# PRICE ELASTICITIES OF KENYA'S EXPORTS

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*Abstract:* Despite a recent boost of export price indices, Kenya's exports earnings growth are still low. The value of exports grew by 9.1 percent while imports growth stood at 16.6 percent over the period 2005/2012. In addition, Kenya's exports share in the world as a percentage of GDP has been gradually weakening as imports share grew significantly. This left the economy with a wide current account deficit and constrained growth. This study attempts to determine the responsiveness of Kenya's exports (both at aggregate and product levels) to prices.

Empirical evidence explains export performance in Sub-Saharan African countries on the basis on two main factors. First, external factors which unfavorably affect exports including slow growth of demand for primary commodities (these account for the largest share of African exports), as well as worsening terms of trade. Secondly, internal factors which are specific to African economies including the capacity to export (macroeconomic environment, status of infrastructure in place among others) and existing trade policies that facilitate international trade. More importantly, evidence suggests that African exports respond positively to price falls in an effort to maintain revenue balance for foreign earnings, so that for a unit price fall, more is supplied, (Morrissey&Mold, 2006).

We use panel data from UNCOMTRADE; Harmonized System HS1992 for the period of 1997-2010. Building on assumptions of imperfect substitute's model developed by Goldstein and Khan (1985); we adopt Mold and Prizzon (2010) model of export analysis based on volume index instead of export value. In addition, we base our analysis of specific product price elasticities on Jones (2008). A generalized method of moments model (GMM) is run to study total exports and OLS used to conduct a deep analysis at product level.

Results show that in both the short and long-run Kenyan total exports are price inelastic. In addition, the real exchange rate has a negative influence on exports, which implies that a depreciation would not lead to improved exports volume growth. On the other hand, the world demand is found to have a positive effect on exports, suggesting that continuous global recession would reduce Kenya's exports. Further analyses on exports price elasticities by products revealed that vegetable product exports (which include among others tea, coffee and horticulture) are however price elastic; indicating existing export potentials. However, even at higher price incentives, results show a net lose of market for other export products including chemical products, and other manufactured goods. Policy implications include continuous efforts towards identifying and eliminating all barriers that hinder increased tea, coffee and horticulture production and exports.

*Keywords:* Exports, Kenya, Price elasticity, Products, World demand.

## INTRODUCTION

Exports of goods and services play an important role as a source of foreign earnings needed to pay for imports and maintain a balance of an economy's external position. Exports also contribute to economic growth by creating production and demand linkages and improving efficiency and technology adoption. More importantly exports provide multiple employment opportunities. Africa's export performance has been poor despite the continent's efforts towards building a strong export-oriented base needed to achieve a sustainable economic growth to eradicate poverty. Most of these endeavors arose in early 1980s with the introduction of structural adjustment programs (SAPs); followed by the establishment and strengthening of regional trading blocs. In this line, Kenya was part of many trading partnership agreements and at the same time a member of regional economic cooperation and integration blocs such as East African Community (EAC) and Common Market for Eastern and Southern Africa (COMESA). Nevertheless over the last decades, Kenya's exports share in the world as a

percentage of GDP has been gradually weakening. Kenya's exports stood on average at 30.5 percent of GDP for the period of 1960-1979. It shrank to 26.6 percent in 1980-1999 and contracted further to 26 percent in 2000-2012. Kenya's exports like that of most Africa countries are dominated by agricultural commodities; constituting of tea at 20 percent of total exports, coffee at 4 percent of total exports, horticulture at 11 percent of total exports, with manufactured goods only accounting for 11 percent of total exports in 2012. On the other hand, imports share grew significantly from 20.5 percent of GDP in 1960-1979 to 26.5 percent in 1980-1999 and reached a peak of 31.2 percent of GDP in the period of 2000-2012. Consequently, Kenya has been running a widening current account deficit, which stood at 10.7 percent of GDP at the end of 2012. Figure 1 shows exports as a share of GDP for the period 1960-2012 while Figure 2 depicts the downwards trend of exports as a share of world total exports.

Kenya's export volume growth lagged behind imports although export prices experienced an upward surge over the years. Evidence shows a marginal rise of export quantum indices for the period 1995-2010 from 175 to 292 mainly driven by animal and vegetable oils together with beverages and tobacco. Nevertheless, export price indices increased more than two fold from 489 in 1995 to 1230 in 2010. Larger upsurges in prices were experienced for manufactured goods, which on the contrary recorded a decline in volume index by 71, from 308 in 1995 to 237 in 2010.This resulted in stagnant export earnings which affected not only Kenya's external position, but also sustained the economy's constrained growth. Table 1 shows export volume and price indices for the period of 1995-2010.

The largest market for Kenya's exports is Africa. In line with other developing economies exports patterns; evidence shows an upward trend in South – South trade growth (both value and volume) relative to trade with the rest of the world, (Shirotori and Molina, 2009). Africa accounted for 47 percent of total Kenya's exports, Europe 28 percent while Asia's share stood at 17 percent on average during the period 2000-2012. In fact, the East Africa (countries of Rwanda, Burundi and Tanzania) only constitute 55 percent of the total market for Kenya's exports in Africa.

## EMPIRICAL EVIDENCE

Empirical evidence explains export performance in Sub-Saharan African countries on the basis of two main factors. First, external factors which unfavorably affect exports including slow growth of demand for primary commodities (these account for the largest share of African exports), as well as worsening terms of trade. Second, internal factors which are specific to African economies including the capacity to export (macroeconomic environment, status of infrastructure among others) and existing trade policies that facilitate international trade. More importantly, evidence suggests that African exports respond positively to price falls in an effort to maintain revenue balance for foreign earnings; so that for a unit price fall, more is supplied, (Morrissey and Mold, 2006).It has also been argued that export performance (demand and supply) has been constrained by overvalued exchange rate, insufficient efforts towards building capacity to exports, unfavorable trade policies and lack of diversification in export products, (Babatunde, 2009). In addition, African exports are responsive to changes in the world income. The role of infrastructure in African countries is a missing key ingredient in export sector development. Poor transport facilities affects export performance negatively, (UNCTAD, 2005); and this suggest that there is need to invest in infrastructure to support export supply capacity of the continent. Other scholars have stressed the role of foreign direct investments (FDI) towards exports sector transformation through adoption of technological innovations, (Morrissey and Mold, 2006), (Mekonnen, 2011), (Mold and Prizzon, 2010) and (Fugazza, 2004). On the other hand African exports respond positively to price falls.

