Curbing Illicit Financial Flows from Resource-rich Developing Countries: Improving Natural Resource Governance to Finance the SDGs

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Abstract: Mispricing of international trade in natural resource commodities are a significant channel for cross-border illicit financial flows and tax base erosion from resource-rich, developing countries. However, existing evidence and research methodologies remain limited. This paper provides novel evidence of abnormal pricing in copper and coffee exports in Laos by applying price filter methods, which compare transaction level commodity export prices with an assumed arm's length price range. Our empirical methodology is informed by intensive qualitative investigation of commodity markets. This allows us to develop and transparently discuss our underlying assumptions regarding appropriate market benchmark prices, commodity heterogeneity and various other market-based and institutional factors affecting commodity sector in Laos. Based on these assumptions, our results indicate significant evidence of abnormal pricing in commodity exports from Laos especially undervaluation of green coffee exports and both overvaluation and undervaluation of copper concentrate exports, driven by fixed pricing of copper exports throughout our study period.

JEL classification: F18 – Trade and Environment, O13 – Agriculture, Natural Resources; Energy; Environment; other Primary Products, Q17 – Agriculture in International Trade, Q01 – Sustainable Development

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1. Introduction

Illicit financial flows (IFFs) from low-income and resource-rich countries have emerged prominently in contemporary debates about the challenges associated with increasing government

revenues and reducing reliance on foreign aid. IFFs are broadly defined as cross-border financial flows which are illegally earned, transferred or utilized (Carbonnier and Mehrotra, 2018; Forstater, 2018). This capital flight leads to concerns regarding tax base erosion in developing countries, where tax revenues as a proportion of economic activity remain significantly below potential. According to Modica, Laudage, & Harding (2018), tax revenue-to-gross domestic product ratios in year 2015 displayed considerable heterogeneity between and within regions, between 10.8 per cent to 30.3 per cent in Africa and 12.4 per cent to 38.6 per cent in Latin America, compared to 16.2 per cent to 45.9 per cent in the OECD countries. Resource-rich countries are particularly susceptible to commodity trade-related IFFs which erode public revenues from the production and sale of mineral and agricultural commodities. Therefore, effective governance of the mining sector is crucially important to domestic revenue mobilization, especially in developing countries that comprise 63 of the top 70 mining countries by contribution of the sector to the economy (Readhead, 2018; International Council on Mining and Metals, 2014). Similarly, agricultural commodities can also contribute significant revenue in developing countries, where there is an increased focus on prioritizing policies to promote high-value agricultural commodity production (Fukase & Martin, 2017).

Lao People's Democratic Republic (Laos hereafter) is a resource-rich developing country in Southeast Asia. Economic growth averaged more than 7 percent per year for most of the last decade, amongst the fastest in Asia. The Lao economy is heavily dependent on capital-intensive natural resource sector exports, which include mineral and agricultural commodities (copper, gold, coffee, wood products, cassava), as well as significant hydroelectricity generation and export to neighboring countries. These sectors play a major role in driving domestic economic growth through export earnings and attracting foreign direct investment (FDI). However, domestic revenue mobilization remains low in Laos. According to latest figures by the central bank, total domestic revenue including grants from donors equaled 15.7 percent of GDP in 2018 (Bank of the Lao PDR, 2018). Expanding the tax base, improving tax administration and increasing revenue contributions from the natural resource sector are important priorities for the administration. While significant risks for tax base erosion due to commodity-trade related illicit financial flows (IFFs) have been identified, there is a lack of available evidence on the magnitude and channels, which can be used to inform policymakers and motivate well-targeted regulatory responses.

Researchers have identified two prominent, overlapping channels for commercial actors to transfer financial capital across national boundaries: trade misinvoicing and intra-firm transactions of multinational firms (Beer et al, 2018; Carbonnier and Mehrotra, 2018; Crivelli et al, 2015). Trade misinvoicing is defined as a form of customs and/or tax fraud involving exporters and importers deliberately misreporting the value, quantity, source, destination, or nature of goods or services in a commercial transaction. The economic motives driving include tax-motivated profit shifting and evasion of customs duties or trade restrictions on particular commodities or countries. Low-income countries can often lack the tax and customs administration capacity required to monitor complex tax avoidance techniques in international commodity trade. For example, MNEs may establish local subsidiaries in developing countries that sell their production to affiliated marketing or purchasing companies. These local subsidiaries also receive finance, services, and equipment from either the parent or related companies. The process of determining the value of these transactions is called transfer pricing. As per normal business practice, the terms and pricing conditions of transactions between related parties should be comparable to arm's length terms and prices, i.e. conditions under which the transaction would have taken place between unrelated parties. However, abusive transfer pricing occurs when related parties distort the price of a transaction outside an arm's length value to shift profits to lower-taxed jurisdictions and thereby reducing the MNE's overall tax bill. Mispricing of commodities exported and transferred to related parties is therefore one of the main transfer pricing risks related to international commodity trade (Readhead, 2018).

Evidence of trade mispricing is generally limited to macroeconomic studies of partner-country trade gaps or asymmetries in aggregate and product-level export and import statistics of trading partners. However, the methodologies used in these studies and the underlying aggregate trade data have some important limitations due to which their large estimates of trade mispricing are generally considered weak evidence of trade mispricing and cross-border financial flows (Global Financial Integrity, 2017; Ndikumana, 2016). Certain studies have also used transaction-level trade data to analyze trends of abnormal pricing at the commodity level. This evidence currently remains limited to certain advanced economies due to administrative restrictions on public access to transaction-level Customs data (Hong & Pak, 2017; Hong, et al. 2014; Zdanowicz, et al. 1999).

1.1. Research objectives

This paper aims to estimate the magnitude of abnormal pricing, i.e. magnitude of trade valued outside an assumed arm's length price range, for Lao commodity exports. Copper and coffee are selected for this first stage of the analysis because copper is the country's largest export mining commodity and coffee is also a major agriculture export. Our estimations are based on price-filter analysis whereby transaction-level export prices are compared to global benchmark prices from commodities exchanges or trading associations (similar to Keejae, Cabrini, & Simon, 2014). This empirical method is motivated by 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; United Nations, 2017). Next, we compare these abnormal pricing estimates with endogenously calculated interquartile range (IQR) price filters. The IQR price filter assumes that the price range between the 25th and 75th percentile of observed prices represents an arm's length price range. According to (Keejae et al., 2014), this method corresponds to United States Internal Revenue Service (IRS) transfer pricing regulation (Internal Revenue Code 482) which specifies that an interquartile range is an acceptable arm's length transaction range. The OECD Transfer Pricing Guidelines also mention that interquartile range or other percentiles can be used to help enhance the reliability of any transfer pricing analysis (OECD, 2017, p. 164 paragraph 3.57). Outliers in the price distribution can disproportionately influence the IQR, therefore it should be considered with some caveats. However these estimates are useful to consider in the case of commodities without a clear market reference price. Our analysis is based on transaction-level exports data from Lao Customs on copper and coffee for the period 2011-17.

