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Innovation and Productivity in Services: Evidence from Germany, Ireland and the United Kingdom

Bettina Peters, Rebecca Riley, Iulia Siedschlag,
Priit Vahter and John McQuinn

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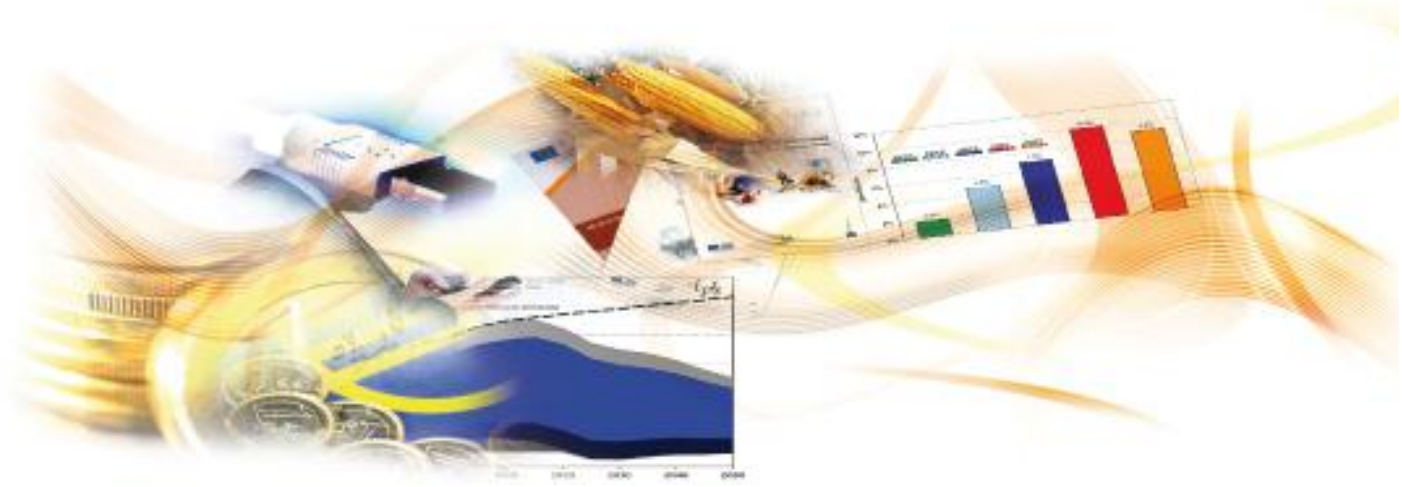

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The main authors of this paper are: Bettina Peters (Centre for European Economic Research (ZEW), Mannheim, Germany and University of Zürich, Switzerland), Rebecca Riley (National Institute for Economic and Social Research, London, United Kingdom and Centre for Learning and Life Chances in Knowledge Economies and Societies, London, United Kingdom), Iulia Siedschlag (Economic and Social Research Institute (ESRI), Dublin, Ireland, Trinity College Dublin, Ireland and European Commission, Joint Research Centre, Institute for Prospective Technological Studies), Priit Vahter (University of Tartu, Estonia) and John McQuinn (Cambridge Econometrics, United Kingdom).

Contact information

Fernando Hervás Soriano

Address: European Commission, Joint Research Centre - Institute for Prospective Technological Studies

Edificio Expo. C/ Inca Garcilaso, 3 E-41092 Seville (Spain)

E-mail: jrc-ipts-kfg-secretariat@ec.europa.eu

Tel.: +34 95 448 84 63

Fax: +34 95 448 83 26

https://ec.europa.eu/jrc

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Abstract

This paper examines the links between innovation and productivity in service enterprises. For this purpose, we use micro data from the Community Innovation Survey 2008 in Germany, Ireland and the United Kingdom, and estimate an augmented structural model. Our results indicate that innovation in service enterprises is linked to higher productivity. In all three countries analysed, among the innovation types that we consider, the strongest link between innovation and productivity was found for marketing innovations. Our empirical evidence highlights the importance of internationalisation in the context of innovation outputs in all three countries. The determinants of innovation in service enterprises appear remarkably similar to the determinants of innovation in manufacturing enterprises.

Key Words: Internationalisation of services; innovation; productivity.

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Corresponding Author: iulia.siedschlag@ec.europa.eu

1 Introduction

Innovation is of crucial importance for growth and competitiveness in the context of intensified global competition. Services account for a growing share of economic activity, and innovation in services is widely seen as a new source of economic growth. Furthermore, technological advances, particularly in information and communication technologies (ICT), have enabled a greater tradability of services and thus greater exposure to competition. In this context, innovation in services is increasingly important for a firm's survival and also a pathway for sustainable economic growth. Understanding the determinants of innovation and productivity in service enterprises is important for designing effective innovation policies.

However, despite this growing importance of services in modern economies, existing empirical evidence on innovation and productivity in services is still limited.

Previous analyses of innovation in services have highlighted a number of specific characteristics of services, such as their intangibility, simultaneity of production and consumption, and perishability (Johne and Storey 1998; Hipp and Grupp 2005; Miles 2005; Gallouj and Savona 2009, 2010; Savona and Steinmueller 2013). Following on from these specific characteristics, relative to manufacturing, it has been pointed out that innovation in services is predominantly non-technological, less related to R&D, and it is closer to consumer demand (Licht and Moch 1999; Tether 2005; Tether and Tajar 2008). Notwithstanding these specificities, the boundaries between manufacturing and services are less clear as they are becoming increasingly integrated (Howells 2001). A growing number of researchers argue that innovation in manufacturing and innovation in services are not clearly distinct (Evangelista 2000; Hollenstein 2003; Cainelli et al. 2006). However, it has also been suggested that analysing innovation in services using a similar approach to the one applied for manufacturing may not adequately capture all the forms of innovation in services (Gallouj and Weinstein 1997; Sundbo 1997; Tether and Tajar 2008).

A more recent approach has emerged that combines the insights gained from analysing both innovation in manufacturing – mainly of a technological type – and innovation in services – mainly non-technological innovation (Drejer 2004; Hipp and Grupp 2005; De Vries 2006; Siedschlag et al. 2011; Leiponen 2012).

While the links between innovation and productivity in manufacturing enterprises have been analysed for a large number of countries,[1] only a few studies have examined innovation and productivity in service enterprises (Lööf and Heshmati 2006 - for Sweden; Mairesse and Robin 2009 - for France; Polder et al. 2010 - for the Netherlands; Siedschlag, Zhang and Cahill 2010; and Siedschlag et al. 2011 - for Ireland; Masso and Vahter 2012 - for Estonia). The evidence provided by these studies on innovation and productivity in service enterprises is mixed and, furthermore, comparisons with innovation and productivity in manufacturing enterprises are only limited.

To fill the evidence gap mentioned above, this paper examines the links between innovation inputs, innovation outputs and productivity in service enterprises. More specifically, we ask the following research questions: (i) What types of service enterprises are more likely to invest in innovation? (ii) What types of service enterprises have higher innovation investment per employee? (iii) What types of service enterprises are more successful in translating innovation investment into innovation outputs? (iv) Is innovation linked to higher productivity in service enterprises? For this purpose, we use micro data from the Community Innovation Survey[2] (CIS) 2008 covering Germany, Ireland and the United Kingdom (UK). To identify any specific features of innovation in services, we compare these results with the results for manufacturing enterprises.

[1] Recent reviews of these studies are Hall (2011), Hall and Mohnen (2013), Ruane and Siedschlag (2013), and Siedschlag and Zhang (2014).

[2] The Community Innovation Survey is a harmonised survey on the innovation activities in enterprises. It is carried out on a voluntary basis, currently every two years, by European Union countries and other countries members of the European Statistical System (ESS) such as countries members of the European Free Trade Area (EFTA) and EU candidate countries. The concepts and underlying methodology of the core survey questionnaire are based on the Oslo Manual (1997, 2005), an internationally recognised set of guidelines on collecting and interpreting data on innovation published jointly by the OECD and the European Commission.

The novelty of our contribution consists in improving, on the basis of theoretical foundations, previous conceptual frameworks and empirical methodologies in several ways. *Firstly*, while most of previous analyses of the link between innovation and productivity have focused on technological innovations (i.e., product and process innovations), we consider in addition non-technological innovations, namely, organisational and marketing innovations. In particular, the link between marketing innovation and productivity has been seldom analysed. Furthermore, in contrast to most previous studies, we model these innovation outputs as being endogenous in the estimated production functions. *Secondly*, we set up and use an unified econometric framework which allows to identify both similarities and differences in the innovation and productivity performance of enterprises in services and manufacturing. *Thirdly*, in contrast to most previous studies, we consider a broader definition of innovation expenditures, beyond R&D expenditure. *Fourthly*, we account in the empirical analysis for the role of internationalisation of services and manufacturing activities on the links between innovation inputs, innovation outputs and productivity. *Finally*, while most of previous contributions are country-specific analyses, we compare the innovation and productivity performance in three countries, namely Germany, Ireland and the UK. The choice of these three countries is motivated by their different innovation and productivity performance of service enterprises. According to data from the CIS 2008, among European Union countries, Germany had the highest proportion of innovative service enterprises, 73.6 %, while the corresponding figures for Ireland and the UK were 54.1 % and 43.0 %, respectively. However, with respect to their productivity performance,[3] in 2008, productivity in services relative to the EU average was higher in Ireland by 28%, while in Germany and the UK it was lower by 8%, and 22 %, respectively.

