The Raw and the Carved: Shipping Costs and Ivory Smuggling

Brendan Moyle, Massey University, PB 102904, Auckland, New Zealand
Ph.: +64 9 4140800
Email: BrendanJM@massey.ac.nz

Abstract

The recent and rapid increase in elephant poaching has caused international alarm. A panel-data regression model was employed to identify possible causes of this upsurge. The large decline in shipping costs after the GFC is strongly correlated to the rise in large shipments interdicted in recent years. Other factors include the decline in global interest rates, which motivates increased stockpiling by criminal organisations. A sharp decline in stability in Africa, especially Central Africa can also be linked to the raw ivory seizures. This evidence also indicates that the recent upsurge is more supply-driven than it is demand-driven. Criminal organisations appear to be taking advantage of current conditions to transfer and store ivory in stockpiles out of Arica. This raises doubt that the upsurge is demand-driven event related to the current markets for ivory.

Keywords: CITES, Elephant, ivory, poaching, smuggling, wildlife economics

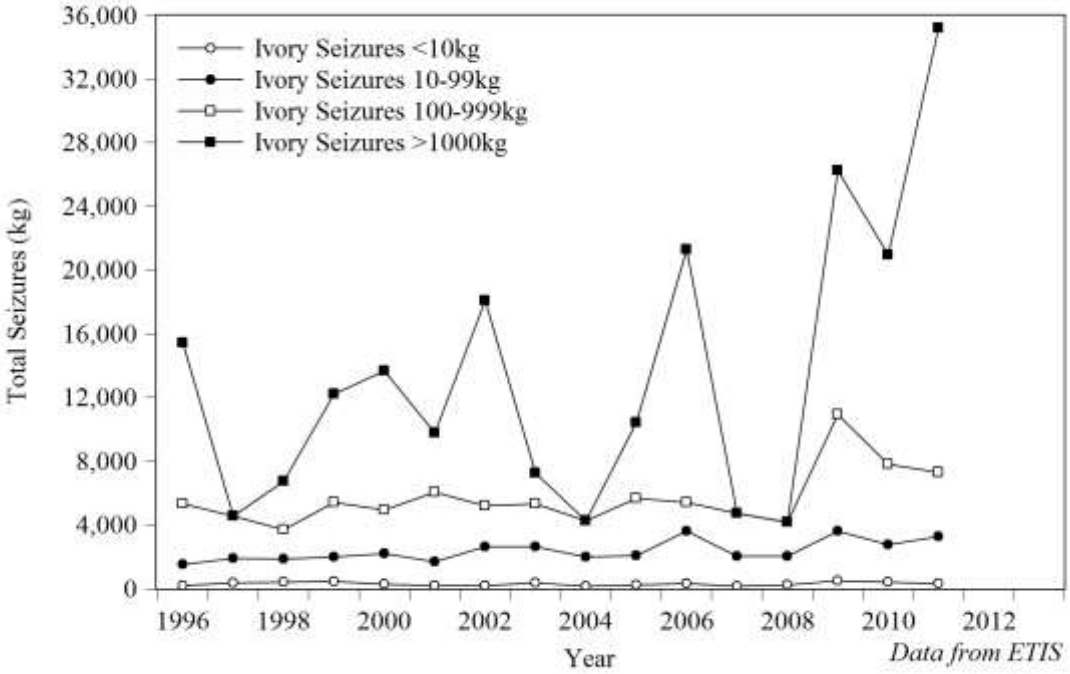
JEL Classification: C33, K42, Q28, Q57

1. Introduction

Poaching levels of African elephants have in recent years surged to an appalling level. Since 2007 the illegal traffic in ivory has more than doubled (UNEP et al., 2013). By 2011 the numbers of elephants killed annually was estimated to be 25,000 animals (UNEP et al., 2013). Poaching appears to have accelerated since 2009 (CITES et al., 2013). The human cost of this includes a rising death toll of wildlife rangers (Dell'Amore, 2012). This slaughter is now a pressing international conservation issue.

The increase in poaching is reflected in the seizure rates of raw ivory (Figure 1). Seizures of worked ivory are much lower and do not exhibit the dramatic increase in raw ivory. The recent increase is also dominated by seizures over 100kg (CITES et al., 2013; Underwood, et al., 2013). This seizure metric is supported by evidence from shrinking wild populations and collation of kill reports (CITES et al., 2013; Underwood, et al., 2013).

