Use or destruction: on the economics of ivory stockpiles

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Abstract

This paper examines the economic arguments surrounding the fate of ivory stockpiles. It centres on the polarized debate between their destruction and various schemes of how to put them to economic use in the context of conservation policy. In section I we examine the policy option consisting in the destruction of ivory stockpiles. We argue that maintaining stockpiles in place supports expectations of a future stable supply of ivory. The self-reinforcing effects from the combination of these expectations, sunken investments and the creation of new market-associated institutions can contribute to a lock-in process in a trajectory of consolidated and expanding ivory trade. Section II focuses on arguments that favour the strategic use of stockpiles as a deterrent against speculators. We show that results of economic models that recommend this option (including models on extinction scenarios) are heavily dependent on simplifying assumptions about key market interactions and on logically inconsistent notions. In section III we examine the case for selling stockpiles in a legal market as a policy instrument to reduce poaching. We show that the economic analysis used to support this recommendation is deficient on many grounds. Its theoretical foundations are flawed and it abstracts from crucial aspects of market structures and dynamics of price formation. Our conclusions hinge around the fact that in the present context destroying ivory stockpiles is the best option to reduce poaching in the long term.

Résumé

Cet article examine les arguments économiques relatifs au sort des stocks d'ivoire. Il se focalise sur le débat polarisé entre leur destruction et les différentes propositions concernant leur utilisation économique dans un contexte d'une politique de conservation. Dans la première partie nous examinons l'option qui consiste à détruire les stocks d'ivoire. Nous soutenons que le maintien des stocks en place encourage les anticipations sur une offre d'ivoire stable dans l'avanir. Les effets auto-renforçant qui résulteraient de la combinaison de ces anticipations, des investissements déjà faits et la création des institutions de marché nouvelles pourraient contribuer à un processus qui renfermerait les agents économiques dans une trajectoire de commerce de l'ivoire á la fois consolidé et élargi. La Partie II traite les arguments favorisant l'utilisation stratégique des stocks comme un facteur de dissuasion contre les spéculateurs. Nous montrons que les résultats des modèles économiques qui recommandent cette option (y compris les modèles de scenarios sur l'extinction) dépendent des hypothèses simplificatrices sur les interactions clés du marché et des notions logiquement contradictoires. Dans la Partie III nous examinons la proposition de vendre les stocks sur le marché légal comme un instrument de politique visant à réduire le braconnage. Nous montrons que l'analyse économique utilisée pour appuyer cette recommandation est déficiente pour de nombreuses raisons. Ses fondations théoriques sont incorrectes et elle laisse de côté des aspects cruciaux des structures de marché et des dynamiques de la formation des prix. Nos conclusions ressortent du fait que dans le contexte présent, détruire les stocks d'ivoire est la meilleure option pour réduire le braconnage dans le long terme.

Introduction

The pressure on elephant populations has accelerated in recent years across most range states. Between 2006 and 2013 the estimated total (definite + probable) African Elephant population decreased from 550,000 to 470,000 (Wittemyer et al. 2014). While habitat loss and fragmentation, together with climate change continue to represent both short and long term threats, pressure from poaching and ivory trafficking has become the primary source of population reduction (CITES 2016). The proportion of Illegally Killed Elephants (PIKE) remained above sustainable rates

for four consecutive years since 2010. In turn, the international trend of illegal ivory transactions shows a progressive increase since 2007, while raw data on annual seizures has been higher in the period 2009 to 2013 (excepting 2010) than in any other year since 1989 (all data from CITES 2016). The upsurge of illegal poaching and trafficking has renewed the discussion about the available policy options to reduce poaching within the international framework that regulates wildlife trade. Against this background, the fate of ivory stockpiles is a key component to elephant conservation policy.

This paper focuses on the economic arguments that surround ivory stockpile management. The paper looks at three options: destruction of stockpiles, use of stockpiles as a deterrent against speculators (who may bank on extinction), and the sale of stockpiles in a legal market in order to reduce the incentives for poaching. Section I focuses on the first option and examines the arguments for and against destroying the ivory stockpiles. We review the underlying assumptions and contrast positions against evidence on key ivory flows. Section II focuses on models that recommend the use of ivory stockpiles as an instrument that undermines the activities of speculators. Particular attention is given to the possible use of stockpiles to minimize the risk of extinction equilibria. Section III examines the core arguments to sell ivory stockpiles in a legal market from a structural perspective of market development and price formation dynamics. Conclusions are presented in the final section.

