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Property Rights as a Predictor for the Eco-Efficiency of Product-Service Systems

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PROPERTY RIGHTS AS A PREDICTOR FOR THE ECO-EFFICIENCY OF PRODUCT-SERVICE SYSTEMS

Abstract

Over the past decade product service systems (PSS) study has established itself as a research field. Most recently scholars have occupied themselves with the design and implementation of product service systems, which they posit help reduce environmental and economic inefficiencies. However, extant literature leaves open the question why such inefficiencies exist in the first place. This paper proposes opportunistic behaviour, bounded rationality, and asymmetric information as possible explanations for the existence of the inefficiencies discussed by PSS scholars. It continues by exploring five types of property rights and the role they can play in increasing eco-efficiency.

Keywords: Eco-efficient services, product service systems, property rights

1 Introduction

In 1976, Walter Stahel and Geneviève Reday (1981 [1976]) presented the European Commission with a groundbreaking report entitled *Jobs for Tomorrow – The Potential for Substituting Manpower for Energy.* The report's central idea was simple and seductive: During the 1970s environmental problems and unemployment had been constantly increasing. According to the two authors a throw-away society in which products are mass-produced had forced out labour intensive services such as repair and maintenance that traditionally kept products in circulation.

> *"A new industrial strategy could consist of a slow shifting of production activities […] from manufacturing to a corresponding service sector, concentrating on e.g. long-term leasing, maintenance, and reconditioning activities." (Stahel and Reday, 1981 [1976]: 93)*

Stahel and Reday launched the notion that a shift towards recycling and remanufacturing services might help create jobs while saving resources and energy. They hypothesized that an economy focused not on products but only on selling the utility of products would be more labour-intensive and less energy-demanding than the predominant system.

Thirty year's later the ideas of Stahel and Reday have spawned an engaged academic debate that most recently coalesced under the umbrella of Product Service Systems (PSS) research (Mont, 2000; Ehrenfeld, 2001; Mont & Plepys, 2004; Tukker & Tischner, 2006b). However, over time the basic inspiration of Stahel and Reday has been given many different labels. The earliest publications surfaced in the late 1980s. They suggested constructs and conceptual frameworks to describe specific but isolated phenomena such as least-cost planning (Lovins, 1985; Lovins, 1989; Moskovitz, 1989; Lovins & Lovins, 1991), the utilization-focussed service economy (Stahel, 1994, 1997, 1998b, 2007), eco-leasing (Braungart, 1991; Braungart & Engelfried, 1992; Braungart, 1993, 1994a), material intensity per service unit (Schmidt-Bleek, 1993, 1994; Hinterberger, Luks, & Schmidt-Bleek, 1997), the longer-life option (Cooper, 1994) or function-orientation (Arndt, Leinkauf, Sartorius, & Zundel, 1993; Leinkauf & Zundel, 1994; Zundel, 1999).

The following years saw an attempt to integrate these diverging contributions in systematic literature reviews and typologies. The Bayreuth Initiative for Business Ecology (Hockerts, Geissler, Petmecky, & Seuring, 1993; Axt, Hockerts, Hauch, & Petmecky, 1994; Hockerts, Petmecky, Hauch, Seuring, & Schweitzer, 1994; Hockerts, 1995, 1999) was the first to suggest a typology identifying three types of eco-efficient services: product-orientation (take-back, maintenance, life extension services), use-orientation (eco-leasing, rental, shared use), and need orientation (least-cost planning, facility management). Other authors discussing models for eco-efficient services include Empacher et al. (1994), Hinterberger et al. (1994), Cogoy (1995), Belz (1999), Manzini (2001), Heiskanen and Jalas (2003), Bartolomeo et al (2003), and Halme et al. (2007).