1.2. Main findings

The main findings of this paper are as follows. First, we find significant abnormal pricing in the export of coffee from Laos. 66.5 percent of the export transactions of the unroasted and not decaffeinated green bean coffee are consider under-valued, which is defined as the transaction with prices lower than 20 per cent of free-market prices assumed to account for product heterogeneity, transportation costs, and normal business variation based on our field research. The estimated undervaluation of green coffee export is 260 million USD or 77.1 percent of total coffee exports during the study period of 2012-2017. Under-valued transaction was largely seen in exports to Vietnam between affiliated firms. IFFs' risks in coffee export are trade among affiliated firms, facilitating roles of local agents and misreporting.

Second, we do not observe significant magnitude of abnormal pricing in the export of copper cathodes. We find that the prices of refined copper exports were mostly declared within the range of +10 percent and -5 percent around the benchmark free market prices assumed to account for transportation and other logistic costs and normal business variation. Over-valued transactions are estimated to be 2.83 million USD (equivalent to 0.18 per cent of total export value) while under-valued transactions are estimated to be 9.47 million USD (equivalent to 0.32 per cent of total export value) during the study period.

Third, we find that the price of copper concentrate export has been fixed at 2 USD per kilogram and 1.6 USD per kilogram in our export data during the whole study period. Our research interviews and consultation workshops[1] with relevant authorities confirm that invoiced prices are different from actual prices. The custom data recorded in the Ministry of Finance (Custom Department) is the invoiced price that is apparently the hedged prices. Any differences between the hedged price and actual price are later settled between exporters and customers. However, the Lao PDR's Ministry of Energy and Mine uses market price from London market to calculate royalties and concession fees. Given this context, we find overvaluation of 210 million USD or 11.4 per cent of the total export value and undervaluation of 104 million USD or 5.6 per cent of total invoiced export.

2. Natural resource sector in Laos

2.1. Copper sector: Risks for IFFs

Copper has contributed significantly to Lao economy as one of main export commodities and an important source of government revenue. The copper sector also provides substantial indirect contributions to the socioeconomic development in the form of local development funds and environmental protection funds. The production of refined copper sheets has remained constant from 64.3 kilotons in 2010 to 63.8 kilotons in 2017 while the production of copper concentrates increases from 298.7 kilotons to 398.8 kilotons during the same period (Lao Statistics Bureau, 2011, 2018). The value of copper export increased from 886 million USD in 2012 to 1,183 million USD in 2018, approximately equal to 90 per cent of total mineral exports from Laos during this period. The main export markets of copper are Thailand (65 percent of total copper export), Vietnam (17 percent), China (7 percent), the Republic of Korea (5 percent) and Malaysia (5 per cent) (Department of Export and Import, 2018). The copper industry is dominated by two large

scale mining operations: Lane Xang Mineral (LXML) and Phu Bia Mining (PHB). There are also other several medium and small scale operations, which are now mostly at the prospecting and exploration stage. The extractive sector contributes an average of 4.2 percent of total domestic revenues during 2012 to 2017, 92.8 per cent of which is contributed by the two largest mining firms (Department of Tax, 2018). In addition, the contribution of the mining sector to the government revenue has declined significantly from 9.3 percent of total domestic revenue in 2012 to 0.8 percent in 2017. The majority of investments in this sector come from China. Other investors are from Vietnam, Australia, Canada, Hong Kong, Taiwan, South Korea and Germany. Domestic investors also have large presence in the copper sector (Department of Investment Promotion, 2018). Laos mainly produces and exports copper concentrates and copper cathodes. LXML engages in mining stage of the value chain to produce and export mining concentrate while PHB goes further the value chain to mine, produce and export copper cathodes (Lane Xang Minerals Limited (LXML), 2018; Phu Bia Mining, 2018).

In order to examine the risks for miss-valuation of copper exports, this paper follows IGF-OECD practice note for monitoring the value of mineral exports (Readhead, 2018). Followings are some major risks for IFFs of the Lao copper industry:

1) Transfer pricing - transactions between affiliated firms:

Our data indicates that transactions between affiliated firms are most common. PHB export cooper concentrates mainly to the firm's affiliated smelter located in China. In 2016 other importing countries of Lao copper concentrates include Thailand, Vietnam and Switzerland (Phu Bia Mining, 2018). LXML exports the copper cathodes to markets in Thailand and China (Lane Xang Minerals Limited (LXML), 2018). The main importer of copper cathodes in China is the exporter's affiliated company and importers of copper cathodes in Thailand are electrical and electronic manufacturer, automobile manufacturer and trading company. Transactions between firms under the same multinational company, on one hand, make it difficult to evaluate intra-firm transactions. In addition, hypothetically, with differences in tax and non-tax regime across countries, it is possible that affiliated firms could cooperate in declaring the invoice value in the way that could general more net revenue for the company as a whole.

2) Price hedging practices:

Price hedging is used significantly in Lao copper sector especially for the copper concentrates. According to this practice, the realized price is compared with the provisional price and hedging gain or loss is offset in final invoice and final payment between the company and the customer (PanAust, 2014, pp. 77–80). This pricing strategy could lead to a gap between invoice prices reported to the custom and actual prices for the company. In addition, our key informant interview suggests that price hedging is only applied to a certain proportion of export to balance between price hedging transactions and free market transactions (Phu Bia Mining, 2018). Such pricing strategy is very new and complicated for Lao mining industry. This could limit the capacity of relevant government authorities to evaluate financial statement of the company and calculate tax and non-tax obligations of the company. In addition, price hedging practice contributes to inconsistency in trade data. For instance, the value of copper concentrate export from our custom data during 2012 to 2016 is equivalent to 46.6 percent of the value from UN COMTRADE. This could affect the analysis of abnormal prices. Finally, payments for exports of copper are usually taken place offshore between customers and headquarter. According to Bank of the Lao PDR, (2019), exporters are required to transfer their income from exports and others from overseas to their bank account in Laos within 120 days after receiving the payment. However, in practice, export revenues of some large concession projects are transferred directly from the buyer and the head quarter of the exporter company. This is allowed under the concession agreement. Such offshore direct payments limit the ability of relevant local authorities to monitor their financial flows and effectively valuate those transactions.

3) Lack of international benchmark price for the copper concentrates:

Prices of the copper cathodes used in the export valuation and tax, royalty and custom calculations are based on the London Metals Exchange (LME) (Lane Xang Minerals Limited (LXML), 2018). However, there is a lack of international benchmark price for the copper concentrate, making it difficult for the authority to assess the valuation of the export from the invoiced prices. Such difficulties add more IFF risks to the copper sector.

4) Limited capacity of local authorities in valuation:

The capacity of local authorities in understanding and valuating complicated off-shore and intra-firms transactions are still limited. Currently the tax department is under the process of improving its technical capacity in calculating taxes from mineral export using more advanced

and better consistent formula and using international reference prices as reference[2]. This limitation hinders the capacity to detect IFFs associated with the copper sector.

