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Ratio Working Paper No. 293

Employment Impacts of Market Novelty Sales: Evidence for Nine European Countries

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Accepted for publication in*: Eurasian Business Review*

Abstract:

This study investigates the impact of new market product (market novelty) sales on labour demand (employment). Based on a two-output cost function (market novelties and existing products) a relative employment equation is derived with the ratio of labour to material inputs as dependent variables. The relative labour demand model is estimated using biennial data for 25 industries, nine European countries and five time periods (2002-2010) or by use of a size-class dataset with broad industry groups. System GMM estimations accounting for endogeneity show that the turnover (sales) of market novelties (in relation to existing products) has a significant impact on relative employment in manufacturing industries. On average, an increase in the relative turnover of new market products by one percentage point is associated with a 1.6 per cent increase in the employment ratio. In contrast, employment in service industries does not benefit from new market products but instead from the intensity with which information and communication technology innovations are used, approximated by the proportion of broadband internet connected employees. When instead the size-class dataset is employed, it becomes clear that market novelties primarily drive employment in small firms.

Keywords: Cross-country panel data, labour demand, product innovations, new market products, broadband internet.

JEL Codes: J23, O33, O57.

Acknowledgments: We would like to thank Eric Bartelsman, Randolph Bruno, Bertrand Koebel, Anna Sabadash, Willi Semmler and the participants of the IPTS-ESSLait workshop (March 2014) in Seville, the Conference of European Statistics Stakeholders (November 2014) in Rome, the Austrian Economic Association (NOEG) (June 2015), the WCCE in Rome (June 2015) and the Schumpeter conference in Montreal (July 2016) for helpful comments on earlier versions of the paper. This work was initiated within the collaboration between WIFO and the ESSLait project (Eurostat Grant Agreement number 50721.2013.001-2013.082). The authors would also like to thank the Austrian National Bank for financial support (Grant number 16524).

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1. Introduction

Numerous firm-level studies, mainly based on data for the manufacturing sector, conclude that product innovations have a positive impact on employment, while the effects of process innovations are more ambiguous (Van Reenen, 1997; Harrison, Jaumandreu, Mairesse and Peters, 2008, 2014; Vivarelli, 2013, 2014 and Calvino and Virgillito, 2017 for summaries of recent research). Despite the well-known advantages of longitudinal data, these studies seldom use dynamic panel data methods (for recent exceptions see Lachenmaier and Rottmann, 2011; Bogliacino, Piva and Vivarelli, 2012). Panel data models make it possible to take into account time-invariant fixed effects, persistence of employment and lagged effects of technological innovations. In addition, these models make it feasible to treat innovations as predetermined. The lack of dynamic approaches often has its origin in data deficits.

The aim of this study is to provide further empirical evidence on the employment effects of innovations at the industry and size-class level for nine European countries (Austria, Denmark, Finland, France, Italy, the Netherlands, Norway, Sweden and the United Kingdom). By use of a cost function with two types of output (market novelties and existing products), a relative labour demand equation is derived. The demand function is estimated by System GMM, which allows endogeneity to be taken into account. In addition, the effects of the intensity with which the employees use information and communication technology (ICT) innovations, in this case broadband internet, will be investigated. The data used originate from the Micro Moments Database (MMD) and consist of industry-level and size-class information on production as well as innovation activities and ICT usage in firms for the years 2002 to 2010.

The study builds on work by Mastrostefano and Pianta (2009), Bogliacino and Pianta (2010), Lucchese and Pianta (2012) and Bogliacino and Vivarelli (2012), all of whom investigate the link between employment and product innovations. Each of the three first studies uses industry-level data originating from the EU-harmonised Community Innovation Survey (CIS) and the fourth study employs OECD industry-level R&D data for 15 European countries. Based on information for ten manufacturing industries and an equal number of European countries, Mastrostefano and Pianta (2009) find a significant and positive relationship between the turnover of new products and employment growth during the period 1994-2001, although process innovations are less job-friendly. Analogous results are shown by

Bogliacino and Pianta (2010). Lucchese and Pianta (2012) demonstrate that the positive relationship between product innovations and employment in six European countries can only be observed during upswing phases. Overall, there is no consensus regarding the magnitude of the link between employment and product innovations, measured as market novelties.

Besides the presumptive employment effects of technological innovations, there is also an ongoing discussion about R&D activities or other innovation inputs and job destruction. Bogliacino and Vivarelli (2012) discover that R&D expenditures (also considered as good predictors of product innovations) are job-friendly in 25 industries across 15 European countries during the years 1996-2005. Of late, the presumptive employment effects of ICT activities have spurred the debate among both academics and policy makers (Brynjolfsson and McAfee, 2011; Frey and Osborne, 2017). A recent industry-level study of nine European countries shows that the increase in ICT or e-commerce activities over time has not led to a decline in jobs (Biagi and Falk, 2017), independent of industry and size-class. Other studies report that broadband internet supply is significantly related to the employment rate at the county level (Atasoy, 2013).