Our study results indicate that innovation in service enterprises is linked to higher productivity, over and above other enterprise and industry characteristics. In all three countries analysed, the strongest link between innovation and productivity was found with marketing innovations. Successful innovation in service enterprises appears to be associated with a number of factors, such as enterprise size, innovation expenditure

[3] Gross value added per person employed in constant (2010) prices taken from the European Commission's *Ameco* data base available at: http://ec.europa.eu/economy_finance/ameco/user/serie/SelectSerie.cfm.

intensity (Germany and the UK), foreign ownership (Ireland), exporting, and the engagement in cooperation for innovation activities. The determinants of innovation in service enterprises appear remarkably similar to the determinants of innovation in manufacturing enterprises.

The rest of this paper is organised as follows. Section 2 discusses the theoretical and empirical foundations of our analysis. Section 3 describes the empirical methodology that we use. Section 4 describes the data-sets and summary statistics. Section 5 presents the empirical results. Finally, section 6 summarises the key findings and policy implications.

2 Theoretical and empirical foundations

To analyse the links between innovation and productivity, we draw on theoretical and empirical foundations provided by four literature strands: (i) industrial organisation; (ii) endogenous growth; (iii) innovation systems; and (iv) international trade with heterogeneous firms.

Following on from Schumpeter (1942), the literature on *industrial organisation* has analysed the relationships between innovation (measured by R&D expenditures or patents) enterprise size, and market structure. Empirical evidence on the relationship between market concentration and innovation is mixed, with most recent studies suggesting that this relationship is non-linear and that market structure is influenced by innovation rather than being exogenous as often assumed in earlier studies (Cohen and Levin 1989; Geroski and Pomroy 1990; Sutton, 1998). As pointed out by Cohen (2010), other determinants of technological change and innovation such as knowledge spillovers and absorptive capability have not been considered by this literature strand.

To fill this analytical gap, the *endogenous growth* literature is relevant (Romer 1990; Grossman and Helpman 1990; Aghion and Howitt 1992; Griliches 1996). The main

established result of this literature is that technological change is endogenous and that both private R&D investment and knowledge spillovers affect productivity growth.

The literature on *innovation systems* (Freeman 1987; Lundvall 1992; Nelson 1993) has conceptualised innovation as the result of interactions between enterprises and institutions governed by both market forces and non-market institutions. In this context, it has highlighted the role of non-R&D inputs and of interactive learning as determinants of innovation outputs (Soete et al. 2010).

Finally, our analytical framework is underpinned by insights from the most recent *international trade theory* (New-New Trade Theory[4]). More specifically, this literature has established that enterprises with international activities are more productive than enterprises serving only the domestic markets. While this literature has assumed that enterprise productivity is exogeneous, more recent theoretical contributions allow for the possibility of enterprises increasing their productivity through innovation activities (Yeaple 2005; Bustos 2011). A positive correlation between exporting and innovation activity has been found in several studies (Wagner 1996; Love and Roper 2002; Liu and Buck 2007; Bratti and Felice, 2012; Siedschlag and Zhang 2014). Furthermore, additional recent empirical evidence suggests that foreign-owned enterprises and exporters are more likely to innovate (Criscuolo et al. 2010; Siedschlag and Zhang 2014).

3 Econometric methodology

To analyse the relationships between innovation inputs, innovation outputs and productivity, we estimate an augmented version of the widely used structural model proposed by Crépon, Duguet and Mairesse (1998), known as the CDM model. The CDM model estimates three groups of relationships linking innovation and productivity. The first group consist of two equations explaining the propensity of enterprises to invest in innovation and the innovation expenditure intensity. The second relates the various types

[4] New-new trade theoretical models have been introduced by Melitz (2003) and Helpman et al. (2004).

of innovation outputs to innovation expenditure intensity and to other determinants of innovation. The third links productivity to innovation outputs and other determinants of firm-level productivity.

We estimate an augmented version of the original CDM model underpinned by the theoretical and empirical literature discussed in Section 2. More specifically, we add to the original CDM model explanatory variables that measure internationalisation of service enterprises and their engagement in cooperation for innovation activities within national innovation systems.

Below, we describe in more detail the augmented version of the CDM model that we have estimated in this paper.

The innovation investment equations

This stage of the model comprises two equations that explain the firms' decision to invest or not to invest in innovation and, if investing, the amount of innovation expenditure per employee. However, we only observe the innovation expenditure reported by innovative firms. To the extent that this group of firms is thus no longer random, this implies a possible selection bias. To account for this potential bias, the propensity of firms to invest in innovation is modelled by the following selection equation:

$$y_i = \begin{cases} 1 \;\; if \;\; y_i^* = x_i\gamma + u_i > \tau \\ 0 \;\; if \;\; y_i^* = x_i\gamma + u_i \leq \tau \end{cases} \qquad (1)$$

where y_i is an observed binary variable which equals one for firms engaged in innovation investment, or zero for the rest of the firms. Firms engage in innovation and/or report innovation expenditure if y_i^*, an unobserved latent endogenous variable, measuring the propensity to innovate, is above a certain threshold level τ. The latent variable can be interpreted as a decision criterion, such as the expected present value of a firm's profit accruing to innovations. x_i is the vector of the variables explaining the innovation decision, γ is the vector of parameters and u_i is the error term.

The vector of independent variables to explain the propensity of enterprises to invest in innovation includes enterprise characteristics such as size, indicators of engagement in international activities (international investment and exporting) and NACE two-digit industry dummies. As highlighted by the previous literature (for example, Crépon, Duguet and Mairesse 1998; Mairesse and Mohnen 2002; Griffith et al. 2006), enterprise size captures the effect of access to finance, scale economies and different organisation structures, while industry dummies proxy unobserved industry-specific technological opportunities, intensity of competition, demand growth and industry-targeted innovation policies.

Conditional on investing in innovation, the innovation intensity measured as the amount of innovation expenditure per employee (w_i) is given by the following equation:

$$w_i = \begin{cases} w_i^* = z_i\beta + \omega_i, & if\ y_i = 1 \\ 0 \quad if \quad y_i = 0 \end{cases} \qquad (2)$$

where w_i^* is the unobserved latent innovation intensity variable, z_i is a vector of enterprise and industry characteristics explaining innovation intensity and ω_i is an error term.

We allow the error terms of both equations to be correlated and assume that they follow a bivariate normal distribution with zero mean, variances σ_u^2 and σ_ω^2 and correlation coefficient ρ. Equations (1) and (2) are thus simultaneously estimated using the Heckman two-step estimator (Heckman 1976, 1979). For identification purposes, we follow Griffith et al. (2006) and exclude enterprise size in Eq. (2). Excluding size corresponds to the stylised fact established by Cohen and Klepper (1996). Their survey of empirical evidence led them to conclude that among R&D performers, R&D expenditure rises monotonically with enterprise size. This implies that R&D intensity, measured as R&D expenditure per employee, is independent of enterprise size.

The innovation output equation

This second stage of the model explains the innovation outcomes given by the following innovation production function:

$$g_i = \overline{w_i}\alpha + h_i\delta + e_i \quad (3)$$

Where g_i is the innovation output proxied by the product, process, organisational or marketing innovation indicators, and $\overline{w_i}$ is the predicted innovation expenditure per employee estimated from the selection model. These values are predicted for all the enterprises and not just for the sample reporting innovation expenditure. By doing this, we follow the modified CDM approach suggested by Griffith et al. (2006).[5] By using the predicted, rather than the observed, values of the innovation effort w_i, we account for the possibility that the innovation expenditure per employee and the innovation outputs could be simultaneously determined. Equations (1) and (2) correct for the endogeneity in this instrumental variables approach. The three-digit industry dummies used in estimating Eqs (1) and (2) are excluded in estimating Eq. (3); instead, we use two-digit industry dummies when estimating Eq. (3) (note, the statistical tests validate these exclusion restrictions). h_i is the vector of the other determinants of innovation output, namely enterprise size, indicators of engagement in international activities, and indicators of engagement in co-operation for innovation activities. α and δ are the parameter vectors, and e_i is the error term.

The output production equation

The last stage of the model explains the output production as a function of labour, capital and innovation outcomes, as follows:

$$p_i = k_i\lambda + \overline{g_i}\mu + \nu_i \quad (4)$$

where p_i is the labour productivity (log of sales per employee), k_i is a vector that includes enterprise and industry characteristics, $\overline{g_i}$ denotes the innovation outcomes (product, process, organisational and marketing innovations), λ and μ are the corresponding parameters vectors, and ν_i is the error term. To correct for the fact that innovation output and productivity could be simultaneously determined, the predicted innovation output

[5] In the original CDM model, this equation was only estimated for the sample of innovative enterprises.

probabilities estimated in the previous stage by Eq. (3) are used for g_i. The cooperation variables used in estimating Eq. (3) function as exclusion restrictions.

4 Data and summary statistics

We used data from the Community Innovation Survey (CIS) 2008 from Germany, Ireland and the UK. The data cover enterprises with more than 10 employees over the period 2006–2008.[6] Our main analysis focused on market services, including the following service sectors: wholesale trade; transport, storage and communications; financial services; computer and related activities; and other business activities.[7] In total, the analysed sample consisted of the following numbers of service enterprises in the three countries analysed: 1 333 in Germany; 1 286 in Ireland; and 4 344 in the UK.

Table 1 shows the weighted summary statistics[8] for service enterprises for the main variables, for all enterprises, and separately for three types of enterprises: foreign-owned, domestic exporters, and domestic non-exporters. This distinction was motivated by the fact that, as discussed in Section 2, the innovation behaviour and performance of enterprises with international activities differ systematically from those that serve domestic markets only. The summary statistics reveal a lot of heterogeneity in terms of size, innovation and productivity across the three countries.