Figure 1: Total Seizures of Raw Ivory by Weight



The challenge is to explain this dramatic surge in seizures. Why are over 30,000 elephants now being poached? Poaching levels accelerated in the late 2000s and the estimated volume of ivory trafficked has greatly increased. Has demand for ivory by consumers in a short space of time increased by perhaps over double?

Research on the ivory black-market has already identified some factors that influence poaching levels (CITES et al., 2013; Underwood, et al., 2013). These include affluence in China and poor governance in Africa. These however, did not change dramatically in the late 2000s. Governance accounts for some of the cross-sectional variation in poaching levels in Africa (Underwood et al., 2013). Affluence in East Asia and especially China has been growing steadily and is likely a slow, steady trend rather than a surprising recent trigger.

One variable overlooked to date is transport costs. Ivory is sourced in African range states and sold in distant markets in Asia (CITES et al., 2013). It is also sold in Africa in domestic markets and markets outside of Asia. Nonetheless, the importance of East Asian markets is indicated by the quantity of ivory being intercepted in those markets (Underwood et al., 2013). All shipments over 500kg since 2008 have been destined for Asia. This paper tests the hypothesis that transport cost, specifically along the shipping route, is an important determinant of smuggling activity.

In January 2013 I was able to inspect ivory stockpiles in China. I was impressed by the bulk and weight of ivory in the storerooms. This emphasised that ivory is a heavy product. Its value increases if the tusks are large and intact (Stiles, 2004). This means that some of the value of the ivory is destroyed if it is cut into smaller pieces for concealment.

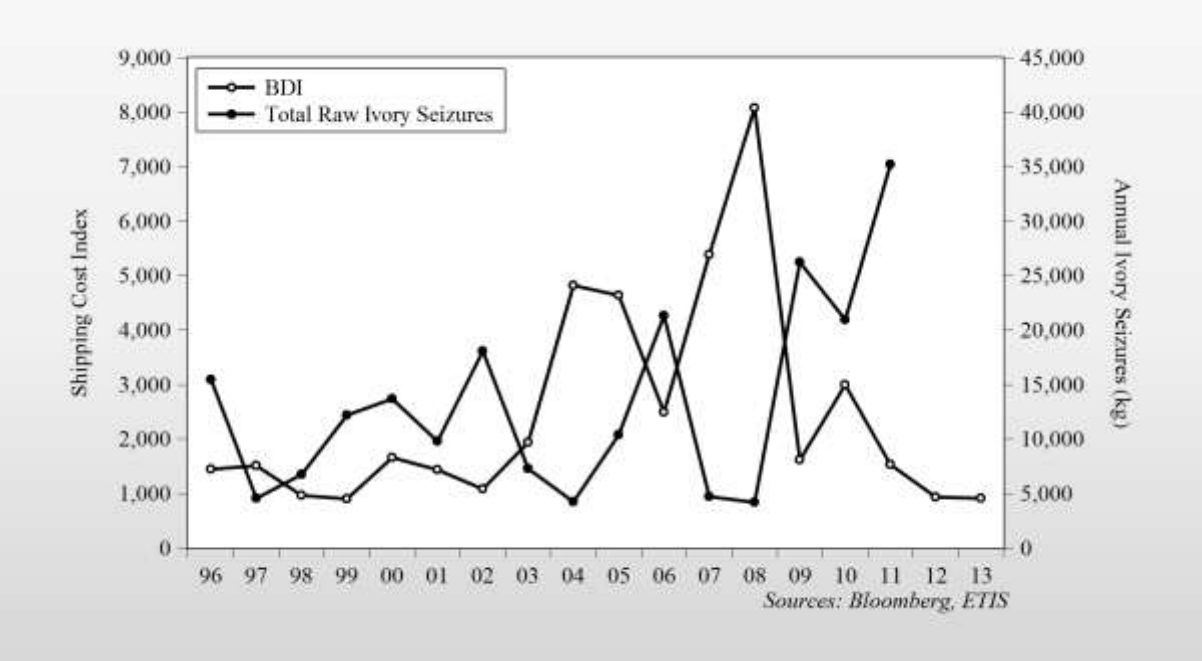
There is already evidence that smugglers consider shipping costs to be important. Two-thirds of shipments over 500kg intercepted since 2009 were in shipping containers (CITES et al., 2013). Smugglers have a low preference for small quantities in say, suitcases and shift the bulk of their ivory in large lots.

