Service gap

The Impact of Service Sector Innovation and Internationalisation on Growth and Productivity

SEVENTH FRAMEWORK PROGRAMME

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

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

SEEK Conference 2015

Mannheim 9 October 2015

This project was funded by the European Commission, Research Directorate General as part of the 7th Framework Programme, Theme 8: Socio-Economic Sciences and Humanities, Grant Agreement no. 244 552

Motivation

- **Innovation is of crucial importance** for economic growth and competitiveness in the context of intensified international competition

- **Relevant for effective innovation policy design**

  - Enterprise characteristics and performance vary within and between industries

  - Understanding the links between innovation investment, innovation output and productivity at enterprise level

- **Focus on services**

  - Services account for a growing share of economic activity

  - Innovation in services is seen as a new source of economic growth

  - Growing tradability of services, increasing exposure to competition – more pressure to innovate

  - *Evidence on innovation and productivity in services is still limited*

Key Questions

Innovation Investment

- *Which types of enterprises are more likely to invest in innovation?*
- *Which enterprises have higher innovation investment per employee?*

Innovation Output

- *Which types of enterprises are more likely to translate innovation investment into innovation outputs?*

Productivity

- *Does innovation in services contribute to higher productivity?*

Novelties

- Analyse both technological and non-technological innovations in services
- Consider a broader definition of innovation expenditure in services, beyond R&D expenditure
- Account for the role of internationalisation of services on the links between innovation inputs, innovation outputs and productivity
- Comparative analysis of innovation and productivity in three countries: Germany, Ireland, the United Kingdom

Summary of Key Findings

- The predominant innovation types in service enterprises are non-technological innovations
- International activities are important for innovation outputs
- Enterprises more likely to invest in innovation were large enterprises and domestic enterprises with export markets
- Enterprises more likely to innovate successfully were enterprises with higher innovation expenditure per employee, large enterprises, domestic enterprises with export markets and enterprises with co-operation in innovation activities
- Innovation is positively linked to labour productivity – the strongest link found in the case of marketing innovation

Theoretical and Empirical Foundations

- **Industrial organisation**: Schumpeter (1942); Sutton (1998)
  - *Firm size, market structure and R&D; R&D and firm growth*
- **Endogenous growth**: Griliches (1984); Romer (1990); Aghion and Howitt (1998)
  - *Productivity growth is endogenous; private R&D investment and knowledge spillovers affect productivity growth*
- **Innovation systems**: Freeman (1987); Lundvall (1992); Nelson (1993)
  - *R&D and non-R&D influences on innovation*
  - *Role of institutions and organisations*
  - *Role of interactive learning*
  - *Role of interactions between agents*
- **Firms and global trade**: Bernard and Jensen (1995); Melitz (2003); Helpman et al. (2004)
  - *Low productivity firms serve only domestic markets; most productive firms export and invest abroad*

Econometric Model

Innovation decision	Innovation input	Innovation output	Productivity
Propensity to invest in innovation	Innovation expenditure intensity	Product innovation Process innovation Org. innovation Marketing innov.	Sales/employee

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

$$w_i = \begin{cases} w_i^* = z_i\beta + \omega_i, \; if \; y_i = 1 \\ 0 \; if \; y_i = 0 \end{cases}$$

1st stage: Innovation investment Selection equation and innovation investment function

$$g_i = \overline{w_i}\alpha + h_i\delta + e_i$$

2nd stage: Innovation production function

$$p_i = k_i\lambda + \overline{g_i}\mu + \nu_i$$

3rd stage: Augmented production function

Based on the Crépon-Duguet-Mairesse (CDM) model

Data

- **CIS 2008**
  - Service enterprises with 10+ employees
    - Germany: 1333; Ireland: 1286; United Kingdom: 4344
- **Innovation expenditure**
  - R&D expenditure; acquisition of machinery, equipment and software; acquisition of patents, licences, product design
- **Innovation output**
  - Product, process, organisational innovation, marketing innovation
- **Sources of external knowledge - cooperation in innovation**
  - Other enterprises within the same group; suppliers; clients or customers; competitors or other enterprises in the same sector; consultants, commercial labs or private R&D institutes; universities or other higher education institutions; government or public research institutions
- **Other data**
  - Employment, ownership, exporting, industry affiliation