This study makes five contributions to the literature of the relationship between market novelties and employment. Such contributions are achieved in the following ways: i) by using a novel dataset with internationally comparable industry and firm size data for nine European countries, including the often neglected service industries, ii) by employing a more narrow measure of product innovations than in most other studies, iii) by using panel data estimators that take possible endogeneity of innovations into account, iv) by theoretically deriving the employment equation from a CES multi-output cost function and v) by providing separate estimates for manufacturing and service industries as well as for different size-classes of firms.

The structure of this article is as follows: Section 2 presents the theoretical background and Section 3 the empirical model. In section 4, various summary statistics and the description of the data are reported. The empirical results are provided in section 5 and Section 6 concludes.

2. Theoretical background

The theoretical literature offers limited guidance on the expected sign and magnitude of the relationship between product innovations and employment. Introducing a new (single)

product may stimulate demand and thereby also firms' output and the need for labour. However, with multiple products the links of this chain become less distinct. New goods and services might replace old ones, while the overall output expansion effect is still unclear (Stoneman, 1983; Katsoulacos, 1986; Van Reenen, 1997; Edquist, Hommen and McKelvey, 2001). Product innovations can create jobs (compensation effects) or destroy them (displacement effect). Firm-level analysis shows a positive link between product innovations and employment growth (Vivarelli, 2014). In addition, the use of innovations, such as, information and communication technologies (ICT), may affect employment. ICT can have direct negative effects on employment due to its labour-saving features, or create jobs (Evangelista, Guerrieri and Meliciani, 2014). The effects are likely to be larger in services than in manufacturing given that the former use ICT more intensively. ICT also has the potential to enable completely new services and business models (Evangelista and Savona, 2003). Pantea, Sabadash and Biagi (2017) investigate manufacturing and services firms in seven European countries and conclude that an increased use of ICT does not reduce employment. Similar results are reported by Biagi and Falk (2017) for the industry level.

Microdata studies demonstrate that firms introducing new products (market novelties) tend to create more jobs than non-innovative ones (Van Reenen, 1997; Greenan and Guellec, 2000; Harrison, Jaumandreu, Mairesse and Peters, 2008, 2014; Evangelista and Vezzani, 2010, 2012; Lachenmaier and Rottmann, 2011; Dachs and Peters, 2014; Dachs et al., 2016, 2017). Jobs created by innovative firms may also be more persistent over time (Ciriaci, Moncada-Paternò-Castello and Voigt, 2016). Based on the EU-harmonised Community Innovation survey (CIS), Dachs et al. (2016) investigate the contribution of new products, process innovations and organisational changes to employment in 20 European countries for the period 1998-2010. Their results show that the contribution of new products to employment growth is large and can be observed in all phases of the business cycle.

Firm-level analyses have the advantage of making it possible to investigate the direct effects of product innovations on employment. However, the introduction of new products often occurs at the expense of the existing supply from competitors (Pianta and Vaona, 2007). This means that the innovative firms can take business from non-innovative ones. Chen et al. (2005) find that a large portion of gains in the market share of innovating firms is due to this "business stealing" effect from industry rivals. Industry-level data allow for this broader approach where also indirect effects are accounted for (Sabadash, 2013).

Studies at the industry level, show a positive impact of product innovations or market novelties (Mastrostefano and Pianta, 2009; Bogliacino and Pianta, 2010; Bogliacino and Vivarelli, 2012; Lucchese and Pianta, 2012). The first two of these four studies focus on product innovations whereas the third employs R&D expenditures and the fourth turnover due to market novelties. Lucchese and Pianta (2012) discover that the positive relationship between turnover of market novelties and employment can only be observed during economic upswing phases in six European countries (France, Germany, Italy, the Netherlands, Spain and the United Kingdom). Based on industry data for France, Greenan and Guellec (2000) report a positive relationship between product innovations and employment. In contrast, Antonucci and Pianta (2002) obtain an insignificant or even a negative impact of new product sales on employment.

Thus, given the unanimous results from earlier industry-level research, a significant and positive link is expected to be found between market novelties and employment, although there might be variations across industries and size-classes. The intensity with which employees use broadband internet is also assumed to affects employment.