The smuggler preference for large shipments of elephant ivory conforms to seeking economies-of-scale in transport. Economies-of-scale mean that the average cost per kilogram

of shipping the ivory falls as the shipment-size rises. The fall in these costs, presumably dominate the smuggling decision. The strategy has a cost in terms of the seizure risk. Losing four tons of ivory in one shipment is a bigger cost than splitting the shipments and losing only some of them. A large shipment is strong evidence that smugglers consider lowering transport-costs as worth the risk of losing an entire shipment to interdiction.

Transports costs may therefore influence smuggling levels. Shipping costs are also highly variable because the number of transport ships is strictly limited in the short term (Figure 2). If shipping costs are examined a relationship to seizure rates is indicated. The period 2003-5 had high shipping costs and low seizure rates. Shipping costs collapsed after the 2008 Global Financial Crisis (GFC) and interdictions of containers surged. The CITES secretariat (2010, n26) claimed that some of the recent seizures came from elephants poached in the early 2000s. This is consistent with the high shipping costs in the mid-2000s deterring smuggling until these costs fell.

Figure 2: Shipping Costs



Shipping costs provide two potential explanations for the increase in poaching. One is the arbitrage explanation. Arbitrage is the process of buying goods cheap in one market to sell at

a higher price in another market. The arbitrage profit of this is the difference in the prices less the transaction costs of the trade.

Transport costs absorb some of the arbitrage profits of smuggling. A reduction in transport costs increases arbitrage profits. It also gives scope to increase the price offered for ivory in Africa and decrease the selling price in final markets. If prices for ivory are being lowered to consumers then ivory-sales would increase, absorbing the extra volumes being trafficked. There is however, no evidence that ivory prices are falling.

A second explanation is that ivory is being stockpiled as an investment. Ivory can be stored at a negligible cost. If humidity levels are optimal it can be stored for years (Figure 3). It has already been noted that the durability of ivory means it can be treated as an investment good (Kremer and Morcom, 2000; Bulte et al., 2003).

If the criminal firm also expects ivory prices to increase faster than their discount rate, stockpiling becomes a viable investment. For instance, if hoarders expect ivory to rise in price by 10% and interest rates are 5%, stockpiling is viable. While there are risks to hoarding ivory (future prices might be lower than expected, the tusks might be seized by enforcement agencies) and storage costs, the margin can be large enough to compensate. If such firms also have market power they could also restrict the flow of raw ivory to the consumer market to keep prices rising.

Figure 3: Raw Ivory Stored in Chinese Factory

The cost to convert the 'living stock' in one location to a 'dead sterile stock' in another is an obstacle to stockpiling. If shipping costs fall then a preference for stockpiling tusks in warehouses outside Africa can be acted on. In effect the criminal organisation rebalances its 'portfolio' of ivory between tusks on live animals, and stockpiled tusks in response to this conversion cost.

2. Methodology

Data was obtained from several sources to generate an appropriate econometric model. The model is estimated at a global scale. It presages research at a regional, route-based level. This also limits the variables to those that operate at global or much aggregated scales. It also means it makes no inferences about the distribution of poaching at regional or country levels. It is presented as an introductory, and very general, test of the shipping-cost hypothesis.

Ivory-seizure data is difficult to analyse for several reasons. Given that smugglers do not fill out statistical returns on their activity all data sets are in this sense, incomplete. In this case the number of time periods is also statistically small (16 annual observations). As smugglers

do not reveal their decision making process it is also challenging to identify the variables that influence these decisions. This means that proxy or instrumental variables have to be identified that will correlate to these unobserved variables. This implies that non-statistical rationales for modelling the data and selecting variables are important to reinforce the low power of statistical tests. This approach is outlined in detail to make transparent the decisions made.

The dependent variable is the annual weight of ivory seized from 1996 to 2011, obtained from the Elephant Trade Information System (ETIS) database. The data was classed as either worked or raw. Each category was then divided into four weight classes; those less than 10, those between 10kg and 99kg, those between 100kg and 999kg, and those 1000kg or more. Submissions of seizure data to the ETIS is subject to lengthy lags that delay the publication of recent seizures.