[Table 1 about here]

With respect to the types of service enterprises, in the samples for Germany and the UK, over two thirds of all enterprises serve only the domestic market, while in Ireland, enterprises with international activities (foreign-owned and domestic exporters) represent half of the sample. This is not surprising given the smaller size and greater openness of

[6] The specific characteristics of the data collected with CIS and related implications for econometric analysis are discussed extensively by Mairesse and Mohnen (2010). Our econometric methodology discussed above deals, as satisfactorily as possible, with the qualitative and censored nature of the data. The quality of the data we analyse may be uneven across the three countries given the subjective nature of answers to the survey questions.

[7] A number of service sectors (e.g. retail) that are available in the CIS for Germany and are excluded to facilitate comparison with the CIS data for Ireland.

[8] For comparability purposes, these summary statistics are weighted to correct for the stratification of the CIS sample by size class, industry and region.

the Irish economy. Foreign-owned enterprises represent a much larger share in Ireland (18.6 per cent) in comparison to Germany (3.1 per cent) and the UK (8.3 per cent), while domestic exporters account for about one third of all enterprises in the three countries.

The average size of service enterprises in the industries and estimation sample that we consider is higher in the UK (86 employees) than in Germany (50.5 employees) and in Ireland (50.4 employees).[9] The average labour productivity (sales per employee) in Ireland is 3.7 times higher than in Germany and 2.3 times higher than in the UK. The total average innovation expenditure per employee (across enterprises) in Ireland is also higher than in Germany (2.3 times higher) or the UK (9 per cent higher). However, while 51 per cent of service enterprises in the UK report innovation expenditures, the corresponding figures for Germany and Ireland are lower (37 per cent and 26 per cent, respectively). The predominant type of innovation in service enterprises appears to be organisational innovation in Ireland and the UK, and marketing innovations in Germany (however, here the share of service enterprises with organisational innovations is only slightly lower than the share with marketing innovations; both marketing and organisational innovations are substantially higher in Germany than in Ireland and the UK). The patterns of engagement in cooperation for innovation activities differ in the three countries, with the highest engagement rates reported in the UK. Amongst cooperation types, the highest engagement rates in all three countries are reported for cooperation with suppliers and cooperation with clients or customers. For example, while on average, 25 per cent of enterprises in the UK reported an engagement in cooperation for innovation with clients and customers, the corresponding rates for Germany and Ireland were only 2 per cent and 5 per cent, respectively.

For comparison purposes, Table 2 shows the weighted summary statistics for enterprises in manufacturing in Germany, Ireland and the UK.

[9] The sampling unit in the UK is the establishment rather than the enterprise (though the vast majority of establishments are in fact single establishment enterprises). Note that the mean number of employees is substantially higher than the median number of employees due to some very large establishments in the sample. Exclusion of the top 0.5% of establishments by employee size brings the mean number of employees in the UK service sector establishments much closer to that in Germany and Ireland.

[Table 2 about here]

In all three countries, manufacturing enterprises with international activities represent around 60 per cent of all enterprises included in the sample (specifically, 61 per cent in the cases of Germany and Ireland, and 56 per cent in the UK). Thus, in all three countries analysed, manufacturing enterprises are more internationalised than service enterprises. The average sizes of the manufacturing enterprises in the three countries are more similar than in the case of service enterprises, where the largest average manufacturing enterprise size is in Germany (80 employees) and the lowest is in the UK (64 employees), while Ireland lies in between these two (72 employees). Ireland leads again with respect to the average labour productivity in all enterprises, and also in each of the three types of enterprises, where, in the case of foreign-owned enterprises, labour productivity is two times higher than in Germany and 2.5 times higher than in the UK.

In contrast to services, the average innovation expenditure per employee amongst manufacturing enterprises is the highest in Germany. However, Ireland stands out with the highest average innovation expenditure per employee in foreign-owned manufacturing enterprises, about 3.5 times higher than in the UK and two times higher than in Germany. In contrast, Germany has the highest innovation expenditure per employee in enterprises that serve the domestic market only, with a value 4.6 times higher than in Ireland and about three times higher than in the UK.

A striking result that emerges from the statistics is that the predominant innovation type in manufacturing enterprises is different in the three analysed countries, being marketing innovations in Germany, process innovations in Ireland and product innovations in the UK. As in the case of service enterprises, among the three analysed countries, the UK has the highest overall rates of engagement in cooperation for innovation activities. In the UK, the highest rates were for the engagement in cooperation for innovation activities with clients or customers (30.5 per cent of all manufacturing enterprises), while in Germany and Ireland, the highest rates were for cooperation with suppliers of equipment, materials, components or software (6.3 per cent and 8.4 per cent, respectively).

5 Empirical results

Tables 3 to 6 show the estimates of the augmented CDM model for innovation and productivity in service enterprises in Germany, Ireland and the UK over the period 2006-2008.

Table 3 presents the estimates of the Heckman two–stage model of innovation investment. The propensity to invest in innovation (first stage) is estimated by a probit model as a function of enterprise size (measured by the number of employees), ownership (a dummy variable which takes the value of one for foreign-owned enterprises, or zero otherwise), exporting (a dummy variable which takes the value of one for domestic exporters, or zero otherwise) and industry specific effects (industry dummies at the three-digit NACE Rev. 1 classification). The innovation expenditure intensity is measured as the innovation expenditure per employee and is estimated as a function of ownership, exporting and industry specific effects. Following Griffith et al. (2006), we use the enterprise size as an exclusion restriction in the innovation investment equation. The figures shown in Table 3 are marginal effects.

[Table 3 about here]

Our results indicate that service enterprises that invested in innovation were more likely to be large enterprises and enterprises with export markets. In Germany and the UK, innovation expenditure intensity was significantly higher for domestic service enterprises with export markets, than for domestic non-exporters and foreign-owned enterprises, while in Ireland, foreign-owned enterprises had a significantly higher innovation expenditure intensity. In the UK, both foreign-owned enterprises and domestic exporters show significantly higher innovation intensity than domestic non-exporters. Furthermore, industry-specific characteristics matter for the decision to invest in innovation in services as they are highly significant. The likelihood ratio test on whether $\rho = 0$ rejects the null hypothesis, and hence, selection bias has to be corrected for.

Table 4 shows the estimates for determinants of product innovation in the three countries analysed. In addition to the indicator for product innovation, it distinguishes between product innovations that are new to the market (market novelties) and those that are only new to the enterprise but not new to the market (enterprise novelties). The dependent variable is a categorical variable that takes the value of one if product innovation was reported, or zero otherwise. The explanatory variables include the innovation expenditure intensity predicted on the basis of the innovation investment equations, enterprise size, ownership, exporting, engagement in cooperation for innovation activities (dummy variables are equal to one if cooperation was reported, or zero otherwise) and industry specific effects (industry dummies at a two-digit level NACE Rev. 1 classification[10]).

[Table 4 about here]

The results in Table 4 highlight that a higher innovation expenditure intensity significantly increases the likelihood of successfully introducing product innovations in services (this result does not hold true in Ireland). The probability of implementing product innovations is also higher for large enterprises (not valid in the case of UK), and for enterprises with exporting markets. In Ireland, foreign-owned enterprises were more likely to successfully implement product innovations, in particular, as market novelties. Service enterprises with successful product innovation were more likely to engage in cooperation for innovation activities with other enterprises within the same enterprise group; with suppliers (Ireland and the UK); with customers (Germany and the UK); with universities (Germany); and with public research labs (the UK). Cooperation with the science base (universities in Germany or public research labs in the UK) has an impact, particularly for introducing market novelties in services.

Table 5 shows the results of the probit model for other innovation outputs, namely, process, organisational and marketing innovations in service enterprises in the three countries analysed. The dependent variables in the probit models are categorical variables,

[10] The industry dummies are at a two-digit level NACE Rev. 1 classification to ensure the identification of the determinants of innovation outputs, as we used three-digit industry dummies in the innovation expenditure intensity equation. Wald tests validate the exclusion of three-digit industry dummies.

which take the value of one if the respective innovation output was reported, or zero otherwise.

[Table 5 about here]

As shown in Table 5, process innovation in service enterprises was more likely in larger enterprises, in enterprises with higher innovation expenditure intensity (Germany and the UK), and in foreign-owned and exporting enterprises (in Ireland). Moreover, successful process innovation was positively linked to engagement in cooperation for innovation activities with other enterprises (Germany and the UK), with suppliers (Ireland and the UK), with customers (Germany and Ireland) and with consultants and universities (Ireland). In contrast, in the sample analysed, in the UK, service enterprises cooperating with competitors, and in Ireland, those with cooperating with public research labs were less likely to introduce process innovations.

Furthermore, our results indicate that organisational innovation in service enterprises is more likely in larger enterprises, in enterprises with higher innovation expenditure intensity (Germany and the UK), in foreign-owned enterprises (Ireland and the UK), and amongst domestic exporters (Ireland). Moreover, the successful implementation of organisational innovation in service enterprises was positively linked to cooperation in innovation activities with other enterprises within the same enterprise group (Germany and the UK), and with suppliers and customers (Ireland and the UK). In contrast, in Germany, service enterprises that cooperated with public research institutes were less likely to successfully implement organisational innovations.

Finally, Table 5 indicates that marketing innovations in service enterprises were more likely among enterprises with higher innovation expenditure per employee, larger enterprises (Germany and Ireland), and with domestic exporters (Ireland). Moreover, the successful implementation of marketing innovations was positively linked to cooperation with other enterprises within the same enterprise group (Germany), with suppliers (Ireland and the UK), with customers (the UK), and with universities (Germany).