3. Empirical approach

Inspired by the concepts of Jaumandreu (2003), Harrison et al. (2008, 2014) as well as Dachs and Peters (2014), output is assumed to be heterogeneous and consist of new and old products. Following Antonucci and Pianta (2002) and Mastrostefani and Pianta (2009), labour demand is expected to depend on output, labour costs and innovation activities (new products, for instance). This leads to an employment equation with two types of output (turnover of market novelties and existing products) and two variable production factors (labour and material inputs) that can be derived from the non-homothetic CES cost function. With subscripts *i* for industry and *t* for time suppressed, the cost function is specified as follows (see Chambers, 1988):

$$C(W, P_M, Y_1, Y_2) = \left(A_1 W^{\rho} Y_1^{\alpha_1} Y_2^{\beta_1} + A_2 P_M{}^{\rho} Y_1^{\alpha_2} Y_2^{\beta_2}\right)^{\frac{1}{\rho}}.$$

W is the average labour cost per worker, P_M reflects the price index of materials, Y_1 stands for turnover of new market products and Y_2 for turnover of existing products. The technology level is illustrated by *A*, the substitution parameter is denoted by ρ and σ is the elasticity of

substitution between the two types of inputs $\sigma = (1-\rho)$. Absolute values of σ close to zero indicate limited substitution while values approaching infinity imply a high degree of substitutability. Since the production technology is non-homothetic, total costs are a function of output. The factor demand equations for labour L^* and material M^* inputs in constant prices can be obtained by applying Shephard's lemma:

$$L^* = \frac{\partial C}{\partial W} = \frac{1}{\rho}\left(A_1 W^{\rho} Y_1^{\alpha_1} Y_2^{\beta_1} + A_2 P_M{}^{\rho} Y_1^{\alpha_2} Y_2^{\beta_2}\right)^{\frac{1}{\rho}-1} \rho A_1 W^{\rho-1} Y_1^{\alpha_1} Y_2^{\beta_1}$$
$$= C^{1-\rho} A_1 W^{\rho-1} Y_1^{\alpha_1} Y_2^{\beta_1}$$

and

$$M^* = \frac{\partial C}{\partial P_M} = \frac{1}{\rho}\left(A_1 W^{\rho} Y_1^{\alpha_1} Y_2^{\beta_1} + A_2 P_M{}^{\rho} Y_1^{\alpha_2} Y_2^{\beta_2}\right)^{\frac{1}{\rho}-1} \rho A_2 P_M{}^{\rho-1} Y_1^{\alpha_2} Y_2^{\beta_2}$$
$$= C^{1-\rho} A_2 M_2^{\rho-1} Y_1^{\alpha_2} Y_2^{\beta_2}$$

.

The relative labour demand function is then achieved by dividing the labour demand equation by the material inputs equation:

$$\frac{L^*}{M^*} = \frac{A_1}{A_2}\left(\frac{W}{P_M}\right)^{\rho-1} Y_1^{\alpha_1-\alpha_2} Y_2^{\beta_1-\beta_2}$$

.

Taking the natural logarithm on both sides, substituting $(\rho-1)$ by $-\sigma$ and adding an error term ε leads to the final relative labour demand equation:

$$\ln\frac{L}{M} = \ln\frac{A_1}{A_2} - \sigma \ln\left(\frac{W}{P_M}\right) + (\alpha_1-\alpha_2)\ln Y_1 + (\beta_1-\beta_2)\ln Y_2 + \varepsilon$$

.

Additional parameter restrictions can be imposed on the relative labour demand (employment) equation relating to the underlying production technology. In order to increase the efficiency of the estimates, it is assumed that the relative labour demand depends on the ratio of the output of new products to that of existing products, $\eta = (\alpha_1-\alpha_2) = (\beta_1-\beta_2)$. This leads to the following specification (subscript *i* for industry and *t* for time added for a given country):

$$\ln\frac{L_{it}}{M_{it}} = \ln\frac{A_1}{A_2} - \sigma \ln\left(\frac{W_{it}}{P_{M,it}}\right) + \eta \ln\left(\frac{Y_{1,it}}{Y_{2,it}}\right) + \varepsilon_{it}$$

.

The production technology is homothetic when η =0.

Given that different types of innovations do not necessarily occur independently of each other or with similar effects, the specification is augmented by a set of variables representing process innovations, organisational change and a measure of the intensity with which the employees use ICT innovations (Antonucci and Pianta, 2002; Mastrostefani and Pianta, 2009; Biagi and Falk, 2017). The ICT variable reflects how an innovation may indirectly affect employment through advanced usage. Added is also a capital variable, which enables an investigation of substitutability between employment and investments (Hamermesh, 1993; Van Reenen, 1997; Borjas, 2010).