Enterprise Innovation Rates in Services (%)
All Enterprises (weighted sample)

Innovation Outcome	Germany	Ireland	United Kingdom
Product Innovation	28.6	24.4	30.3
Process Innovation	27.5	29.9	18.8
Organisational Innovation	**39.1**	**32.2**	**32.9**
Marketing Innovation	**39.3**	26.5	24.4
Innovative Turnover Share	6.2	6.9	11.6

Innovation Input

Country	**Germany**		**Ireland**		**UK**	
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	1333		1286		4346	
Lambda	0.936***		1.568***		1.828***	
	(0.179)		(0.605)		(0.139)	
rho	0.627***		0.742***		0.822***	
	(0.091)		(0.170)		(0.033)	
Wald test for H0: rho=0	24.31***		6.37**		130.2***	
Log-likelihood	-1787.94		-1374.86		-7246.00	

Notes: Marginal effects; robust standard errors

Innovation Output - Product Innovation

Country	Germany			Ireland			UK		
Dependent variable	Product innovation	Market novelties	Firm Novelties	Product innovation	Market novelties	Firm Novelties	Product innovation	Market novelties	Firm 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)
Co-operation 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)
Co-operation 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)
Co-operation 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)
Co-operation 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)
Co-operation 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)
Co-operation 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)
Co-operation with public research lab	-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)	(0.028)	(0.028)
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	1333	1327	1333	1256	1247	1256	4346	4333	4346
Log-likelihood	-666	-386	-660	-584	-451	-530	-1956	-1360	-1851

Notes: Marginal effects; robust standard errors

Innovation Output - Process, Organisational and Marketing Innovation

Country	Germany			Ireland			UK		
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)	(0.013)	(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)
Co-operation 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)
Co-operation 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)
Co-operation 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)
Co-operation 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)
Co-operation 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)
Co-operation 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)	(0.023)	(0.043)	(0.028)
Co-operation with public research	-0.093	-0.269**	-0.129	-0.209**	-0.094	-0.008	-0.022	0.018	0.031
	(0.113)	(0.111)	(0.112)	(0.093)	(0.109)	(0.111)	(0.025)	(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	1333	1333	1333	1256	1247	1256	4546	4346	4346
Log-likelihood	-738	-844	-856	-699	-730	-689	-1686	-2333	-2016

Notes: Marginal effects; robust standard errors

Product Innovation and Productivity

Country	**Germany**			**Ireland**			**UK**		
	Productivity Equation (Dependent variable = Turnover/Employees)								
Dependent variable	Product innovation	Market novelties	Firm Novelties	Product innovation	Market novelties	Firm Novelties	Product innovation	Market novelties	Firm Novelties
Estimator	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Predicted innovation output	**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***	-0.22***						
	(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	1333	1327	1333	1256	1247	1256	4346	4333	4346
Log-likelihood	-1545	-1531	-1545	-2151	-2136	-2150	-6090	-6070	-6090

Notes: Marginal effects; robust standard errors

Process, Organisational, Marketing Innovation and Productivity

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 output	**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	1333	1333	1333	1256	1247	1256	4346	4346	4346
Log-likelihood	-1543	-1544	-1545	-2149	-2137	-2149	-6089	-6090	-6090

Notes: Marginal effects; robust standard errors

Summary of Key Findings

- The predominant innovation types in service enterprises were non-technological innovations
- International activities are important for innovation outputs
- Enterprises more likely to invest in innovation were large enterprises and domestic exporters
- Enterprises more likely to innovate successfully were enterprises with higher innovation expenditure per employee, large enterprises, domestic exporters and enterprises engaged in co-operation for innovation activities
- Innovation is positively linked to productivity - the strongest link found in the case of marketing innovation

Policy Implications

- Innovation in service enterprises could benefit from policies which
  - enable enterprise growth
  - enhance innovation capability
  - enhance co-operation in innovation activities with other enterprises and knowledge providers
- Non-technological innovation as a source of productivity growth

Innovation Measures

The Oslo Manual (OECD/EUROSTAT, 2005):

- **Product innovation**: “the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses: significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics”.