Table 6 shows the estimates of the productivity equation for service enterprises in the three countries analysed. The dependent variable is labour productivity measured as turnover per employee. The explanatory variables include the predicted probability to innovate successfully (to implement product, process, organisational or marketing innovations), enterprise size, ownership, and exporting. Unfortunately, the CIS data does not contain data on the physical capital in all three countries. We control for differences in capital endowment by including industry dummies at the three-digit level (NACE Rev. 1 classification). The productivity equation for Germany also includes a dummy variable which is equal to one for enterprises located in East Germany, since even 20 years after reunification, there is a productivity gap between firms in West and East Germany.

[Table 6 about here]

Innovative service enterprises had higher productivity. This positive link is evident for all types of innovation in Germany and the UK; in Ireland innovation was also positively correlated with productivity, but it was statistically significant only for process and marketing innovations. In all three countries, the strongest link between innovation and productivity was found for marketing innovations (the productivity elasticity with respect to marketing innovation was 0.32 in Germany, 0.77 in Ireland and 0.07 in the UK).

Although, given the dearth of evidence, our main interest is innovation in service enterprises, we also consider innovation in manufacturing enterprises for the sake of comparison. Tables 7 to 10 show the estimates for innovation and productivity in manufacturing enterprises in Germany, Ireland, and the UK. Table 7 shows the results for the innovation investment equations (Eqs 1-3).

[Table 7 about here]

Our results indicate that, in all three countries, the manufacturing enterprises which were more likely to invest in innovation were mostly those firms which were larger, foreign-owned and those with export markets. In Ireland and the UK, foreign-owned and domestic exporters had the highest innovation expenditure intensity, while in Germany being a foreign affiliate or an exporter does not affect the innovation expenditure intensity.

Instead, the results indicate that innovation expenditure intensity is positively associated with human capital and training.[11]

Table 8 shows the results for product innovation in manufacturing enterprises.

[Table 8 about here]

These results are similar as those obtained for services. That is, in all three countries, the probability of implementing product innovation is higher in domestic manufacturing enterprises operating with export markets. In Germany and Ireland, larger enterprises and foreign-owned enterprises were more likely to implement product innovations. This result holds true for products new to the market, as well as for products new to the enterprise but not necessarily new to the market.

A higher innovation expenditure intensity was positively associated with the probability to implement product innovations in Germany (for both market and enterprise product novelties) and the UK (for products new to the market). However, as in the case for services, it appears that innovation expenditure intensity in Ireland's manufacturing enterprises is not significantly associated with product innovation output.

Furthermore, our results indicate that manufacturing enterprises engaged in cooperation for innovation activities were more likely to introduce new or significantly improved products. We identify such positive associations in the case of the following cooperation types: cooperation with other enterprises within the same industry (in Germany and the UK), cooperation with suppliers (all three countries), cooperation with clients or customers (in all three countries), cooperation with universities (in all three countries), and cooperation with public research institutes (in Germany). With the exception of the importance of cooperation with universities, the importance (and type) of cooperation for successful innovation is similar among both manufacturing and service enterprises.

[11] While we aimed at estimating the same model specification for all three countries, human capital and training are excluded elsewhere (in services and other countries), because the data are not available for Ireland; However, these variables were included in the estimation for Germany because it was not possible to identify the model for German manufacturing without these additional variables.

Table 9 shows the results for the determinants of the other types of innovations, namely, process, organisational and marketing innovations.

[Table 9 about here]

Surprisingly, it appears that only in Germany, innovation expenditure intensity in manufacturing enterprises is positively associated with the probability of introducing process, organisational or marketing innovations. In contrast, in Ireland and the UK, an increase in innovation expenditure intensity does not increase significantly the likelihood of these innovation outputs.

Furthermore, in all three countries analysed, process innovations in manufacturing enterprises were more common in larger enterprises and in domestic enterprises with export markets. In Germany and Ireland, foreign-owned enterprises were more likely to introduce process innovations.

Our results identify a positive link between the propensity to introduce process innovations and engagement in various types of cooperation, as follows: cooperation with other enterprises in Germany and the UK; cooperation with suppliers in all three countries; cooperation with customers in Germany and the UK; and cooperation with consultants and private research laboratories in Ireland. In the UK, cooperation with competitors was negatively associated with the introduction of process innovations.

The propensity to introduce organisational innovation was positively associated with enterprise size and with being a larger domestic exporter in all the countries, and with foreign ownership – in Ireland and the UK. Engagement in cooperation for innovation activities was positively linked to the propensity to introduce organisational innovations, as follows: cooperation with other enterprises within the same group – in the UK; cooperation with suppliers – in Ireland and the UK; with clients or customers – in Germany and the UK; with consultants – in Germany and the UK; with universities – Germany and Ireland; and with public research institutes – in Ireland. In Ireland, cooperation with competitors was negatively associated with the propensity to introduce organisational innovations.

The propensity to introduce marketing innovations was higher in domestic manufacturing exporters in all three countries, and in Germany only also in foreign-owned enterprises. Enterprise size was not significantly associated with the propensity to introduce marketing innovations in any of the three countries analysed. Engagement in cooperation for innovation activities was positively associated with the propensity to introduce marketing innovations, as follows: cooperation with other enterprises within the same group, with suppliers, with universities – in the UK; cooperation with clients or customers – in Germany and the UK; and with consultants – in Ireland and the UK. In Ireland, cooperation with public research institutes was negatively associated with the introduction of marketing innovations.

Table 10 shows the estimates for the innovation–productivity link in manufacturing enterprises.

[Table 10 about here]

With respect to the innovation–productivity link, our results indicate that innovative manufacturing enterprises in Germany and the UK had a higher labour productivity. This result holds for all types of innovation outputs. In the UK, the output elasticity with respect to innovation outputs is similar in magnitude for manufacturing and service enterprises, while in Germany, with the exception of marketing innovations, the elasticity of output to innovation outputs in manufacturing is much lower than in services. The strongest innovation–productivity link was in the case of marketing innovations in Germany and the UK (productivity elasticity with respect to innovation was 0.32 and 0.08, respectively). In Ireland, while innovation and productivity in manufacturing are positively linked, this link appears not to be statistically significant.

6 Summary and policy implications

This paper has examined the links between innovation inputs, innovation outputs and productivity in service enterprises. For this purpose, we estimated a structural model using micro data from the Community Innovation Survey over the period 2006-2008 from Germany, Ireland and the UK to answer the following research questions: (i) What types of service enterprises were more likely to invest in innovation? (ii) What types of service enterprises had higher innovation expenditure per employee? (iii) What types of service enterprises were more likely to successfully translate innovation expenditures into innovation outputs? (iv) Were innovation outputs linked to higher productivity? To uncover any specific features of innovation in services, we compared the results of our analysis with the results for innovation and productivity in manufacturing. While the cross-sectional nature of the CIS data we analyse does not allow us to draw conclusions about causality, we identify a number of structural stylized facts which are informative for both research and policy design.

The predominant innovation types in service enterprises over the period analysed in the three countries were organisational and marketing innovations. In manufacturing, the highest innovation rates varied across the three countries analysed: in Germany, the highest innovation rates were for marketing innovations, in Ireland for process innovation and in the UK for product innovation.

Our econometric analysis reveals that investment in innovation in service enterprises is more likely in larger enterprises and in enterprises with export markets. Conditional on investing in innovation, in comparison to enterprises that served only domestic markets, in Ireland and the UK, the innovation expenditure per employee was significantly higher in foreign-owned enterprises, while in Germany, this was the case for German-owned enterprises with export markets. Innovation expenditure intensity was positively and significantly linked to all innovation outputs in Germany and the UK, while in Ireland this result holds true only in the case of marketing innovations.

Our empirical evidence highlights the importance of internationalisation in the context of innovation outputs in all three countries. For all types of innovations, innovation rates were the highest in enterprises with international activities (foreign-owned and domestic exporters) in Ireland and the UK. In Germany, this is true for foreign-owned enterprises, while enterprises serving the domestic market only had higher process and marketing innovation rates compared to domestic exporters.

Our research results illustrate the importance of knowledge and technology transfer for successful innovation in service firms. Over and above enterprise size, innovation expenditure intensity (in Germany and the UK), foreign ownership (Ireland) and exporting, successful innovation in service enterprises appears to be positively associated with engagement in cooperation for innovation activities with other enterprises (suppliers and customers) and with knowledge providers (universities, public and private research institutes, consultants). In contrast, cooperation for innovation activities with competitors was associated with a lower probability to innovate.

Innovation in service enterprises appears positively and significantly linked to labour productivity for all types of innovation in Germany and the UK. In Ireland, this positive link was statistically significant only in the cases of process and marketing innovations. In all three analysed countries, the strongest link between innovation and productivity in service enterprises was found to be for marketing innovations. Given the specificities of services, this result is noteworthy. It could be interpreted as indicating a positive link between marketing innovations and demand for new or improved services. It also highlights the importance of investment in intangible capital for productivity growth in services.

We found that the determinants of innovation and productivity in service enterprises were similar, in many respects, to the determinants of innovation and productivity in manufacturing enterprises. We also found some differences in the determinants of innovation and productivity between manufacturing and service sector enterprises: foreign-owned enterprises in manufacturing appear more likely to invest in innovation compared to foreign-owned enterprises in services; and engagement in cooperation with universities

appears to play a more important role in innovation outputs in manufacturing than in services.

Our research findings suggest that innovation in service enterprises could benefit from many of the policies that were designed to incentivise and foster innovation in manufacturing enterprises, such as policies which enable firm growth, and which enhance innovation capability and cooperation in innovation activities with other enterprises and knowledge providers. In addition, our results suggest that targeting resources to foster marketing innovation in service enterprises would be beneficial in terms of productivity.