An important problem of the early conceptual contributions was the lack of sound empirical data. Most authors simply relied on anecdotal evidence or hypothetical cases to illustrate their ideas. Only as of the late 1990s have these theoretical contributions been empirically substantiated using grounded theory approaches. Empirical studies have been conducted on mobility services (Frick, Diez, & Reindl, 1998; Meijkamp, 1998; Schrader, 1999; Meijkamp, 2000b), services linked to chemicals (Kauffman, Johnson, White, & Hearne, 1997; Reiskin, White, Johnson, & Votta, 1999; Stoughton & Votta, 2003), least-cost planning in infrastructure projects (Eberle, 1996), the leasing of baby prams (Mont, Dalhammar, & Jacobsson, 2006), the leasing of electronic and electric equipment (Tasaki, Hashimoto, & Moriguchi, 2006), and services in the household (Jalas, 2002; Halme, Jasch, & Scharp, 2004; Halme, Anttonen, Hrauda, & Kortman, 2006). Furthermore, cross-sectional cases studies were conducted by a number of authors (Fleig, 1997; Fleig & Krause, 1997; Behrendt, Pfitzner, & Kreibich, 1999).

In the past decade the focus of research has changed in two important ways. Firstly, rather than talking about eco-efficient services researchers have begun to conceptualise their research under the new umbrella term of "Product Service Systems" (PSS) (Goedkoop, 1999; Mont, 2000; Roy, 2000; Ehrenfeld, 2001; Luiten, Knot, & van der Horst, 2001; Manzini et al., 2001; Mont, 2002; Mont & Plepys, 2004; Tukker & Tischner, 2006b). Secondly, researchers have become preoccupied with designing and implementing PSS systems (Brezet, 2001; Jelsma & Knot, 2002; Morelli, 2003; Boughnim & Yannou, 2005; Van Halen, Vezzoli, & Wimmer, 2005; Aurich, Fuchs, & Wagenknecht, 2006; Lindahl, Sundin, Shimomura, & Sakao, 2006; Morelli, 2006; Tukker & Tischner, 2006a). It is also interesting to note that much of this PSS literature is a-historical, rarely referring back to the early literature by Stahel, Lovins, Braungart, or Schmidt-Bleek. A notable exception is the work by Mont which is both more academically rigorous and grounded in prior literature (Mont, 2002; Mont, 2004; Mont et al., 2006).

The extant literature of over thirty years notwithstanding researchers still lack a coherent PSS theory. Quality criteria for theory building (Mintzberg, 1979; Bacharach, 1989; Eisenhardt, 1989) require a good theory to have explanatory as well as predictive power.

This requires the formulation of parsimonious and testable hypotheses, the identification of boundary conditions, and the integration of new theory with the general stream of literature. Past PSS literature, which was mostly normative-prescriptive or descriptive-empirical, has so far not been able to generate such theory. If the depth and breadth of PSS theory is to be increased then future research contributions will have to acknowledge at least some of the following two questions on a more abstract level:

- *What can explain the existence of inefficiency in the first place?* PPS research proclaims to aim at increased efficiency. However, very few authors discuss why these inefficiencies exist in the first place. Given global competition and the increasing concern for environmental impacts PSS theorists have to explain why the market has not yet identified the inefficiencies and reacted accordingly. Thirty years seems a long time for markets to ignore blatant inefficiencies.

- *Why should services help solve the problem of inefficiencies?* It is the main contention of the PSS literature that these inefficiencies can be overcome through a shift from products to services. Intuitively this suggestion seems odd, as the countries in which services play a more important role (i.e. the developed countries) also account for the largest part of environmental destruction. Again the PSS literature owes more explanations on why they focus on services as the independent variable.

In the following this paper will suggest the outline of a PSS theory that provides answers to these questions.

2 Why Resource Allocation Can Be Inefficient

The work on product service systems falls into the larger stream of eco-efficiency literature. Eco-efficiency scholars study under which conditions win-win scenarios exist which would allow the simultaneous reduction of environmental impacts and an increase

in economic profitability (Schaltegger & Sturm, 1990; Ayres, Flückiger, & Hockerts, 1995; DeSimone & Popoff, 1997; Schaltegger & Sturm, 1998; Rennings, 2000; Hukkinen, 2001; Dyllick & Hockerts, 2002; Bleischwitz, 2003; Figge & Hahn, 2004; Young & Tilley, 2006; Mauerhofer, 2008).