Since the first-differencing of the variables can exacerbate potential problems of measurement errors in the data (Griliches and Hausman, 1986), panel data models are used to estimate the relative labour demand, including size-class as an additional data layer. Following Lachenmaier and Rottmann (2011), a partial adjustment mechanism is assumed to capture dynamic effects in the employment adjustment process. Neglecting the influence of past employment may otherwise result in an omitted variable bias or impact the other explanatory variables. Assuming a partial adjustment mechanism and by substituting the technology level *A* for the set of innovation parameters, the dynamic relative labour demand equation in levels can be specified as follows:

$$\ln\frac{L_{ijst}}{M_{ijst}} = \alpha_{ijs} + \alpha_1 \ln\frac{L_{ijst-2}}{M_{ijst-2}} - \sigma \ln\left(\frac{W_{ijst}}{P_{M,ijst}}\right) + \eta_1 \ln\left(\frac{Y_{1,ijst}}{Y_{2,ijst}}\right) + \theta_1 K_{ijs} + \theta_2 INPS_{ijs}$$
$$+ \theta_3 ORGIN_{ijs} + \theta_4 BROADPCT_{ijs} + \lambda_t + \varepsilon_{ijst} \quad ,$$

where α_{ijs} denotes the country-industry-size-class fixed effects and λ_t the time effects. *K* is the capital stock in constant prices, *INPS* reflects the percentage of firms with process innovations, *ORGIN* the percentage of firms with organisational changes and *BROADPCT* the share of broadband internet connected employees. The two-year lagged employment ratio is included to allow for persistence.

The relative labour demand equation is estimated by the System GMM panel data estimator developed by Blundell and Bond (1998). This estimator is particularly useful for panel data with a relatively large number of cross section units and a narrow time dimension, as is the case here with a pooled, unbalanced multi-country, industry and size-class dataset with five

time periods. The labour demand equation is estimated with the finite sample correction developed by Windmeijer (2005). To account for endogeneity, the market novelty ratio as well as wages, capital, organisational change and process innovations and the ICT intensity in firms are treated as predetermined.

The system GMM estimator builds on two equations: one in first differences and the other in levels. In the difference equation, lagged levels of the variables are used as instruments while the equation in levels is instrumented by lags of the first differences. Depending on the dataset, the first to the fourth lag are used. As a rule-of-thumb the number of instruments should not exceed the number of groups in the regression (Roodman, 2009). There are fewer observations in the service industries and size-class datasets than for the manufacturing industry, implying that only the first lag of each explanatory variable is used as an instrument.

The dynamic relative labour demand equation is estimated separately for manufacturing and service industries, size-classes as well as for the economic boom phase ending in 2008. Lucchese and Pianta (2012) show that employment effects of new products are only significant during economic upswings, while Dachs et al. (2016) find that the contribution of new products to employment in firms is larger in economic upswing or boom phases than in recession periods.

4. Data sources and descriptive statistics

The main data source for this analysis is the Micro Moments Database (MMD)[1]. This database was created by an EU-funded collaboration (ESSLait) among national statistical offices in 14 European countries (Austria, Germany, Denmark, Finland, France, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Sweden, Slovenia and the United Kingdom) and encompasses micro-aggregated information derived from the Structural Business Statistics, the EU-harmonised Community Innovation (CIS) and ICT usage in enterprise surveys (Bartelsman, Hagsten and Polder, 2017). Data are available at the NACE 1.1 two-digit industry-level as well as for broad industry groups (EUKLEMS alternative hierarchy) and in several other dimensions such as size- and age-class, international experience as well

[1] See http://ec.europa.eu/eurostat/web/microdata/micro-moments-dataset).

as ICT intensity for the years 2001-2010 (Appendix B). All underlying sources except the CIS are updated annually.

This study specifically makes use of data split by two-digit industry-level or broad industry group and size-class. Five of the 14 countries in the MMD (Germany, Ireland, Luxembourg, Poland and Slovenia) are excluded from the analysis because of data limitations relating to information on capital or innovations or due to disclosure issues. In practise, this leaves an unbalanced panel dataset with nine countries, 24 industries (Table I. in Appendix B) and five time periods (2002, 2004, 2006, 2008 and 2010) for the analysis. The design of the CIS is the reason behind why annual data are not used. In the size-class dataset, there are nine countries, four size-classes, five broad industry groups (Table II. in Appendix B) and five time periods. Data from 2008 onwards are converted from NACE rev 2 to NACE rev 1.1.

Following the specification outlined in the empirical approach, the relative labour demand variable (L/M) is based on employment (L) measured as full-time equivalents or headcounts and materials (M) represented by gross output minus value added. The turnover of market novelties (Y_1/Y_2) is the proportion of new product sales. Since the underlying firm-level innovation data available for this study are linked over time, there is no need to make assumptions about when in time the market novelties are introduced, an otherwise common approach in innovation research (Harrison et al., 2008, 2014). The micro-aggregated data also circumvent general problems of high attrition in linked firm-level datasets, caused by rotating design of sample surveys such as the CIS (see Raymond et al., 2010; Mairesse and Mohnen, 2010).

