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Does the EU *Eco-design for Sustainable Product Regulation* Address Premature Obsolescence? A Systemic Perspective on Barriers to Longer Product Lifetime

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Abstract: Premature obsolescence has significant environmental and socioeconomic impacts. Extending the lifetime of products is a key aim of the Eco-design for Sustainable Product Regulation (ESPR), recently introduced by the European Commission. Several barriers to achieving longer product lifetime have been identified in the literature. By examining the systemic interplay among these barriers and forms of premature obsolescence, we develop a framework to analyse the potential effectiveness of ESPR. Our findings reveal that these barriers are interconnected and mutually reinforcing, confirming the need for public policies that address these interactions and reduce premature obsolescence. Moreover, while the ESPR successfully addresses technical and economic challenges related to product lifetime extension, it remains limited in tackling symbolic obsolescence and ingrained societal consumption patterns.

Introduction

On 18th July 2024, the European Commission adopted the new Eco-design for Sustainable Product Regulation (ESPR henceforth) (European Commission, 2024). Its aim is to promote the sustainability of products in the European market by increasing their circularity and their environmental performance. To achieve this, the ESPR further enhances the focus on strategies for prolonging product lifetime, via increasing product durability, reliability, repairability, upgradability and reusability. Product lifetime refers to the period from when a product is purchased until it is no longer used (Jensen, 2021). A key factor influencing product lifetime is obsolescence, which refers to the state of a product being outdated or no longer in use (Butt et al., 2015; Mellal, 2020). Often, "natural" obsolescence is "planned", that is deliberately accelerated by supply-side strategies driven by the competitive process. As it is not easy to disentangle to what extent this is due to explicit business strategies (Dalhammar et al., 2023), the term "premature" obsolescence is often preferred, and is also used in ESPR.

Public policies for addressing premature obsolescence and extending product lifetime are justified by both socio-economic and environmental motives. Premature obsolescence generates useless resource depletion and waste (Maycroft, 2009; Friedel, 2013; Guiltinan, 2009; Bisschop et al., 2022; Rivera & Lallmahomed, 2016). The firms' risk of passively suffering obsolescence is often seen as a driver of firms' innovation, but this can cause adverse effects such as fostering incremental upgrades on existing technologies rather than ground-breaking innovations (Guiltinan, 2009; Bisschop et al., 2022), complicating investment decisions given the uncertain life of fixed assets (Moonitz, 1943), undermining economic performance, efficiency, organizational effectiveness and safety of firms whose capital goods and technologies are becoming obsolete (Sørensen and Stuart, 2000; Ma, 2021; Mellal, 2020). Additionally, accelerated obsolescence can exacerbate income and wealth inequality (Monserand, 2022), engender consumers' dissatisfaction and harm wellbeing (Becher & Sibony, 2021). Consequently, extending product lifetime can potentially reap both environmental and socioeconomic benefits (Kagawa et al., 2006).
To the best of our knowledge, the literature appears to lack a systemic view of the interplay between various barriers to long-lasting products. To contribute to filling this gap,

building on Jensen (2021), we propose here a systemic perspective linking barriers to longer product lifetime (hereafter referred to as LPL) and forms of obsolescence. This theoretical framework enables us to explore ESPR's potential in reducing barriers to LPL and its role in mitigating premature obsolescence. Some studies on the ESPR have already been published, although they were conducted before the final legislative text was released[1].

A Systemic Perspective on Barriers to LPL and Premature Obsolescence

This section offers a systemic perspective on barriers to LPL and premature obsolescence. First, after revisiting the literature, we propose an improved classification for premature obsolescence. Second, we recall the many barriers to LPL. Third, we outline the interactions between these barriers and their link with premature obsolescence.

Within the literature on obsolescence, many classifications have been proposed, some of which overlap, while others refer to the same concept under different names or can be subsumed into more general categories (Dallhamar, 2023; Becher & Sibony, 2021; Mellal, 2020; Cooper, 2004; Keeble, 2013). To address these issues, we propose here four macro-categories to classify premature obsolescence.

- *Forced functional obsolescence*[2] occurs when a product can no longer perform its intended function due to decisions made by manufacturers, either by producing short-lived products or by 'killing' products. Firms can decide to use low-quality materials or components that wear out quickly (i.e., material obsolescence), to poorly design products resulting in deterioration after a short time (i.e., in-built obsolescence), to stop the production of spare parts (i.e., logistical obsolescence) or to force software updates that are not compatible with the product.
- *Technical (or technological) obsolescence* occurs when a product becomes undesirable due to advancements in technology. It happens when a newer product devaluates an existing one, making the older version outdated despite being functional.
- *Economic obsolescence* (also known as financial obsolescence) occurs because of economic factors. On the consumer side, a functional product may be replaced if newer models involve lower operational costs. Consumers may also decide not to repair a faulty product if the repair costs, including spare parts, are too expensive as compared to buying a new replacement model (i.e., limited-repair obsolescence). On the producer side, economic obsolescence can occur if supporting an existing product becomes financially unviable.
- *Symbolic obsolescence* occurs when consumers view a product as no longer desirable due to a desire for novelty or perceive it as outdated because of social factors such as peer expectations or changing fashion trends, often triggered by marketing campaigns. Perceived obsolescence shortens the consumer replacement cycle.