Insert "Figure 1: Indicators for the Eco-efficiency of Product Service Systems" about here

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Most PSS scholars imply that PSS design can improve eco-efficiency. Figure 1 provides an overview of mechanisms through which PSS reportedly increase eco-efficiency (adapted from Hockerts, 1999), differentiating four categories of inefficiencies: those pertaining to the usable lifetime of a product, those referring to energy and material consumption efficiency in the use phase, those concerned with effectiveness in the use phase, and finally inefficiencies at the point of disposal.

1. Authors concerned about product lifetime point towards the fact that the useful lifetime of products has decreased in recent decades (Stahel & Reday, 1981 [1976]). As a consequence the need for replacement products has increased resulting in growing environmental impacts from production and raw material consumption. According to these authors eco-efficiency would increase if products could be made more durable. In products with fast changing technology one item that is particularly important in determining the useful lifetime of a product concerns its upgradeability. Although a Pentium I computer might still function today it will only be used if it can be easily upgraded to the latest technology. The PSS literature assumes that a move from product sales towards services would realign incentives so as to promote

increased durability and upgradability of products (i.e. Stahel & Reday, 1981 [1976]; Cooper, 1994; Stahel, 1998b; Cooper, 2002).

2. A second item concerns the efficiency of a product during its use. Both the consumption of energy as well as the utilization of consumables impact a product's overall efficiency. However, many products are not designed with use efficiency in mind. Where available more efficient products are not adopted as widely as one might have expected (Howarth, Haddad, & Paton, 2000). Again PSS solutions are discussed as a means to drive use phase efficiency (i.e. Bergsma & Kroese, 1994; Roy, 2000).

3. A third way proposed by PSS scholars is to increase product effectiveness through shared product use (Meijkamp, 1998; Muheim, 1998; Mont, 2004). The higher the use intensity of a product the less physical goods are supposed to be needed to meet the demands of society. Another strand of literature concerns the potential of consulting and insurance services as a means of increasing use effectiveness. PSS variants such as "crop insurance" (Smith & Goodwin, 1996) or chemical "servicizing" (Reiskin et al., 1999) aim to provide users with the support they need to achieve optimal use effectiveness.

4. A final line of PSS research concerns the efficiency of product disposal. Here PSS are believed to ease product take-back logistics while providing producers with incentives to design products with recycling and remanufacturing in mind (i.e. Braungart & Engelfried, 1992; Stahel, 1998b; Mont et al., 2006).

The PSS literature's claim of inefficiencies warrants closer scrutiny. What can explain the existence of such inefficiencies in the first place? Economists start from the assumption that in a situation of perfect competition a free market of goods and services will automatically lead to an efficient allocation of goods and resources. In such a case win-win scenarios are impossible. However, as Robinson ([1933] 1950: 5) points out, complete competition is a rare occasion. Institutional economics knows three mechanisms which can propagate inefficient systems: opportunistic behaviour, bounded rationality, and information asymmetries.

2.1 Opportunistic Behaviour

In the real world market players often possess private information allowing them to exploit the ignorance of their counterparts. Williamson (1987) calls this opportunistic behaviour. There are multiple types of opportunism:

- One party may own *hidden information* and use it to the detriment of other actors (i.e. only the producer knows the average lifetime or the effective recyclability of a product thus making it impossible for the client to include these points in the calculation of a product's true value).

- A player may have the opportunity to perform *hidden action* (i.e. when a client asks a mechanic to service his product, the mechanic can change more parts than would be necessary from a strict maintenance point of view – and thus charge a higher price – without the client ever being able to verify this).

- A party may perform acts of *ex-post opportunism* (i.e. to encourage clients to buy new products the producer of a durable good may discontinue the production of replacement parts although there is still a demand).

Many firms use for example strategies of "planned obsolescence" (Bulow, 1986) whereby they reduce the durability of their products on purpose to increase the number of replacement sales. As long as customers cannot judge the durability of a product at the point of sale they are not able to counter these strategies. Producers may also ignore issues of waste disposal and reusability because their clients are often unaware of the potential disposal cost they will incur at the end of the useful lifetime of the material product. On the other hand customers at a hotel may leave the lights on all day or the windows open while the heat is turned on. Because the actions are hidden the hotel management cannot charge the individual causing the extra costs.

