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Environmental policies and eco-innovations by service firms: An agent-based model

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ABSTRACT

Contrary to a widely held prejudice, service activities are polluting because they make use of physical tools and require travel, both of which give rise to externalities. In order to deal with these externalities, service firms can implement eco-innovations. The aim of this article is to evaluate the sensitivity of this eco-innovation to environmental policies by comparing the effectiveness of two such policies: the environmental tax and consumer information. To this end, we construct an agent-based model of innovation that draws on evolutionary biology and theories of innovation in services (Gallouj and Weinstein, 1997 [26]). A test of 123 different scenarios confirms that service firms are sensitive to environmental policies. The results suggest that the eco-tax is more effective, since it produces a lower and more stable level of pollution than a consumer information policy. The information policy appears to give rise to a perverse effect that causes market niches for the most environmentally friendly services to disappear.

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1. Introduction

Although a number of recent studies [18,2,14] have highlighted the particularly polluting and paradoxically material nature of service economies, the environmental impact of service activities continues to be minimised. Thus, in contrast to manufacturing industry or agriculture, services are often regarded as environmentally friendly [48,44,4]. This paradox can be explained by a failure to take proper account of the material dimension of services when greenhouse gas emissions by sector are being calculated [18,14]. The materiality of tangible products is, after all, regarded as the main source of negative externalities, while services are regarded as being, by definition, intangible and therefore not very polluting. This argument is mistaken, since there is in fact a fundamental association, both direct and indirect, between services and materiality. To be persuaded of this, it is sufficient simply to re-examine the traditional definition of

a service [30,17,21]. A service is a processing operation carried out by a service provider at the request of a customer and intended to bring about a change of state in a medium. This medium may be a material object, codified information, an individual or knowledge. The customer frequently participates in the processing operation, as part of a co-production relationship. A definition of this kind brings to light various sources of materiality: the medium, the tools and goods (including real estate) used to provide the service and the co-production relationship itself, which may require the customer and/or service provider and/or the medium to travel or be transported.

Services' contribution to employment and the creation of value added in contemporary economies, as well as the negative environmental impact of these activities, mean that the question of eco-innovation in and by services should be regarded as a major concern. However, the treatment of environmental problems is often characterised by a 'sectoral and technologist bias' [11] that causes non-technological eco-innovations in manufacturing and agriculture and eco-innovations in the service sector (whether technological or not) to be ignored. Thus not a single service activity is included in the activities investigated in a recent European

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Commission report on eco-innovations [12] and only technological innovations are discussed.

According to Gallouj [20] (see also Gallouj and Weinstein [26]; Gallouj and Savona [25]; Gallouj [24]), the question of innovation in services can be approached from three different theoretical perspectives: assimilation, differentiation and integration. All three approaches can be applied to the problem of eco-innovation in services [11]. In the assimilation approach, innovation in services is regarded as resulting from the adoption of technological innovations produced in other sectors. From this perspective, therefore, eco-innovation in services consists quite simply of the adoption of more environmentally friendly technologies (e.g. new types of heating, electric vehicles, etc.). The differentiation approach, for its part, emphasises the importance of non-technological forms of innovation in services. In this framework, eco-innovations are non-technological advances that reduce a service's environmental impact (eco-tourism, savings accounts associated with sustainable development programmes, use of local products in restaurants, etc.). The integration approach [26], which takes as its starting point the observation that manufacturing and industry are converging to some extent, uses the same tools to analyse innovation processes and their results in both manufacturing and service activities. This approach is based on the decomposition of the product (good or service) into vectors of characteristics, following the tradition established by Lancaster [42].¹ An innovation is produced when a product's internal or external vectors of characteristics are modified. From this integrationist perspective, an example of eco-innovation is the development by manufacturing companies of strategies for leasing their products. In this case, the good in question is no longer regarded as a material artefact but rather as a package of service functions or characteristics.

The question we wish to investigate in this paper is not whether or not eco-innovation exists in services. The examples that have just been mentioned, to which many others could be added, are sufficient to establish the idea that services themselves can produce eco-innovation. Rather we are concerned here with public policies. We are seeking to verify the extent to which service firms' eco-innovation is sensitive to public policies on protecting the environment and to compare different types of public policies in terms of their ability to foster eco-innovation in services.

The objective of this paper is to provide a theoretical response to these two questions by constructing an agent-based model of eco-innovation in services. More precisely, the aim is, on the one hand, to investigate the extent to which environmental tax policies and consumer information policies are able to foster eco-innovation in services and, on the other, to assess which of these policies is the more effective in terms of its ability to bring about the creation of a more or less environmentally friendly dominant design. It should be noted that, in the light of the above-mentioned trend to convergence between services and manufacturing industry, we are proposing a model based on the integrationist approach to innovation. The article is divided into three sections. In the first part, we lay the theoretical foundations for a model of eco-

innovation in service firms. In the second part, we construct the model that arises from these foundations and outline its properties. In order to take account of the specificities of services, the model incorporates the two main channels through which service activities pollute: their material nature and their interactivity (co-production), which may give rise to travel. In the third part, we present and discuss the results of our simulations of the influence of fiscal and consumer information policies on eco-innovation in service firms.

2. Theoretical framework

The amount of literature on innovation in services is steadily increasing, shifting (as reminded in the [Introduction](#)) from assimilation to differentiation and finally integration perspectives. The integrative approach which we favour in this paper is built on the Lancasterian conception of the product (goods or services), conceived as a set of technical and service characteristics [42]. In such a characteristic-based approach [51,26], a product can be broken down into three broad categories of service characteristics²:

- the principal characteristics, that is those that motivate purchase of the product in the first place;
- the complementary characteristics, which determine the performance of the principal characteristics;
- the externalities, which are characteristics that are not desired.

According to the above mentioned definition of service activities, we will single out two types of negative externalities linked to the two sources of pollution identified previously: those arising out of the mobility caused by the interactive nature of services and those arising out of the material environment in which services are provided.

It follows that the environmental problem of a service firm can be regarded as a choice of the “best” vector of final characteristics. From this point of view, three important characteristics can be identified: the price³ of the service, the externalities it generates and the requirement for consumers to travel.⁴ The externalities include the two sources listed above, namely those linked to mobility (in this case, mobility on the part of the customer, service provider and service medium) and those linked to the service's materiality. The introduction of consumer mobility as a characteristic is justified by the fact that consumers may be sensitive to the mobility constraints (prefer mobility) regardless of the question of pollution. The vector of the service characteristics is given by Eq. (1).

$$\begin{pmatrix} x_{kt} \\ y_{kt} = f(m_{kt}) + v_{kt} \\ z_{kt} \end{pmatrix} \quad (1)$$

² A service or final characteristic is a characteristic that gives utility to customer.

³ Price is not a service characteristic as defined by Saviotti and Metcalfe [51] since it does not in itself provide utility. However, it is an essential lever that can be activated by the public authorities in order to encourage the diffusion of environmental products.

⁴ Since the vector of characteristics we are creating is evaluated by the customer, the mobility of the service provider and of the service medium is not included in this dimension of mobility.

¹ For applications on the field of innovation in services, see Gallouj and Weinstein [26], Saviotti and Metcalfe [51], de Vries [10] and Windrum and Garcia-Goñi [53].

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