EXPORT AND IMPORT PRICE INDICES (XMPI)

TECHNICAL MANUAL

GHANA STATISTICAL SERVICE
MAY 2024

EXPORT AND IMPORT PRICE INDICES (XMPI)

TECHNICAL MANUAL

GHANA STATISTICAL SERVICE
MAY 2024

CONTENTS

1. INTRODUCTION

The primary organization in charge of obtaining statistics to support evidence-based decision-making in Ghana is the Ghana Statistical Service. Producing economic data to track the economy and helping the government formulate policies for sustainable economic development is one of the main duties. An essential macroeconomic indicator for monetary and fiscal policymaking is provided by price statistics. Ghana Statistical Services produces the monthly Consumer Price Index (CPI), Producer Price Index (PPI), and Gross Domestic Product (GDP) already.

There is no indicator for Ghana's export and import prices yet, while this is an important input for accurate GDP calculations, since export and import price indices should be used to deflate nominal trade figures to real trade figures. Before the computation of export and import price indices, the exchange rate was used to deflate trade figures, which is an inaccurate measure. Therefore, the creation of Ghana's Export and Import Price Indices (XMPI) is a crucial step in bolstering the nation's economic statistics and will significantly enhance GDP projections.

Export and import price indices measure the rate of change over time in the prices of exported and imported goods (International Monetary Fund, 2009). An export price index (XPI) measures the rate of change in the prices of goods sold by residents of that country to, and used by, foreign buyers. An import price index (MPI) measures the rate of change in the prices of goods purchased by residents of that country from, and supplied by, foreign sellers.

The most cost-effective way to calculate such XMPIs is using unit value indices (UVI). Hereby we must note that UVIs are a surrogate to price indices, as they can change due to changes in prices as well as product quality and composition. UVIs therefore have to be used with caution. However, a large advantage of UVIs is that they are low-cost as it can be calculated using solely administrative customs data. The unit value is calculated by dividing the total trade value by the corresponding total trade quantity. The UVI is an index of the ratio of the unit value in the present period to the unit value in the previous period. Unit value indices are biased when used to aggregate distinct, heterogeneous commodities, but they perform effectively when used to aggregate identical, homogeneous products. Therefore, unit values and their relative prices will be firm specific and calculated at the most detailed product level (harmonized system, HS 10 digits). These firm and product specific relative prices are then aggregated to create the UVI for higher levels of HS aggregation, as well as for imports and exports in total.

It must be noted that there is a potential bias in unit value indices, especially due to changes in the mix of heterogeneous items in the customs data, as well as poor quality data on quantities (International Monetary Fund, 2009). Therefore, the UVI compilation can be accompanied by surveys, specifically the export and import price surveys. The

Ghana Statistical Service is considering this approach in the near future, but due to cost constraints now limits itself to the UVI.

XMPIs play a significant role in the establishment of various trade agreements and general commercial commerce by the government. Moreover, the XMPIs are required for the evaluation of a nation's competitiveness, the measurement and forecasting of inflation, the evaluation of the exchange rate, and the compilation of real GDP. Additionally, XMPIs and their movements are important to all international organizations concerned with general economic policy, including the World Trade Organization (WTO), the International Monetary Fund (IMF), the Organisation for Economic Co-operation and Development (OECD), the World Bank, and other United Nations (UN) organisations. Consequently, the collection of reliable export and import price indices is required.

The Ghana Statistical Service (GSS) Export and Import Price Indices (XMPI) technical manual is available here in the 2024 edition. Anyone who wants to know how the XMPI are computed should refer to this technical document. It discusses the source of the data, the definition and scope of the indices, the commodity selection, the construction of the indices, data management issues, and the dissemination and application of the indices.

2. DATA SOURCE

This report uses data from the Customs division of the Ghana Revenue Authority as main source of the trade data. All trade statistics compiled by the Ghana Statistical Service closely follow the International Merchandise Trade Statistics (IMTS) Manual of the United Nations to ensure alignment with international standards. Based on the IMTS Manual, GSS has developed a technical manual detailing the compilation of trade statistics in Ghana. This manual, available on the trade page of the GSS website, explains the application of the IMTS Manual to Ghana's trade statistics and clarifies how the country's trade data is used in compliance with IMTS guidelines. For a comprehensive overview of the methodology applied in all GSS publications that utilize trade data, including the compilation of data used to compute the XMPIs, please refer to the technical manual.