2.2 Bounded Rationality

Furthermore, the hypothesis of complete competition assumes that all players act rational. In reality, however, an assumption of bounded rationality (Simon, 1972) might be more

appropriate. Many clients, for example, base their decision to buy a product primarily on the price at the point of sale. Economically it would make more sense to consider the full cost of ownership (i.e. sale price plus cost of maintenance, disposal and replacement). However, even if all information is available many clients do not always consider it in their decision making. Kempton and Montgomery (1981), for example, examined the methods by which residential consumers computed energy savings from investments in efficiency, finding that they systematically underestimated savings. For this very reason many producers are wary of increasing the *use efficiency* of a product (e.g. energy efficiency) when this leads to a higher sales price.

2.3 Information asymmetries

Even in the absence of opportunism and given the existence of perfectly rational clients inefficiencies can exist due to information asymmetries. Many clients, for example, are not able to realize the full potential of their products since they lack proper information. They use more consumption goods (i.e. detergents, pesticides etc.) than would be required to achieve a given goal. Long-living products (i.e. cars, washing machines etc.) on the other hand remain idle most of the time. This problem of use effectiveness could be overcome at least partly if producers had incentives to help clients increase efficiency.

3 Why the Focus Should be on Property Rights Rather Than Services

> *"We keep [durable inconsumable commodities] by us even if we do not want them at the moment. But their utility will of course, be increased the more often we can arrange to use them, so that it is often better to hire, or to buy and sell, or to make various arrangements for common usership."*
>
> *Stanley JEVONS ([1871] 1965)*

Over the past decade an increasing number of PSS scholars have identified services as a potential solution to address the environmental and economic inefficiencies described

above. However, no theoretical framework has been proposed that would explain why PSS should be a useful tool to achieve that goal. This paper uses institutional economics to abstract from the product-to-services argument. It focuses particularly on the redistribution of property rights as a means to create better incentives for producers to increase the efficiency of their products. As will be illustrated the redistribution of property rights can induce producers and clients to act efficiently even in the presence of opportunism, bounded rationality and information asymmetries.

Institutional theory differentiates five types of property rights (Furubotn & Pejovich, 1972; Silver, 1989): the right to retain profits, the right to maintain and operate a product, the right to dispose of a product, the right to exclude others, and the right to use a product. It is important to note that the first three of these rights also include important obligations, namely the duty to cover losses, the obligation to maintain a product, and the duty to pay for the disposal of a product at the end of its useful life. While we are used to exchange these rights and obligations as a bundle at the point of sale it is of course possible to make separate agreements for each property right. As will be shown in the following each property right and duty has particular impacts on the inefficiencies described above. Jointly they are able to describe the different effects attributed to product service systems by extant literature.

3.1 The right to retain profits/the obligation to cover losses

Traditionally all rights concerning profit retention are transferred to the client at the point of sale. However, by letting the producer retain part of this right it is possible to create incentives for the manufacturer not only at the point of sale, but over the whole life cycle. This can for example be reached through leasing or rental arrangements (i.e. Stahel & Reday, 1981 [1976]; Braungart & Engelfried, 1992; Mont et al., 2006). By letting the producer participate in the value created by a product during its use phase such PSS variants encourage the producer to increase the lifetime of products. This strategy helps discourage opportunistic behaviour (such as a strategy of planned obsolescence). The longer a product lives, the higher the benefits of the producer will be.

A second option discussed by PSS scholars concerns the least-cost planning model proposed by Lovins (1991). In this approach electricity and water utilities are investing in energy and water conserving measures at their clients' homes. In return they receive the right to participate in parts of the savings resulting from those investments. PSS scholars have described similar approaches in the chemical industry (i.e. Kauffman et al., 1997; Stahel, 1998a; Reiskin et al., 1999).

