



Monetary evaluation of end-of-life vehicle treatment from a social perspective for different scenarios in China



Shuhan Hu ^{a, b}, Zongguo Wen ^{a, b, *}

^a State Key Joint Laboratory of Environment Simulation and Pollution Control (SKLESPC), School of Environment, Tsinghua University, Beijing, 100084, China

^b Key Laboratory for Solid Waste Management and Environment Safety (Tsinghua University), Ministry of Education of China, Tsinghua University, Beijing, 100084, China

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ABSTRACT

Every year, a great number of ELVs in China are treated informally, that is without government supervision. Because of conflicting standpoints concerning Chinese ELV treatment, there is a need to compare different treatment scenarios based on their impacts on society as a whole. We extracted three scenarios (i.e. the advanced formal sector, the informal sector and the common formal sector) that represent the current state of Chinese ELV treatment, and tried to examine them for societal effects. A framework was proposed for modeling the social value and cost of ELV treatment in the three scenarios, which considers externalities in both the consumption and treatment process stages. A wide variety of data resources were employed and critical externalities were monetized using several valuation methods. It was found that Chinese ELV treatment causes huge loss to society due to the extensive existence of informal sector. Of the three scenarios, the informal sector ranks last for net social value due to the higher costs of traffic accidents and airborne emission caused by the low-quality products, environmental costs of environmental-unfriendly treatment process and taxation losses. However, it ranks top for net private value because of the higher sales in products. Only the net social value in the advanced formal sector is positive because of its consideration to environmental protection. The integration of these two sectors is therefore suggested to be worth considering to improve the status quo. The results also show that the absence of waste disposal fee and decontamination costs results in much higher social cost in the common formal sector than in the advanced formal sector, which indicates the ex-ante environmental measure is superior to the ex-post environmental measure for Chinese ELV treatment.

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1. Introduction

Vehicle, as a hi-tech product, composed by tens of thousands of components and contains hazardous substances as well as recyclable substances, so the improper treatment of end-of-life vehicles (ELVs) is not only associated with environment pollution but also a resource wasting problem.

In China, the largest vehicle market in the world, the status quo of ELV management is not optimistic. A great number of ELVs are treated informally and out of government's control every year. The ratio of ELVs treated informally in China from 2006 to 2014 is calculated to be around 60% (See Table 1). There are two conflicting

viewpoints concerning Chinese informal sector of ELV treatment. One is against the informal sector, due to the belief that it causes serious environmental pollution and transportation safety problems, huge government taxation losses, etc.; the other is supportive of the sector, because it is regarded as favorable for maximizing the economic interests of all market participants, conserving resources and reducing unemployment. Therefore, there is a need to compare the various scenarios of Chinese ELV treatment in terms of their social value and cost (private value/cost plus externalities) to help decision-making develop the appropriate strategies for ELV management to maximize social welfare.

Developed countries have conducted a number of studies on the private value and cost of ELV treatment, including qualitative studies (Bellmann and Khare, 2000; Field et al., 1994) and quantitative studies (Coates and Rahimifard, 2008; Field et al., 1994; Malcolm and Isan, 2003; Sakkas and Manios, 2003; Staudinger and Keoleian, 2001). In the aspect of externalities, environmental

* Corresponding author. State Key Joint Laboratory of Environment Simulation and Pollution Control (SKLESPC), School of Environment, Tsinghua University, Beijing, 100084, China.

E-mail addresses: hshjk84@163.com (S. Hu), wenzg@tsinghua.edu.cn (Z. Wen).

Table 1
The calculated ratio of ELVs treated informally in China from 2006 to 2014.

Year	Number of deregistered ELVs (thousand)	Number of ELVs collected formally (thousand)	Ratio of ELVs treated informally
2006	1034.8	700.0	32.35%
2007	1373.0	840.0	38.82%
2008	1440.7	888.6	38.32%
2009	2210.4	708.2	67.96%
2010	3642.0	1478.7	59.40%
2011	3772.6	1186.0	68.56%
2012	4313.7	1323.0	69.33%
2013	5721.4	1350.0	76.40%
2014	4810.0	2200.0	54.26%
Total	28318.6	10818.7	62.31%

Note: “The ratio of ELVs treated informally” was calculated as “the ratio of ELVs not collected formally”. In reality, ELVs not collected formally might have another destiny than informal treatment, like being abandoned, stored, exported, treated another year than it is deregistered etc.