Kenya's exports depend significantly on external demand. Income of trading partners has been a key determinant of Kenya's exports, (Kiptui, 2007). Illustrated this using a bounds testing approach on tea, coffee and horticulture data which are the major exports products in Kenya for the period 1998-2004. The existence of a positive relationship between trading partners' income and Kenya's exports was also proven by Were et al. (2002). Moreover, exchange rate appeared not to be a major threat to Kenya's exports growth. Kiptui (2007) disagreed with the argument that Kenya's real exchange rate appreciation has been constraining exports growth. On the contrary, Kennedy (2013) in a study covering the period 1963-2012 argued that real exchange rate has been worsening Kenya's trade balance. And therefore a gradual depreciation would improve exports growth, Were et al. (2002). On the relationship between exports price and volume, Kenya, Tanzania and Uganda fish exports were found to be price inelastic by Bukenya et al. (2012). While most of the empirical analysis covered major exports like tea, coffee and horticulture; there exists little knowledge on the relationship between Kenya's exports and their respective prices.
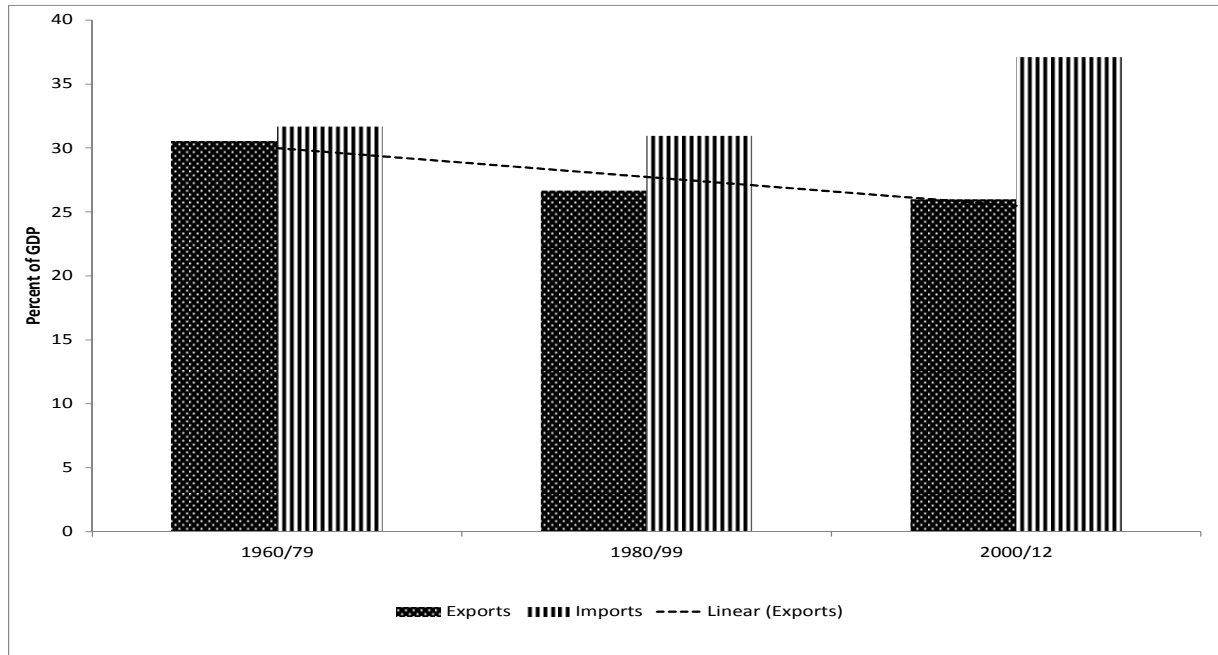
**Figure 1:** Kenya's exports as a share of GDP
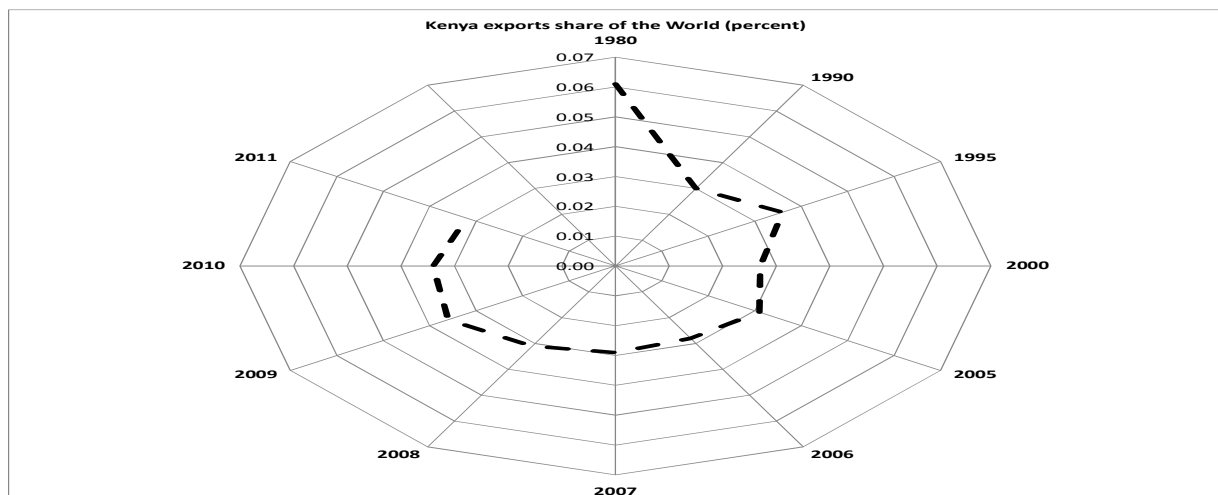Source: World Bank (2013).