Wages (W) are calculated as the total wage bill per employee, Capital (K) is either the capital stock or book value and the proportion of employees with broadband internet connections of a certain minimum speed (*BROADPCT*) reflects the intensity with which firms use ICT innovations (see also Hagsten, 2016). Information on innovative activities beyond products, is illustrated by the proportion of firms with process (*INPS*) or organisational innovations (*ORGIN*). All monetary values are expressed in Euro and constant prices have been calculated by use of deflators from the EUKLEMS and WIOD databases.[2]

[2] www.euklems.net and www.wiod.org.

Descriptive statistics reveal that the main variables (employment per materials, wages, capital, turnover of new products, process innovations, organisational change and broadband connected employees), vary somewhat across countries, industries, size-classes and over time (Tables 1 and 2). The ratio of employees to materials is higher in the service than in the manufacturing industries, while the ratio of market novelties is almost the same across industries and size-classes, approximately seven per cent on average over the period of time studied. Somewhat more than a third of the manufacturing firms engage in process innovations, whereas services firms do this to a lesser extent. Changing the organisation is equally common across industries and occurs in slightly more than one out of three firms.

Table 1: Descriptive statistics main variables (unweighted values across industries and countries)

	L/M, Euro 1000*	W, Euro 1000*	K, Euro 1000*	Y_1/Y_2, %	INPS, % firms	ORGIN, % firms	BROADPCT, % employees
				Manufacturing			
Mean	7.1	43.9	4800212	6.7	35.9	37.2	38.1
Median	6.8	42.3	1573340	5.2	35.3	36.0	35.1
Std. dev.	3.2	9.6	8268427	5.1	11.1	11.5	18.2
				Market services			
Mean	12.2	45.2	17538968	7.1	28.2	36.8	61.3
Median	10.6	44.1	3925030	4.4	28.4	36.4	63.5
Std. dev.	8.3	13.4	32100000	7.0	11.9	13.3	23.1
				Small firms (10-19, 20-49 employees)			
Mean	9.9	40.8	1782916	7.2	25.9	29.0	43.0
Median	9.5	37.7	491392	5.1	26.0	28.9	38.9
Std. dev.	3.6	49.5	2839764	5.9	7.3	9.8	22.2
				Medium-sized and large firms (50-249, 250+ employees)			
Mean	8.5	44.4	11056629	7.6	48.4	53.7	47.5
Median	6.8	43.8	2762362	6.5	45.7	52.3	47.1
Std. dev.	6.0	7.6	18900000	4.7	16.0	15.3	18.2

*Calculated in constant prices.
Source: ESSLait Micro Moments Database.

The broadband connected employees is the variable that deviates the most across industries, with the services employees being far more digitalised in this respect than their manufacturing counterparts (61 and 38 per cent, respectively). In comparison, this variable does not vary markedly across size-classes. The size-class dataset also reveals that the relative employment is slightly higher in the smaller firms, while market novelties are somewhat more common in medium-sized and large firm. However, most apparent in this dataset is how innovation activities are spread over size. Almost every second medium-sized or large firm engages in process innovations or changes of their organisations, activities which are twice as common as in the small firms.

By studying the employment, market novelty and broadband variables across countries and over time, additional insights can be reached. Broadband connected employees is the only variable with a steady growth trend. There are also signs of a geographic dimension where countries to the north (and west) generally use this innovation more frequently. There are no clear patterns over time for either the employment or the market novelty variables, although they both vary across countries. The former is highest in Danish manufacturing as well as in Norwegian and Finish services firms. The turnover of market novelties is clearly higher than average in Sweden and France and lower in Norway (Table 2).