When addressing the barriers to LPL, a broadly accepted classification was provided by Jensen et al. (2021). We expanded it by adding two additional barriers, that is, product repairability (Van den Berge et al., 2023; Magnier & Mugge, 2022) and consumer purchasing power (Cooper, 2010). Table 1 summarises the barriers, categorised by those encountered by businesses, product developers, and consumers.

[1] Previous studies have dealt with ESPR by examining its contribution to circular economy (Galatola, 2024; Park, 202 and climate goals (Fabšíková, 2024), by suggesting methods to set eco-design standards (Schuberth et al., 2024; Yang & Vezzoli, 2024; Bundgaard et al., 2024), or by focusing only on one measure such as the Digital Product Passport (Götz et al., 2022; Lövdahl et al., 2023)

[2] Keeble (2013) makes a distinction between "forced" and "natural" obsolescence. "Natural" obsolescence refers to the inevitable aging or deterioration of products over time, occurring without human intervention or deliberate manipulation. As our focus is on premature obsolescence, we specifically address forced functional obsolescence.

Business	Product Developer	Consumer
B1. High cost of changing the business model	B6. Inability to follow fast-moving trends and fashions	B10. Short lifecycles promoted by retailers affects user behaviour
B2. Customer rejection of the business model change	B7. Technological innovation makes long-lasting products obsolete	B11. Lack of attachment to the products
B3. High price points of long-lasting products	B8. Change in societal behaviour makes long-lasting products obsolete	B12. Barriers to repair products
B4. Vulnerability regarding short, fixed leasing periods	B9. Lack of focus on longevity in innovation	B13. Customers are partly unaware of material quality/ Lack of product information
B5. Time-consuming changes in customer perceptions of products and brands		B14. Evaluating longevity in a purchase situation
		B15. Misperception of modularity in advanced products
		B16. Consumer purchasing power

Table 1. Barriers to long-lasting products, Adapted from Jensen (2021)

We can now outline the most relevant interactions between barriers and premature obsolescence. As a general point, it is worth noting that all these barriers are shaped by the societal and psychological conditions characteristic of capitalism, which include a desire for novelty, materialistic values, and compensation for declining social capital through consumption. More importantly, the interplay of barriers faced by businesses, developers, and consumers exacerbates premature obsolescence.

Let us begin from the economic challenges businesses face when increasing product lifetime. Firstly, such a shift requires initial investments (B1)[3]. Additionally, long-lasting products often have higher production costs, creating a competitive disadvantage for firms in price-sensitive markets, where cheaper, less durable alternatives dominate (B3)[4]. The higher cost of more durable goods often acts as a direct barrier for low- and middle-income consumers (B16). Moreover, if a brand is perceived as offering short-lived products, changing this perception can take time, thereby jeopardizing the firm's short-term profitability (B5).

The risk of economic obsolescence for the company is further increased by customers' resistance to this business model shift (B2). This resistance arises from several demand-side barriers. First, it is often difficult to evaluate longevity (B14) due to lack of information or awareness on product quality (B13) leading consumers to choose cheaper, less durable options. Second, when manufacturers opt to produce modular products to extend product lifetime, customers may perceive these products as less advanced compared to the integrated ones (B15).

Moreover, retailers also play an important role. Their business models influence consumer behaviour and manufacturers' priorities regarding product longevity. Short leasing or rental periods, as well as subscription models, incentivise frequent product turnover over durability (B4) and reduce consumer's attachment to the product (B10), discouraging the production of long-lasting goods.

When looking at consumers, psychological and sociological factors cannot be overlooked. The taste for novelty leads consumers to replace functional items with aesthetically appealing new variants, a behaviour exploited by firms. Materialism drives status-seeking through consumption, social conformity (Keeble, 2013), and supports mass production systems (Matutinović, 2007). Consumption activates the brain's pleasure circuits, fostering a sense of gratification (Sterling, 2016). Declining social

[3] According to Jensen et al. (2021), small and medium-sized enterprises are particularly hesitant or unable to make such investments without a guaranteed return, as they are more vulnerable and often operate in markets characterized by rapid technological advancements.