**Figure 2:** Kenya's exports as a share of World total exports
Source: UNCTAD (2012).

**Table 1:** Exports volume and price indices for the period 1995-2010.

| Exports 1982 =100 | 1995 | 2000 | 2005 | 2010 | 95-10 | 1995 | 2000 | 2005 | 2010 | 95-10 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Price Indices | | | | | Quantum Indices | | | | |
| Food and live animals | 558 | 613 | 577 | 1141 | 583 | 151 | 194 | 271 | 261 | 110 |
| Beverages and tobacco | 390 | 641 | 314 | 847 | 457 | 1618 | 909 | 4536 | 4561 | 2943 |
| Crude matererials (inedible) | 510 | 666 | 853 | 1991 | 1481 | 178 | 202 | 340 | 247 | 69 |
| Mineral fuel | 310 | 575 | 745 | 922 | 612 | 59 | 109 | 211 | 62 | 3 |
| Animal and vegetable oils and fats | 316 | 358 | 311 | 789 | 473 | 6694 | 3637 | 8543 | 13415 | 6721 |
| Chemicals | 480 | 545 | 458 | 836 | 356 | 354 | 348 | 1189 | 1140 | 786 |
| Manufactured goods | 600 | 920 | 1276 | 2580 | 1980 | 308 | 179 | 272 | 237 | -71 |
| Machinery and transport equipment | 222 | 315 | 674 | 956 | 734 | 578 | 404 | 453 | 940 | 362 |
| Miscellaneous manufactured articles | 644 | 714 | 892 | 1347 | 703 | 530 | 619 | 926 | 1809 | 1279 |
| *All exports* | *489* | *620* | *676* | *1230* | *741* | *175* | *191* | *318* | *292* | *117* |
| **Non-oil exports** | **530** | **632** | **658** | **1297** | **767** | **207** | **219** | **358** | **361** | **154** |

Source: Kenya National Bureau of Statistics (2000 - 2012).

**Table 2:** GMM and fixed effects for export supply of Kenya

| Dependent Variable | Net Weight Index(1) GMM | | Net Weight Index (2) FIXED EFFECTS | |
|---|---|---|---|---|
| | Coefficient | p-value | Coefficient | p-value |
| LOGNETWEIGHTX(-1) | -0.093789 | 0.0000 | - | - |
| LOGPRICEX | -0.947134 | 0.0000 | -0.842360 | 0.0000 |
| LOGGDPPC | -0.630832 | 0.4664 | -0.257956 | 0.6226 |
| LOGOECDM | 1.889523 | 0.0000 | 2.131486 | 0.0000 |
| LOGREER | -4.161026 | 0.0001 | -2.496999 | 0.0034 |
| C | - | - | -39.63417 | 0.0249 |
| J-statistic | 19.40 | | - | |
| Adjusted R-squared | 0.3514 | | 0.741 | |
| Number of observations | 219 | | 259 | |
| Period/adjusted sample | 2000-2010 | | 1998-2010 | |

Note: The dependent variable is the logarithm of net weight index

**Table 3:** Sectors (21) elasticities (pooled OLS & fixed effects) for the period 1997-2010

| | Export Volume (1) Pooled OLS | | Export Volume (2) Fixed effects | |
|---|---|---|---|---|
| | Coefficient | p-value | Coefficient | p-value |
| Sector 1 | -0.612 | 0.236 | -0.955** | 0.0026 |
| Sector 2 | 4.022*** | 0.000 | -0.207 | 0.8332 |
| Sector 3 | -0.304 | 0.908 | 1.370 | 0.3748 |
| Sector 4 | -2.106 | 0.151 | -0.288 | 0.7369 |
| Sector 5 | -2.224*** | 0.000 | 0.418 | 0.6193 |
| Sector 6 | -2.856** | 0.005 | -1.691** | 0.0057 |
| Sector 7 | 0.979 | 0.414 | 0.341 | 0.7142 |
| Sector 8 | -0.283 | 0.833 | 0.056 | 0.9569 |
| Sector 9 | -0.531 | 0.309 | -0.780* | 0.0404 |
| Sector 10 | 0.776 | 0.513 | 0.468 | 0.6779 |
| Sector 11 | 0.459 | 0.453 | 0.195 | 0.6017 |
| Sector 12 | -1.803*** | 0.000 | -0.676* | 0.0391 |
| Sector 13 | -0.490 | 0.652 | 1.285 | 0.5846 |
| Sector 14 | -1.117*** | 0.000 | -1.197*** | 0.0000 |
| Sector 15 | -0.656 | 0.658 | 0.000 | 0.9998 |
| Sector 16 | -0.861* | 0.036 | -0.480 | 0.1583 |
| Sector 17 | -1.300** | 0.006 | 0.342 | 0.4366 |
| Sector 18 | -1.830*** | 0.000 | 0.451 | 0.2820 |
| Sector 19 | -2.521*** | 0.000 | 0.259 | 0.1884 |
| Sector 20 | -1.190* | 0.042 | 1.064 | 0.0519 |
| Sector 21 | -2.527*** | 0.000 | -0.530 | 0.2988 |
| Constant | 16.816*** | 0.000 | 16.290*** | 0.000 |
| Number of observations | 286 | | 286 | |
| Adjusted R-squared | 0.61 | | 0.88 | |
| Period | 1997-2010 | | 1997-2010 | |

Note: The dependent variable was the natural logarithm of export volume (kg)
And Sector 1 coefficient is the one for LOGPRICE_D1 as per equation (2), see results in Appendix V
Legend:* $p<0.05$; ** $p<0.01$; *** $p<0.001$

This paper attempts to determine exports price elasticities (both at an aggregate level and by products). Even if Kenya is considered as a small economy and therefore a price taker;we assume that in the event of export price uptick, the volume would rise. The rest of the paper is organized as follows. Section two describes the methodology and results are presented and discussed in section three. Section four provides policy implications related to the main findings.