Dividing the data into weight categories based on order of magnitude follows the same approach as other researchers using ETIS data (cf. Underwood et al. 2013) but with one important difference. In this instance the seizures above 100kg were divided by order of magnitude into above 100kg and above 1000kg. The motive for this is that it is far more likely a shipment of 2000 kg say, is from a shipping-container seizure than a 200kg seizure. Lumping the all these seizures into one class conflates non-container seizures with container seizures.

The other issue is that if shipments are sensitive to shipping costs, and these have not been constant (Figure 2) then identifying a structural break becomes problematic. This is before the variance in the data is taken into account. The decision to divide the weight categories by order of magnitude was consistent with other work, it does separate the visible trends (Figure 1) and it aligns to different smuggling technology.

Dividing the data into four separate weight categories prompted use of a panel-data technique. The next problem was the functional form for the equations. A log-transformation was awkward with the zero observations in the shipments over 1000kg series. Manipulating this would be contrived and make the coefficients harder to interpret.

A differenced format to the data would be appropriate especially if the series were non-stationary and lacked cointegration. Most tests for stationarity however, are not powerful. The small sample size and probable structural break around 2007-8 and then 2009 eliminates most common tests for stationarity. The Harris-Tzavalis unit root test for panel data was employed. This indicated the panels were stationary but also a time trend was present. Hence the functional form of the model was with the data as original levels.

The selection of explanatory variables for the model faced a number of hindrances. The first is that many potential data-series from China do not extend as far back as the mid-1990s. Many only start from the early or mid-2000s. This problem is not unique to China. Data from Sub-Saharan Africa is even poorer in quality with sizable gaps in series. Hence the explanatory variables that were able to be used in practice were restricted by this limitation.

The second problem was that the small data set and the dramatic rise in large seizures in the late 2000s. In practice, any variable that showed a steady trend over the period (whether up or down) will correlate to this. The raw-ivory seizure data however does not exhibit a steady trend, but marked rises and falls. For instance, Chinese GDP over the sample period grew steadily. It grew when seizures shrank dramatically in the 2007-2008 period. It also grew when seizures rose. This suffices to establish a statistical correlation but it may be a spurious measure.

This risk of spurious relationships was countered by searching for variables that exhibited rises and falls. For instance, affluence in consumer countries contributes to smuggling levels. Using Chinese GDP to measure this affluence is a poor measure. Chinese consumer confidence however does exhibit rises and falls. It would appear to be a better measure for affluence. This is also plausible as household expenditures are only one component of Chinese GDP whilst consumer confidence is specifically household-based.

Another option is to use the export of Swiss watches as a metric for the changes in affluence. It also narrows down more on the East Asian households whose rising incomes are the

market for prestigious goods like ivory. This proxy therefore, would link to other growing markets in Asia.

This search affected the selection of other variables. For instance, child-poverty rates in Africa are a proxy for some of the socio-economic variables that determine local poaching rates (Underwood et al., 2013). Child-poverty levels do not exhibit big swings on a year-by-year basis. They appear to be good at explaining cross-sectional variation between African states. Nonetheless, for this type of panel-data analysis it is necessary to have data that varies over time.

The solution to the African socio-economic variable problem was to use refugees from African range states as a proxy. This is a variable that shows the kind of swings that might align to the smuggling levels. At a statistical level, the advantage of refugee numbers is that it is a fast response to local conditions. Humanitarian motives also lead to this data being swiftly collected and published.

Refugees are often a product of increasing internal conflict. Such conflicts can lead to a decline in the management of nature reserves so that less deterrence is achieved (Baral and Heinen, 2006). The Maoist people's war in Nepal led to a rapid increase in poaching and illegal wildlife trade. They also generate armed groups that have an incentive to poach wildlife to pay for their operations. An eyeball check of refugee numbers showed that these had increased rapidly in Central Africa and this is one of the current poaching hotspots (Underwood et al., 2013).

The international transport cost is the primary hypothesis tested in this research. The international costs have one candidate that meets the condition to extend back to 1996. This is the Baltic Dry Index (BDI) and it is the benchmark for shipping costs globally. The alternative Shanghai Containerized Freight Index (SCFI) only extends to 2005 and has not supplanted the BDI.

Local transport costs in Africa should also play a role unless the international costs dominate this part of the supply chain. Nonetheless, data to approximate this does not exist. There is

not a road-transport index for Africa that is analogous to the BDI. The size of the road-network in Sub-Saharan Africa is replete with large data gaps both across time and across countries.