- **Process innovation**: “the implementation of a new or a significantly improved production or delivery method: significant changes in techniques, equipment and/or software”.

- **Organisational innovation**: “the implementation of a new organisational method in the firm’s business practices, workplace organisation or external relations”.

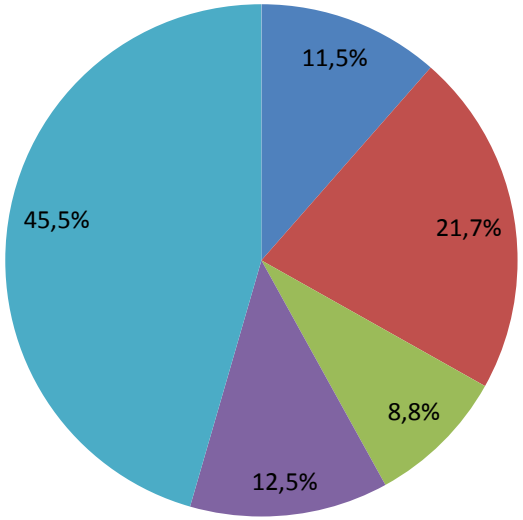
- **Marketing innovation: “**the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing”.

Enterprise Innovation Rates in Services by Enterprise Type (%, weighted sample)

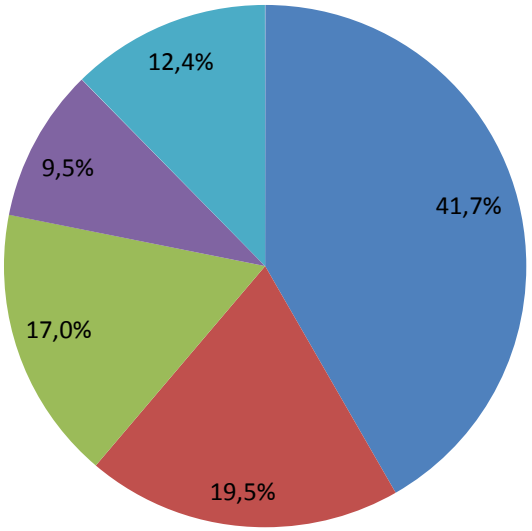
	Product	Process	Organisational	Marketing
Germany				
Foreign owned	63.9	54.2	57.3	54.6
Domestic exp	56.8	47.6	47.9	57.0
Dom. non-exp	28.6	32.0	32.8	34.9
Ireland				
Foreign owned	49.6	55.0	48.7	31.9
Domestic exp	46.5	55.1	40.5	37.5
Dom. non-exp	12.7	27.4	17.7	17.6
UK				
Foreign owned	48.7	24.1	45.1	24.7
Domestic exp	46.5	23.9	38.4	21.1
Dom. non-exp	24.7	16.5	23.1	16.4

Sectoral Composition

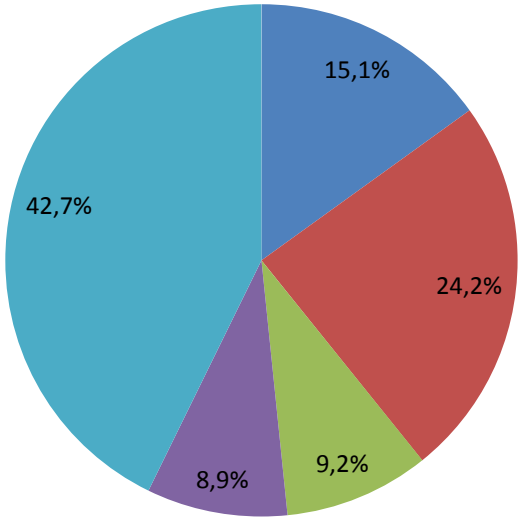
German sample, CIS 2006-2008



Irish sample, CIS 2006-2008



UK sample, CIS 2006-2008



- Wholesale trade
- Transport, storage and communications
- Financial services
- Computer and related activities
- Other business activities