## MODEL AND DATA

Building on assumptions of imperfect substitute's model developed by Goldstein and Khan (1985); we adopt Mold and Prizzon (2010) model of export analysis based on volume index. Various studies have used export value which limits analysis of exports price on exports. This study determines price elasticities of exports; and includes the role of Kenya's supply capacity, world demand effect as well as the extent of some domestic distortions on Kenya's exports. The model is expressed as:

$$\ln \ Netweightx_{it} = \alpha_0 + \alpha_1 \ln \ Pricex_{it} + \alpha_2 \ln \ GDPPC_{it} + \alpha_3 \ln \ oecdim_{it} + \alpha_4 \ln REER_{it} + \varepsilon_{it} \ldots (1)$$

Exports volume expressed as *netweightx* is measured as an index at time t for product i. Export prices, *pricex*, are calculated using exports net weight and exports value, before being converted into an index. Both exports volume and price data were obtained from UN COMTRADE.To proxy for the supply capacity of the economy we use GDP per capita in K Sh from World Development Indicators, *GDPPC*; assuming that a rise of GDP per capita means increased production and therefore increased exports. The variable *oecdm*is expressed in current US dollar represents imports by Organization for Economic Co-operation and Development (OECD) countries.While OECD countries constitute major destinations of Kenya's exports, this variable helps to capture the effect of the world demand on Kenya's exports. Both GDP per capita and OECD imports data are obtained from WDI.  Finally, *REER* variable is the real effective exchange rate; with 2000 as the base year (2000 =100). An increase of REER represents a depreciation and indicates that an economy gains competitiveness on international market; which is followed by increased exports. It has been argued that Kenya's exchange rate appreciated and therefore worsened exports growth. Data on REER was obtained from Central Bank of Kenya (CBK).

Particular attention is also given to price elasticities of different export products grouped into sections by World Custom Organization classification (WCO). WCO's Harmonized System (HS) nomenclature 2012 edition clusters commodities in 21 sections/sectors.

These are from a wider pool of 2- digits 97 industries. A list of these sections is part of annexes. Sectors elasticities analysis follows a methodology adopted by Jones (2008); each of the twenty one sectors is given a dummy D which in turn is interacted with export price using equation (2). Exports volume, *netweight* ,this time is expressed in kilograms for all products, while exports price *price* is in US dollar, so that;

$$\ln netweight_{it} = \alpha_0 + \alpha_1 \lfloor \ln Price_{it} \ x \ D_{it} \rfloor + \epsilon_{it} \ldots (2)$$

We estimate equation (1) and (2) using panel data for the periods 1998-2010 and 1997-2010 respectively. First to get the unit price (which is not available at 2-digit level), we transform 6-digit level exports data for each product (both value and net weight) into a 2-digit level. Then the sum of net weight and the sum of export value at 2-digit level are used to produce export unit price. The following step is then used to generate indices for both price and volume, for which year 2000 is the base year (2000 = 100). Second, HS nomenclature presents a set of 97 industries at 2-digit level and these are grouped into 21 sections (in this study sections are also called sectors). To estimate equation (2),  twenty one dummies are generated for each sector where for example dummy 1 is equal to one for all industries belonging to sector/section one (i.e. from 01 -05) and equal to zero for all the other industries (i.e. 06-97). This process is done for all sections/sectors leading to 21 dummies respectively. Equation (1) was estimated using Generalized Moments Methods (GMM) following Arellano and Bond (1991) because of three reasons. First the variable GDP per capita is endogenous; there exists causality in both direction between exports and economic growth, and therefore this variable will be correlated with the error term. Another factor is introduction of lagged exports volume which also associated with autocorrelation. Finally, the panel data has a short time dimension (T = 12) and a larger products dimension (N = 21). Equation (2) is therefore estimated using pooled OLS but for both equations fixed effects results are also reported.

## RESULTS AND DISCUSSION

### Aggregate Price Elasticities of Kenya's Exports

The results of estimated price elasticities of exports are reported in Table 2. Kenya price elasticity of exports is fairly price inelastic (-0.95), indicating that exports volume respond less proportionately to changes in export unit price. It also confirms the findings by Morrissey and Mold (2006) that African economies supply more to strike a balance of foreign earnings. For a long-run elasticity coefficient we use :$\alpha_2/(1 - \alpha_1)$ where α1 is the coefficient of lagged exports volume index and α2 the coefficient of export

price index (Reimer et al., 2012; Babatunde and Olofin, 2007; Babatunde, 2009).Its coefficient is estimated at -0.87, suggestingthat both the short run and the long-run Kenya's exports are notquick to respond to price changes. The lagged variable of export net weight is consistent with a slowdown of exports that was experienced in the last decades. Its coefficient is significant.

The effect of productivity (here represented by GDP per capita) is small and statistically insignificant. The same results were gotten by Babatunde (2009) for SSA. However, other studies on export performance in Africa found that economies supply capacity proxied by GDP per capita plays a key role in export performance (Mold and Prizzon, 2010). The coefficient of OECDM variable standing for the world demand for Kenya's exports is positive and statistically significant as expected. This implies that higher demand from trading partners induces more exports. In the event of a reduced demand by just one percent, exports volume would drop by 1.9 percent. This is compatible with Kiptui (2007) findings on Kenya's major exports products (tea, coffee and horticulture).

Real exchange rate has an unexpected sign: significant and negative. This variable turns out the biggest impact on exports relative to the other explanatory variables. The estimated negative sign suggests that a depreciation of Kenya's real effective exchange rate (in this case an increase of REER means a depreciation because it was computed as ePf/Pd) would be followed by a decrease in exports. Furthermore it has been argued that Kenya's real exchange rate is overvalued and therefore adversely impacts on exports by making them uncompetitive. But our findings contradict this argument. Our findings are in line with Kiptui (2007) analysis though the latter only focused on major export products (tea, coffee and horticulture).

**Price Elasticities of Kenya's Exports by Sectors**

Estimation results of equation (2) are reported in Table 3. Among twenty one estimated coefficients, only twelve are statistically significant. And the most elastic sector is vegetable products, while the remaining have unexpected (negative) signs. The price elasticity of vegetable product exports represented by sector is estimated at 4.0 and is statistically significant at all confidence intervals. It is under sector two that products such as tea, coffee and horticulture are found and these contribute significantly to Kenya's exports. With a fair price elastic (and positive) supply, Kenya still has the potential to impact global markets. According to the results, it is the only positive and also highest price elasticity relative to the other export products.