2.2. Coffee sector: Risks for IFFs

Coffee is Laos's major agriculture export, contributing significantly to the value added of the agriculture sector. Coffee harvested area increases from 50.6 thousands ha in 2010 to 93.3 thousands ha in 2017 and coffee's production also increases from 46.3 kilotons to 150.8 kilotons (Lao Statistics Bureau, 2011, 2018) . In 2016 the coffee plantation area shares 6.4 percent of total agricultural land and covers less than 1 percent of global harvested area and 1.46 percent of the world output (FAO, n.d.). Laos produces and exports both Robusta and Arabica coffee varieties. The local production emphasis has changed from Robusta beans towards Arabica beans in recent years. For instance, the share of Arabica coffee in the total coffee export was 25 per cent during 2006 to 2010 and it increases to an average of 52 per cent during 2011 to 2017. However, still, the majority of Lao coffee export is in the form of green coffee beans (more than 90 percent in 2017) where coffee roasting is taken placed overseas.

Lao coffee industry mainly focus at plantation, primary processing and export stage of the coffee supply chain while most of the roasting is done offshore. Lao coffee producer comprises of many players of different scales and several producer groups. The biggest planters are foreign companies[3] and one domestic company. In addition, there are many small scale producers especially at household level and many of them engage in some kinds of contract farming. Wholesale buyers and collectors usually engage in the processing and the exporters are responsible for the milling stage such as cleaning, sorting and grading

The Lao coffee sector presents some risky characteristics for IFFs, which are described below.

1) Transfer pricing - Trade between affiliated firms:

Lao coffee industry has become increasingly competitive with the presences of many exporters. Dao Heuang, the biggest exporter, and other foreign exporters trade a lot with their own affiliated firms locating in its major export market such as Thailand and Vietnam. According to Readhead, (2018, p. 14), the tendency for undervaluation is higher for trade among affiliated firms.

2) Facilitating role of local agents:

Most international and regional traders have their local agents to help facilitate price negotiations between Lao exporters and coffee buyers and supervise the contract. Local agents also engage in quality control and prepare other exporting procedures (Galindo J, Manivong P, David A, & Mongpadith S, 2007, p. 54). Local agents have good relationship with the buyers hence theoretically collusion is possible and there could be risk for IFFs.

3) Misreporting and misinvoicing of quantity and quality to reduce tax liability:

Laos mainly exports coffee bean, which is the early stage of the value chain. There are large variations of product quality and prices. However, currently there is no quality control body to verify the coffee quality and consequently the declared prices[4]. These make valuation of coffee export difficult and relies largely on the exporter. In addition, there are concerns that there could be under-reporting of the export quantity hence affecting the export value (National Institute for Economic Research, 2019) and the revenues that could be collected from this sector.

3. Empirical methodologies and data

As discussed in Section 1, mispricing of commodity trade transactions is a prominent channel for IFFs from resource-rich developing countries. It refers to the practice of exporting firms understating their trade values on Customs invoices, or importers overstating their import expenditures, with the motivation of transferring financial capital abroad either for private gain or for reducing corporate tax liabilities. In order to quantify the magnitude of this phenomenon, researchers have analysed asymmetries in partner-country trade statistics or examined pricing anomalies in transaction-level data. In this section, we discuss the price-filter analysis methods introduced by Zdanowicz, Sullivan, & Pak (1999) and (Keejae et al., 2014), alongside a brief discussion of their limitations.

Price filter analysis is an alternative methodology to analyse abnormal pricing in international trade which relies on a single country's transaction-level trade microdata on product-type (based on the Harmonized Commodity Description and Coding System or HS code), quantity, and unit value. This data is used to identify the arm's length price range for individual products which is then used to distinguish between normally and abnormally priced transactions. There are two main approaches to applying price filter analysis which are presented below.

3.1. Inter-quartile range price filter analysis

This methodology assumes that the inter-quartile range, between the 25th and 75th percentile, of the observed distribution of unit prices for a particular commodity represents the arm's-length price range. Under this approach, the overpriced amount is assumed to be the deviation of the price from the upper-quartile price when a declared unit value (price) is above the upper-quartile price. Similarly, when a declared price is below the lower-quartile price, the under-priced amount is assumed to be the deviation of the price from the lower-quartile price. Essentially, we test the following hypothesis using the interquartile range price filter method:

Hypothesis: The transaction price for a normally valued product lies within the arm's length price range defined by the interquartile range of the observed price distribution.

Accordingly, any transaction values, which exceed the 75^{th} percentile or fall below the 25^{th} percentile of the observed price distribution, is designated to be abnormally priced. The under or over-valued amounts for each transaction is then calculated as follows:

$$\text{Undervalued amount} = \text{Quantity} \times \text{MAX}(0, \text{LoQ} - \text{P}) \quad (1)$$

$$\text{Overvalued amount} = \text{Quantity} \times \text{MAX}(0, \text{P} - \text{UpQ}) \quad (2)$$

Where:

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

LoQ = Lower-quartile price

UpQ = Upper-quartile price

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 transactions that are priced outside the interquartile price range. Therefore, these estimates of trade mispricing should be interpreted with some caveats and supplemented with further analysis regarding product characteristics and trends in pricing by different source firms or geographic locations. For example, the level of purity of a precious metal and any contemporaneous commodity price shocks will play a key role in determining whether the observed transaction price falls within the interquartile price range during a given period. We discuss these limitations in more detail below.

3.2. Free-market price filter analysis

This framework compares actual transaction-level unit prices for a particular commodity with their contemporaneous free-market price, plus/minus an assumed range of deviation to account for expected price volatility due to product characteristics, transportation costs, contract terms, and business conditions. This range is assumed to represent the arm's length price range for the particular traded product. All transaction prices within this price range are assumed to be normally priced, while any prices outside the range as designated to be abnormally priced. More specifically, we test the following hypothesis by applying this method:

Hypothesis: All normally valued transaction prices for a particular product fall within the arm's length price range defined using the corresponding free-market prices.

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

$$\text{Undervalued amount} = \text{Quantity} \times \text{MAX}\,(0, P_{Low} - P) \quad (3)$$

$$\text{Overvalued amount} = \text{Quantity} \times \text{MAX}\,(0, P - P_{High}) \quad (4)$$

Where:

P = Declared price (unit value implied in the quantity and value in each declared import record)

P_{Low} = Lower bound of the free market price range

P_{High} = Upper bound of the free market price range

The main advantage of using the free-market price filter method is that we do not need to endogenously estimate arm's length price using the observed transaction prices. Therefore, this method is not affected by related party transaction records in the import and export database. However, this method requires easily identifiable and commonly acknowledged benchmark prices which may not be readily available for products where there is no established commodity market.

3.3. Methodological limitations of price-filter analysis

According to Reuter (2011) and Carbonnier & Zweynert de Cadena (2015), price filter analysis based on trade micro-data is an intuitive methodology, however it has some important limitations in accurately estimating abnormal pricing: firstly, the interquartile price range is endogenously estimated so this method will always identify some magnitude of over and under-priced

transactions, irrespective of any illicit activity. Therefore, the IQR price filter method is less preferable to the free-market-price filter method when the market reference prices are clearly identifiable. Secondly, product heterogeneity needs to be clearly understood in the application of this methodology. For product categories which are very heterogeneous in terms of quality and prices, this method can incorrectly identify high-end products as overpriced and low-end products as under-priced. Meanwhile, abnormally priced transactions of mid-range products might be wrongly classified as legitimate transactions. This problem is further exacerbated by limitations in the international commodity classification system which contains several broad and open-ended categories for very diverse product types. Finally, transaction-level trade data can also suffer from poor reliability due to frequent misclassification of products by Customs authorities as well as mis-recording of quantities, rather than prices.