3. DEFINITION AND SCOPE

Export-Import price Indices (XMPI) are compiled by three general methods, the nature of which is largely dependent on the source of data used. The three methods are as follows.

1. The first method uses unit value indices compiled from detailed import and export data derived from administrative customs documents.
2. The second method is to compile price indices from surveyed establishments on the price of representative items exported and imported.
3. The third method is a hybrid approach that involves compiling establishment survey-based price indices for some product groups and customs-based unit value indices for others.

Ghana Statistical Service will focus on the first approach, compiling the XMPIs using unit value indices, due to the low cost of compilation. However, in the future GSS will try to move towards the third method in which establishment surveys will be used to replace the unit value indices for certain goods.

The focus of the XMPIs is on goods solely, while leaving out services, as they are not part of the administrative data that is used for the index computation.

The XMPIs do not aim to monitor the average price changes for goods sold in Ghana, nor is it intended to replace the consumer price index or the producer price index. The primary focus of the XMPIs is on tracking the price changes of imported and exported commodities, illustrating shifts in price levels. The indices are then used to adjust nominal trade figures to real values, allowing for the tracking of changes in export and import volumes, without distortions due to price changes.

4. COMMODITY SELECTION

The XMPIs are indices that represent the price of exports and imports to identify changes in price levels. For an accurate estimate of changes in price levels, the same goods need to be compared between different time periods. Therefore, the selection of goods is essential for the computation of the indices, which is described in this section.

The commodity selection is based on the Harmonized Commodity Description and Coding System (HS). This is the primary nomenclature used to compile export and import data by customs authorities. It is a classification system of trade commodities which is split up in 4 hierarchical levels, that is the chapter level (2 digits), heading level (4 digits), subheading level (6-digits), and the commodity level (10 digits) in the case of Ghana). In total there are 99 chapters, all with their own headings, subheadings, and finally including more than 6000 detailed commodity level codes.

As trade is dynamic, the basket of included goods should not be fixed for a long time. For example, when crude oil was discovered in Ghana, it became a major export commodity, that should be included in the basket of goods. On the other hand, there might also be goods that are traded less and less frequently, and hence need to be removed from the so-called basket.

Because the Unit Value Indices are based on Customs data, they are not bound to a certain basket of goods, which survey-based indices have to stick to. This means that every good for which there is a price in two subsequent periods can be included in the index. The main important aspect for the UVI though is that homogenous goods should be compared from one period to another. Hence, we calculate relative prices not only on a commodity level by using the HS 10-digit codes, but we do this on a firm specific level. This is based on the assumption that the same firm will more likely trade in a more homogenous good within one HS classification. For example, one firm might trade in premium quality products of one HS code whereas another firm trades in a much lower quality product which falls within the same HS code.

This method means that the included goods are those for which the same firm has had at least one transaction of the same good in the previous time period (quarter) as well. For all other goods it is not possible to calculate a relative price, and they are thus excluded from the index. Every quarter the included goods can therefore differ, and the base period is therefore always the previous quarter. After the first index computations these quarterly indices can then be chained to create a timeseries index. This will be elaborated on in Section 6.

5. CONSTRUCTION OF THE UNIT VALUE INDICES

The Unit Value Indices are a measure of price change of imported and exported goods. The UVIs are compiled based on Customs data of all export and import transactions. In this chapter we will start by explaining what unit values are, after which different types of index formulas are presented, and the final index formula will be presented. Moreover, the base year and methodology for rebasing and chain linking is described.

5.1 Unit Values

A variety of index formulas can be used to compute Unit Value Indices. Let us start by defining what exactly unit values are, and then dig into the different possible index formulas that can be used.

The unit value is defined as the ratio of the value to the quantity, giving the value per unit. Therefore, for each transaction the unit value is calculated as the value of the transaction in Ghana Cedis (CIF for imports, FOB for exports) divided by the corresponding quantity in kilograms.

This unit value is calculated on an HS 10-digit product and firm level, for exports and imports separately, for every quarter. The unit values are a type of weighted values, as for each product and firm combination the total value exported/imported within a certain quarter is added up, as well as the weights, and then the unit value is calculated as the sum of the values divided by the sum of the weights. Hence, a higher weight is given to the unit value of transactions with a higher value.