It is not obvious what sign the road network should have. Whilst roads can bring poachers closer to wildlife (Watson et al., 2013), roads rapidly deteriorate in areas of civil conflict. Roads could have both positive and negative coefficients. The effects of roads on a small, local scale may not persist at country or continent scale. Given ivory smugglers in particular seem much more sensitive to the international costs, the analysis below will assume that road transport costs show little annual variation and have much less impact on smuggling decisions. This assumption may need to be revised upon further research.

The explanatory variables are:

1. Transport Costs (BDI). This is based on the Baltic Dry Index. A negative coefficient was predicted. This was supplemented with a slope-dummy of all shipments 1000kg or over. This dummy variable was KG4. This was to test the hypothesis that the large shipments of ivory were more responsive to shipping costs than smaller. A negative coefficient was predicted for this variable.
2. Consumer affluence. Two alternative measures of this were employed. One was Chinese consumer confidence (CCONF) and the other was the export of Swiss watches (SWATCH). A positive coefficient for this variable was predicted.
3. African instability (REFUGEE). Refugee numbers originating in elephant range states were used as a proxy for instability. A positive coefficient was predicted. The increase in civil conflicts in several Central African nations has increased refugee numbers. These states are also important sources for illegal ivory. This was supplemented with a slope-dummy variable for all raw ivory shipments (RAW). This was to test the hypothesis that it was raw ivory in particular that responded to instability.
4. The 3-month LIBOR Interest rate (LIBOR). Interest rates are expected to have a negative coefficient as low interest rates should stimulate stockpile growth (Kremer and Morcom, 2000). The LIBOR has a global impact that makes it a good candidate for the global interest rate. This was supplemented with a slope-dummy variable for

all shipments over 1000kg (KG4). This is because such shipments were most likely to be 'investment grade' whilst small items in suitcases were intended for personal consumption. It was expected that this variable would have a negative coefficient.

5. A time trend (YEAR). The Harris-Tzavalis diagnostic test for stationarity indicated the presence of a time trend. This was expected to have a positive coefficient.

The data above was collected from Bloomberg with the exception of refugee numbers. Refugee numbers came from the United Nations refugee agency, the UNHCR.

Seizure data is subject to potential biases. It is not known if seizure rates are stable (Underwood, et al., 2013). Enforcement effort may increase in certain periods and this leads to seizure rates increasing. For instance, China seized many small worked items between 2009 and 2010 as part of a crackdown on passenger arrivals. Criminal organisations may try to reduce seizure rates by changing smuggling strategies. In panel-data these interactions between enforcement agencies and criminals should result in the residuals of each cross-section being correlated. This provides additional information that can be used to reweight the least-squares function used to estimate the econometric model. In the case below, SUR weights were used to adjust the residuals in each cross-section.

Seizure rates also come from an unknown probability distribution. The mean of this is very uncertain (CITES Secretariat, 2010, n21). One potential indicator of bias in seizure data is shipment size (Moyle, 2009). Reducing shipment size is one strategy smugglers use to reduce seizure risk. For example, in 2013 a smuggling-conspiracy spread the ivory over three smaller shipments in response to earlier interdictions (South China Morning Post, 2013).

If seizure rates have trended up then average shipment-size should be in decline. Nonetheless average shipment size is stable over the sample period (Figure 4). The slight decrease is not statistically significant. A route-based study may detect evidence of declines that are masked at a global level. This may be present on smuggling routes that include Hong Kong after the big interdictions from 2011. Nonetheless the analysis proceeds by assuming the seizure data is a representative sample of global smuggling activity over this period.