In our application of the price filter analysis method, we introduce some methodological innovations to address some of these limitations. Firstly, we use qualitative research and expert interviews on commodity characteristics and supply chains to inform our assumptions regarding the selection of price filters around the free-market prices. The main factors we discuss are product heterogeneity, market conditions and contract terms, and shipping costs.

4. Estimates of abnormal pricing

This section estimates the magnitude of illicit financial flows (IFFs) through trade mispricing. The market price is taken as a reference to define an arm's length price range to capture the normal variation in prices, depending on product quality, associated transportation and insurance costs, as well as contract terms and transaction situation (Keejae et al., 2014, p. 211). These underlying assumptions are based on commodity sector research and are clearly discussed. The estimation of undervaluation and overvaluation is based on the method of price filter analysis at free market, which has been explained at length in section 3. The method of interquartile price filter is also used for comparison at the daily basis. Estimation of the magnitude of trade mispricing will first provide estimation results for refined copper and copper concentrate, which is then followed by the estimation for unroasted decaffeinated coffee. Before the empirical analysis of trade mispricing, the data used is presented as follows.

4.1. Data

This paper uses transaction level data from Laos's custom data for the price filter analysis during the period of 2012-2017. Since the means of unit price for three commodities are much higher than the means of the market price. In particular, there were some transactions for copper concentrate with the unit price as extremely high as 16,462 USD per kg which might indicate some outliers in the statistics presumed due to the hand error typing or poor record. Therefore, we exclude the extremely outliers who are above 99 per cent of sample's distribution with the quantities of less than 0.5 percent of total for each trading commodity. Thereafter, 26, 23 and 19 transactions for three trading commodities (refined copper, copper concentrate and coffee bean) are excluded. For the outliers below 1 percent of sample's distribution, we still keep the sample because a large quantity of export product is significantly observed. The export of coffee bean, for example, there were 19 transactions with 74,500 tons (33.8 percent of total) below 1 percent of sample's distribution. Therefore, if excluding the sample below 1 percent of distribution, the analysis would be much under-estimation. Thereafter, the final data set includes a total of 2,600 observations for refined copper export prices, 2,349 variables for copper concentrate export price and 1,950 variables for coffee export data. The summary statistics is reported in Table 1. Overall, there are large deviations around the means for all prices of three commodities where the minimum price unit price was 0.0021 USD per kg and the maximum price was 16.01 USD per kg. The table reports the summary statistics not only the total transactions but also quantity, value and unit price for three commodities. Note that the unit price is calculated from the quantity and value of each transaction. To overcome the homogenous issue, we used the Harmonize System (HS) classification code at 8 digits. Therefore, the HS codes for refined copper, copper ores, and coffee (not roasted and not decaffeinated) are 74301100, 26030000, and 09011110 respectively.

Meanwhile, the market price used as the benchmark for copper is the daily LME-Copper, Grade A price at the London Metals Exchange. The source of database is the Intercontinental Exchange (ICE) Administration accessed via Thomson Reuters Datastream. For green coffee export, the market price is the daily prices of Arabica and Robusta green bean at New York market and the data source is the International Coffee Organization (ICO).

insert Table 1 here

4.1. Abnormal Pricing Estimates for Refined Copper Exports

Lao mining companies use LME prices as a benchmark to set the price (Lane Xang Minerals Limited (LXML), 2018). In order to define the arm's length price range for Lao refined copper exports, the following assumptions are used.

1. **Product heterogeneity (+/-):** Copper cathodes refer to refined products extracted from the ore or concentrate then shaped into bars or plates of bullion through the process of a whole-of-ore leach, solvent extraction and electro winning before being transported to manufacturers of cable, wire and tube in foreign markets. There are different grades of refine copper traded in international market. The difference between grades depends on the purity of copper or the chemical composition. For instance, Grade A copper contains the purity of copper with 99.9 per cent while Grade B contains 95 per cent of copper purity. Off-grade refine copper is copper scrap. The refined copper export from Laos is of grade A quality containing 99.9 per cent of copper (Lane Xang Minerals Limited (LXML), 2018). Therefore, the variation in the purity is expected to be small and in our baseline we assume there is no variation in prices due to product heterogeneity.

2. **Transportation and other logistic costs (+):** A premium is added to the LME commodity exchange price (Lane Xang Minerals Limited (LXML), 2018) equal to approximate 2-3 per cent of copper price. This price premium incorporates transport cost and other logistic costs from the mine site to the seaport in Thailand. Therefore, we assume the premium can result in the variation of 5 per cent above the LME prices for Grade A copper.

3. **Normal market condition (+/-):** Some small normal variation in prices due to other market condition than those discussed above could be anticipated. There are not many producers of copper cathodes in Laos and Lao copper company engage in different stages of the value chain from mining to smelting and processing. Therefore, in our baseline we conservatively assume price variation due to normal business condition to be 5 per cent around the benchmark price.

To account for all the above-mentioned factors, we assume the range of arm's length price filter to be 10 per cent above (plus) and 5 per cent below (minus) from the free market. Figure 1

provides a picture of a scatter-plot of the daily prices of Lao refined copper cathode in USD per kilogram (blue dots) compared with the daily LME-Copper, Grade A price from London Metals Exchange (red line) and ranges of price filters (black dash lines). The estimates of undervalued and overvalued exports are reported in Table 2 and Table 3 respectively.

We find that the prices of refined copper exports were mostly declared with the range of the free market with + 10 per cent and – 5 per cent around the free market prices over the period of 2012-2017. With a total of 2,600 transactions, only 101 transactions were declared with the prices above the arm's length price range and 162 transactions were declared with the prices below the price range. Accordingly, the over-valuation is 2.83 million USD and under-valuation is 9.47 million USD during 2021-2017 and total miss-pricing is estimated to be less than 0.4 per cent of total copper export value.

The interquartile range price filter method generates larger estimates (56 million USD for over-valuation and 58.9 million USD for undervaluation and total mispricing of 3.9 per cent of actual export value during 2012-2017) compared to the free-market price filter method. This can be explained by the fact that the IQR is endogenously defined and therefore always designates some proportion of transactions to be over and under-valued. As discussed earlier, we prefer the free-market price filter estimates due to the availability of a clear market benchmark price from LME.

insert Figure 1 here

insert Table 2 here

insert Table 3 here

4.2. Abnormal Pricing Estimates for Copper Concentrate Exports

The price for copper concentrates depends on the percentage of contained copper, market price of refine copper, value and price of contained gold, value and price of contained silver, charge of refining and treatment, charge of penalties and delivery terms (Devlin, 2015). Therefore, the export price for copper concentrate per unit is defined in the simple formula as follows.