5.2 Index Formulas

The Unit Value Index is then calculated as an average of the price change from quarter to quarter over all selected products for exports and imports separately. Let us for now assume that there is a base period for which the unit values are seen as the base unit values. Then, in the next quarter the unit prices for all products are compared to those base period unit values to generate relative prices. These relative prices are then aggregated over all products to compile the Unit Value Index. The way in which you aggregate over the products and compile the final index is determined by the chosen index formula. In this section we follow Gaulier, Martin, Méjean, & Zignago (2008) in their explanation of different index formulas.

Two commonly used index formulas are the Paasche and Laspeyres indices, which both measure the price evolution of a given basket of good between a reference period and current periods (Gaulier, Martin, Méjean, & Zignago, 2008). The difference is that the Laspeyres index uses the base period quantities to decide on the weights of the products, whereas the Paasche index weights prices by current quantities.

The Laspeyres Unit Value Index ($L_{t/0}$) is an average of the unit value ratios, weighted by the share of each good in the base period:

$$L_{t/0} = \frac{\sum_k p_{k,t} q_{k,0}}{\sum_k p_{k,0} q_{k,0}} = \sum_k w_{k,0} \frac{p_{k,t}}{p_{k,0}},$$

where $p_{k,t}$ is the unit value, also described as the price as it is the price per unit, of product k in time period t. $q_{k,t}$ is the traded quantity in kilograms, and $w_{k,0} = \frac{p_{k,0} q_{k,0}}{\sum_k p_{k,0} q_{k,0}}$ is the share of the value of the trade flow of product k in time period t, which is the weight in the base period.

The Paasche Unit Value Index ($P_{t/0}$) is different from the Laspeyres index in the way that it aggregates the prices using current period weights, instead of base period weights. Hence, the Paasche Unit Value Index is defined as:

$$P_{t/0} = \frac{\sum_k p_{k,t} q_{k,t}}{\sum_k p_{k,0} q_{k,t}} = \frac{1}{\sum_k w_{k,t} \frac{p_{k,0}}{p_{k,t}}}.$$

Both indices have a bias because they measure price evolutions between two time periods, using a single time period to determine the weighting, this therefore ignores possible substitution effects. The Laspeyres index tends to overestimate the real price evolutions, as when prices rise users tend to substitute their consumption towards cheaper goods, thereby reducing the quantity. On the other hand, the Paasche index tends to underestimate the price evolution by giving higher weight to products that had a price drop.

This means that the Laspeyres and Paasche index suffer from measurement bias because of the use of a single period for the weighting. It has empirically been shown that the Laspeyres and Paasche indices are upper and lower bounds of the real price evolution (Feenstra, 1997). Therefore, computing the geometric mean of these indices gives us a superlative index, the Fisher index. The Fisher index is the geometric mean of the Laspeyres and Paasche index:

$$F_{t/0} = (L_{t/0} \times P_{t/0})^{1/2}.$$

This index is superlative, which means that it is the best index to use as it is most exact. One should note that most price indices, such as the Consumer Price Index (CPI) and the Producer Price Index (PPI) use the Laspeyres index formula. This is because such survey-based indices rely on a base-period survey to decide on the weighting attached to each product. As Unit Value Indices rely on Customs data for both the index as well as the weighting, it is one of the few indices for which a Paasche and therefore Fisher index is possible. Since the Fisher index is superlative, proven to be less biased when the data is available, the Fisher index should be used for the Unit Value Indices instead of the Laspeyres index.

5.3 Base Year and Chained Indices

The other source of measurement error using these indices is due to extensive margin effects. This means that both indices neglect the change in the commodities that are

being traded. Therefore, important newly introduced goods can either be omitted, or goods that are not very relevant anymore, but were in the past, can be included. This means that the basket of goods is not reliable anymore, which will bias the results. Especially for Export and Import Price Indices, this is a very common problem. Hence, fixed-base indices in which the basket of goods is fixed in one base year and not frequently updated is not suitable. Therefore, it is better to used chained indices.