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Table 1. CIS 2008, services weighted sample: summary statistics

Enterprise type	Innovators and non-innovators											
	All			Foreign-owned			Domestic exporters			Domestic non-exporters		
Country	DE	IE	UK	DE	IE	UK	DE	IE	UK	DE	IE	UK
Sample size	1 333	1 286	4344	84	291	580	354	404	1 193	895	591	2 571
Enterprise characteristics												
Foreign-owned (%)	3.1	18.6	8.3									
Domestic exporter %)	32.5	31.7	29.2									
Domestic non-exporter (%)	64.5	49.7	62.5									
Size (number of employees)	50.5	50.4	86.0	118.9	90.3	171.1	45.1	47.3	116.1	50.0	37.5	60.6
Labour productivity (turnover per employee, euros)	242600	897863	389850	1392071	3361860	2714350	324412	384241	225500	146925	302815	103700
Innovation inputs												
Decision to invest in innovation (%)	36.6	25.9	50.7	58.0	28.4	39.3	41.6	36.6	60.9	33.0	18.1	47.4
Total innovation expenditure per employee (euros)	2 131	4 969	4 547	9 433	11 033	5 036	2 853	6 062	7 353	1 422	2 003	1 672
Decision to invest in R&D (%)	14.3	14.6	28.1	29.2	19.6	22.8	15.3	22.9	43.0	13.0	7.4	21.8
R&D expenditure per employee (euros)	697	2 094	2 826	2 673	4 858	989	900	3 076	6 401	500	434	494
Innovation outputs												
Product innovation (%)	28.6	24.7	30.3	36.6	41.9	37.8	42.1	32.6	41.7	21.4	13.3	24.1
Market novelties (%)	9.0	15.1	14.6	18.9	25.5	21.9	14.5	22.8	20.3	5.8	6.4	10.9
Enterprise novelties (%)	25.2	18.1	22.7	33.1	28.7	26.3	36.3	23.0	32.0	19.3	11.1	17.8
Process innovation (%)	27.5	29.9	18.8	47.6	41.5	19.1	22.6	36.5	26.9	29.0	21.4	15.0
Organisational innovation (%)	39.1	32.2	32.9	56.7	42.0	42.7	38.5	42.9	40.5	38.5	21.7	28.0
Marketing innovation (%)	39.3	26.5	24.4	53.7	29.8	24.8	37.8	35.4	29.5	39.3	19.5	22.0
Innovative turnover share (%)	6.2	6.9	11.6	9.5	10.4	13.1	9.2	9.6	16.3	4.5	3.8	9.3
Innovative turnover share (new to market, %)	1.1	3.2	2.6	2.5	5.4	2.4	1.5	4.9	3.3	0.8	1.3	2.3
Innovative turnover share (new to enterprise, %)	5.1	3.7	4.0	6.9	5.0	3.7	7.8	4.7	6.1	3.7	2.5	3.1

Table 1. cont. CIS 2008, services weighted sample: summary statistics

Enterprise type	Innovators and non-innovators											
	All			Foreign-owned			Domestic exporters			Domestic non-exporters		
Country	DE	IE	UK	DE	IE	UK	DE	IE	UK	DE	IE	UK
Sample size	1 333	1 286	4344	84	291	580	354	404	1 193	895	591	2 571
Engagement in cooperation for innovative activities												
Cooperation with other enterprises within the same enterprise group (%)	2.5	4.9	17.0	9.4	14.6	33.1	2.3	3.1	20.5	2.2	2.3	13.2
Cooperation with suppliers (%)	2.5	5.7	20.9	6.3	8.6	26.6	3.6	7.0	26.6	1.7	3.7	17.4
Cooperation with clients or customers (%)	2.0	5.4	25.4	3.8	8.8	36.0	3.1	8.3	29.9	1.4	2.3	21.9
Cooperation with competitors (%)	1.2	2.8	11.4	0.1	4.5	14.7	1.4	3.3	11.9	1.2	1.8	10.8
Cooperation with consultants, commercial laboratories or private R&D institutions (%)	2.1	2.9	9.3	1.1	4.7	10.8	2.6	4.2	10.2	1.9	1.4	8.7
Cooperation with universities or other higher education institutes (%)	2.0	3.3	8.1	6.3	5.1	10.5	2.9	5.6	9.2	1.4	1.0	7.2
Cooperation with government or public research institutes (%)	0.4	1.8	8.1	0.0	2.4	8.6	0.9	3.0	8.1	0.2	0.9	8.0

Notes: Innovators are enterprises that report having at least one of the following types of innovation: product, process, organisational or marketing innovation. Enterprises reporting no innovation are considered non-innovators. Enterprise types include: foreign-owned (as indicated in the original survey; in the case of the UK, as indicated by information linked to the CIS from the Inter-Departmental Business Register), domestic exporters (other than foreign-owned enterprises that export) and domestic non-exporters (enterprises that serve domestic markets only). The samples are weighted by number of enterprises stratified by size class, industry and region. UK figures converted from £ to € using the exchange rate £1 = €1.2588 (2008 year average provided by the Bank of England). The UK figures for innovative turnover share "new to market" and "new to firm" do not add up to the UK figures for the total innovative turnover share because these sub-components do not include the share of turnover associated with significantly improved goods or services.

Table 2. CIS 2008, manufacturing weighted sample: summary statistics

Enterprise type	Innovators and non-innovators											
	All			Foreign-owned			Domestic exporters			Domestic non-exporters		
Country	DE	IE	UK	DE	IE	UK	DE	IE	UK	DE	IE	UK
Sample size	2 292	831	2 990	257	218	580	1 467	350	1 367	568	263	1 043
Enterprise characteristics												
Foreign-owned (%)	6.1	19.2	11.0									
Domestic exporter %)	55.2	41.8	45.4									
Domestic non-exporter (%)	38.7	39.0	43.6									
Size (number of employees)	79.5	72.4	64.3	189.2	187.9	177.8	101.2	62.3	63.8	31.3	26.2	36.2
Labour productivity (turnover per employee, euros)	150 826	265 215	138 342	323 100	645 548	254 278	164 205	198 039	144 007	104 767	149 696	102 970
Innovation inputs												
Decision to invest in innovation (%)	61.6	40.9	62.4	78.2	55.3	65.1	73.3	52.7	72.3	42.3	21.2	51.4
Total innovation expenditure per employee (euros)	6 449	5 932	3 074	7 385	14 289	4 013	6 604	6 381	3 920	6 081	1 328	1 956
Decision to invest in R&D (%)	41.1	28.1	42.7	62.4	41.3	53.3	54.9	38.1	56.7	18.1	11.0	25.6
R&D expenditure per employee (euros)	2 095	2 462	1 109	3 674	4 681	2 281	2 860	3 420	1645	756	338	256
Innovation outputs												
Product innovation (%)	46.3	33.9	37.8	63.9	49.6	48.7	56.8	46.5	47.9	28.6	12.7	24.7
Market novelties (%)	21.5	19.5	20.8	33.7	31.6	28.8	30.3	26.2	28.1	7.1	6.5	11.1
Enterprise novelties (%)	40.7	25.8	28.2	58.7	33.0	36.4	49.2	37.1	34.7	25.9	10.2	19.4
Process innovation (%)	42.0	44.3	20.7	54.2	55.0	24.1	47.6	55.1	23.9	32.0	27.4	16.5
Organisational innovation (%)	42.6	33.2	32.5	57.3	48.7	45.1	47.9	40.5	38.4	32.8	17.7	23.1
Marketing innovation (%)	48.3	28.7	19.4	54.6	31.9	24.7	57.0	37.5	21.1	34.9	17.6	16.4
Innovative turnover share (%)	12.4	7.9	12.5	14.4	10.4	14.4	15.3	11.5	15.7	8.0	2.7	8.6
Innovative turnover share (new to market, %)	3.0	3.4	3.1	3.9	5.3	3.7	4.0	4.7	4.3	1.5	1.1	1.8
Innovative turnover share (new to enterprise, %)	9.4	4.5	4.1	10.5	5.1	4.2	11.3	6.8	4.9	6.5	1.7	3.2

Table 2. cont. CIS 2008, manufacturing weighted sample: summary statistics

Enterprise type	Innovators and non-innovators											
	All			Foreign-owned			Domestic exporters			Domestic non-exporters		
Country	DE	IE	UK	DE	IE	UK	DE	IE	UK	DE	IE	UK
Sample size	2 292	831	2 990	257	218	580	1 467	350	1 367	568	263	1 043
Engagement in cooperation for innovative activities												
Cooperation with other enterprises within the same enterprise group (%)	3.8	6.2	17.5	19.0	18.8	41.4	3.7	4.3	18.3	1.4	1.7	10.5
Cooperation with suppliers (%)	6.3	8.4	25.8	17.2	13.6	38.1	8.5	10.0	30.0	1.5	3.6	18.3
Cooperation with clients or customers (%)	4.5	7.6	30.5	10.6	12.6	43.2	5.6	9.7	36.5	1.8	2.4	21.1
Cooperation with competitors (%)	2.2	2.4	10.7	2.5	3.1	11.5	2.5	3.0	11.6	1.7	1.2	9.6
Cooperation with consultants, commercial laboratories or private R&D institutions (%)	2.5	6.7	11.4	2.8	11.7	19.2	3.4	7.6	14.2	1.1	2.9	6.6
Cooperation with universities or other higher education institutes (%)	6.9	5.7	9.3	13.9	12.3	15.9	9.4	6.2	11.9	2.2	1.6	4.8
Cooperation with government or public research institutes (%)	2.6	4.0	6.7	3.9	3.7	9.7	3.7	6.1	7.8	0.9	1.7	4.8

Notes: Innovators are enterprises that report having at least one of the following types of innovation: product, process, organisational or marketing innovation. Enterprises reporting no innovation are considered non-innovators. Enterprise types include: foreign-owned (as indicated in the original survey; in the case of the UK, as indicated by information linked to the CIS from the Inter-Departmental Business Register), domestic exporters (other than foreign-owned enterprises that export) and domestic non-exporters (enterprises that serve domestic markets only). The samples are weighted by number of enterprises stratified by size class, industry and region. UK figures converted from £ to € using the exchange rate £1 = €1.2588 (2008 year average provided by the Bank of England). The UK figures for innovative turnover share "new to market" and "new to firm" do not add up to the UK figures for the total innovative turnover share because these sub-components do not include the share of turnover associated with significantly improved goods or services.