Price = (% copper*reference price) + (value of gold, silver) - (charges for treatment and refining)-(penalties) + delivery terms

Where the reference price refers to the daily market price of refined copper Grade A at London Metals Exchange (USD per metric ton, converted to USD per kilogram)

This is consistent with the information from our key informant interview that the price of Lao copper concentrate is determined mainly based on the level of contained copper in the exported copper concentrate (Phu Bia Mining, 2018). Lao copper concentrate contains between 23-25 per cent of copper, up to 9 grams per ton of gold and up to 60 grams of silver per ton of copper ore (PanAust, 2017b). The value of other contained minerals is equivalent to less than 1 per cent of copper price per ton. Therefore, we assume that the free market price of copper concentrate to be 25 per cent of the LME-Copper Grade A price. The following assumptions are used in the estimation of abnormal prices in copper concentrate exports:

- **Product heterogeneity (+/-):** According to our field research, the copper concentrate exported from Laos has high quality and there are not many exporters of copper concentrate hence product heterogeneity is expected to be small. Therefore, like the case of refining copper, we assume that product heterogeneity has no variation around the benchmark price, which is based on the free market price of copper concentrate.
- **Transportation and other logistic costs (+):** The exporter could charge additional premium from the world market to account for other costs. According to the financial statement of PBM in 2013, the marketing, realization and freight cost shared around 2-5 per cent of sale revenue during 2012-2013. This information is confirmed during our key informant interview that the exporter is responsible for transport cost from the mine site to the seaport in Thailand. Accordingly, we conservatively assume 5 per cent variation above the free market price of copper concentrate.
- **Normal market conditions (+/-):** Our Customs data suggests that prices of copper concentrate exported from Laos are almost fixed throughout the study period. The fixed prices observed in the data could be a result of the price hedging practice of the mining company for copper concentrate exports in Laos (PanAust, 2017a, p. 24). Following this observation, we conservatively assume 5 per cent around the benchmark price due to normal business condition and contract term. Based on the discussion with key informants from the department of custom and department of mining, there are two prices in practice for tax collection. The price used by the Ministry of Energy and Mines to calculate the

royalties or natural tax (the tax for using natural resources) is the market price from London market. Whereas, the price that is used to calculate the profit tax is the invoice price at the custom submitted by the mining exporters.

Therefore, to account for all the above mentioned factors, in our baseline we assume the range of arm's length price filter to be 10 per cent above and 5 per cent below the free market price of copper concentrate.

insert Figure 2 here

The invoice prices of the copper concentrate export were mainly over the range of free market (+10 per cent and – 5 per cent) over the period of 2012-2017. The invoice prices of most transactions were at the constant price around 2 USD per kg and 1.6 USD per kg during the studied period. This is attributed to the price hedging strategy by mining exporters. When the mining company hedges the price, the company agrees with the customer on a certain price. The exporter would lose when the actual price is above the agree price while the exporter will gain when the actual price is less than the agreed price. Differences in actual and agreed prices are then settled among the exporters and customers. The exporter reports the hedged price at the time of export hence the price becomes almost fixed in the custom statistics. The adjustment on price is not taken into account in the custom statistics hence there is clearly a deviation of invoice prices from the free market prices during the studied period. However, gain or loss from price hedging is considered as additional incomes or expenses of the exporting company (Expert interview, World Bank 2019). Figure 2 has plotted the invoice prices of Lao export copper concentrates against the market price with the ranges of price filter. It shows the prices of invoice are above the market price especially during 2014-2015 because the world price had steadily declined from 2012 reaching the lowest level of 1.98 USD per kg in early 2016 before picking up steadily until the end of 2017. The result, based on the free market price filter analysis, indicates that 1,748 transactions out of 2,349 (or 74.4 per cent of the transaction number) were above the market price whereas only 136 transactions were below the market price.

Table 4 and 5 present the estimates of undervaluation and overvaluation of copper concentrate exports based on the free market filter analysis. We find large magnitude of overvaluation and small scale of undervaluation around the filter prices. Overvaluation is estimated to be 210 million USD or 11.4 per cent of the total export value during the study period. Undervaluation is estimated

to be 104 million USD or 5.6 per cent of total invoiced export. If all records of transactions were priced at the free market price, the value of all transaction would be 1.5 billion USD instead of 1.8 billion USD.

The interquartile price filter method provides somewhat different results. The interquartile method suggests that there are much more undervaluation (101.7 million USD) than overvaluation (27.13 million USD) in the export of copper concentrates. This might be largely attributed to the price hedging where the price is fixed at a certain level leading to limited variations. Therefore, the interquartile range may not be appropriate to define the arm's length price range for analysis because of the fixed prices observed in the data.

The analysis in this sub-section on the magnitude of trade mispricing in the export of copper concentrate faces with data limitation. The analysis relies on reported customs prices that are apparently the hedged price. Given the fact that there are some adjustments between exporter and importer on the differences of agreed prices (hedged price) and realized prices, the use of hedged prices may affect the estimates in the free price filter analysis because it does not take into account such price adjustments. Our estimates should therefore be interpreted in this context.

insert Table 4 here

insert Table 5 here

4.4. Export of unroasted, non-decaffeinated coffee

This section provides the empirical analysis of abnormal price for Lao coffee export. The unroasted and not decaffeinated green bean coffee (HS: 09011110) is selected as a case study because this type of coffee is the most traded coffee from Laos. Lao coffee industry follows the coffee prices in the New York market (Coffee companies & Lao Coffee Association (LCA), 2018). The database of free market daily prices from the International Coffee Organization (ICO) is used because ICO daily price series provides daily prices of green coffee for all major origins and types at the international markets such as New York, German and French markets. Therefore, the daily prices of coffee bean at the New York from ICO database are considered as the free market benchmark. Prices are made at the time of contract. Prices are also influenced by quality and other additional cost especially transportation. The free price filter analysis uses the following assumptions.

- **Product heterogeneity (+/-):** Arabica and Robusta are two main types of coffee variety traded internationally. The database of ICO daily price series provides daily prices at the New York market for those two coffee beans. However, our custom data cannot differentiate prices by coffee variety. To overcome this, this paper uses data from Lao Coffee Association to understand the structure of coffee export. Accordingly, the share of Arabica in coffee export was in upward trend over the last decade from 19 per cent in 2006 up to 67 per cent in 2017. Therefore, the share of Lao coffee export by coffee variety on monthly basis during 2012-2017 is use as a weight to construct the daily prices of coffee-ICO Arabica and Robusta Mild at New York market into the composite ICO daily price as a reference price.[5] In addition, our field research suggests that there are many exporters of coffee and many international and regional buyers. Exporters are both foreign and domestic firms of different scales. Therefore, exported coffee could be of different qualities. Therefore, in our baseline we assume that product heterogeneity could result in the variation of 10 per cent around the benchmark prices.

- **Transport and other logistic cost (+):** Exporters of coffee in Laos usually are responsible for transport cost from their factories to the Lao-Thai border and then to the seaport in Thailand. According to (Galindo J et al., 2007), the transportation, insurance and additional cost is accounted for 13 per cent of the contract price to export Robusta coffee to Bangkok (Table 6). This additional cost includes weight losses due to drying and grading, manual sorting, export quality bags and bagging, weighting, stocking and loading. Such cost for the Arabica coffee is 21.4 per cent of the contract price. Accordingly, we assume that the variation of price due to transport and other logistic cost is 20 per cent.