With chained indices, the reference period changes over time, thus allowing to account for changes in the composition of the basket of goods (Gaulier, Martin, Méjean, & Zignago, 2008). For the XMPIs regular changing the selected basket of goods is essential due to impact of a changing composition of exports and imports on the indices. If, for example, Ghana suddenly discovers a new natural resource, which it starts exporting, this new product should be included in the index. Therefore, our index is a quarterly chain-linked index. This means that for each quarter the base period is simply the previous quarter, and all goods that are traded in both quarters are included. However, this also means that in each quarter the previous quarter is treated as a base period with a price level of 100. Hence, the quarterly indices need to be chain linked to be able to have one continuous time series in which over time comparisons can be made. Therefore, the final index is a quarterly chain-linked index.

The computation of Unit Value Indices starts in the year 2021, using the first quarter of 2021 (Q1 2021) as the price reference period of 100. This has two reasons, first of all, in July 2020 the Ghana Revenue Authority changed to a new record keeping system, and since that date GSS has refined its methodology of compiling trade statistics. Therefore, it is ideal to start the compilation of the indices after July 2020. Moreover, GSS has multiple economic indicators, each with their own base year, which is good to try to align as much as possible. The base year for the GDP is 2013, which will be rebased in the near future. The base year of the Producer Price Index (PPI) is March 2020 to February 2021, and the base year for the Consumer Price Index (CPI) is 2021 for the prices and 2018 for the expenditure weights. Hence, to align as much as possible with the CPI and PPI, while simultaneously making sure to use data from the newest Customs system, the price reference period of Q1 2021 as 100 is chosen.

The chained Laspeyres and Paasche indices are computed as follows:

$$cL_{t/0} = \prod_{i=1}^{t} L_{t/0} \ ,$$

$$cP_{t/0} = \prod_{i=1}^{t} P_{t/0} \ ,$$

where $L_{t/0}$ ($P_{t/0}$) is the quarterly Laspeyres (Paasche) index with the previous quarter as its reference period.

Finally, the chained Fisher index is computed as follows:
$cF_{t/0} = (cL_t \times cP_t)^{1/2}$.

6. DATA AND OUTLIERS MANAGEMENT

Unit Value Indices largely depend on the quality of the data that is being used. Therefore, it is essential that there is a robust method for data cleaning, such as how to deal with outliers as well as any missing values. In general, the trade statistics published by Ghana Statistical Service follow the Technical Manual for Trade Statistics of GSS. Hence, please refer to that Technical Manual to understand which data goes into the Unit Value Indices as well. However, for the index computation, some additional data cleaning steps are being performed, which are explained in this section.

6.1 Missing or Zero Values

Firstly, if there are any missing or zero values for the value of the transaction, or the net weight, these observations are sent back to Customs to be cross-checked and adjusted. If it happens that any observation remains to have a zero or missing value for the value or net weight, it will be discarded from the data.

6.2 Outliers

Unit value indices rely on outlier detection and deletion, as outlier unit values will bias the indices greatly. Therefore, it is important to have a robust method for outlier filtering.

First of all, the trade data is analysed monthly to check for any extraordinarily high trade values, by comparing the data to historic data and analysing the exports and imports with the highest values. However, that process might not always be perfect in removing all outlier unit values. Therefore, there is an additional procedure of outlier deletion for the Unit Value Indices.

Then, for every quarter the unit values are first calculated for each transaction. Afterwards, the median unit value in that quarter is calculated for each commodity for each firm, separately for export and import. One can assume that unit values of a product should not hugely deviate between different transactions of the same commodity traded by the same firm within the same quarter. Therefore, to take out outliers but to not remove any important data, for each product and firm combination we replace all unit values by the median unit value for that specific product and firm combination in that quarter. This is a first step of taking out obvious outliers and smoothing the data.

For example, if firm A has 25 different transactions of cocoa exports of HS code 1801001200, they all have their own value and weight. Hence, for all transactions a unit value can be calculated, which is the value per kilogram. These values should be similar, but if for one transaction a wrong weight is filled in, the unit value might be distorted. Hence, we replace all the 25 unit values by the median unit value for firm A of cocoa beans. This is done for all firm and product combinations.

6.3 Relative Price Filtering

After the missing and zero values have been removed from the data, and the median unit values are taking for every firm and product combination, all transactions for a specific firm and product combination are grouped together and a total value and total weight is calculated. Then, for each firm and product combination the relative unit value (price in Ghana Cedis per kilogram) is calculated, by simply dividing the current period median unit value by that of the previous period. However, if there are any remaining outlier unit values in the data, this can greatly impact the final index. Therefore, there needs to be a certain level of relative price filtering.