I The Debate on the Destruction of Ivory Stockpiles

Endorsement of ivory stockpile destruction is based on the argument that their continued existence leads to the anticipation that ivory may be sold in the future, feeding expectations of continuing trade and disabling demand reduction policies. Ivory stocks are expected to accumulate due to both natural and human causes, yet the management of ivory stockpiles involves increasing protection costs and security risks. The heavy management burden and the risk it entails also support the policy to permanently dispose of stocks. Stockpile destruction seeks to prevent ivory from entering commercial circuits at any future date, reducing as well margins for corruption.[1] It also aims at preventing expectations about future trade (both legal and illegal) leading to lock-in processes and trajectories in poaching and trafficking.

Criticism to ivory stockpile destruction, on the other hand, argues that destroying stockpiles reduces supply, increases prices and strengthens incentives to poaching. An accompanying argument states that selling stockpiles will increase supply and reduce prices (Bergstrom 1990; see section III), while yielding economic gains to finance conservation. The common assumption here is that of a fundamental negative relationship between changes in supply and price variations.

Two points require clarification in this general discussion. The first one is that most references to the "ivory market" are based upon an abstraction in which unique prices prevail and all agents are homogeneous. The reduction of a wide variety of agents and countries where markets exist to one representative entity can be seriously misleading. Simplification may facilitate the discussion on policy options but it does so at a great cost.

The second is the lack of key basic information about market conditions and structures, which severely reduces the quality of analysis. The over simplification and lack of key basic information about market conditions and structures is not helpful for the assessment of available policy options (see section III).

I.1 Stockpile destruction, outflows and the ivory trade

Ivory stockpile destruction as a conservation policy option began in 1989 in Kenya (when 12 tonnes was burned). Subsequent destruction events took place in 1991 in Kenya (6.8, tonnes), and in 1992 Zambia (9.5 tonnes) and the United Arab Emirates (12 tonnes). The practice was resumed in 2011. In total over 260 tonnes of ivory have been destroyed in 21 countries to date (WCS 2016). The importance of stockpile destruction can be appreciated in Table 1, which compares the stockpile destructions with the total volume of trade (or market turnover) of ivory, both legal and illegal. Illegal trade comes from the usual estimation of assuming a 10% confiscation rate. These calculations must be taken as an approximation to orders of magnitude. Total Trade turnover may be underestimated, as it excludes relevant data like legal flows of carved ivory and trophy hunting, outflows from private stockpiles and leakage from confiscations. On the other hand, Total Trade may be overestimated by the amount of the raw ivory that left the Hong Kong stockpile to

[1] A 2010 estimate by TRAFFIC indicates that as much as one third of stockpiles may have "leaked" illegally (Milliken 2010).

be traded internationally. Changes in the Hong Kong stockpile and confiscations include both raw and carved ivory.

There exist very poor data on the remaining ivory stockpiles in either range or non-range states. CITES (2016b) suggests global ivory stockpiles could hold over 1000 tonnes. Considering a low estimate by CITES (2014) of over 816 tonnes only in Africa, the above figures on stockpile destructions are significant. The most important episode in ivory stockpile destruction took place on April 30, 2016 in Nairobi as 105 tonnes of tusks and some carved ivory, representing 10+ years of Kenya's accumulated ivory stocks. From a total of 29 destruction events, 20 took place after 2014 (see Table 1 below).

Table 1 helps look at the key question about the effects of stockpile destruction and the evolution of the legal and illegal trades. It shows that relative size of the destruction of stockpiles in the period 2008–2014 is small (approximately, 2.9% of the total market turnover). The amount of stockpiled ivory destroyed before 2015-2016 could not have contributed significantly to the rise in prices and to the increased poaching (raw ivory went from $750 USD/kg to $2100 USD/kg in China between 2010 and 2014; cfr. Vigne and Martin 2014).

Information about private ivory stocks is poor. Japan's private ivory stockpile in 2014 amounted to 339.1 tonnes (whole tusks and cut pieces; CITES 2014b). By 2013, the private stockpile of raw and carved ivory in Hong Kong contained 117.1 tonnes (Martin and Vigne 2015). Given its historical role as a trade hub, Hong Kong traders accumulated a vast stock of 665 tonnes of ivory, both raw and worked during the 1980's (Martin and Stiles 2003).[2] The stock was rapidly depleted after the 1989 trade ban to 306 tonnes by 1995 (even though at decreasing rates; cfr. Martin and Vigne 2015). Between 1996 and 2008 the annual stock outflow maintained a level of 6 tonnes on average (Martin and Vigne 2015).