But producers might also be held responsible for future losses. Consider the example of architects. Usually they will aim to keep the building costs low to win contracts. This might, however, lead to suboptimal heating standards as a result of which the maintenance of a building might be far more costly (Eberle, 2000: 179). However, building contracts might contain a clause whereby architects would have to pay a fine if heating costs exceed a defined industry average amount. This would ensure that energy efficiency is at the top their mind when designing the building.

3.2 The right / obligation to maintain and operate a product

If a company sells a product this implies normally that the right to change a product and the obligation to maintain it are transferred to the clients. However, the client might not be best suited to operate and maintain a product efficiently, particularly if the operational efficiency is partly impacted through design decisions by the producer. By retaining the obligation to maintain and operate a product the producer can be motivated to help increase efficiency either through improved design or by helping clients via training and maintenance services. Facility management services are an example for such types of PSS. Due to its specialised knowledge a facility management company is more likely to pay attention to energy efficiency in the buildings it manages than the average tenant would.

Firms can also offer clients protection against the risks underlying the usage of a material product. Often the risk aversion of clients creates considerable inefficiencies. Rather than running the risk to be out of a car in a crucial moment people will refrain from giving up

their own vehicle. Farmers tend to use much more pesticide than would be economical simply to avoid the loss of income in the rare event of a pest occurrence. By relocating this risk one can not only increase the environmental efficiency of product use. A car sharing company, for example, may offer guaranteed taxi services or access to rental cars in the rare occasion that no car sharing vehicle is available. Pesticide producers may offer crop insurance along with the product thus offering to reimburse the few farmers that actually lose their crop (Braungart, 1994b).

3.3 The right / obligation to dispose of a product

What is true for the maintenance of a product can also be applied to its disposal. Traditionally the cost of disposal is borne by the client. However, this implies also that he can reap all benefits from material recovery. In practice this means that producers have no incentive to design easy to recycle products. Those that do, on the other hand, usually do not benefit from a positive residual value as clients will rather sell the old product for a profit to other recycling outfits. By relocating the obligation of disposal to the producer one can generate incentives for efficient design as well as making sure that valuable materials find their way back to the producer for remanufacturing and recycling. Such take-back services may also have economic advantages: They may help with follow-up sales by bringing client and provider together at point of disposal.

Among all elements of PSS strategies it is the take-back (Ayres, Ferrer, & Van Leynseele, 1997; Fishbein, 2000) and remanufacturing potential (Stahel, 1998b; Mont et al., 2006) that is probably the most promising. Regulation in recent years has increasingly used the tool of reassigning the duty of disposal back to the producer (Fishbein, 2000; Matthews, 2004; Nakajima & Vanderburg, 2006).

3.4 The right to exclude others

A major property right lies in the possibility of owners to exclude others from the usage of a product. If companies retain this right they may accordingly offer sharing facilities. In these cases different clients may use the same product thus reducing idle time and increasing efficiency. A second possibility lies in a product pool service. A pool contains a number of different product variations (e.g. from two seater to limousine in the case of a car pool). Thus clients can chose the product that best reflects their current needs (rather than driving the family limousine at every occasion).

Scholars have discussed many different examples of such PSS variants: Car-sharing (Meijkamp, 1999, 2000a, b; Schrader & Koch, 2001; Hockerts, 2007), the joint use of power tools (Mont, 2003), and shared washing facilities (Garcilaso, Jordan, Kumar, Hutchins, & Sutherland, 2007) are just some of the possible applications of this property right.

3.5 The right to use a product

The right to use a product is traditionally assigned at the point of sale and is often associated with a considerable amount of fixed cost. The owner of a car, for example, loses part of the value of a car due to age even if the vehicle sits in the parking lot all day. The same is true for ownership taxes. By offering a service, the right to use a product can be dissociated from its ownership. From the viewpoint of the user, formerly fixed cost can become variable.

This has important consequences for decision-making as the user can chose between different options on the basis of the true cost of a single usage. Thus the comparison between public transport and individual transport by car may come to a different conclusion than it does in the case of car ownership where fixed cost must be regarded as sunk cost. Langendorf (cited in Hockerts, 2003) speaks in this context of the “price illusion of car-ownership” which car-sharing can help undo.