Table 2. Descriptive statistics by country and over time

	Manufacturing					**Market services**				
	Broadband internet connected employees (BROADPCT), %									
Country	2002	2004	2006	2008	2010	2002	2004	2006	2008	2010
AT	19.2	25.0	30.4	35.1	n.a.	32.8	37.3	44.9	43.6	n.a.
DK	21.7	28.9	33.0	33.6	23.1	33.9	42.2	46.8	45.4	35.3
FI	35.4	43.0	46.2	50.9	52.4	55.3	59.4	69.2	73.3	76.4
FR	n.a.	n.a.	28.2	36.2	40.9	n.a.	n.a.	38.6	43.8	48.1
IT	11.1	20.4	20.6	25.6	n.a.	22.9	36.8	37.0	41.2	n.a.
NL	12.4	27.5	37.3	38.9	44.7	32.2	46.6	62.0	60.6	65.3
NO	32.6	41.8	46.3	50.1	53.7	48.3	59.8	62.3	66.3	71.5
SE	36.2	45.4	44.9	47.4	66.4	56.3	63.0	61.8	63.7	65.3
UK	17.9	31.3	37.3	42.0	47.4	24.9	42.9	47.9	53.9	62.2
	Turnover new products/old products (Y_1/Y_2), %									
Country	2002	2004	2006	2008	2010	2002	2004	2006	2008	2010
AT	5.7	4.7	4.8	5.7	6.0	3.7	3.8	3.4	3.2	3.5
DK	n.a.	n.a.	7.2	6.3	5.5	n.a.	n.a.	4.8	4.3	2.8
FI	3.9	3.9	4.0	3.4	3.5	3.4	3.5	2.9	3.1	3.4
FR	n.a.	n.a.	15.7	14.9	13.6	n.a.	n.a.	15.1	14.5	17.1
IT	3.7	3.8	4.3	5.6	n.a.	2.2	1.9	2.3	3.4	0.0
NL	3.8	3.6	4.9	6.5	5.2	1.9	2.0	2.9	5.4	3.5
NO*	3.0	2.9	3.0	3.6	1.8	3.8	4.1	3.7	5.0	2.4
SE	13.0	13.0	11.7	10.9	9.9	15.8	15.9	14.5	13.8	13.7
UK	3.4	4.0	8.6	7.2	3.7	2.8	3.4	8.3	5.5	2.7
	Employment/ materials (L/M), Euro 1000**									
Country	2002	2004	2006	2008	2010	2002	2004	2006	2008	2010
AT	7.5	6.5	5.9	5.8	6.1	6.8	6.9	6.1	5.8	5.8
DK	9.4	8.8	7.8	7.6	6.3	5.5	5.3	4.5	4.8	5.0
FI	6.0	5.9	4.9	4.3	4.4	13.9	14.6	14.6	15.0	15.7
FR	5.5	5.1	4.7	4.0	4.9	6.1	6.4	6.0	5.4	35.7
IT	5.0	5.0	4.8	4.9	n.a.	5.1	5.0	4.9	4.7	n.a.
NL	3.7	3.4	2.8	3.3	3.7	4.4	4.2	3.8	3.6	5.0
NO	7.8	7.3	5.4	6.2	6.0	17.1	16.4	15.6	15.1	15.5
SE	7.0	6.4	5.9	5.8	6.1	13.8	13.5	12.5	12.2	11.7
UK	6.8	5.9	5.9	4.6	4.7	9.0	8.6	8.3	7.5	7.8

*A unit error in the Norwegian data series for the turnover of new market products for 2010 has been identified and corrected specifically for this analysis.

**Calculated in constant prices.

Source: ESSLait Micro Moments Database.

5. Empirical results

The main result of the system GMM estimations show that turnover of market novelties (relative to existing ones) has a significant impact on relative employment for the period 2002-2010 in manufacturing industries, although no equivalent effect can be found for service industries (Tables 3 and 4).[3] These results are robust over the three specifications employed: i) including process innovations and organisational change, ii) excluding process innovations and organisational change (since they are not significant) and iii) with all explanatory variables instrumented. For a better model fit, the market novelty ratio is not estimated in its logarithm, as described in the empirical approach section.

Table 3: Impact of market novelties on relative labour demand, manufacturing industries (System GMM estimations)

		(i)			(ii)		X's predetermined (iii)		
	Coeff.		z-stat	Coeff.		z-stat	Coeff.		z-stat
ln ratio of employment to materials (t-2)	0.704	***	11.59	0.700	***	11.21	0.699	***	10.70
ln relative wages (t)	-0.752	***	-5.69	-0.723	***	-5.67	-0.527	***	-5.78
Ratio of turnover new market products to old products (t)	1.406	***	3.50	1.534	***	3.23	1.625	***	3.08
ln capital stock (t)	-0.021	**	-2.08	-0.018		-1.47	-0.020	*	-1.76
Broadband internet-connected employees (t)	0.214	*	1.94	0.183	*	1.75	0.158		1.50
% process innovations (t)	-0.286		-1.48						
% organisational change (t)	0.248		1.29						
Year dummy variables	Yes			Yes			Yes		
Constant	1.482	***	3.38	1.302	***	2.92	0.599		1.36
Number of observations	608			625			625		
Number of country/industry pairs	152			152			152		
Number of instruments	132			154			136		
AR (1) test (p-value)	0.024			0.023			0.016		
AR (2) test (p-value)	0.267			0.316			0.317		
Hansen test (p-value)	0.117			0.799			0.655		
Diff-in-Hansen test (p-value)	0.018			0.655			0.808		

Notes: Asterisks *, ** and *** mean statistically significant at the 10, 5 and 1 per cent levels, respectively. Z-values are based on the small sample correction of the variance estimates proposed by Windmeijer (2005), and are robust to heteroscedasticity. The Hansen J test checks for the validity of instrumental variables. Diff-in-Hansen test reports difference-in-Hansen tests of exogeneity of GMM instruments for levels.