However, even at higher price incentives, results show a net loss of market for other export products including chemical products, and other manufactured goods. Under this category, estimated coefficients were negative and greater than a unit. They include export of products of the chemical or allied industries (sector 6), arms and munitions (sector 19), mineral products (sector 5), miscellaneous manufactures (sector 20), footwear and headgear (sector 12), optical and precision instruments (sector 18) as well as vehicles and transport equipment (sector 17). These are compatible with data trend where manufactures export price indices for the period of 1995-2010 increased by 1980 points while the corresponding volume index went down by 71 points.

There were however, other products under manufacturing sector whose exports were found to be inelastic but their coefficients turned out to be statistically insignificant. These include plastics (sector 7), leather and related (sector 8), wood products (sector 9), papers and textiles (sector 10 and 11 respectively), and cement (sector 13) and base metals (sector 15). Babatunde and Olofin (2007) revealed that East Africa manufactured exports had a small, negative and insignificant effect on relative price. Apart from being insignificant, the coefficient for Sector one representing live animals was close to Bakenya et al. (2012) findings.Natural and cultured pearls as well as work of arts (Sector 14 and 21 respectively) exports were also price elastic, with estimated coefficients of -1.17 and -2.5.

**CONCLUSION**

In recent decades, export prices experienced an uptick while Kenya's export volume stagnated. We estimated price elasticity of Kenya's exports based on Mold and Prizzon (2010) and Jones (2008) models. Results showed that Kenya's exports are fairly price inelastic with a negative price effect, implying that despite a fall in export unit price, exports volume would rise though less proportionately. A negative effect of real exchange rate was found suggesting that currency depreciation should not be used to resolve Kenya's trade deficit. On the contrary, Kenya's exports were found to be induced by foreign demand, with an elasticity of almost 2. Further analysis of price elasticity at a disaggregated product level, showed that Kenya still has potential in vegetable products exports. However, even at higher price incentives, Kenya still faces loss of markets for other export products including chemical products and other manufactured goods. Based on these findings, there is need to continuously enhance tea, coffee and horticulture production and exports since evidence showed that Kenya still has potential on the global export market. This study acknowledges that there are other non-price factors that impact on production

and export supply such as costs of different inputs. A further comprehensive analysis (at industry level) would shade lights on other determinants of Kenya's exports supply response.

**ACKNOWLEDGEMENT**

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**APPENDICES**

### Names of sectors

| Sectors | Names |
|---------|-------|
| Sector 1 | Live animals |
| Sector 2 | Vegetable products |
| Sector 3 | Animal or vegetable oil & fats |
| Sector 4 | Prepared food stuffs, beverages and tobacco |
| Sector 5 | Mineral products |
| Sector 6 | Chemicals |
| Sector 7 | Plastics |
| Sector 8 | Raw hides and skins |
| Sector 9 | Woods and articles of woods |
| Sector 10 | Pulp of wood and paper |
| Sector 11 | Textiles |
| Sector 12 | Footwear and headgear |
| Sector 13 | Articles of stones |
| Sector 14 | Natural and cultured pearls, stones and metals |
| Sector 15 | Base metals |
| Sector 16 | Machinery and mechanical |
| Sector 17 | Vehicles and aircrafts |
| Sector 18 | Precision instruments |
| Sector 19 | Arms and munitions |
| Sector 20 | Miscellaneous manufactured articles |
| Sector 21 | Works of arts |

### Description of variables

| Variables | Description |
|-----------|-------------|
| Exports (netweightx) | Volume Index 2000 =100 calculated using HS92 6-digit level data from UNCOMTRADE |
| Export unit price (Pricex) | Price Index 2000=100 calculated using HS92 6-digit level data from UNCOMTRADE |
| GDP per capita (gdppc) | Local Current Units from WDI |
| OECD imports (oecdm) | Current US$ of OECD members from WDI |
| REER | 2000 = 100 calculated using monthly data from CBK |

**Example of data transformation "from 6-digit to 2-digit level" for both net weight (kg) and value (US$)**

| Year | Codes | Description | Net weight (kg) | Value (US$) |
|---|---|---|---|---|
| 1998 | 050400 | Guts, bladders and stomachs of animals (other than fish),whole and pieces thereof, fresh, chilled, frozen, salted, in brine, dried or smoked. | 97 | 13 |
| 1998 | 050590 | Other | 2375 | 5196 |
| 1998 | 050800 | Coral and similar materials, unworked or simply prepared but not otherwise worked; shells of molluscs, crustaceans or echinoderms and cuttle-bone, unworked or simply prepared echinoderms and cuttle-bone, unworked or simply prepared, but not cut to shape, powder and waste thereof. | 265792 | 384040 |
| 1998 | 051191 | Products of fish or crustaceans, molluscs or other aquatic invertebrates; dead animals of Chapter 3 | 133303 | 947924 |
| *1998* | *05* | *Products of animal origin, not elsewhere specified or included (SUM)* | *401567* | *1337173* |

**Descriptive statistics**

|  | LOGGDPPC | LOGNETWEIGHTX | LOGOECDM | LOGPRICEX | LOGREER |
|---|---|---|---|---|---|
| Mean | 10.58225 | 5.950863 | 29.71203 | 4.695293 | 4.429663 |
| Median | 10.50732 | 5.312940 | 29.73318 | 4.704083 | 4.474684 |
| Maximum | 11.04070 | 14.79123 | 30.19967 | 8.128158 | 4.605170 |
| Minimum | 10.26272 | 1.487777 | 29.26271 | -0.883898 | 4.216080 |
| Std. Dev. | 0.264834 | 2.053214 | 0.318639 | 1.283253 | 0.143669 |
| Skewness | 0.476936 | 1.740933 | 0.047725 | -0.933454 | -0.297052 |
| Kurtosis | 1.746355 | 6.460437 | 1.466143 | 6.333156 | 1.447527 |
|  |  |  |  |  |  |
| Jarque-Bera | 26.77950 | 260.0577 | 25.48805 | 157.5074 | 29.81879 |
| Probability | 0.000002 | 0.000000 | 0.000003 | 0.000000 | 0.000000 |
|  |  |  |  |  |  |
| Sum | 2740.803 | 1541.273 | 7695.415 | 1216.081 | 1147.283 |
| Sum Sq. Dev. | 18.09532 | 1087.647 | 26.19502 | 424.8585 | 5.325354 |
|  |  |  |  |  |  |
| Observations | 259 | 259 | 259 | 259 | 259 |