While the relationship between the legal and the illegal supply is not evident before 2007, after 2008 the legal and illegal markets expanded substantially and simultaneously as prices continued to increase (Martin and Vigne 2011; Vigne and Martin 2014; Martin and Vigne 2015). Around the second one-off sale, important investments were carried out on the supply side in China, as measured by increasing number of licensed carving factories, traders, and outlets (Vigne and Martin 2014; Gabriel et al. 2012). Driven by increasing purchasing power, China emerged thus both as the main recipient of legal trade flows and also the main intended destination from seizures (Underwood 2013). Figure 2 below compares stockpile destructions with flows from legal and illegal trade. The data on rising confiscations suggest that the one-off sale in 2008-09 did not contract the illegal market and did not reduce ivory prices. While it can be argued that the effects of increasing supply are not immediate (as stocks from the on-off sales were planned to be used gradually, at least in China), this questions the mechanisms by which the legal trade has been assumed to crowd out illegal traders via reduced prices.

Due to lower travel barriers Chinese demand overflowed into Hong Kong Mainland Chinese visitors to Hong Kong increased from 6.8 to 47.2 million per year between 2002 and 2014 (UNTWO 2015), becoming the main market for Hong Kong ivory traders and retailers (90% of buyers, according to Martin and Vigne 2015). Prices of ivory in Hong Kong increased steadily, between 2010 and 2014, but remain 50% lower than in Beijing (Martin and Vigne

Table 1. Elephant ivory trade and the relative size of stockpile destruction (tonnes)

	2008-2014	%
Total Trade (1+2+3)	2,432.2	100.0
Illegal Trade (1) *Confiscations*	2,208.3 220.8	90.8
Hong Kong stock outflow (3)	63.0	2.6
Stockpile destructions	71.6	2.9
Stockpile destructions (2015-16)	155.3	

Sources: Illegal trade is an estimation from unadjusted data on confiscations and seizures of both raw and worked ivory, from the Elephant Trade Information System (ETIS) database, assuming a confiscation rate of 10%. Legal trade flows are total gross imports of tusks declared to CITES (Loxodonta africana, Appendix II), which include (but is not restricted to) the volumes introduced by one-off sales in 1999 and 2008 to Japan and China. Hong Kong's stock outflows are the reductions (taken as a positive value) in total private stocks of raw and worked ivory registered with the Department of Agriculture, Fisheries and Conservation (Martin and Vigne 2015). Stockpile destruction figures come from WCS (2016).

[2]Between 1977 and 1989, Hong Kong concentrated half of global ivory imports, about 3.5 thousand tonnes (CITES trade database).

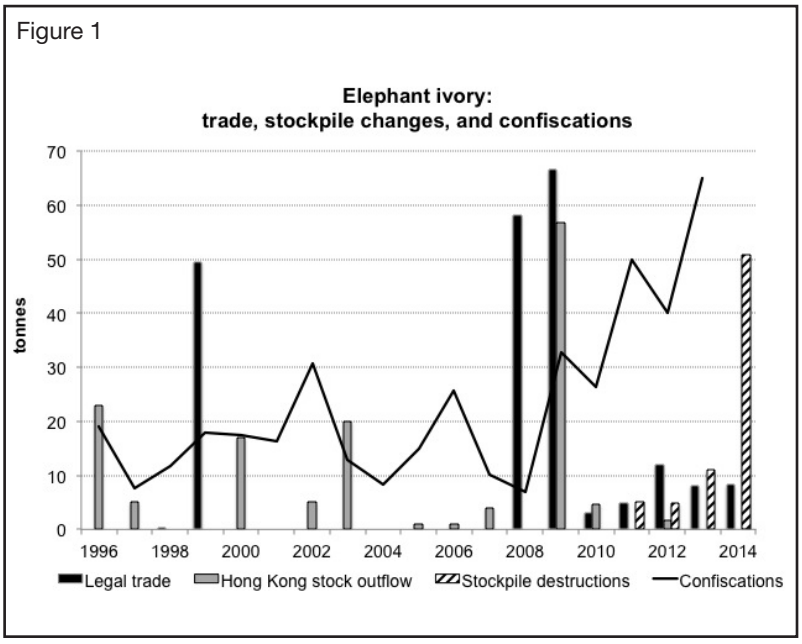
2015). Further, there is evidence that legal business facilitate laundering between Hong Kong and China (Crosta et al. 2015; Gabriel et al. 2012). Finally, the expansion of double way flows of mammoth ivory, imported by Hong Kong to be re-exported to China, further illustrates complementarities seized by agents trading in both goods (Martin and Vigne 2015; Vigne and Martin 2014).