Figure 4: 95% Confidence Ellipse of Large Ivory Seizures

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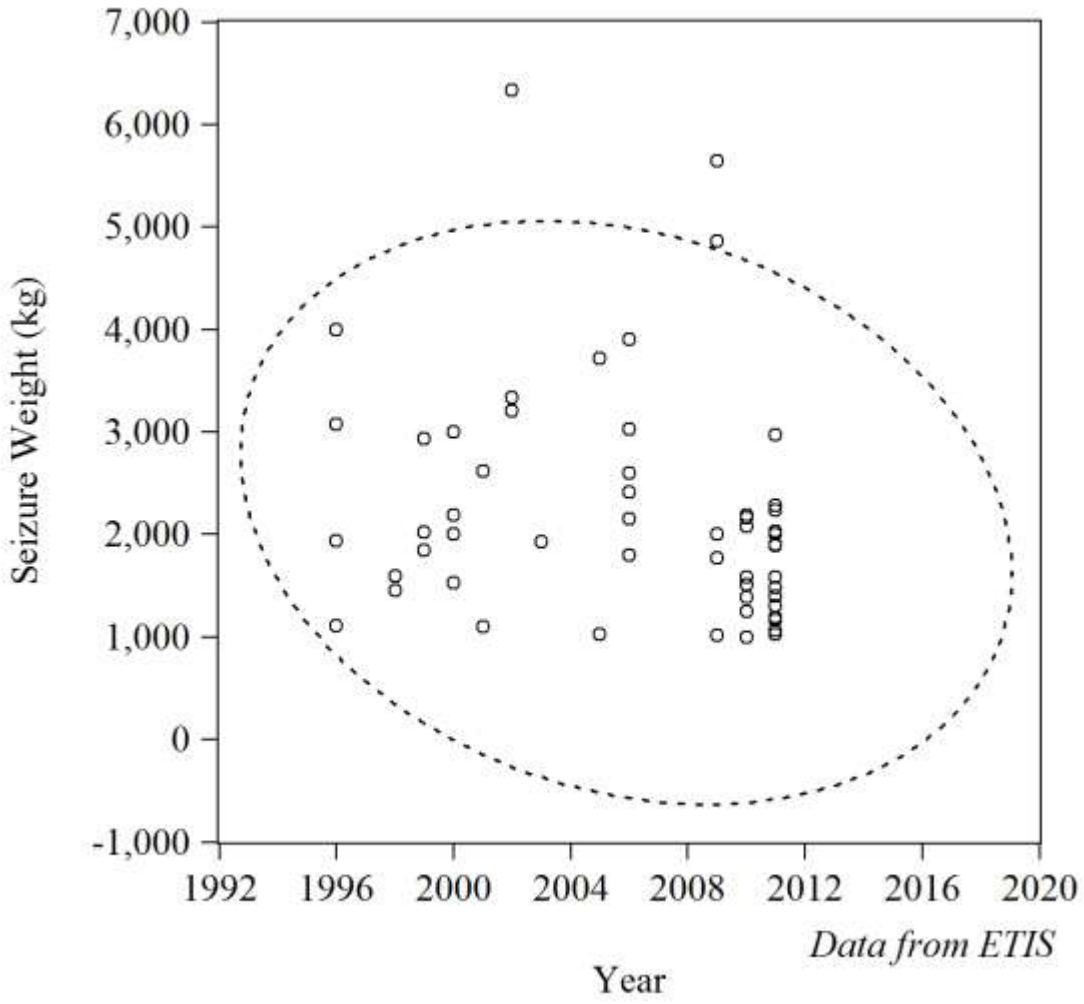
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
-1,000
Seizure Weight (kg)
1992
1996
2000
2004
2008
2012
2016
2020
Year
Data from ETIS

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Fixed-effects balanced panel linear regressions were used to analyse the data. The large deviations in the weight of ivory seized in the largest shipments introduced heteroskedascticity to the model. This was corrected with the White adjustment to the standard errors of the least-squares covariance matrix. Eviews 7.2 was used to estimate the models.

3. Results

The results are presented in Table 1. The hypothesis that transport costs matter is supported. This effect is strongest for the large shipments 1000kg and over. Transport costs are also robust to model specification. Using a differenced format also preserved the significance of transport costs (Moyle, 2013). This reflects the fact that transport costs have followed a similar trajectory as large seizures for the entire period and not just recent years.

Table 1: Panel Data Regression Results

Variables	**Model 1**	**Model 2**	**Model 3**
Dependent Variable: ***Seizures*** **Explanatory Variables:**			
BDI	-0.3240	-0.4124	-0.3276
	(0.0290)***	(0.0518)***	(0.0308)***
KG4×BDI	-0.4000	-0.4000	-0.4000
	(0.1347)***	(0.1347)***	(0.1341)***
REFUGEE	-0.0015	-0.0026	-0.0015
	(0.0011)	(0.0016)	(0.0011)
RAW×REFUGEE	0.0038	0.0038	0.0038