Data source: China Auto Market Almanac 2011, 2013, 2014, 2015.

impacts arouse the first and most concern of researchers. At the beginning, the evaluation of environmental impacts of ELV treatment was performed as a part of life cycle assessment of vehicles (Castro et al., 2003; Schmidt et al., 2004). Gradually, some researchers in developed countries began to focus on solely evaluating the environmental performance of ELV treatment (Fonseca et al., 2013; Jeong et al., 2007; Tasala Gradin et al., 2013). The social dimension has been also gaining attention in recent years, but the related research is much less than that related to environmental dimension. Similar to the studies of Klang et al. (2003) on demolition waste, Kijak and Moy (2004) on municipal solid waste and Vinyes et al. (2013) on used cooking oil, Mergias et al. (2007) evaluated the social impacts of ELV treatment alternatives in Cyprus in terms of score along with environmental, financial and technical aspects for selecting the best compromise one. Regarding the evaluation of social value and cost, the research in the field of waste treatment concentrates on the area of the final waste disposal, i.e. waste incineration and landfills (Ayalon et al., 2006; Dijkgraaf and Vollebergh, 2004; Karmperis et al., 2012; Mery, 2005; Zhou et al., 2014) and municipal solid waste (Jamasp and Nepal, 2010; Weng and Fujiwara, 2011). There is still a lack of similar studies in the area of ELV, although there are some concern in developed countries. Cassells (2004) discussed the externalities and social costs connected with abandoned ELVs in New Zealand, but did not perform quantitative analysis on them. Based on a number of scenarios describing the outcomes of different treatment routes for an ELV consistent with either 2006 targets or 2015 targets under the ELV directive, GHK/BIO intelligence Service (2006) calculated the additional environment impacts and benefits of higher targets in the EU in terms of greenhouse gas emission and money as well as the additional private costs of meeting the higher targets.

As for the ELV studies in China, there is no shortage of review and analysis of ELV policies and administration system (Chen, 2005; Chen et al., 2015; Wang and Chen, 2013a, 2011; Zhang and Chen, 2010), investigation of ELV dismantling and recycling situation (Chen, 2005; Hu and Wen, 2015; Wang and Chen, 2013b), estimation of the potential ELV quantity (Hu and Kurasaka, 2013a; Li et al., 2014), introduction of technology roadmap, industry development goals and dismantling and pollution control technologies (Li et al., 2014; Wang and Chen, 2013a). Very recently, more detailed and thorough research has also been performed. Using a typical case, Xia et al. (2016) conducted the construction and investment analysis of ELV disassembly plant in China. Taking Corolla taxi for example, Li et al. (2016) used the LCA method to compared three different technology level of ELV recycling in China under the environmental perspective. However, there is still a lack of evaluation of Chinese ELV treatment from the standpoint of

society as a whole. This paper presents a framework for modeling the social value and cost of Chinese ELV treatment that considers externalities in the consumption stage as well as those in the treatment process stage. Using this framework, we originally estimate and compare the monetary social value and cost of ELV treatment for three representative scenarios in China, a developing country which has become the world's largest vehicle market since 2009. We collected data from various sources both in China and overseas and adopted evaluation methods for monetizing externalities according to their attributes and the availability of data. Uncertainty analyses were also conducted. Based on the evaluation results, some policy implications were drawn for Chinese ELV management. This framework and comparative examination of the social value and cost of Chinese ELV treatment is expected to provide a reference for policy research on ELV management, as well as to be extendable to policy research on other waste management systems, especially for end-of-life durable products.

2. Representative scenarios for the current state of ELV treatment in China

It is generally acknowledged that Chinese ELVs are passing into two sectors, i.e. an informal sector operated by unlicensed processors and a formal sector operated by licensed processors. Among the licensed processors there are not only those who substantially comply with environmental protection regulations but also those who do not comply with environmental protection regulations; the latter predominates in the formal sector (Hu, 2013; Toyota Tsusho Corporation, 2011). We can extract three scenarios to represent the current state of Chinese ELV treatment. We term them the “Informal Sector”, “Advanced Formal Sector” and “Common Formal Sector”. The “Informal Sector” refers to the situation of unlicensed processors illegally selling reused/refurbished/reassembled ELVs and reused/refurbished ELV parts at low prices but with high emissions and risk of accident while taking no environmental measures. According to the highest law pertaining to ELV treatment in China, i.e. “The Management Regulations of Recycling ELVs” (“Decree No.307”), ELVs in China include vehicles which meet the national compulsory scrapping standards. The national compulsory scrapping standard requires vehicles (except private cars) to be scrapped when their service period or mileage reach the prescribed standard. A significant number of such ELVs are illegally sold as second-hand vehicles in China every year. “Reused ELVs” refers to ELVs directly sold as second-hand vehicles. “Refurbished ELVs” or “Refurbished parts” refer to ELVs or ELV parts which cannot be directly reused but which can be sold after replacing parts with obvious problems or repairing areas of major damage, processing sheet metal, polishing and painting, etc. “Reassembled ELVs” refers

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