The simultaneous expansion of the legal and illegal ivory supplies in Mainland China and Hong Kong in a context of rising prices does not support the hypothesis that increasing the legal supply will reduce traffic. The signals point at self-reinforcing effects between legal and illegal trade that weaken the case against stockpile destruction (we return to this point in section III), a hypothesis that requires more rigorous testing.

The argument that destroying stockpiles is equivalent to a reduction in supply and thus leads to higher prices has a mirror image. As long as stockpiles are maintained in place, they support the prospect that a stable supply will be a reality in the not too distant future. This may contribute to a consolidation of expectations concerning the future stability and even expansion of the ivory trade, by reinforcing the interrelations between consumer preferences, investment choices, and institutions. The reinforcement mechanism between elements of collective choice guarantees that one specific market configuration is locked-in, even when more desirable alternatives exist (David 1985; Arthur 1988; Unruh (2000; Dolfsma and Leydesdorff (2009). The prospect of capturing the profits from future ivory trade will lead traders and processors to remain in the business. In turn, this persistence can lead to renewed investments, the creation of new institutions (such as schools for carvers) and consolidate the array of consumer preferences and social routines that are related to market operations and regulations (Bowles 1998). Sunken costs and adaptive expectations may very well contribute to lock-in future demand for and supply of ivory (Arthur 1988). Maintaining ivory stockpiles sends a message to incumbents that it makes good economic sense to hold on to their assets. Tomorrow's stable supply is an incentive that counters the impulse to liquidate assets and close a business. The bigger the trader and the larger the assets involved, the greater the barriers to exit and the stronger the desire to remain in the trade. This may even translate into new investments designed to take advantage of the perceived upcoming opportunities.

The assumption that destroying stockpiles implies subtracting from supply and therefore must contribute to higher prices disregards the fact that in the context of a contracting economy and pessimistic expectations, disposing of these stockpiles can be interpreted as a signal that ivory is a declining market. As China's economy continues to slow down and macroeconomic policies fail to prop up its growth rates, deflationary symptoms continue to be felt. This is compatible with reports on dramatic reductions in ivory prices.[3] Against the background of this combination of events the recent destruction of 105 tonnes by Kenya's authorities may very well contribute to even more pessimistic expectations and still lower ivory prices. Multiple economic variables affect expectations' formation and their evolution needs to be carefully tracked.

Figure 1



Sources: See Table 1.

[3]See the press release by Save the Elephants: http://savetheelephants.org/about-ste/press-media/?detail=sharp-fall-in-the-prices-of-elephant-tusks-in-china.

Stockpile destruction is not a risk-free option. The possibility of further stimulating high prices, poaching, and speculative stockpiling is real and will not be eliminated by stockpile destruction alone. To achieve its goal stockpile destruction would require to be carried along on a regular basis. It must be accompanied by coordinated efforts in law enforcement that increase and multiply the costs of poaching and trafficking, while at the same time reducing expectations on future trading. The latter can only be achieved through a total ban on domestic markets. Demand reduction efforts should also be pursued and intensified. The phasing out of ivory trade entails in turn additional problems of coordinating collective action (Harvey, 2015). We argue however that these risks are less important than those associated with other uses of ivory stockpiles, a point to which we turn in the following sections.

II Using Ivory Stockpiles as a Deterrent Against Speculators

The prevailing debate on stockpile management is organized around the possible economic use of ivory stockpiles versus their destruction. One possible economic use is as a tool to control prices without selling the stock, namely as a deterrent against speculators. Another is to sell them in a legalized market. In this section we focus on the first set of issues while the second avenue is examined in the following section.

The most developed argument in favour of this policy option for ivory stockpiles is Kremer and Morcom (2000) who build on the well-known Gordon-Schaefer bio-economic model but with the added novelty of allowing for storage. Their model examines the case of rational expectations equilibria with perfect foresight where agents believe the economy will follow a deterministic path but with multiple equilibria. It derives combinations of elephant population, stocks, and prices that are consistent with rational expectations equilibria, specifying the conditions that lead either to extinction or to a high-population steady state. They construct a model in which storage and poaching incentives feed on each other in a cycle capable of bringing even stable populations to extinction. The model points at two strategies to eliminate the extinction equilibria: 1) imposing strong antipoaching policies (raising poaching costs) if elephant population becomes endangered, and 2) maintaining large stockpiles and threaten to sell them if population falls beyond a threshold. Authors then show that the cheapest long-run policy is the second, especially when the government is not able to credibly commit to strong antipoaching. Once the government accumulates sufficient stores, the force of deterrence is enough to take the system away from the extinction equilibrium path.

