Environmental policy for circular economy: Applying deposit–refund systems

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1 Introduction

The transition from a linear to a circular economy (CE) is becoming a global trend in recent years. For example, the European Union, China, and Japan have considered the CE as one of the pillars of sustainable development. The goal here is to overcome linear production and consumption by proposing a circular system in which goods and resources remain in the closed economic loop for a longer period of time. It requires households and firms to work together to promote the prevention and recycling of consumer waste. Firms should incorporate Design for the Environment (DfE), such as improved durability and recyclability, into product design and manufacturing decisions. DfE leads to longer lengths of the loop that includes extraction, production, use, sorting, recovery, and recycling. To encourage DfE, households need to sort and return waste to producers through formal collection channels. In doing so, the firms should make it easy for households to return waste from the consumption of their products in order to reuse inputs as much as possible. To build the CE, policymakers should implement environmental policies that take into account the interaction between firms and households.

However, production and consumption activities in the economy are still linear in reality, and there is no precedent for a successful CE transition. One obstacle to building CE is the incentive problem between firms and households. Households are tempted to reduce their effort to keep waste streams separate and return that because the effort is costly and unobservable. Such less efforts will not close the loop in the CE. On the other hand, the profit-seeking firms are willing to sell the goods with low durability to stimulate the replacement demand. This is called *planned obsolescence*, which means that the firms design their products to have a shorter life span than they should, or to profit from expensive repair costs. Thus, planned obsolescence falls into the shorter lengths of the loop and increasing externalities.

As a promising environmental policy to close and lengthen the loop in the CE, we will focus on the deposit-refund system (DRS), which is a market-based, combined instrument that taxes products at the point of purchase and offers a rebate when the used product or its waste is returned. An important feature is that DRSs could encourage households to sort and return waste under conditions where household efforts are unobservable.

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Developing a standard theory of industrial organization, this paper aims to determine the optimal DRS to close and lengthen the loop in the CE. We then explore some properties of the DRSs to prevent waste emissions and promote DfE.

2 Model

By extending Bulow (1986), we present a two-period model, in which households purchase the products in one period and then have to pay for the labor of sorting and returning the waste in the next period. The government cannot observe the sorting and returning by households. Under the asymmetric information between households and the government, the government must set a DRS that satisfies an incentive compatibility constraint of the household, and the DRS should promote product durability. The firm chooses both the quantity and the durability of the product. Households pay the deposit fee at the time of purchase. Some of the products are broken during the period, and households continue to use the unbroken units in the following period. In order to receive the refund, at the end of the product's life, households make an effort to sort some of the waste or used products into recyclables and return them to the firm. The firm is obliged to accept returned items.

3 Results

We find the following results. First, a partially backed DRS is desirable for durable goods as long as the unit effort cost for recycling activities is not too low. A traditional theory of durable goods shows that firms with monopoly power have an incentive to reduce durability; Deposit has the effect of curbing such planned obsolescence.

Second, we find a new type of planned obsolescence under DRS. Since more durable products take longer for households to receive refunds and households discount future refunds, households prefer less durable products under DRS. We call this the *refund-back effect*. Thus, the firm has an additional incentive to reduce its durability under DRS. The smaller the refund, the smaller the refund-back effect and the better the durability. However, under information asymmetry, the DRS must ensure that the level of refund satisfies the incentive compatibility constraint for households to make effort to sort and return waste. Consequently, a combination of a high deposit and a low refund, which still satisfies the incentive compatible constraint, can be an optimal DRS.

Third, the shift toward a CE under the optimal DRS is welfare-improving when the cost of the household ' s effort is smaller ,and/or the firm's fixed cost of the transition toward CE is lower, and/or the marginal damage costs associated with production and disposal are larger.

References

Bulow, J., 1986. An economic theory of planned obsolescence. Quarterly Journal of Economics 101, 729–749.