Table 3. Innovation investment in service enterprises, 2006-2008

Country	**Germany**		**Ireland**		**UK**	
	Innovation Investment Equations					
Dependent variable	Propensity to invest in innovation	Intensity of Innovation expenditure per employee	Propensity to invest in innovation	Intensity of Innovation expenditure per employee	Propensity to invest in innovation	Intensity of Innovation expenditure per employee
Estimator	Heckman stage 1	Heckman stage 2	Heckman stage 1	Heckman stage 2	Heckman stage 1	Heckman stage 2
Size (log # emp.)	0.085***	-	0.050***	-	0.046***	-
	(0.012)		(0.011)		(0.006)	
Foreign-owned	0.033	0.171	0.049	0.962***	-0.070***	0.375**
	(0.066)	(0.254)	(0.037)	(0.271)	(0.026)	(0.148)
Domestic exporter	0.153***	0.399***	0.165***	0.179	0.093***	0.686***
	(0.035)	(0.118)	(0.032)	(0.233)	(0.018)	(0.099)
Industry fixed effects (3-digit)	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1 333		1 286		4 346	
lambda	0.936***		1.5683**		1.828***	
	(0.179)		(0.6055)		(0.139)	
rho	0.627***		0.7421***		0.822***	
	(0.091)		(0.1700)		(0.033)	
Wald test for H0: rho = 0	24.31***		6.37**		130.2***	
Wald test (Industry fixed effects)	578.06***		3 630.50***		865.59***	
Log-likelihood	-1 787.94		-1 374.86		-7 246.00	

Notes: Marginal effects; robust standard errors; CIS 2006-2008.

Table 4. Determinants of product innovation in service enterprises, 2006-2008

Country	**Germany**			**Ireland**			**UK**		
	Innovation Output Equation – Product Innovation								
Dependent variable	Product innovation	Market novelties	Enterprise novelties	Product innovation	Market novelties	Enterprise novelties	Product innovation	Market novelties	Enterprise novelties
Estimator	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Predicted innovation expenditure	0.083***	0.033***	0.074***	0.040	0.029	0.024	0.055***	0.022***	0.043***
	(0.016)	(0.009)	(0.015)	(0.026)	(0.018)	(0.022)	(0.008)	(0.005)	(0.007)
Size (log # emp.)	0.022**	0.007	0.029***	0.041***	0.011	0.023**	0.005	0.001	0.002
	(0.011)	(0.006)	(0.010)	(0.013)	(0.009)	(0.011)	(0.006)	(0.003)	(0.005)
Foreign-owned	0.012	0.048	-0.006	0.142***	0.095**	0.065	-0.032	0.001	-0.025
	(0.061)	(0.040)	(0.056)	(0.053)	(0.044)	(0.045)	(0.025)	(0.015)	(0.020)
Domestic exporter	0.148***	0.055**	0.157***	0.124***	0.115***	0.055	0.051**	0.043***	0.031*
	(0.037)	(0.023)	(0.035)	(0.041)	(0.033)	(0.035)	(0.021)	(0.013)	(0.017)
Cooperation with other enterprises	0.243**	0.024	0.159*	0.305***	0.203***	0.128*	0.110***	0.042**	0.071***
	(0.095)	(0.041)	(0.082)	(0.097)	(0.073)	(0.070)	(0.030)	(0.017)	(0.024)
Cooperation with suppliers	0.072	0.019	0.066	0.316***	0.108	0.234***	0.132***	0.038**	0.089***
	(0.111)	(0.044)	(0.094)	(0.094)	(0.067)	(0.083)	(0.027)	(0.016)	(0.023)
Cooperation with customers	0.408***	0.131*	0.165	0.095	0.066	0.113	0.423***	0.192***	0.311***
	(0.112)	(0.068)	(0.102)	(0.089)	(0.059)	(0.074)	(0.023)	(0.019)	(0.022)
Cooperation with competitors	-0.022	0.056	-0.034	0.112	0.061	0.039	0.009	-0.000	0.024
	(0.095)	(0.055)	(0.079)	(0.117)	(0.076)	(0.078)	(0.033)	(0.016)	(0.026)
Cooperation with consultants	0.145	-0.017	0.053	0.059	0.057	0.089	0.023	0.025	0.011
	(0.104)	(0.033)	(0.086)	(0.104)	(0.072)	(0.087)	(0.034)	(0.019)	(0.026)
Cooperation with universities	0.168	0.135**	0.114	0.217	0.024	0.144	-0.064*	-0.024	-0.025
	(0.108)	(0.067)	(0.094)	(0.142)	(0.067)	(0.100)	(0.037)	(0.018)	(0.029)
Cooperation with public research labs	-0.039	0.056	-0.078	0.043	0.013	-0.075	0.006	0.060**	-0.033
	(0.133)	(0.070)	(0.097)	(0.156)	(0.074)	(0.062)	(0.042)	(0.029)	(0.029)
Industry fixed effects (2-digit)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1 333	1 327	1 333	1 256	1 247	1 256	4 346	4 333	4 346
Log-likelihood	-665.694	-385.769	-660.119	-584.228	-451.396	-530.409	-1 956	-1 360	-1 851
R^2/ Pseudo R^2	0.2037	0.1760	0.1743	0.2024	0.1852	0.1519	0.272	0.234	0.211
Wald test (Industry fixed effects)	40.80***	10.41	39.40***	9.32	13.91*	9.44	35.43***	49.93***	11.38

Notes: Marginal effects; robust standard errors; CIS 2006-2008.

Table 5. Determinants of process, organisational and marketing innovations in service enterprises, 2006-2008

Country	**Germany**			**Ireland**			**UK**		
	Innovation Output Equation – Process, Organisational and Marketing Innovations								
Dependent variable	Process innovation	Organisational innovation	Marketing innovation	Process innovation	Organisational innovation	Marketing innovation	Process innovation	Organisational innovation	Marketing innovation
Estimator	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Predicted innovation expenditure	0.089***	0.050***	0.055***	0.013	0.039	0.050*	0.027***	0.029***	0.023***
	(0.016)	(0.015)	(0.015)	(0.030)	(0.029)	(0.026)	(0.006)	(0.008)	(0.007)
Size (log # emp.)	0.076***	0.061***	0.038***	0.028**	0.061***	0.025**	0.008*	0.035***	0.003
	(0.010)	(0.011)	(0.011)	(0.014)	(0.014)	(0.013)	(0.004)	(0.006)	(0.005)
Foreign-owned	-0.049	-0.027	-0.010	0.115**	0.114**	-0.010	-0.019	0.061**	-0.016
	(0.057)	(0.065)	(0.059)	(0.054)	(0.054)	(0.047)	(0.018)	(0.028)	(0.021)
Domestic exporter	0.027	0.028	-0.022	0.103**	0.170***	0.089**	0.007	0.009	0.005
	(0.036)	(0.037)	(0.037)	(0.042)	(0.042)	(0.038)	(0.015)	(0.021)	(0.017)
Cooperation with other enterprises	0.458***	0.402***	0.207***	0.048	-0.023	0.063	0.061***	0.128***	0.034
	(0.074)	(0.057)	(0.078)	(0.084)	(0.074)	(0.071)	(0.022)	(0.030)	(0.023)
Cooperation with suppliers	0.164	0.021	-0.070	0.407***	0.170**	0.297***	0.149***	0.116***	0.119***
	(0.104)	(0.116)	(0.088)	(0.077)	(0.086)	(0.081)	(0.023)	(0.027)	(0.023)
Cooperation with customers	0.216**	-0.022	0.053	0.197*	0.251***	0.015	0.233***	0.336***	0.225***
	(0.101)	(0.109)	(0.097)	(0.104)	(0.086)	(0.076)	(0.022)	(0.023)	(0.022)
Cooperation with competitors	-0.016	0.004	0.116	-0.000	-0.003	0.067	-0.054***	-0.008	-0.018
	(0.091)	(0.101)	(0.096)	(0.112)	(0.100)	(0.093)	(0.018)	(0.035)	(0.024)
Cooperation with consultants	0.089	0.145	0.016	0.255*	0.120	0.112	0.070**	0.033	0.033
	(0.097)	(0.102)	(0.085)	(0.135)	(0.106)	(0.100)	(0.028)	(0.036)	(0.028)
Cooperation with universities	-0.062	0.061	0.173*	0.269**	0.159	0.043	-0.032	-0.030	-0.044
	(0.082)	(0.099)	(0.091)	(0.128)	(0.107)	(0.095)	(0.025)	(0.043)	(0.028)
Cooperation with public research lab	-0.093	-0.269**	-0.129	-0.209**	-0.094	-0.008	-0.021	0.018	0.031
	(0.113)	(0.111)	(0.112)	(0.093)	(0.109)	(0.111)	(0.026)	(0.045)	(0.035)
Industry fixed effects (2-digit)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1 333	1 333	1 333	1 256	1 247	1 256	4 346	4 346	4 346
Log-likelihood	-737.580	-843.752	-855.947	-699.129	-729.851	-689.118	-1 686	-2 333	-2 016
R^2/ Pseudo R^2	0.1340	0.0864	0.0616	0.1146	0.1018	0.0786	0.206	0.181	0.135
Wald test (Industry fixed effects)	20.68**	28.73***	25.97***	4.51	14.62*	5.98	34.71***	42.86***	24.34***

Notes: Marginal effects; robust standard errors; CIS 2006-2008.