**Correlation matrix**

|  | LOGGDPPC | LOGNETWEIGHTX | LOGOECDM | LOGPRICEX | LOGREER |
|---|---|---|---|---|---|
| LOGGDPPC | 1.00 | 0.32 | 0.93 | 0.25 | -0.94 |
| LOGNETWEIGHTX | 0.32 | 1.00 | 0.35 | -0.39 | -0.31 |
| LOGOECDM | 0.93 | 0.35 | 1.00 | 0.22 | -0.90 |
| LOGPRICEX | 0.25 | -0.39 | 0.22 | 1.00 | -0.26 |
| LOGREER | -0.94 | -0.31 | -0.90 | -0.26 | 1.00 |

**Estimation results for all models/all regressions**

Dependent Variable: LOGNETWEIGHTX
Method: Panel Generalized Method of Moments
Transformation: Orthogonal Deviations
Date: 08/08/13   Time: 12:32
Sample (adjusted): 2000 2010
Cross-sections included: 20
Total panel (unbalanced) observations: 219
White period instrument weighting matrix
White period standard errors & covariance (d.f. corrected)
Instrument list: @DYN(LOGNETWEIGHTX,-1) LOGPRICEX
        LOGGDPPC LOGOECDM LOGREER

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LOGNETWEIGHTX(-1) | -0.093789 | 0.006329 | -14.81861 | 0.0000 |
| LOGPRICEX | -0.947134 | 0.008659 | -109.3872 | 0.0000 |
| LOGGDPPC | -0.630832 | 0.864628 | -0.729600 | 0.4664 |
| LOGOECDM | 1.889523 | 0.265076 | 7.128238 | 0.0000 |
| LOGREER | -4.161026 | 1.015156 | -4.098904 | 0.0001 |

Effects Specification

Cross-section fixed (orthogonal deviations)

| R-squared | 0.363387 | Mean dependent var | -0.520192 |
|---|---|---|---|
| Adjusted R-squared | 0.351488 | S.D. dependent var | 1.367753 |
| S.E. of regression | 1.101455 | Sum squared resid | 259.6254 |
| J-statistic | 19.40270 | Instrument rank | 20.00000 |

Dependent Variable: LOGNETWEIGHTX
Method: Panel Least Squares
Date: 08/08/13   Time: 12:29
Sample: 1998 2010
Cross-sections included: 20
Total panel (unbalanced) observations: 259
White period standard errors & covariance (d.f. corrected)

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -39.63417 | 17.55188 | -2.258115 | 0.0249 |
| LOGPRICEX | -0.842360 | 0.153902 | -5.473368 | 0.0000 |
| LOGGDPPC | -0.257956 | 0.523408 | -0.492840 | 0.6226 |
| LOGOECDM | 2.131486 | 0.489973 | 4.350210 | 0.0000 |
| LOGREER | -2.496999 | 0.842870 | -2.962496 | 0.0034 |

Effects Specification

Cross-section fixed (dummy variables)

| | | | |
|---|---|---|---|
| R-squared | 0.741708 | Mean dependent var | 5.950863 |
| Adjusted R-squared | 0.716428 | S.D. dependent var | 2.053214 |
| S.E. of regression | 1.093367 | Akaike info criterion | 3.104487 |
| Sum squared resid | 280.9312 | Schwarz criterion | 3.434077 |
| Log likelihood | -378.0310 | F-statistic | 29.34006 |
| Durbin-Watson stat | 1.464925 | Prob(F-statistic) | 0.000000 |

Dependent Variable: LOGNETWEIGHT
Method: Panel Least Squares
Date: 08/16/13   Time: 10:22
Sample: 1997 2010
Cross-sections included: 21
Total panel (unbalanced) observations: 286

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 16.81519 | 0.214507 | 78.38990 | 0.0000 |
| LOGPRICE_D1 | -0.611667 | 0.515403 | -1.186776 | 0.2364 |
| LOGPRICE_D2 | 4.023463 | 0.962277 | 4.181189 | 0.0000 |
| LOGPRICE_D3 | -0.305183 | 2.617504 | -0.116593 | 0.9073 |
| LOGPRICE_D4 | -2.106443 | 1.460660 | -1.442117 | 0.1505 |
| LOGPRICE_D5 | -2.224903 | 0.382230 | -5.820843 | 0.0000 |
| LOGPRICE_D6 | -2.856839 | 1.000280 | -2.856038 | 0.0046 |
| LOGPRICE_D7 | 0.980700 | 1.198849 | 0.818034 | 0.4141 |
| LOGPRICE_D8 | -0.281918 | 1.337034 | -0.210853 | 0.8332 |
| LOGPRICE_D9 | -0.531125 | 0.520599 | -1.020218 | 0.3086 |
| LOGPRICE_D10 | 0.777567 | 1.188038 | 0.654497 | 0.5134 |
| LOGPRICE_D11 | 0.458900 | 0.610485 | 0.751697 | 0.4529 |
| LOGPRICE_D12 | -1.802444 | 0.440105 | -4.095485 | 0.0001 |