The model has several drawbacks that significantly weaken the policy conclusions. Firstly, it does not contain an explicit price formation mechanism. Prices do change, but they do so in response to elephant population dynamics: price is inversely related to population and that is the only rule we have. This means that prices change in response to an anonymous process in which "the market" continues to be a black box. Agents endure the effects of changes in prices, but just who changes prices remains an unanswered question.

Secondly, the model does not specify how individual agents operate, other than saying that they are price takers. For example, the model describes poaching as a decreasing function of the elephant population. Because this is valid for all poachers alike, regardless of their capacity, this is equivalent to assuming there is only one poacher. Moreover, assuming perfect rationality is similar to assert that agents behave exactly as one. The resulting description of market dynamics is rather simplistic, although based on several many constraining conditions and may be misleading.

More important, the model applies to storable goods, but not to durable goods (goods that are not destroyed when they are consumed) like ivory. The authors remark that while stockpiles can help protect animals which are killed for goods which are storable but not durable, such as rhino horn, stockpiles will not help protect species which are used to produce durable goods, i.e., goods which are not destroyed when they are consumed" (Kremer and Morcom 2000).

The paper by Kremer and Morcom (2000) has been a key reference in the debate on stockpile management. But most of the references that rely on citations from that paper completely ignore its intrinsic problems or the authors' caveats about its applicability (see for example 't Sas-Rolfe, Moyle and Stiles 2014).

Another issue in the discussion on the use of ivory stockpiles as a policy tool revolves around the issue of who controls these ex situ resources. Bulte, Horan and Shogren (2003) recommend privatizing all stockpiles. They consider the case of African elephants where governments compare the expected returns from two strategies. In the conservation strategy, a government

invests in anti-poaching enforcement and stores ivory from confiscations and culling. In the extinction strategy the governments forgo enforcement and could even promote hunting the elephants to extinction. The authors conclude that "conditions exist in which African nations prefer the extinction strategy" and that "ivory storage by African range states enhances the relative profitability and probability of an extinction strategy" (Bulte, Horan y Shogren 2003) because a government in a poor country may find it lucrative to drive in situ stocks (live animals) to extinction.

An even more extreme view of this stance can be found in Bulte, Mason and Horan (2003) where a speculator promotes depletion of wild populations in the short-run, wipes competition off and attains the status of monopolist in the long run. To counter this situation the authors recommend that the international community invest in purchasing these storable commodities from the African nations in order to undermine the profits of the extinction strategy. It is argued that the international organizations buying the stored commodities could adopt the Kremer and Morcom (2000) strategy of using these stockpiles as a deterrent against speculators. Kremer and Morcom (2003) express their disagreement pointing out that the essence of their policy recommendation is precisely to prevent the extinction equilibrium. The consequence of this recommendation is that African nations would be deprived of the control of their ivory stockpiles and the priorities for their conservation policies would effectively pass to the hands of international organizations (private or public).

The analysis in Mason, Bulte and Horan (2012) concludes that strategic ivory stockpiles are potentially dangerous liabilities when in the hands of profit-maximizing individuals. They conclude that "from a conservationist perspective, it makes sense to promote the transfer of such stocks from private to public parties–either through confiscation or purchase."

It is important to note that the models reviewed in this section are extremely aggregate in nature. The ivory market is described as a homogeneous entity and there is no room for the analysis of structures or such things as big firms that may corner a significant part of the market. But this is not the only problem. They also rely on simple assumptions regarding market demand curves and price formation mechanisms (see section III.1 below).

Most importantly, these analyses look at scenarios where "banking" or "betting" on extinction, and dumping or using stockpiles as a deterrent, are the only alternatives. Destruction of stockpiles as a rational conservation policy option is excluded by assumption. There is no justification for this approach. In fact, if "driving to extinction" scenarios outperform (from an economic standpoint) other scenarios, as these authors claim, this may very well strengthen the case for stockpile destruction.