- **Normal market conditions (+/-):** Some normal variation in prices of coffee due to normal business conditions is expected because of many players involved in coffee export (National Institute for Economic Research, 2019). Lao exports mostly green coffee beans where coffee roasting is taken placed overseas hence coffee price could be quite volatile based on market conditions. We therefore, in our baseline, assume 10 per cent variation of coffee price due to normal business conditions.

Given these assumptions, the arm's length price range of 40 per cent above (plus) and 20 per cent below (minus) from the free market price is assumed for our analysis on the export of coffee from Laos.

insert Table 6 here

Based on our analysis, there are evidence of abnormal pricing in the transactions of unroasted and not decaffeinated coffee exports from Laos. Figure 3, which plots the prices of daily transactions against the coffee green bean price at New York market with various ranges of the price filters, clearly illustrates that there are both undervaluation and overvaluation in Lao coffee export transactions. However, the size of undervaluation outweighs the overvaluation during the studied period. For instance, by using the free market filter analysis, 1,297 transactions or 66.5 per cent of total transaction are considered as under-valued transactions and 87 transactions or 4.5 per cent of total transactions are over-valued. The undervaluation is estimated to be 260 million USD or 77.1 per cent of total coffee export. The under-valued transaction was largely seen in the export to Vietnam which covers 81.4 per cent of total undervaluation. Thailand shares 4.2 per cent while Belgium, Japan and Denmark gains fractions of 4.0 per cent, 3.5 per cent and 2.9 per cent respectively. Most of under-value transactions to Vietnam are mainly attributed to the trade between affiliated firms (Project's political economic team, 2019). On the other hand, the overvaluation is estimated to be 2.2 million USD or less than 1 per cent of total coffee export value. Such overvaluation is very small. Over-value transactions are found in transactions to Thailand (54.5 per cent), France (12.5 per cent), Vietnam (9.7 per cent), Japan (8.4 per cent), and Belgium (6.6 per cent). In addition, the estimates from interquartile analysis supports a presence of large undervaluation in the export of coffee. However, the estimates of overvaluation by the interquartile is larger than the estimate from the free market price filter method but undervaluation is still lower..

insert Figure 3 here

insert Table 7 here

insert Table 8 here

5. Conclusions and policy implications for Laos

The natural resources sector has important role in Lao economy and contributes significantly to government revenues. However, several research has pointed out that revenue collections from the natural resource sector in developing countries are well below its potential and part of the reason is attributed to the problem of illicit financial flows (IFFs). The main objective of this paper is to estimate the magnitude of abnormal pricing for exports of copper and coffee from Laos. The paper uses the price-filter analysis by comparing transaction-level export prices against the free-market benchmark prices. The more conventional methods such as interquartile price filter analysis is also used to compare with the main estimates. Given the availability of data at the time of the research, the study finds economically significant magnitude of abnormal prices in the export of coffee from Laos (Section 4.4). The study also finds some evidences of abnormal prices in copper concentrate exports but the magnitudes are quite small (Section 4.3). These results should be used as indicative for further in-depth assessment for IFFs. In the future, the study will further research on how to adjust the transaction level data with the price hedging policy to improve the estimates by the free market price filter method. This study has several policy implications for Laos as below.

IFF is a new concept for Laos but it does have potentially sizable impact on the revenue collection. Given current fiscal difficulties of the government, the issue of IFF should not be neglected and be better understood by policymakers.

Financial transactions in the mining sector are very complicated. Valuation of the minerals is complex and difficult to understand. Furthermore, there are many transactions between affiliated firms and most of the payments and price negotiations are made offshore. This situation makes it challenging for the Lao tax and custom authorities to monitor and govern these transactions. Therefore, capacity building in tax and custom administration specifically for the mining sector is utmost important for Laos. A regulatory framework and legal guidelines are required to identify and govern illicit and illegal flows related to commodity exports from Laos. The government could explore the possibility of using various technologies and innovations to strengthen trade governance. Following the IGF-OECD guideline Readhead, (2018), this paper proposes a following recommendations to strengthen the valuation of copper exports in Laos:

- Valuation of copper export in Laos are proposed to largely rely on monitoring company's export valuation process. Direct measurement may be too costly for Laos considering the financial limitation of the Lao government and the scale of the mining industry.

- The government should allocate sufficient budget for relevant authorities to visit and inspect mine site without relying on company's support like current practices. This will promote the independence of the monitoring leading to better quality of the supervision.
- It is very important to set requirements for the mining company to use only certified and internationally accredited laboratory. Several successful mining countries including Canada, South Africa and Australia have strict requirements on the accreditation of the mining laboratory.
- There is a need to develop a standard on mineral sampling and testing and disclosure requirements. This is particularly helpful when the government does not engage in direct measurements. The quality and reliability of sampling is equally important as the reliability of mineral testing.

Coffee is among the promoted agriculture commodity in Laos with huge potential for foreign and domestic investments. Our study finds that the supply chain of this sector is complicated with many stakeholders and sizable intra-firms transactions across borders. Therefore, relevant tax and custom authorities are also required to increases their understandings of the nature, flow and transactions of this sector. There is a need to develop measures to verify or evaluate the declared export prices against the quality of coffee export.

Trade statistics recording practices in Laos need to be significantly improved. Trade statistics are not only important for improving the balance of payment analysis but also crucial for the study of IFFs. Transactions level custom data is needed to be further improved in terms of the completeness and accuracy to include specific information such as product quality, relationship between importers and exporter (trade among affiliated firms), de facto origin and destination of products Finally, developing counties can utilize the methodologies used in this paper to examine the magnitude of IFFs in their countries. Although data quality is one of the major limitations, some forms of administrative firm level export data may be available in the custom, trade or other database. Therefore, price filter analysis exercise could be attempted and findings can be used to help researchers and policymakers to have better understandings of the IFF issue and their implications for resource mobilization in the country.

Table 1. Summary statistics of selected commodities

HS Code: 74031100	Refined copper: cathodes and sections of cathodes				
	N	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Quantity (kg)	2,600	170,164	81,571	333	601,834
Value (USD)	2,600	1,133,621	593,001	11	4,621,135
Unit price (USD/kg)	2,600	6.66	1.11	0.033	8.54
Market price (USD/kg)	2,600	6.57	1.05	4.49	8.60
HS Code: 26030000	**Copper ores and concentrates**				
	N	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Quantity (kg)	2,349	462,859	578,469	103	9,622,700
Value (USD)	2,349	784,106	589,288	20	2,334,578
Unit price (USD/kg)	2,349	2.01	1.35	0.05	16.01
Market price (USD/kg)	2,349	6.14	0.99	4.33	8.33
HS Code: 09011110	**Coffee, not roasted, not decaffeinated: Arabica or Robusta**				
	N	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Quantity (kg)	1,950	112,264	1,373,098	100	60,000,000
Value (USD)	1,950	173,279	187,292	62	1,734,640
Unit price (USD/kg)	1,950	2.38	0.93	0.0021	5.67
Market price (USD/kg)	1,950	3.24	0.47	2.02	4.81

Source: Lao Custom Department, Ministry of Finance.