Table 6. Innovation and productivity in service enterprises, 2006-2008

Country	**Germany**			**Ireland**			**UK**		
	Productivity Equation (Dependent variable = Turnover/Employees)								
Dependent variable	Product innovation	Market novelties	Enterprise novelties	Product innovation	Market novelties	Enterprise novelties	Product innovation	Market novelties	Enterprise novelties
Estimator	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Predicted innovation outputs	0.163***	0.131*	0.270**	0.188	0.580	0.451	0.043*	0.055*	0.051*
	(0.063)	(0.080)	(0.112)	(0.283)	(0.398)	(0.333)	(0.023)	(0.030)	(0.027)
Size (log # emp.)	0.009	0.016	-0.005	0.051	0.043	0.044	-0.092***	-0.092***	-0.092***
	(0.021)	(0.021)	(0.023)	(0.044)	(0.042)	(0.042)	(0.013)	(0.013)	(0.013)
Foreign-owned	0.454***	0.403***	0.457***	0.747***	0.705***	0.734***	0.867***	0.869***	0.867***
	(0.141)	(0.141)	(0.141)	(0.144)	(0.143)	(0.136)	(0.061)	(0.061)	(0.061)
Domestic exporter	0.270***	0.296***	0.200**	0.307***	0.256**	0.299***	0.455***	0.449***	0.455***
	(0.069)	(0.071)	(0.091)	(0.098)	(0.104)	(0.093)	(0.038)	(0.039)	(0.038)
East Germany	-0.221***	-0.215***	-0.220***						
	(0.044)	(0.043)	(0.044)						
Industry fixed effects (3-digit)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1 333	1 327	1 333	1 256	1 247	1 256	4 346	4 333	4 346
Log-likelihood	-1544.808	-1530.697	-1545.249	-2150.776	-2136.429	-2149.938	-6090	-6070	-6090
R^2	0.504	0.505	0.504	0.2018	0.2029	0.2029	0.401	0.399	0.401
Wald test (Industry fixed effects)	38.71***	36.28***	39.25***	1132.10***	597.65***	203.07***	81.53***	80.39***	81.51***

Notes: Marginal effects; robust standard errors; CIS 2006-2008.

Table 6 cont. Innovation and productivity in service enterprises, 2006-2008

Country	**Germany**			**Ireland**			**UK**		
	Productivity Equation (Dependent variable = Turnover/Employees)								
Dependent variable	Process innovation	Organisational innovation	Marketing innovation	Process innovation	Organisational innovation	Marketing innovation	Process innovation	Organisational innovation	Marketing innovation
Estimator	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Predicted innovation outputs	0.211***	0.226***	0.320**	0.508*	0.520	0.767*	0.065**	0.056**	0.070**
	(0.071)	(0.084)	(0.129)	(0.297)	(0.438)	(0.436)	(0.028)	(0.028)	(0.035)
Size (log # emp.)	-0.027	-0.017	-0.013	0.041	0.023	0.035	-0.095***	-0.097***	-0.093***
	(0.026)	(0.025)	(0.025)	(0.042)	(0.050)	(0.043)	(0.013)	(0.014)	(0.013)
Foreign-owned	0.474***	0.467***	0.468***	0.713***	0.701***	0.741***	0.867***	0.854***	0.868***
	(0.141)	(0.141)	(0.141)	(0.137)	(0.149)	(0.131)	(0.061)	(0.061)	(0.061)
Domestic exporter	0.317***	0.337***	0.356***	0.272***	0.224*	0.233**	0.458***	0.462***	0.462***
	(0.060)	(0.059)	(0.058)	(0.097)	(0.126)	(0.109)	(0.037)	(0.037)	(0.037)
East Germany	-0.223***	-0.222***	-0.221***						
	(0.044)	(0.044)	(0.044)						
Industry fixed effects (3-digit)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1 333	1 333	1 333	1 256	1 247	1 256	4 346	4 346	4 346
Log-likelihood	-1542.575	-1543.706	-1545.310	-2149.246	-2136.920	-2148.947	-6089	-6090	-6090
R^2	0.506	0.505	0.504	0.2038	0.2023	0.2042	0.401	0.401	0.401
Wald test (Industry fixed effects)	36.89***	39.71***	37.16***	1254.48***	95.43***	273.09***	76.43***	77.44***	76.34***

Notes: Marginal effects; robust standard errors; CIS 2006-2008.

Table 7. Innovation investment in manufacturing enterprises, 2006-2008

Country	**Germany**		**Ireland**		**UK**	
	Innovation Investment Equations					
Dependent variable	Propensity to invest in innovation	Intensity of Innovation expenditure per employee	Propensity to invest in innovation	Intensity of Innovation expenditure per employee	Propensity to invest in innovation	Intensity of Innovation expenditure per employee
Estimator	Heckman stage 1	Heckman stage 2	Heckman stage 1	Heckman stage 2	Heckman stage 1	Heckman stage 2
Size (log # emp.)	0.085***	-	0.139***	-	0.045***	-
	(0.009)		(0.022)		(0.008)	
Foreign-owned	0.119***	0.021	0.188***	0.972***	0.053*	0.574***
	(0.036)	(0.135)	(0.068)	(0.311)	(0.029)	(0.119)
Domestic exporter	0.200***	0.003	0.274***	0.441*	0.157***	0.394***
	(0.029)	(0.109)	(0.049)	(0.244)	(0.021)	(0.094)
HC	0.004***	0.016***				
	(0.001)	(0.003)				
Training	0.085***	0.301***				
	(0.012)	(0.036)				
Industry fixed effects (3-digit)	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2 292		831		2 990	
lambda	0.065		0.9658**		0.489***	
	(0.105)		(0.4187)		(0.104)	
rho	0.052		0.6125***		0.305***	
	(0.084)		(0.2089)		(0.061)	
Wald test for H0: rho = 0	0.38		4.55**		22.26***	
Wald test (Industry fixed effects)	287.03***		4.3e+05***		8 249.52***	
Log-likelihood	-3 600.07		-1 136.68		-5 430.00	

Notes: Marginal effects; robust standard errors; CIS 2006-2008.

Table 8. Determinants of product innovation in manufacturing enterprises, 2006-2008

Country	**Germany**			**Ireland**			**UK**		
	Innovation Output Equation – Product Innovation								
Dependent variable	Product innovation	Market novelties	Enterprise novelties	Product innovation	Market novelties	Enterprise novelties	Product innovation	Market novelties	Enterprise novelties
Estimator	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Predicted innovation expenditure	0.148***	0.118***	0.101***	0.026	-0.008	0.021	0.068**	0.048**	0.017
	(0.024)	(0.020)	(0.023)	(0.030)	(0.023)	(0.025)	(0.029)	(0.021)	(0.025)
Size (log # emp.)	0.071***	0.042***	0.066***	0.069***	0.032**	0.044**	0.002	-0.002	-0.001
	(0.010)	(0.008)	(0.010)	(0.021)	(0.015)	(0.018)	(0.009)	(0.007)	(0.008)
Foreign-owned	0.086*	0.088**	0.095**	0.175**	0.164**	0.124*	0.032	0.038	0.037
	(0.045)	(0.045)	(0.046)	(0.078)	(0.072)	(0.073)	(0.040)	(0.032)	(0.036)
Domestic exporter	0.185***	0.152***	0.162***	0.292***	0.197***	0.234***	0.132***	0.095***	0.096***
	(0.029)	(0.024)	(0.029)	(0.056)	(0.049)	(0.050)	(0.028)	(0.022)	(0.024)
Cooperation with other enterprises	0.154**	0.095**	0.002	0.188	0.105	0.005	0.091***	0.057**	0.059**
	(0.063)	(0.046)	(0.054)	(0.117)	(0.082)	(0.081)	(0.034)	(0.025)	(0.029)
Cooperation with suppliers	0.231***	0.127***	0.186***	0.188*	0.121	-0.019	0.237***	0.099***	0.165***
	(0.048)	(0.042)	(0.047)	(0.110)	(0.082)	(0.075)	(0.030)	(0.024)	(0.028)
Cooperation with customers	0.215***	0.033	0.136***	0.307***	0.213**	0.301***	0.385***	0.212***	0.260***
	(0.057)	(0.041)	(0.052)	(0.093)	(0.087)	(0.089)	(0.025)	(0.024)	(0.025)
Cooperation with competitors	0.095	0.022	0.066	-0.074	0.081	0.001	-0.080**	-0.047*	0.020
	(0.076)	(0.047)	(0.067)	(0.221)	(0.142)	(0.135)	(0.041)	(0.025)	(0.035)
Cooperation with consultants	0.043	0.029	0.025	0.010	0.043	0.084	0.027	0.002	0.014
	(0.080)	(0.050)	(0.063)	(0.118)	(0.075)	(0.089)	(0.041)	(0.027)	(0.033)
Cooperation with universities	0.172***	0.137***	0.169***	0.321***	0.202**	0.009	0.129***	0.115***	0.038
	(0.042)	(0.038)	(0.043)	(0.104)	(0.091)	(0.082)	(0.047)	(0.035)	(0.038)
Cooperation with public research lab	0.146**	0.116**	0.005	0.126	-0.069	0.139	-0.063	0.012	-0.008
	(0.070)	(0.051)	(0.060)	(0.153)	(0.067)	(0.113)	(0.052)	(0.035)	(0.042)
Industry fixed effects (2-digit)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2 292	2 292	2 292	806	806	806	2 986	2 986	2 986
Log-likelihood	-1256.785	-1091.567	-1320.278	-410.832	-335.317	-418.327	-1482	-1305	-1518
R^2/ Pseudo R^2	0.2089	0.1848	0.1621	0.2457	0.2442	0.1550	0.270	0.203	0.184
Wald test (Industry fixed effects)	60.50***	35.33**	75.65***	34.89**	37.25**	31.64**	68.26***	65.36***	59.23***

Notes: Marginal effects; robust standard errors; CIS 2006-2008.