The results imply that a change in the turnover ratio by one percentage point is associated with an increase in the employment ratio by 1.6 per cent in manufacturing industries (Specification iii). The lack of significant results for the service industries needs to be interpreted with care, since the smaller number of observations might have an effect. In general, the Hansen J-test supports the validity of the instruments in all cases. Serial

[3] The GMM estimations are carried out using the XTABOND2 command in STATA 14.

correlation tests reject the null hypothesis of second order correlation for the sample of manufacturing and service industries.

Table 4: Impact of market novelties on relative labour demand, service industries (System GMM estimations)

		(i)			(ii)		X's predetermined	(iii)	
	Coeff.		z-stat	Coeff.		z-stat	Coeff.		z-stat
ln ratio of employment to materials (t-2)	0.657	***	6.25	0.636	***	4.94	0.715	***	5.06
ln relative wage (t)	-0.799	***	-3.14	-0.574	***	-3.50	-0.325	*	-1.77
Ratio of turnover new market products to old products (t)	1.464		1.01	1.046		1.42	2.317		1.46
ln capital stock (t)	0.000		0.00	-0.032		-1.27	-0.005		-0.17
Broadband internet connected employees (t)	0.599	***	2.80	0.575	*	1.87	0.859	*	1.84
% process innovations (t)	0.759		1.18						
% organisational change (t)	-0.573		-1.19						
Year dummy variables	Yes			Yes			Yes		
Constant	1.118		1.15	0.632		0.68	-0.572		-0.42
Number of observations	248			255			255		
Number of country/industry pairs	64			64			64		
Number of instruments	68			70			48		
AR (1) test (p-value)	0.133			0.131			0.125		
AR (2) test (p-value)	0.720			0.618			0.772		
Hansen test (p-value)	0.779			0.582			0.256		
Diff-in-Hansen test (p-value)	0.414			0.09			0.271		

Notes: Asterisks *, ** and *** mean statistically significant at the 10, 5and 1 per cent levels, respectively. Z-values are based on the small sample correction of the variance estimates proposed by Windmeijer (2005), and are robust to heteroscedasticity.

The significant employment effect of market novelties is consistent with earlier industry-level studies using new to firm products (Mastrostefano and Pianta, 2009; Bogliacino and Pianta, 2010; Bogliacini and Vivarelli, 2012; Lucchese and Pianta, 2012). However, the findings are not directly comparable because these studies employ broader measures of product innovations. Thus, the new findings imply that the overall significant and positive employment effects of product innovations also hold true when a more radical or narrow measure is considered.

In contrast, process innovations and organisational changes are not significantly related to relative employment, coinciding with results by Mastrostefano and Pianta (2009). The capital stock renders negative estimates for the manufacturing industry, implying that there is substitutability and that additional investments will not generate new jobs. Another new finding is the significant and positive effect of broadband internet connected employees. This variable shows that the ongoing digitalisation of firms, or use of new technology, does not lead to a decline in jobs relative to material inputs. Interestingly, the magnitude of the employment effect of the share of broadband connected employees is much more pronounced in services than in manufacturing (with short run coefficients ranging from 0.60 to 0.86) and

where the latter is only significant when it is not treated as predetermined. Variable real wages has the expected negative sign and is highly significant. The two-year lagged employment ratio is positive and significant in both manufacturing and services industries, with a magnitude of approximately 0.70 in both cases, indicating a high degree of persistence.

When instead the size-class dataset is used for the estimations, the significant and positive results are narrowed down to small firms (Table 5). The coefficient of 1.13 indicates that an increase in the ratio of new market products by one percentage point leads to a surge in the relative employment by 1.1 per cent in the short-run. Broadband internet connected employees are also relevant, but only for large and medium-sized firms, with significance at the five per cent level.

Table 5: Impact of market novelties on relative labour demand, by size-class (system GMM estimations)

	Small firms		Medium-sized and large firms	
	Coeff.	z-stat	Coeff.	z-stat
ln ratio of employment to materials (t-2)	0.486 ***	5.07	0.840 ***	14.10
ln relative wage (t)	-0.570 **	-2.10	-0.120	-0.81
Ratio of turnover new market products to old products (t)	1.130 **	2.07	0.045	0.07
ln capital stock (t)	-0.037	-1.30	0.009	0.90
Broadband internet connected employees (t)	0.332	1.39	0.357 **	2.00
Year dummy variables	Yes		Yes	
Constant	-0.061	-0.05	-0.581	-0.93
Number of observations	346		370	
Number of country/industry pairs	86		90	
Number of instruments	66		66	
AR (1) test (p-value)	0.031		0.005	
AR (2) test (p-value)	0.176		0.235	
Hansen test (p-value)	0.335		0.235	
Diff-in-Hansen test (p-value)	0.834		0.314	

Notes: Small firms include size classes 10-19 and 20-49 employees while medium-sized and large firms encompass 50-249 and 250+ employees. Asterisks *,** and *** mean statistically significant at the 10, 5 and 1 per cent levels, respectively. Z-values are based on the small sample correction of the variance estimates proposed by Windmeijer (2005), and are robust to heteroscedasticity. All explanatory variables are treated as predetermined.