Table 2. Undervalued exports

Year	Export value (USD, million)	Free market price filter: minus 5% (USD, million)	Interquartile range filter: below 25th pctle (USD, million)
2012	608	2.22	0.5
2013	641	0.07	0.0
2014	612	0.16	0.1
2015	507	1.03	18.9
2016	241	2.50	36.2
2017	338	3.49	3.2
Mean	491	1.58	9.8
Total	2,947	9.47	58.9

Data Source: Lao Customs Department, Ministry of Finance.

Notes: Free market price is the daily LME-Copper, Grade A price from London Metals Exchange (USD per metric ton, converted to USD per kilogram). Interquartile range is calculated for unit prices (USD per kg) using transaction-level Lao Customs data.

Table 3. Overvalued exports

Year	Export value (USD, million)	Free market price filter: plus 10% (USD, million)	Interquartile range filter: above 75th pctle (USD, million)
2012	608	0.06	41.7
2013	641	0.34	13.8
2014	612	0.50	0.5
2015	507	1.94	0.0
2016	241	0	0.0
2017	338	0	0.0
Mean	491	0.47	9.3

Total	2,947	2.83	56.0

Data Source: Lao Customs Department, Ministry of Finance.

Notes: Free market price is the daily LME-Copper, Grade A price from London Metals Exchange (USD per metric ton, converted to USD per kilogram). Interquartile range is calculated for unit prices (USD per kg) using transaction-level Lao Customs data.

Table 4. Undervalued exports

Year	Export value (USD, million)	Free market price filter: minus 5% (USD, million)	Interquartile range filter: below 25th pctle (USD, million)
2012	126	0.1	0.1
2013	37.8	0.0	0.0
2014	353	92.0	76.4
2015	256	8.9	10.8
2016	513	0.0	6.3
2017	555	2.8	8.2
Mean	307	17.3	17.0
Total	1,841	104	101.7

Data Source: Lao Customs Department, Ministry of Finance.

Notes: Free market price is 25 per cent of the daily LME-Copper, Grade A price from London Metals Exchange (USD per metric ton, converted to USD per kilogram). Interquartile range is calculated for unit prices (USD per kg) using transaction-level Lao Customs data.

Table 5. Overvalued exports

Year	Export value (USD, million)	Free market price filter: plus 10% (USD, million)	Interquartile range filter: above 75th pctle (USD, million)
2012	126	0	0.0
2013	37.8	0	0.0
2014	353	14.40	0.5

2015	256	29.60	0.1
2016	513	127.00	16.8
2017	555	39.00	9.7
Mean	307	35.00	4.5
Total	1,841	210.00	27.1

Data Source: Lao Customs Department, Ministry of Finance.

Notes: Free market price is 25 per cent of the daily LME-Copper, Grade A price from London Metals Exchange (USD per metric ton, converted to USD per kilogram). Interquartile range is calculated for unit prices (USD per kg) using transaction-level Lao Customs data.

Table 6. Export Freight on Board (FOB) price structure for natural Robusta and washed Arabica beans

Price/cost	Robusta	Share of contract price FOB (%)	Arabica	Share of contract price FOB (%)
1. Average contract price FOB at the port in Bangkok (USD/MT)	1,750	-	2,600	-
2. Shipping costs to the port in Bangkok (USD/MT)	136	7.7%	136	5.2%
3. Conditioning costs (USD/MT)	90	5.1%	420	16.2%
(2 + 3)	228	12.8%	556	21.4%

Source: Author summarized from Galindo J et al., (2007, pp. 84–85, Annex 7&8).

Table 7. Undervalued exports

Year	Export value (USD, million)	Free market price filter: minus 20% (USD, million)	Interquartile range filter: below 25th pctle (USD, million)
2012	50	6.76	0.7
2013	68	9.13	2.5
2014	61	27.30	0.4
2015	52	196.0	133.0

2016	32	11.0	2.5
2017	75	10.40	0.7
Mean	56	43.43	23.3
Total	338	260.0	139.8

Data Source: Lao Customs Department, Ministry of Finance

Notes: Free market price is the International Coffee Organization ICO Daily Price (USD per metric ton, converted to USD per kilogram). Interquartile range is calculated for unit prices (USD per kg) using transaction-level Lao Customs data.

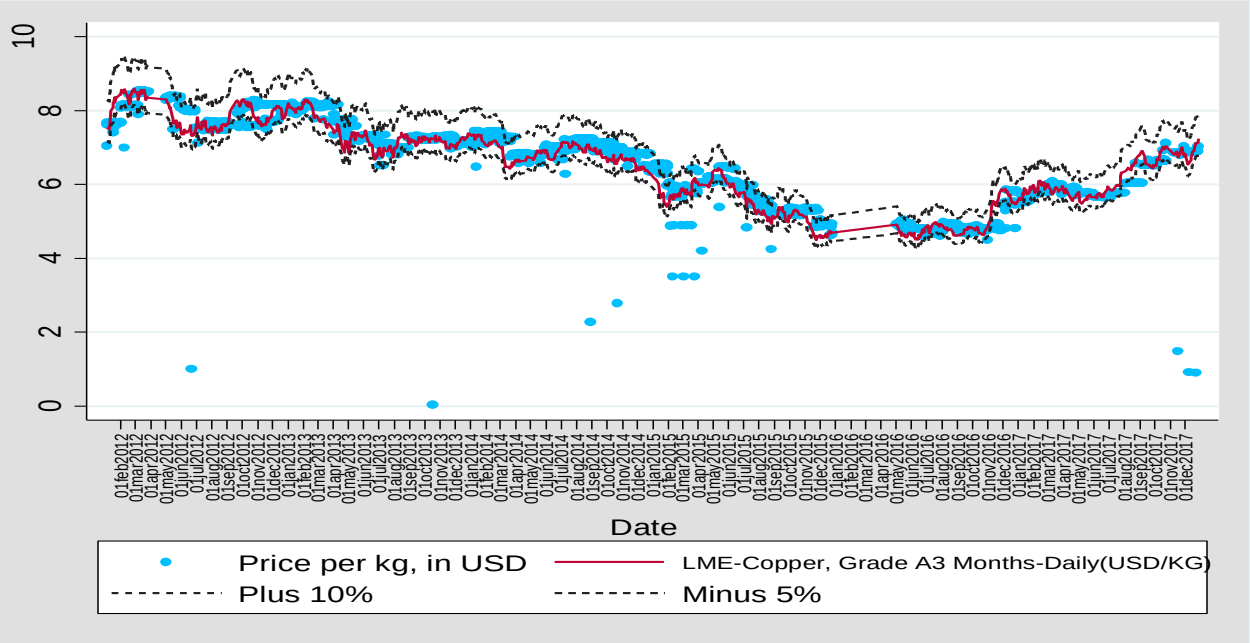
Table 8. Overvalued Exports

Year	Export value (USD, million)	Free market price filter: plus 40% (USD, million)	Interquartile range filter: above 75th pctle (USD, million)
2012	50	0.81	8.8
2013	68	0.57	5.5
2014	61	0.14	2.0
2015	52	0.11	2.2
2016	32	0.09	1.2
2017	75	0.49	3.7
Mean	56	0.37	3.9
Total	338	2.20	23.3