| | | | | |
|---|---|---|---|---|
| LOGPRICE_D13 | -0.491290 | 1.088519 | -0.451338 | 0.6521 |
| LOGPRICE_D14 | -1.117016 | 0.117317 | -9.521365 | 0.0000 |
| LOGPRICE_D15 | -0.656521 | 1.481801 | -0.443056 | 0.6581 |
| LOGPRICE_D16 | -0.860887 | 0.409337 | -2.103125 | 0.0364 |
| LOGPRICE_D17 | -1.299178 | 0.472761 | -2.748064 | 0.0064 |
| LOGPRICE_D18 | -1.829757 | 0.217537 | -8.411238 | 0.0000 |
| LOGPRICE_D19 | -2.520790 | 0.238072 | -10.58835 | 0.0000 |
| LOGPRICE_D20 | -1.189229 | 0.581657 | -2.044554 | 0.0419 |
| LOGPRICE_D21 | -2.526242 | 0.406822 | -6.209694 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.608656 | Mean dependent var | 15.99892 |
| Adjusted R-squared | 0.577527 | S.D. dependent var | 3.827945 |
| S.E. of regression | 2.488085 | Akaike info criterion | 4.734707 |
| Sum squared resid | 1634.310 | Schwarz criterion | 5.015937 |
| Log likelihood | -655.0631 | F-statistic | 19.55234 |
| Durbin-Watson stat | 0.606101 | Prob(F-statistic) | 0.000000 |

Dependent Variable: LOGNETWEIGHT
Method: Panel Least Squares
Date: 08/16/13   Time: 10:25
Sample: 1997 2010
Cross-sections included: 21
Total panel (unbalanced) observations: 286

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 16.28967 | 0.174997 | 93.08517 | 0.0000 |
| LOGPRICE_D1 | -0.955363 | 0.313355 | -3.048816 | 0.0026 |
| LOGPRICE_D2 | -0.207137 | 0.982636 | -0.210797 | 0.8332 |
| LOGPRICE_D3 | 1.370457 | 1.541477 | 0.889055 | 0.3748 |
| LOGPRICE_D4 | -0.287660 | 0.855100 | -0.336405 | 0.7369 |
| LOGPRICE_D5 | 0.417575 | 0.839380 | 0.497480 | 0.6193 |
| LOGPRICE_D6 | -1.691279 | 0.606631 | -2.787988 | 0.0057 |
| LOGPRICE_D7 | 0.340948 | 0.929886 | 0.366655 | 0.7142 |
| LOGPRICE_D8 | 0.055571 | 1.027197 | 0.054100 | 0.9569 |
| LOGPRICE_D9 | -0.780174 | 0.378680 | -2.060245 | 0.0404 |
| LOGPRICE_D10 | 0.467740 | 1.124923 | 0.415797 | 0.6779 |
| LOGPRICE_D11 | 0.202685 | 0.387800 | 0.522654 | 0.6017 |
| LOGPRICE_D12 | -0.676067 | 0.325905 | -2.074430 | 0.0391 |
| LOGPRICE_D13 | 1.285102 | 2.347394 | 0.547459 | 0.5846 |
| LOGPRICE_D14 | -1.196866 | 0.216392 | -5.531012 | 0.0000 |
| LOGPRICE_D15 | -0.000175 | 0.829504 | -0.000211 | 0.9998 |
| LOGPRICE_D16 | -0.480493 | 0.339528 | -1.415178 | 0.1583 |
| LOGPRICE_D17 | 0.342207 | 0.439192 | 0.779174 | 0.4366 |
| LOGPRICE_D18 | 0.451334 | 0.418575 | 1.078263 | 0.2820 |
| LOGPRICE_D19 | 0.259198 | 0.196491 | 1.319135 | 0.1884 |
| LOGPRICE_D20 | 1.063598 | 0.544549 | 1.953174 | 0.0519 |
| LOGPRICE_D21 | -0.529625 | 0.508627 | -1.041284 | 0.2988 |

Effects Specification

| Cross-section fixed (dummy variables) | | | |
|---|---|---|---|
| R-squared | 0.889061 | Mean dependent var | 15.99892 |
| Adjusted R-squared | 0.870420 | S.D. dependent var | 3.827945 |
| S.E. of regression | 1.377955 | Akaike info criterion | 3.613960 |
| Sum squared resid | 463.2971 | Schwarz criterion | 4.150854 |
| Log likelihood | -474.7963 | F-statistic | 47.69296 |
| Durbin-Watson stat | 0.968023 | Prob(F-statistic) | 0.000000 |

WCO HS nomenclature (97 industries in 21 sections/sectors)

| Sections | Codes | Descriptions |
|---|---|---|
| **Section 1**:Live animals; animal products | 01 | Live animals. |
| | 02 | Meat and edible meat offal. |
| | 03 | Fish and crustaceans, molluscs and other aquatic invertebrates. |
| | 04 | Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included. |
| | 05 | Products of animal origin, not elsewhere specified or included. |
| **Section 2**: Vegetable products | 06 | Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage. |
| | 07 | Edible vegetables and certain roots and tubers. |
| | 08 | Edible fruit and nuts; peel of citrus fruit or melons. |
| | 09 | Coffee, tea, maté and spices. |
| | 10 | Cereals. |
| | 11 | Products of the milling industry; malt; starches; inulin; wheat gluten. |
| | 12 | Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder. |
| | 13 | Lac; gums, resins and other vegetable saps and extracts. |
| | 14 | Vegetable plaiting materials; vegetable products not elsewhere specified or included. |
| **Section 3**: Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes | 15 | Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes. |