	(0.0007)***	(0.0007)***	(0.0007)***
LIBOR	110.193	98.182	128.961
	(68.819)	(77.412)	(53.361)**
KG4×LIBOR	-302.111	-302.111	-302.111
	(130.954)**	(130.954)**	(130.373)**
YEAR	138.200	237.849	169.639
	(51.800)***	(55.986)***	(31.226)***
SWATCH	460.002		
	(622.733)		
CCONF		48.323	
		(34.770)	
Sample Period: 1996 to 2011			
N	128	128	128
Weighted R^2	0.927	0.927	0.927
Unweighted R^2	0.564	0.568	0.564

The results demonstrate that African instability partly explains the levels of raw ivory being exported, and that the large shipments of ivory are partly explained by interest rates. The lack of significance of the affluence measures is possibly due to the time-trend variable in the model. Affluence has also steadily increased in East Asia since the mid-1990s and the time-trend likely captures this effect as well.

The effect of the SUR weights in the model provides more efficient estimates of the variables. This results in the weighted R-square of the model being markedly better than the unweighted. This supports the use of this technique to correct for shifts in seizure rates.

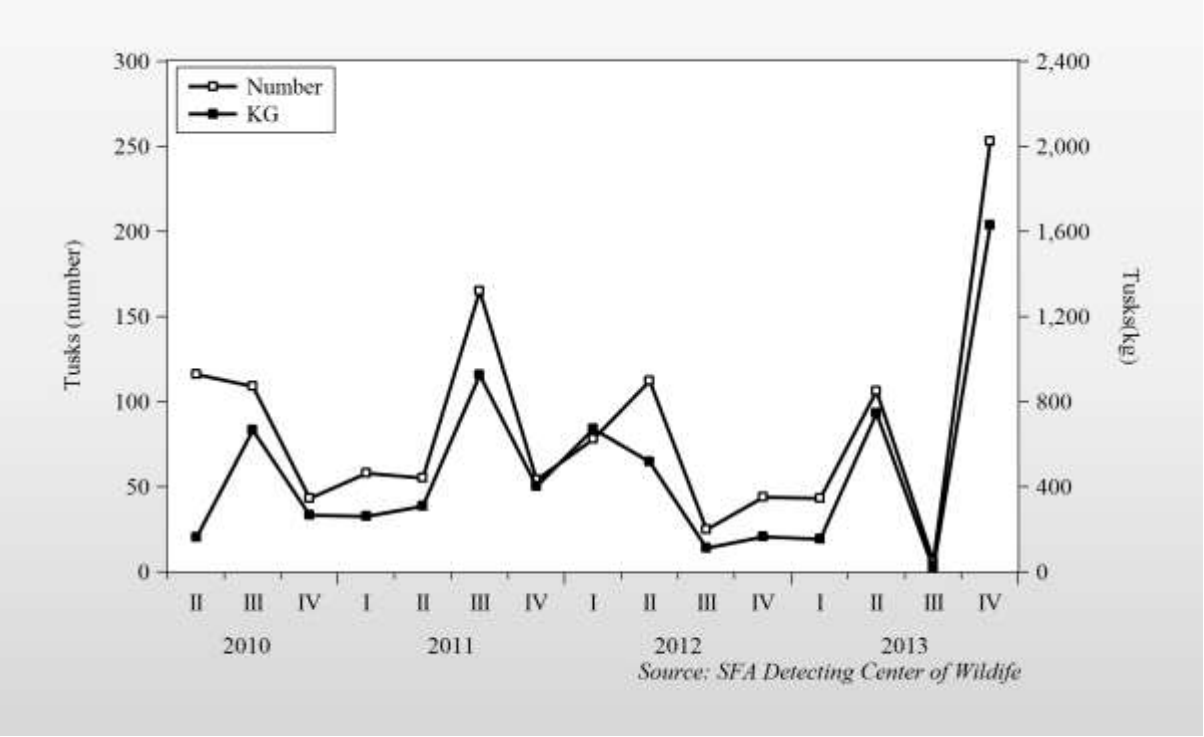
4. Discussion

Even with aggregated data and the use of very general metrics for variables, shipping costs have a significant and robust effect on illegal traffic. This links back to the separation of range states to consumer states, along with the high weight of ivory. This factor has been overlooked in other analysis of the supply chain. This motivates the submission of this research at this early stage. Shipping costs appear to be highly relevant for the volume of trade.