An alternative argument to stockpile policy is 't Sas Rolfes et al. (2014), which also recommends the use of ivory stockpiles a deterrent against speculation. They focus on China and argue that demand in the legal and the illegal markets are specialized in different segments of the market. For them, poaching is the result of the trade ban, but its recent acceleration is due both to rising income as to speculative stockpiling. They infer this from the discrepancy between illegal flows of raw ivory and the limited (both small and stable) processing capability of the legal sector. According to this analysis speculative ivory stockpiling responds to conditions in the prices of a set of aggregate financial variables (price of gold, interest rates).

It must be noted that 't Sas-Rolfes et al (2014) state that productive capacity and demand of carved ivory have remained stable. But Vigne and Martin (2014) contradict this and as record very important increases in both processing and trade capacity. In addition, Crosta et al (2015), among others, dispute the neat separation between legal and illegal segments of the ivory trade in China. Finally, 't Sas-Rolfes et al (2014) advance this hypothesis but fail to provide any data on speculative stockpiling and recognise the need for further research.

III Selling Ivory Stockpiles through Legal Markets

The case for selling stockpiles in order to stop the poaching crisis is based on the premise that legalizing trade will increase and stabilize supply, bringing down prices and displacing the illegal traders from the ivory market. In this section we examine four aspects of the analysis needed to assess this policy option: 1) the implications of using a partial equilibrium approach; 2) market structures; 3) features at the microeconomic or firm level; and 4) demand related issues.

Bergstrom (1990) argues that a trade ban produces scarcity and increases prices up to the level where expected returns in the illegal market outweigh costs and risks. The underlying logic is that for every level of confiscation traffickers will expand poaching in the same proportion, in order to capture the revenue that

they will accrue if trade wasn't banned. Assuming a direct and proportional relationship between rates of confiscation and poaching the argument leads to a very strong position against stockpile destruction. Given the assumptions, the conclusion is that the best policy option is to render trafficking unprofitable by selling confiscated (or harvested) stocks. The mechanism entails a smooth substitution process by which the legal market crowds out the illegal market. The idea that stockpile destruction leads directly to greater scarcity and higher prices is symmetric to the notion that selling the stockpiles will increase supply and lower prices. Damania and Bulte (2007) and Fischer (2004) show that Bergstrom's results fail to hold in the presence of market concentration under price competition, product differentiation, stigma reduction, and laundering.

III.1 Partial Equilibrium and Comparative Statics

Partial equilibrium models are the basis for most ivory trade analysis (including the models examined in section II). Their key assumption is that what happens in other markets or sectors of the economy have no effects on the market being considered.[4] Their main advantage lies in its minimal informational requirements but partial equilibrium modelling is of limited use for real world problems and policy discussions.

Partial equilibrium analysis for ivory concentrates on changes in the price of a single commodity and ignores the effects on the demand schedule for ivory that stem from variations in the rest of the system of relative prices. This has two problematic implications.

First, income effects induced by the changes in other prices may have a significant effect on the ivory demand curve, bending it upwards for some segments and eliminating stability conditions. Second, abstracting from changes in the structure of relative prices obscures the analysis of price movements. Data from a market survey may show that the price of ivory is going down, but if the prices of other commodities are falling at a faster rate, the price of ivory will be in fact increasing relative to those other prices. Keeping track of the evolution of prices requires at least that a constellation of relevant prices be taken into account. Partial equilibrium is not the right methodological choice.

Partial equilibrium frameworks concentrate on comparative statics and compare unique equilibrium positions as supply and demand parameters change. But they say nothing about the actual process through which market forces lead (if at all) to these points. Models as in Damania and Bulte (2007) simply inform us how individual agents make their own calculations without describing the actual market dynamics leading to these positions. In these equilibrium models even if one accepts all the assumptions required by the model, there is no guarantee that this equilibrium points will be attained.

III.2 Market structures

Increased supply is neither a necessary, nor a sufficient condition to bring the price of a commodity down. What actually leads to price reductions is additional competition. But the competition dynamics depend on the structure of the market and the degree of market power that agents brandish. Market structures affect the way in which firms survive in a given environment (Scherer 1980). If the objective is to drive illegal ivory traders out of the business, it is of critical importance to understand the relevant market structures. In some cases legal suppliers of ivory products may not be able to outcompete illegal traders from the market. And in some cases, the outcome may backfire and result in greater poaching (Damania and Bulte 2007).