Data Source: Lao Customs Department, Ministry of Finance

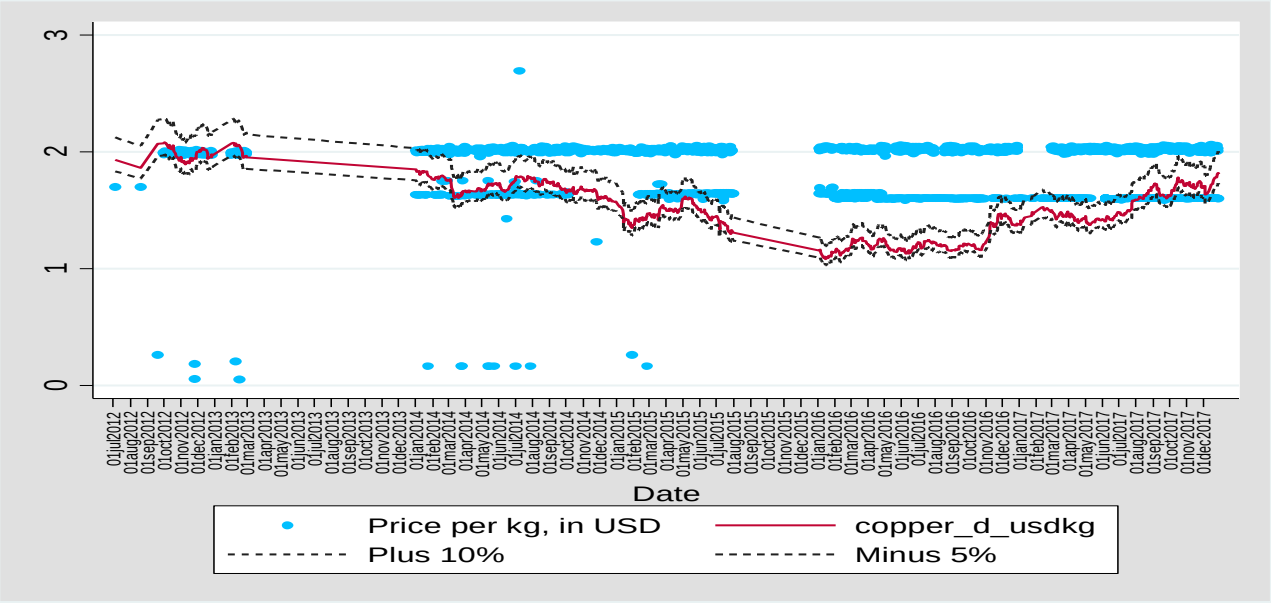
Notes: Free market price is the International Coffee Organization ICO Daily Price (USD per metric ton, converted to USD per kilogram). Interquartile range is calculated for unit prices (USD per kg) using transaction-level Lao Customs data.

Figure 1. Refined copper – transaction-level prices versus free market prices



Source: Author's calculation using the daily transaction data from Lao Custom Department, Ministry of Finance.

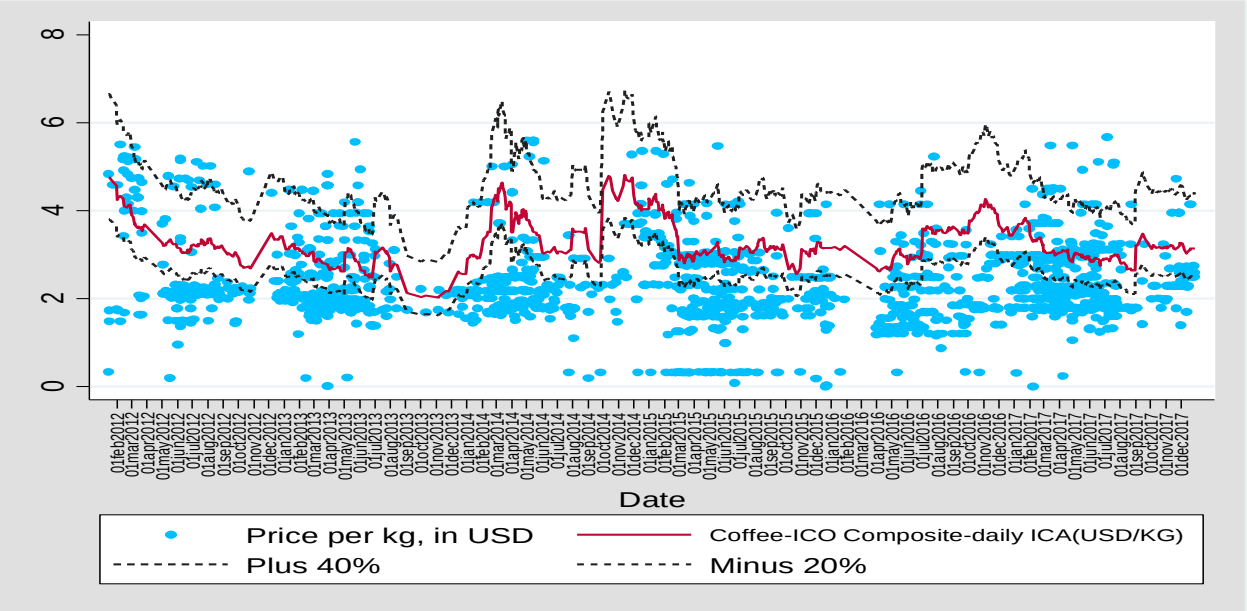
Figure 2. Copper concentrate – transaction-level prices versus free market prices



Source: Author's calculation using the daily transaction data from Lao Custom Department, Ministry of Finance.

Note: to smooth the graph, the transactions with a unit price above 10 USD per Kg are excluded from the figure.

Figure 3. Coffee beans – transaction-level prices versus free market prices



Source: Author's calculation using the daily transaction data from Lao Custom Department, Ministry of Finance.

Notes

1. Inthavong, Thatthawi, Official at Department of Mine Management, Ministry of Energy and Mine, in discussion with the authors in May 2019.

2. According to discussion at the technical seminar on 17 January 2019, the royalty tax for copper concentrate export is calculated based on the percentage content of copper, percentage of other valuable minerals such as silver and gold and the intermediate refining cost. This is consistent with internationally used formula. The LME price is also used as reference price in the calculation. However, this new method might only be applied to smaller mining project other than the LXML and PHB which are covered by their concession agreements.

3. Outsapan - Olam from Singapore own more than 1,100 ha and three big Vietnamese companies also possess between 500 and 1,000 ha

4. Manolom, Thantawan, Researcher at Economic Research Institute for Trade, in discussion with the authors, 24 May 2019.

5. The composite ICO daily price (reference price) = Weight*Arabica ICO daily price + Weight*Robusta ICO daily price

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