| | | |
|---|---|---|
| **Section 4**: Prepared foodstuffs; beverages, spirits and vinegar; tobacco and manufactured tobacco substitutes | 16 | Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates. |
| | 17 | Sugars and sugar confectionery. |
| | 18 | Cocoa and cocoa preparations. |
| | 19 | Preparations of cereals, flour, starch or milk; pastrycooks' products. |
| | 20 | Preparations of vegetables, fruit, nuts or other parts of plants. |
| | 21 | Miscellaneous edible preparations. |
| | 22 | Beverages, spirits and vinegar. |
| | 23 | Residues and waste from the food industries; prepared animal fodder. |
| | 24 | Tobacco and manufactured tobacco substitutes. |
| **Section 5**: Mineral products | 25 | Salt; sulphur; earths and stone; plastering materials, lime and cement. |
| | 26 | Ores, slag and ash. |
| | 27 | Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes. |
| **Section 6**: Products of the chemical or allied industries | 28 | Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, of radioactive elements or of isotopes. |
| | 29 | Organic chemicals. |
| | 30 | Pharmaceutical products. |
| | 31 | Fertilizers. |
| | 32 | Tanning or dyeing extracts; tannins and their derivatives; dyes, pigments and other coloring matter; paints and varnishes; putty and other mastics; inks. |
| | 33 | Essential oils and resinoids; perfumery, cosmetic or toilet preparations. |
| | 34 | Soap, organic surface-active agents, washing preparations, lubricating preparations, artificial waxes, prepared waxes, polishing or scouring preparations, candles and similar articles, modeling pastes, "dental waxes" and dental preparations with a basis of plaster. |
| | 35 | Albuminoidal substances; modified starches; glues; enzymes. |
| | 36 | Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations. |
| | 37 | Photographic or cinematographic goods. |
| | 38 | Miscellaneous chemical products. |
| **Section 7**: Plastics and articles thereof; rubber and articles thereof | 39 | Plastics and articles thereof. |
| | 40 | Rubber and articles thereof. |
| **Section 8**: Raw hides and skins, leather, furskins and | 41 | Raw hides and skins (other than furskins) and leather. |
| | 42 | Articles of leather; saddlery and harness; travel goods, handbags and similar |

| | | |
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| articles thereof; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silk-worm gut) | | containers; articles of animal gut (other than silk-worm gut). |
| | 43 | Furskins and artificial fur; manufactures thereof. |
| **Section 9**: Wood and articles of wood; wood charcoal; cork and articles of cork; manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork | 44 | Wood and articles of wood; wood charcoal. |
| | 45 | Cork and articles of cork. |
| | 46 | Manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork. |
| **Section 10**: Pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard; paper and paperboard and articles thereof | 47 | Pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard. |
| | 48 | Paper and paperboard; articles of paper pulp, of paper or of paperboard. |
| | 49 | Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans. |
| **Section 11**: Textiles and textile articles | 50 | Silk. |
| | 51 | Wool, fine or coarse animal hair; horsehair yarn and woven fabric. |
| | 52 | Cotton. |
| | 53 | Other vegetable textile fibres; paper yarn and woven fabrics of paper yarn. |
| | 54 | Man-made filaments. |
| | 55 | Man-made staple fibres. |
| | 56 | Wadding, felt and nonwovens; special yarns; twine, cordage, ropes and cables and articles thereof. |
| | 57 | Carpets and other textile floor coverings. |
| | 58 | Special woven fabrics; tufted textile fabrics; lace; tapestries; trimmings; embroidery. |
| | 59 | Impregnated, coated, covered or laminated textile fabrics; textile articles of a kind suitable for industrial use. |
| | 60 | Knitted or crocheted fabrics. |
| | 61 | Articles of apparel and clothing accessories, knitted or crocheted. |
| | 62 | Articles of apparel and clothing accessories, not knitted or crocheted. |

| | | |
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| | 63 | Other made up textile articles; sets; worn clothing and worn textile articles; rags. |
| **Section 12**: Footwear, headgear, umbrellas, sun umbrellas, walking-sticks, seat-sticks, whips, riding-crops and parts thereof; prepared feathers and articles made therewith; artificial flowers; articles of human hair | 64 | Footwear, gaiters and the like; parts of such articles. |
| | 65 | Headgear and parts thereof. |
| | 66 | Umbrellas, sun umbrellas, walking-sticks, seat-sticks, whips, riding-crops and parts thereof. |
| | 67 | Prepared feathers and down and articles made of feathers or of down; artificial flowers; articles of human hair. |
| **Section 13**: Articles of stone, plaster, cement, asbestos, mica or similar materials; ceramic products; glass and glassware | 68 | Articles of stone, plaster, cement, asbestos, mica or similar materials. |
| | 69 | Ceramic products. |
| | 70 | Glass and glassware. |
| **Section 14**: Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal and articles thereof; imitation jewellery; coin | 71 | Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal and articles thereof; imitation jewellery; coin. |
| **Section 15**: Base metals and articles of base metal | 72 | Iron and steel. |
| | 73 | Articles of iron or steel. |
| | 74 | Copper and articles thereof. |
| | 75 | Nickel and articles thereof. |
| | 76 | Aluminium and articles thereof. |
| | 77 | ( Reserved for possible future use in the Harmonized System) |
| | 78 | Lead and articles thereof. |
| | 79 | Zinc and articles thereof. |
| | 80 | Tin and articles thereof. |
| | 81 | Other base metals; cermets; articles thereof. |
| | 82 | Tools, implements, cutlery, spoons and forks, of base metal; parts thereof of base metal. |
| | 83 | Miscellaneous articles of base metal. |
| **Section 16**: Machinery and | 84 | Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof. |

| | | |
|---|---|---|
| mechanical appliances; electrical equipment; parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles | 85 | Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles. |
| **Section 17**: Vehicles, aircraft, vessels and associated transport equipment | 86 | Railway or tramway locomotives, rolling-stock and parts thereof; railway or tramway track fixtures and fittings and parts thereof; mechanical (including electro-mechanical) traffic signalling equipment of all kinds. |
| | 87 | Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof. |
| | 88 | Aircraft, spacecraft, and parts thereof. |
| | 89 | Ships, boats and floating structures. |
| **Section 18**: Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; clocks and watches; musical instruments; parts and accessories thereof | 90 | Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof. |
| | 91 | Clocks and watches and parts thereof. |
| | 92 | Musical instruments; parts and accessories of such articles. |
| **Section 19**: Arms and ammunition; parts and accessories thereof | 93 | Arms and ammunition; parts and accessories thereof. |
| **Section 20**: Miscellaneous manufactured articles | 94 | Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, not elsewhere specified or included; illuminated signs, illuminated name-plates and the like; prefabricated buildings. |
| | 95 | Toys, games and sports requisites; parts and accessories thereof. |
| | 96 | Miscellaneous manufactured articles. |
| **Section 21**: Works of art, collectors' pieces and antiques | 97 | Works of art, collectors' pieces and antiques. |