4 Conclusions

This paper contributes to the PSS literature by suggesting property rights as the key mechanism through which product service systems increase eco-efficiency. Five property rights are identified as building blocks of product service systems: the right to retain profits, the right to maintain and operate a product, the right to dispose of a product, the right to exclude others, and the right to use a product.

This paper proposes that it's the redistribution of property rights between producers and users that makes up the core element of product service systems (PSS). Rearranging property rights is seen as the mechanism by which incentives are set to reduce inefficiencies. The focus of intention thus moves from the product/services divide towards the constellation of property rights. By unpacking the concept of Product Service Systems the above model provides a unifying language to describe such different PSS examples as eco-leasing, least-cost planning, and product durability strategies. This has several important consequences.

Firstly, it allows to identify genuinely different cause-effect relationships that in recent PSS literature have been lost in the big picture. Different property rights address different sets of opportunism, bounded rationality, and information asymmetry. Future research could profitably probe the sources of inefficiencies in different industries. Moreover, it would be interesting to understand the importance of these inefficiencies. Are we talking about a few percentage points or is there a much larger eco-efficiency potential hidden?

A second line of research might want to explore the relevance of certain property rights in different industries. While the disposal obligation might be most relevant for makers of electronic goods it could be the right to share in future gains from efficiency increases that will be a main driver for utility companies. A better understanding is needed which property rights have the highest impact on eco-efficiency in different industry settings.

Thirdly, the model proposed here begs the question of policy making. Implicitly most PSS literature assumes that PSS will be adopted through voluntary measures. Given

enough information, so the hypothesis, producers will be likely to integrate PSS rationale into their research and design activities. After all they are likely to participate in the efficiency gains triggered by the PSS. However, in reality we see very few comprehensive PSS innovations. The case of disposal obligations raises the question what role government policy should play. Whereas, most PSS elements have remained irrelevant it is take-back legislation that has caused the most profound transformation of industrial systems in the past decade. Does this indicate that more legislation on the different property rights is needed?

By focussing our attention on property rights as a key variable the approach proposed here allows us to better understand the similarities and differences between various product service systems. This should primarily help researchers to improve the analysis of PSS. In the long run these findings should hopefully help improve on PSS design and implementation.

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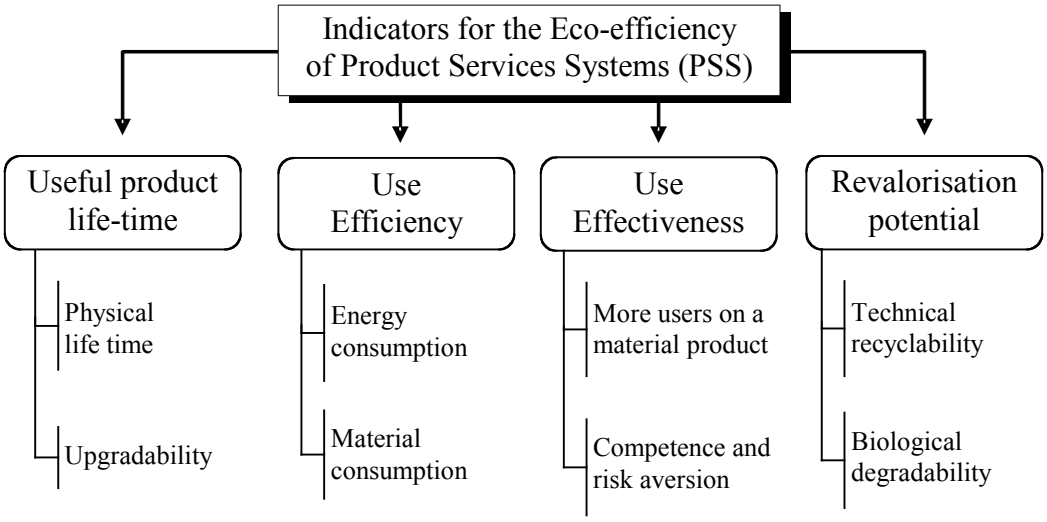
Figure 1: Indicators for the Eco-efficiency of Product Service Systems



Source: Adaptation from Hockerts, 1999: 105.