Market power results from factors that restrain competition (Bain 1956, Tirole 1988). They are all relevant for the case of ivory trade: concentration ratios, entry barriers, privileged access to capital markets or the control of marketing channels. Agents with market power can manipulate prices, control supply chains, influence demand and maintain or expand their market shares with greater flexibility. Through market power traders can start or withstand price wars, depending on their strategies. Their capacity to take advantage of deregulated ivory trade would also depend on their market power. Yet nothing is known about market power in existing ivory markets.

III.3 Firm-level analysis

Policy proposals to sell ivory in a legal trade ignore almost everything that is important about the firms involved in this trade. Although many market surveys have been carried out, almost nothing is known about the types of firms that are involved in the ivory trade (whether legal traders or criminal networks). Costing

[4]This is equivalent to assuming that all other markets have reached a position of equilibrium. In equilibrium allocations market forces have ceased to work and nothing is happening (all agents have maximized their payoff functions and prices have rendered all individual plans compatible). This is a very strong assumption.

structures, capacity to diversify, financial profiles and linkages with the rest of the supply chain determine a firm's capacity to undertake and/or withstand a protracted price war (Porter 1985; Teece and Pisano, 1998).

Cost structures are of critical importance in order to assess the policy of selling stockpiles. Scale economies are a critical aspect of firms' operations in modern market economies and assuming they do not exist in the ivory trade is unrealistic. There are several signs that economies of scale are a feature of the on-going ivory trade. Data suggests this through seizures of large-scale ivory shipments (defined by ETIS as shipments of at least 800 kilograms, Underwood, Burn and Milliken 2013). Nellemann et al (2013) have found indications of increasing occurrence of large-scale ivory shipment. CITES (2012) also reports an increasing trend in the average size of large-scale seizures. Fiorentini (1999) thinks that organized crime is more likely to thrive in the presence of economies of scale and monopoly power.[5]

Agents involved in illegal wildlife traffic tend to be involved in several other activities, just as multi-product firms (EIA 2014, Felbab-Brown 2011, Milliken and Shaw 2012, Wyler and Sheik 2009). Multi-product lines of activity have also been confirmed by reports of multi-product seizures (INTERPOL 2013). The presence of scope economies in wildlife trafficking is a key factor that has been neglected in the policy debate on the use of ivory stockpiles.

Scope economies rely on the ability to produce a combination of products at a lower cost than the costs of producing the same quantities of each product separately. Multiproduct firms spread fixed costs (and risks) along different lines of products that are carried along common fixed investments (Chandler 1990). This explains why product diversification or bundling the production and commercialization of several commodities is a powerful instrument to reduce unit costs.

Evidence suggests that agents in different segments of the supply chain in the ivory trade operate on multiple lines of production (EIA 2014; Felbab-Brown 2011; Milliken and Shaw 2012; Wyler and Sheik 2009). The advantages of product bundling and multi-product synergies strengthen scope economies that liberate profitability from being tied to results in one market. Thus, even if price reductions are achieved in one product, say, ivory, a multi-output organization may be able to remain in operation for a long period of time. Incumbent firms in the ivory trade may choose to remain in the trade with lower profits even if ivory prices do fall.

Chandler (1990) shows that scale and scope economies are complementary, and are fundamentally based on increased throughput. His business history is highly relevant for the analysis of the ivory trade because it reveals how firms become more efficient as they diversify product lines and engage in product differentiation: scale and scope economies end up stimulating endogenous market growth. Firms with access to scale and scope economies actively resort to a strategy of expanding and developing their markets.

III.4 Demand

Proposals to sell ivory stocks in a legal market assume that a stable source of supply will reduce prices but seldom look into the implications of demand expansion that may ensue. With the usual assumptions, a price reduction will bring an increase in demand, but the response of demand to price variations depends on several factors. The risk of enlarging demand and having a runaway process in which the ivory trade expands is only too real.

The assumption that market demand functions are downward sloping is used in all studies on ivory trade. However, downward sloping market demand functions can be constructed in the case of an economy made up of one agent and one commodity (or one commodity and the unit of account). In a real world context with multiple agents and commodities this is no longer possible. The standard assumptions at the level of the individual agent have no equivalent at the market level.[6] Thus, there is no theoretical support for the idea that the market demand curve for ivory has the well behaved properties (downward slope) that are explicitly or implicitly assumed in all renditions of how the ivory market behaves.