For other survey-based indices, such relative price filtering is not required, as for any extreme price changes they can contact the data collector to ensure of the accuracy of the price change. For the UVI all Customs data is included, so a robust method to only include real price changes has to be used. We use a two-level relative price filtering.

First of all, we discard any price changes above 3 and below 1/3. This means that we assume that it is not possible that a firm trades a certain product for 3 times more or less the price per kilogram in one period as compared to the previous period. This would be a 200% increase in a price per kilogram which we have seen in the data to be extremely rare and therefore never accepted to be included for the index computations.

The second layer of relative price filtering is within the HS chapter level. There are 99 distinct HS chapters, all including similar products. For each of such chapters we calculate the median price change in that quarter. Then we assume that all product and firm combinations that are part of that chapter should not have price changes that are far away from the median of the chapter. We set a limit of 1.5 times higher or lower than the median price change. In this way, when price changes in a certain period are very high, we allow for higher price changes as well, which makes sure that we do not affect the truthfulness of the index.

It must be noted that for the CPI and PPI price changes of 1.2 or 1.25 are already marked as out of the ordinary and always double-checked. Since we are not able to do such double-checking for the thousands of Customs records, we need to set a limit on how to filter for relative prices that can be included into the index. Therefore, we set a limit of 1.5 times the median of the HS chapter in that quarter.

7. LIMITATIONS AND ESTABLISHMENT SURVEYS

Unit Value Indices, while valuable tools for gauging changes in the average value of traded goods, come with inherent limitations that warrant consideration. One significant issue is that they do not account for shifts in the composition and quality of traded commodities over time. This is particularly an issue for heterogenous commodity groups, such as for some commodities such as machinery. We tried to limit this as much as possible by calculating relative prices based on the combination of the firm and commodity. However, it is still no guarantee that a firm does not change the quality of the products that they trade in.

This oversight can lead to misleading interpretations of price changes, as fluctuations in the mix of goods, or quality changes, may be mistakenly attributed solely to price movements. To address these limitations, the utilization of establishment surveys emerges as a robust solution for calculating export and import price indices.

Establishment surveys provide a more accurate and granular approach, capturing data directly from businesses involved in trade. By collecting information on prices, quantities, and specifications of specific commodities, establishment surveys enable the calculation of indices that account for changes in product quality, shifts in traded items, and potential substitution effects. Consequently, incorporating establishment survey data enhances the precision and relevance of price indices, offering policymakers and economists a more comprehensive understanding of trade dynamics and inflation trends.

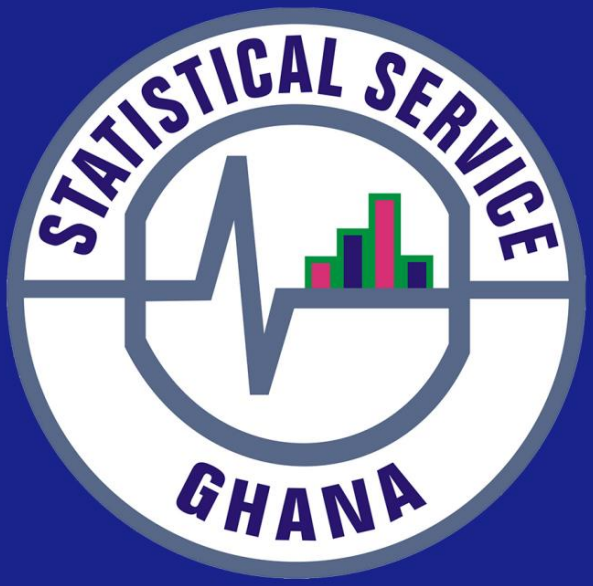
Currently, the Ghana Statistical Service does not have the capacity and financial capability to undertake these establishment surveys, so we fully rely on Customs administrative data. However, in the near future we will also start to undertake establishment surveys, particularly for product groups that are heterogenous in nature.

REFERENCES

Feenstra, R. C. (1997). U.S. Exports, 1972-1994: With state exports and other U.S. data. *NBER Working Papers 5990*.

Gaulier, G., Martin, J., Méjean, I., & Zignago, S. (2008). International Trade Price Indices. *CEPII*.

International Monetary Fund. (2009). *Export and Import Price Index Manual: Theory and Practice*. Washington, D.C.



www.statsghana.gov.gh