[4] This effect can be mitigated in the case of luxury goods targeting affluent consumers, as a price premium may not necessarily pose an obstacle for this consumer segment.

capital encourages consumerism as a coping mechanism for emotional distress, thereby fuelling economic growth (Bartolini & Sarracino, 2021). Together, these factors trigger frequent consumption and reinforce symbolic obsolescence.

The dynamics described above highlight how the interplay between demand and supply-side barriers to LPL encourage firms to adopt practices that intentionally shorten product lifetime by using low-quality materials, designing products with inherent flaws, discontinuing essential spare parts, and implementing software updates that reduce functionality—actions that drive forced functional obsolescence and boost repeated purchases. Moreover, to sustain demand growth, designers create products with incremental changes and manufacturers reserve advanced features for premium models. These strategies push consumers to replace functional goods in pursuit of exclusive features, reinforcing technological obsolescence.

Consequently, product developers face challenges in designing long-lasting products. For instance, the emphasis on new product development reduces the focus on product longevity (B9). Moreover, long lasting products are likely to go out of fashion and lose value for customers due to fast moving trends (i.e. symbolic obsolescence) (Lilley et al., 2016) (B6). Additionally, companies producing durable technological goods face challenges in committing to specific technologies (B7), such as a loudspeaker manufacturer relying on Bluetooth, which risks obsolescence as consumers adopt Wi-Fi streaming or other alternatives (Jensen, 2021). Finally, changes in social practices or laws can make long-lasting products obsolete (B8). All these factors make development of long-lasting products risky.

Additionally, these fast-moving trends and poor product design reduce consumers' emotional attachment to their products (B11). This leads to less care, poor maintenance, and premature disposal of products. Due to a lack of attachment, dissatisfaction with appearance, or preference for updated models lead to symbolic obsolescence, where consumers may opt to dispose rather than repair (Magnier & Mugge, 2022). Repairs are further complicated by limitations in time, knowledge, and skills (McLaren et al., 2015), along with poor design and the lack of spare parts (logistical obsolescence). Additionally, consumers can see replacement as faster and more convenient than repair services which entail high labour costs (Van den Berge et al., 2023; Dalhammar et al. 2023). These various challenges prevent consumers from repairing durable goods (B12).

In summary, as these barriers are interconnected and mutually reinforcing, public policies must consider these interactions to effectively contrast premature obsolescence.

ESPR: Addressing barriers to LPL and Premature Obsolescence

This section analyses how the ESPR addresses barriers to LPL and different forms of premature obsolescence.

The ESPR bridges the European Green Deal, the Circular Economy Action Plan and the Eco-design Directive 2009/125/EC, introducing critical design requirements for a broader range of products[5] than in previous policies and on issues that have been often under-emphasized. Its goal is to enhance product sustainability by prioritizing durability, reliability, repairability, upgradability, reusability (i.e., LPL attributes), energy efficiency, recyclability, and waste reduction, while ensuring functionality, safety, affordability, and fair impact on small businesses (European Commission, 2024).

The ESPR encompasses many policy instruments, however for the purposes of this paper, it suffices to note that it introduces eco-design requirements both on performance and information. The performance requirements are introduced to eliminate the worst performers and promote the best ones through requirements on specific product parameters. The information requirements mandate the provision of clear and accessible information about environmental sustainability and technical issues (such as installation, use, maintenance, and end-of-life handling). To

[5] While the previous Directives were aimed at energy-using and energy-related products, the new ESPR extends to products such as iron and steel, aluminium, textiles (garments and footwear), furniture, tires, detergents, paints, lubricants, chemicals, information and communication technology (ICT) products and other electronics, and energy-related products, whereas medical and veterinary products, food, living plants and micro-organisms are kept out of the scope.

facilitate this, the ESPR introduces the digital product passport (DPP) in addition to the traditional tools (labels or user manuals). These requirements are supported by financial incentives for SMEs, micro-businesses, and consumers (European Commission, 2024, p. 13-14,20).

Barriers / ESPR Regulations	Support to business	Support to customers	Information requirements	Performance requirements
1. High cost of changing the business model	Direct			
2. Customer rejection of the business model change		Indirect		
3. High price points of long-lasting products	Indirect	Direct		Direct
4. Vulnerability regarding short, fixed leasing periods				Indirect
5. Customer perceptions of products and brands	Indirect	Indirect	Direct	
6. Inability to follow fast-moving trends and fashion	Direct	Indirect		Direct
7. Technological innovation makes long-lasting products obsolete				Direct
8. Change in societal behaviour makes long-lasting products obsolete				
9. Lack of focus on longevity in innovation	Direct	Indirect	Indirect	Direct
10. Short lifecycles promoted by retailers affects user behaviour			Indirect	
11. Lack of attachment to the products			Indirect	Indirect
12. Barriers to repair products		Indirect	Direct	Direct
13. Customers are partly unaware of material quality / Lack of product information			Direct	
14. Evaluating longevity in a purchase situation			Direct	
15. Misperception of modularity in advanced products			Direct	
16. Consumer purchasing power for durable products	Indirect	Direct		

Table 2. Analysis of ESPR tackling barriers to LPL

For each of the barriers identified in Table 1, we examined whether ESPR addresses them, either directly or indirectly. We considered whether each measure in the regulation directly targets the barriers or whether it is able to indirectly address them only through a mediating mechanism or only when certain conditions are met, also depending on how it will be implemented. Table 2 summarises our findings.