Assessing a policy of selling ivory stockpiles also needs information on the sensitivity of demand to price variations. Although the literature has frequent references to the price elasticity of demand, this is

[5]Another very important aspect of cost structures is related to vertical integration (i.e., control by one firm of different stages in the supply chain). The more vertically integrated is one operation, the greater the degree of freedom to distribute costs among the different segments of the relevant supply chain. Illegal traders may exhibit different integration profiles in response to risk and profitability (Gereffi 1996).

[6]The Sonnenschein-Mantel-Debreu (SMD) theorems proved that market-level excess demand functions are not restricted by the usual rationality conditions on individual demands (Debreu 1974, Mantel 1974, Sonnenschein 1973).

[7]The elasticity of demand accounts for the amount by which demand would increase (decrease) if price falls (rises).

done superficially and without empirical data.[7] If price elasticity of ivory demand is different between different formats of the same product and between market segments, the complexity of demand reactions to changes in relative prices increases. Lack of reliable data on price elasticity may very well be the most serious blind spot in all evaluations of policy options on ivory stockpiles and trade.

Finally, the demand for ivory should not be treated as a fixed parameter even if it does have cultural or historical roots (‘t Sas Rolfes et al. 2014). The notion of endogenous preferences establishes that markets do more than allocate resources. They are social institutions that shape the evolution of values and tastes by framing the context and scope of consumer choices, as well as the nature of rewards (Bowles 1998). Shaping consumer preferences depends on many factors, including social positioning, the evolution of social institutions and marketing campaigns. This is why firms are not passive vis-à-vis preferences and actively engage in shaping and promoting preferences for their goods.

Evaluating the policy option of selling ivory stockpiles needs to take all these elements into consideration. Ignoring them may produce faulty results and misleading policy advice.

Conclusions

As poaching and ivory trafficking accelerate to become the primary source of elephant population reduction, the rigorous assessment of available policy options becomes ever more demanding. One of the critical aspects of policy-making in this context concerns stockpile management. We have examined the arguments concerning three main courses of action vis-à-vis ivory stockpiles. The first course of action examined here concerns the destruction of ivory stockpiles.

The traditional arguments in favour of taking this course of action have traditionally been framed in terms of maintenance costs and risks of leakage. But we have pointed out a new set of arguments that strengthen the policy option in favour of destroying ivory stockpiles. One of them is that keeping stockpiles in place supports expectations about future supply and the establishment of an international legal market. This consolidates expectations about profits from future trade and acts as an incentive for legal and illegal traders and processors to remain in business. This can lead to new investments and new market-related institutions that lock-in society into a trajectory of more, not less, ivory trade. The synergies between legal and illegal trade may very well be strengthened. Stockpile destruction may be the most effective way to deal with these expectations.

Putting ivory stockpiles into economic use has been explored through two distinct avenues. The first one relates to the use of stockpiles as a deterrent against speculators, while the second looks at selling them and therefore involves lifting the international trade ban. Both of these avenues have been examined through simplistic models that rely on obsolete theoretical notions, disregard market structures and ignore real-world price formation dynamics. Because of these shortcomings the economic use of ivory stockpiles as a conservation policy has not been shown to be a rational course of action.

Too much emphasis in the discussion about the deterrent capacity of stockpiles and of legalizing trade has been placed on the effects on prices. This is an important discussion, but the truly critical variables for the effectiveness of this policy option are *profitability* and *competition*. Since information about market and cost structures has never been generated through research on the existing ivory market, profitability and the resilience of incumbent firms (i.e., illegal traders) remains a key unknown in the complex equation of the economic use of ivory stockpiles. In the absence of serious analysis of market structures, putting ivory stockpiles to economic use (as a deterrent or through sales) remains a risky proposition at best.

One final point on the control of ivory stockpiles needs to be highlighted. Part of the literature on stockpile management recommends giving control of the stockpiles to agencies in the international community (see our analysis in Section II). This would have grave consequences, one of which is that it would effectively deprive African range states from the control of a critical component of their conservation policy. The definition of the strategic priorities of their conservation policies could pass to these agencies in the “international community”. The justification for this recommendation is that ivory stockpiles could be a liability for conservation rather than an asset. But this is precisely why stockpile destruction may be the best policy option.

Destruction of stockpiles in the context of China’s economic contraction and in the presence of pessimistic expectations may signal that ivory is a declining market. As China’s economy continues to slow down and macroeconomic policies fail to prop up

growth rates, semi-stagnation may be the new normal for years to come. Against this background the recent destruction of 105 tonnes by Kenya's authorities can be interpreted as a timely decision.

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