beans between the two countries.

Further policy recommendations include the need to improve data collection capacity of the various institutions engaged in the export of these commodities, greater co-operation among the various institutions in these sectors to reconcile data collected and constant skills improvement of personnel of these units. Information and communication technology tools, especially computers, relevant software and access to critical databases also need be upgraded to match those of the private sector actors in order to ease tax assessments and payments tracking. Regulators may also consider using our research methods based on commodity exchange prices and statistical benchmarks as a means for risk-based selection of cases for customs, tax and transfer pricing audits.

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Appendix

Section A.1. Tax Base Erosion due to Abnormally Undervalued Exports from Ghana

In the following Table A1, we use data on tax revenues, gross domestic product, Ghana Cedi-USD dollar annual exchange rates from the World Bank Development Indicators to calculate Ghana's tax-to-GDP ratios. We present these ratios with and without the inclusion of our estimates of tax revenue loss arising from abnormally valued gold and cocoa exports. Overall, the results indicate that on average the tax-to-GDP ratios between 2011-17 could have been increased 0.27% if the abnormally under-valued magnitude of gold and cocoa exports had been taxed as per Ghana's corporate income tax rate of 25%.

Table A.1. Impact of Estimated Revenue Loss from Undervalued Exports on Ghana's tax-to-GDP Ratio (2011-17)

Year	Abnormal Undervaluation in Gold (2011 Constant USD)	Abnormal Undervaluation in Cocoa Beans (2011 Constant USD)	Abnormal Undervaluation in Cocoa Paste (2011 Constant USD)	Total Revenue Loss (@25% tax rate, 2011 Constant USD)	Original Tax-to-GDP Ratio (%)	Tax-to-GDP Ratio, including Revenue Loss (%)	Decrease in Tax-to-GDP Ratio due to Revenue Loss (%)
2011	225.7	24.6	3.7	63.50	14.87	15.03	0.16
2012	662	10	12.5	171.13	15.37	15.71	0.35
2013	673.4	1.8	17.4	173.15	10.67	10.88	0.21
2014	373.5	101.9	68.8	136.05	10.72	10.85	0.13
2015	192.9	5.5	61.9	65.08	17.95	18.01	0.05
2016	3084.9	23.4	49.1	789.35	11.06	11.60	0.55
2017	3071.1	67.4	93	807.88	11.58	12.04	0.47
Mean	**1183.36**	**33.50**	**43.80**	**315.16**	**13.17**	**13.45**	**0.27**
Total	**8283.50**	**234.60**	**306.50**	**2206.13**	**12.77**	**13.08**	**0.31**

Data sources: World Bank Development Indicators (Accessed: December, 2021); Authors' calculations

Notes: Constant prices in USD are calculated using the average annual Ghana Cedi-US Dollar exchange rate for the base year 2011.