The ESPR offers financial assistance to businesses to help overcome economic barriers in transitioning to long-lasting products. This support encompasses fiscal incentives, investments in physical and digital infrastructure, access to financing, employee training, and both organizational and technical assistance. They are likely to reduce the initial cost of the transition (B1) and, by lowering costs, mitigate the price increase (B3), while also potentially financing marketing campaigns to influence customers' brand perception (B5). Financial incentives for consumers (such as eco-vouchers and green taxation) also support

demand for these businesses, making long-lasting products more accessible (B16). Meanwhile, the combination of financial incentives and performance requirements encourages the developers to focus on product longevity rather than solely attempting to follow fast-moving trends (B9). This approach also helps create a level playing field for long-lasting products, reducing the likelihood of firms facing unfair competition from cheap, low-quality products (B3, B6). Moreover, performance requirements encourage product modularity and upgradability which tackles the risk of technological lock-in for long-lasting products (B7). Finally, information requirements enable conscious consumer purchases, drawing attention to LPL attributes (B12, B13, B14, B15).

While ESPR succeeds in addressing various barriers to LPL, we observe that some barriers are not, or only indirectly, addressed. This includes barriers related to retailers' business models. Producers' vulnerability to short, fixed leasing periods could be mitigated by performance requirements fostering LPL, which could eventually extend leasing periods (B4). Besides, information requirements could partially counteract the effect of short lifecycles promoted by retailers on consumers' perception of product lifetime (B10). Another barrier that is only indirectly addressed is consumer resistance to shifts in business model (B2). This barrier can be mitigated through consumers' financial incentives, but only if they are tied to renting or leasing options. Additionally, lack of attachment to products (B11) is also only indirectly treated through the combination of higher average product longevity and accessible information, which are likely to influence customer expectation on product longevity. Finally, ESPR does not address changes in societal behaviour that can make long-lasting products obsolete. Tackling this issue is challenging, as such changes are often unpredictable, difficult to control, or influenced by external laws.

A key aspect of our research was to examine how ESPR deals with premature obsolescence. The eco-design requirements, supported by financial incentives for both consumers and producers, partially address the interplay between barriers on the demand- and supply-side. They mainly help combat *functional obsolescence* caused by low-quality materials, poor design, lack of spare parts, or software incompatibilities following operating system updates, especially by relieving barriers on product development. The ESPR also addresses *technological obsolescence* to a certain extent, by promoting product modularity and upgradability without affecting the original function of the product. Additionally, it partly tackles *economic obsolescence* by financially supporting producers in adopting sustainable business models and by reducing repair costs for consumers through affordable and accessible spare parts. However, nothing is proposed to reduce labour costs of repair services or to provide financial support for consumer repairs. Hence, this policy makes the shift to long-lasting products more economically viable, thus enabling businesses to avoid choices that trigger *functional obsolescence*.

Finally, the ESPR has limitations in addressing *symbolic obsolescence*. It indirectly tackles this issue by removing the worst-performing products from the market, thereby increasing product longevity, and possibly making long-lasting products more socially desirable as they gradually become the norm. However, it does not include measures on advertisements or marketing campaigns that contribute to symbolic obsolescence, by triggering curiosity for novelty, the pursuit of social status through purchases, or consumption associated with stimulating the brain's pleasure circuits, nor it includes initiatives, such as educational activities, to address these underlying mechanisms.

Conclusions

This article proposes a systemic perspective linking barriers to LPL with forms of premature obsolescence. After highlighting the interactions between business, product development and consumer barriers, we find that the ESPR addresses most of the technical and economic barriers associated with the transition to long-lasting products. However, it overlooks the psychological and sociological factors underlying the current consumerist paradigm that drives symbolic obsolescence. It should be recognised that transitioning business models and product development processes toward the production of longer-lasting goods is not solely a technical and economic challenge; it also requires paradigm shift. The dominant social paradigm equates success with material wealth, driving excessive

consumerism and encouraging the production of short-lived goods (Richins & Dawson, 1992).

Further research is needed to analyse the synergies and trade-offs between the ESPR and other EU policies addressing barriers to LPL and premature obsolescence (e.g., Right to Repair, consumer protection law), as these policies can either reinforce or undermine the effectiveness of ESPR, strengthening barriers to product lifetime extension.

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