Table 9. Determinants of process, organisational and marketing innovations in manufacturing enterprises, 2006-2008

Country	**Germany**			**Ireland**			**UK**		
	Innovation Output Equations – Process, Organisational and Marketing Innovations								
Dependent variable	Process innovation	Organisational innovation	Marketing innovation	Process innovation	Organisational innovation	Marketing innovation	Process innovation	Organisational innovation	Marketing innovation
Estimator	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Predicted innovation expenditure	0.064***	0.069***	0.081***	-0.006	0.010	0.002	-0.021	-0.000	-0.009
	(0.022)	(0.023)	(0.022)	(0.029)	(0.029)	(0.026)	(0.021)	(0.027)	(0.021)
Size (log # emp.)	0.070***	0.053***	0.013	0.082***	0.071***	0.005	0.023***	0.056***	0.003
	(0.009)	(0.010)	(0.009)	(0.020)	(0.020)	(0.018)	(0.007)	(0.009)	(0.006)
Foreign-owned	0.091**	0.065	0.110***	0.124*	0.150**	0.066	-0.001	0.081**	0.006
	(0.045)	(0.044)	(0.043)	(0.071)	(0.075)	(0.069)	(0.029)	(0.038)	(0.029)
Domestic exporter	0.099***	0.074**	0.148***	0.200***	0.190***	0.184***	0.045**	0.103***	0.040*
	(0.029)	(0.029)	(0.028)	(0.052)	(0.055)	(0.049)	(0.022)	(0.027)	(0.021)
Cooperation with other enterprises	0.093*	-0.010	0.036	-0.029	0.042	0.148	0.074***	0.176***	0.063**
	(0.053)	(0.050)	(0.049)	(0.118)	(0.119)	(0.090)	(0.027)	(0.032)	(0.025)
Cooperation with suppliers	0.134***	0.042	0.012	0.373***	0.350***	-0.015	0.244***	0.151***	0.083***
	(0.046)	(0.045)	(0.044)	(0.074)	(0.093)	(0.077)	(0.026)	(0.029)	(0.023)
Cooperation with customers	0.088*	0.195***	0.144***	0.091	0.070	0.127	0.148***	0.222***	0.131***
	(0.049)	(0.046)	(0.046)	(0.110)	(0.103)	(0.082)	(0.024)	(0.027)	(0.023)
Cooperation with competitors	0.083	-0.011	-0.069	0.024	-0.297***	-0.139	-0.058**	-0.060	0.007
	(0.061)	(0.058)	(0.055)	(0.201)	(0.084)	(0.091)	(0.026)	(0.039)	(0.028)
Cooperation with consultants	0.014	0.119**	0.046	0.257**	0.187	0.209**	0.022	0.084**	0.048*
	(0.059)	(0.057)	(0.054)	(0.111)	(0.117)	(0.093)	(0.028)	(0.039)	(0.028)
Cooperation with universities	0.042	0.107***	0.033	0.138	0.281***	0.073	0.038	0.054	0.057*
	(0.041)	(0.041)	(0.041)	(0.114)	(0.099)	(0.086)	(0.033)	(0.043)	(0.032)
Cooperation with public research lab	0.092	-0.062	0.023	-0.117	0.272**	-0.130*	-0.016	-0.007	-0.009
	(0.056)	(0.053)	(0.052)	(0.154)	(0.121)	(0.075)	(0.034)	(0.050)	(0.032)
Industry fixed effects (2-digit)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2 292	2 292	2292	806	802	808	2 986	2 990	2 990
Log-likelihood	-1406.668	-1472.351	-1497.262	-468.841	-426.135	-457.045	-1354	-1606	-1359
R^2/ Pseudo R^2	0.1027	0.0716	0.0573	0.1608	0.2082	0.0914	0.185	0.196	0.118
Wald test (Industry fixed effects)	27.97*	22.44	81.62***	18.76	31.79**	31.37**	24.88	18.32	33.84**

Notes: Marginal effects; robust standard errors; CIS 2006-2008.

Table 10. Innovation and productivity in manufacturing enterprises, 2006-2008

Country	**Germany**			**Ireland**			**UK**		
	Productivity Equation (Dependent variable = Turnover/Employees)								
Dependent variable	Product innovation	Market novelties	Enterprise novelties	Product innovation	Market novelties	Enterprise novelties	Product innovation	Market novelties	Enterprise novelties
Estimator	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Predicted innovation outputs	0.041*	0.090***	0.065*	0.184	0.175	0.172	0.046***	0.064***	0.057***
	(0.021)	(0.032)	(0.034)	(0.220)	(0.207)	(0.290)	(0.016)	(0.023)	(0.021)
Size (log # emp.)	0.099***	0.091***	0.096***	0.117***	0.121***	0.123***	0.087***	0.087***	0.087***
	(0.013)	(0.013)	(0.014)	(0.039)	(0.037)	(0.038)	(0.011)	(0.011)	(0.011)
Foreign-owned	0.656***	0.636***	0.649***	0.508***	0.521***	0.520***	0.484***	0.477***	0.486***
	(0.058)	(0.059)	(0.058)	(0.132)	(0.133)	(0.131)	(0.043)	(0.044)	(0.043)
Domestic exporter	0.290***	0.260***	0.281***	0.102	0.126	0.111	0.175***	0.167***	0.177***
	(0.041)	(0.044)	(0.043)	(0.090)	(0.087)	(0.095)	(0.029)	(0.030)	(0.029)
East Germany	-0.207***	-0.211***	-0.207***						
	(0.029)	(0.029)	(0.029)						
Industry fixed effects (3-digit)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2 292	2 292	2 292	806	806	806	2 986	2 986	2 986
Log-likelihood	-2 079.239	-2 077.195	-2 079.287	-940.611	-940.639	-940.854	-2 739	-2 739	-2 740
R^2	0.364	0.365	0.364	0.3234	0.3233	0.3230	0.266	0.266	0.266
Wald test (Industry fixed effects)	5.94***	5.98***	5.99***	27.88***	40.16***	43.72***	377.05***	403.74***	244.05***

Notes: Marginal effects; robust standard errors; CIS 2006-2008.

Table 10 cont. Innovation and productivity in manufacturing enterprises, 2006-2008

Country	**Germany**			**Ireland**			**UK**		
	Productivity Equation (Dependent variable = Turnover/Employees)								
Dependent variable	Process innovation	Organisational innovation	Marketing innovation	Process innovation	Organisational innovation	Marketing innovation	Process innovation	Organisational innovation	Marketing innovation
Estimator	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Predicted innovation outputs	0.093**	0.116**	0.316***	0.242	0.161	0.210	0.070***	0.068***	0.075***
	(0.045)	(0.049)	(0.073)	(0.243)	(0.210)	(0.337)	(0.021)	(0.022)	(0.028)
Size (log # emp.)	0.089***	0.091***	0.091***	0.111***	0.116***	0.127***	0.080***	0.075***	0.085***
	(0.016)	(0.015)	(0.012)	(0.041)	(0.039)	(0.035)	(0.012)	(0.012)	(0.011)
Foreign-owned	0.644***	0.647***	0.567***	0.509***	0.533***	0.539***	0.494***	0.478***	0.496***
	(0.059)	(0.058)	(0.062)	(0.133)	(0.132)	(0.132)	(0.043)	(0.044)	(0.043)
Domestic exporter	0.286***	0.286***	0.186***	0.103	0.129	0.119	0.183***	0.175***	0.185***
	(0.041)	(0.041)	(0.049)	(0.089)	(0.087)	(0.094)	(0.028)	(0.029)	(0.028)
East Germany	-0.207***	-0.208***	-0.211***						
	(0.029)	(0.029)	(0.029)						
Industry fixed effects (3-digit)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2 292	2 292	2 292	806	802	808	2 986	2 990	2 990
Log-likelihood	-2 079.081	-2 078.494	-2 072.191	-940.478	-936.450	-943.480	-2 737	-2 742	-2 744
R^2	0.364	0.364	0.368	0.3236	0.3240	0.3238	0.267	0.276	0.275
Wald test (Industry fixed effects)	5.73***	5.94***	6.35***	45.41***	46.19***	19.88***	1 683.18***	666.67***	347.8****

Notes: Marginal effects; robust standard errors; CIS 2006-2008.

European Commission

Joint Research Centre – Institute for Prospective Technological Studies

Title: **Innovation and Productivity in Services: Evidence from Germany, Ireland and the United Kingdom**

Authors: Bettina Peters, Rebecca Riley, Iulia Siedschlag, Priit Vahter and John McQuinn

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Abstract

This paper examines the links between innovation and productivity in service enterprises. For this purpose, we use micro data from the Community Innovation Survey 2008 in Germany, Ireland and the United Kingdom, and estimate an augmented structural model. Our results indicate that innovation in service enterprises is linked to higher productivity. In all three countries analysed, among the innovation types that we consider, the strongest link between innovation and productivity was found for marketing innovations. Our empirical evidence highlights the importance of internationalisation in the context of innovation outputs in all three countries. The determinants of innovation in service enterprises appear remarkably similar to the determinants of innovation in manufacturing enterprises.

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