A popular view is the 2008 sale of ivory to China triggered a leap in demand for carvings (IFAW, 2012; Rice, 2012). Nonetheless evidence that market turnover has risen to match the volumes of ivory being smuggled is lacking (CITES Secretariat, 2010). Legal sales appear to have settled at around 4 tons per year (Jin, 2013).

This is supported by the throughput of tusks (Figure 5). The tusks depicted here are those from the CITES approved sale in 2008. Once a raw tusk has been completely carved it is recorded in the SFA database as consumed along with the date it was used up. The throughput of tusks provides a measure of the supply of carvings. Despite the cyclical nature of the supply the throughput is not showing marked upward trend. With annual seizures of raw ivory now in excess of 30 to 40 tons (Figure 1), and presumably with much more getting through, there is a lot of ivory to account for.

Figure 5: Ivory Throughput by Quarter



This lack of evidence of demand is also supported by the small number of ivory carvers in China (Stiles, 2004). Indeed Vigne and Martin (2011) report some factories in Guangzhou had closed because of a shortage of carvers. This small base of carvers hinders output expansion (Stiles, 2004).

Production of ivory-carvings is still largely an artisanal-level of manufacture (Figure 6). Some pieces can take months to complete (Conrad and Moyle, 2013. This is reinforced by the throughput graph (Figure 5). The first allocation of these tusks to factories was in July 2009. It took however, until May 2010 before records of the first of these tusks being entirely used are made. The market for carvings has many inelastic-supply characteristics.

Figure 6: Chinese Ivory Carver

The stockpiling hypothesis appears to be the best fit for the evidence. It is consistent with changes in shipping costs and interest rates. While the production data presented above is not in any sense definitive, it highlights that there are problems with a post-2008 demand eruption. To convert the volumes of raw ivory into carvings for sale would require a large scale and rapid expansion of illegal carving factory capacity, dwarfing the legal sector by an order of magnitude. If this had occurred corroborating evidence in terms of factory-busts ought to have been made by now.

Demand has increased for ivory. This is supported by the time-trend variable above and is plausibly linked to the affluence factor. Nonetheless, this is a steady change over the entire period, and has not leapt in the post-2008 period. Any dispute over demand must be about the degree of change and not whether it increased or not.

The scenario revealed in the model is largely one where supply factors have driven the rapid increase in poaching. Conditions in Africa seem to have deteriorated at a time when criminal organisations desired to increase their stockpiles. This could have a perverse effect. It becomes riskier for these organisations to retain ivory on live elephants in range states. It

would be more likely ivory will be lost to rival poachers. This makes the option to store ivory as tusks outside Africa the less risky option. This would create a negative feedback and accelerate the killing. As more is poached, it would become more risky to keeping tusks on live elephants becomes, which inspires more intensification of poaching.

An illegal stockpiling strategy is perturbing. The economic rationale for stockpiling ivory is that ivory-prices are expected to rise (Kremer and Morcom, 2000). Key participants in the black-market are banking on demand for ivory to be robust enough to sustain price increase into the future. Supply measures like CITES effectively ceasing ivory exports from 2008 onwards after the one-off sale to China and Japan may encourage this expectation. It would be imprudent to disregard this expectation by traffickers given their knowledge of the market.

This comes to another issue that is being overlooked. There are two markets for ivory that are separated by time. There is the current market for carvings. There is also a future market which this smuggled raw ivory will be eventually fed into. With the volumes being trafficked, this would have to be spread over many years. The economic factors driving these two markets are not identical. The cautionary note is that conflating these markets may result in too much focus on the current market, and the adoption of policies that are short-lived in their effectiveness. Some deeper analysis of policies is merited.

5. Conclusion

The criminal firm's operating costs affect poaching decisions. In the case of ivory, shipping costs appear to be a significant part of these costs. This is a consequence of the distance between markets in Asia from sources in Africa and ivory's bulk. The convergence of several risk factors around 2008, many a direct consequence of the GFC, accounts for much of the increase in poaching.

The level of illegal traffic in raw ivory is also an indicator that ivory is largely being stockpiled by criminal organisations. This explanation is consistent with the lower interest rates and transport costs along with bottlenecks in the ivory-carving production process. The alternative hypothesis that there has been a recent, substantial increase in the demand for

414 carvings has much less support. That transport costs remain low well into 2013 (Figure 2)
415 does not auger well for an imminent reduction in poaching. This pessimism is sustained by
416 18 large seizures of 41.6 tons reported for 2013 (CITES et al., 2013).
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