Several robustness checks are conducted. Since new market products may need time to render significant employment effects (Lachenmaier and Rottmann, 2011), the estimations are also carried out with lagged values of the market novelty indicator (t-2, equivalent to two years). However, this variable is not significant at conventional levels. Second, the relative labour demand equation is re-estimated with a reduced panel ending in 2008. This is a measure to avoid the possible effects of the economic and financial crisis during the years 2008-2010, which was characterised by a strong fall in international demand. These results show that the pre-crisis coefficient of the market novelty ratio is smaller than that for the whole time period (1.30, Table 6 in Appendix A), implying that there is no clear evidence of a cyclical pattern,

as opposed to what is suggested in previous studies (Lucchese and Pianta, 2012) and despite the fact that partly the same countries are analysed. Third, the relative labour demand equation is estimated separately for small and large European countries. Unreported results show no marked effect of this. Fourth, the market novelty variable is estimated in its logarithm, as specified in the empirical approach. However, this leads to a less good fit of the model, where the significant estimates shift from one to five per cent. Finally, a separate estimation with eleven countries is performed, including Slovenia and Ireland, who lacks information on capital. These results follow the same pattern as for the nine countries, although with a smaller magnitude in the effect of market novelties.

6. Concluding remarks

In this study, the impact of market novelties on employment is investigated for groups of firms (industries and size-classes) across countries by use of dynamic panel data methods. The empirical relative employment equation is derived from a cost function with two types of output: market novelties and existing products. This approach has not been previously used. The analysis is based on novel datasets containing internationally comparable micro-aggregated information on production, innovation activities and ICT usage in nine European countries by industry or size-class over five time periods. System GMM estimations (where the explanatory variables are treated as predetermined) show that the turnover of new market products (relative to existing products) has a significant impact on relative employment in manufacturing industries. The direction of the results coincides with the literature, although the magnitudes cannot be compared due to different ways of measuring innovations. On average, an increase in the ratio of new market products by one percentage point leads to a surge in the relative employment by 1.6 per cent. The magnitude and sign of the significant impact of market novelties could be interpreted as the effect on employment is larger than a mere business stealing effect. In contrast, other types of innovation activities such as process innovations and organisational changes are not at all significantly related to relative employment, while capital appears partly significant and negative, indicating substitutability.

For service industries, there is no evidence of a significant relationship between market novelties and employment, although the intensity with which ICT is used (broadband internet connected employees) is significant and positive of a non-negligible magnitude. Possibly, this could indicate that in services firms, the ability to use new technology is a stronger driver of

employment than inventing new products. There is no clear indication of a more marked effect in upswing phases of the economy, as suggested in earlier research. However, it is important to keep in mind that the results to some extent could be data driven due to a smaller number of observations in the service dataset. The estimations by size-class, narrow down the positive employment effects to smaller firms, while medium-sized and large firms, just like the services industries, benefit from use of the ICT innovation.

These results give a clear sense of the kind of innovations that creates jobs and in what type of firms this is most likely to happen: New products in manufacturing and small firms. Thus, policy efforts with the aim to promote innovations as a means to increase employment should carefully consider how possible target groups are identified.

There are several directions for future research in this field. One would be to investigate whether complementary factors such as organisational change, formal skills of the workforce or e-sales practices affect the strength of the relationship between market novelties and job generation.

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Appendix A

Table 6: Impact of market novelties on relative labour demand, manufacturing industries, pre-crisis period (system GMM estimations)

		(i)		X's predetermined (ii)	
	Coeff.		z-stat	Coeff.	z-stat
ln ratio of employment to materials (t-2)	0.671	***	7.75	0.643 ***	8.23
ln relative wage (t)	-0.518	***	-5.59	-0.624 ***	-5.65
Ratio of turnover new market to old products (t)	1.390	**	2.20	1.268 **	2.37
ln capital stock (t)	-0.019		-1.44	-0.020	-1.37
Broadband internet connected employees (t)	0.147		1.04	0.131	0.88
Year dummy variables					
Constant	0.430		0.86	0.709	1.58
Number of observations	506			506	
Number of country/industry pairs	152			152	
Number of instruments	111			97	
AR (1) test (p-value)	0.011			0.009	
AR (2) test (p-value)	0.452			0.417	
Hansen test (p-value)	0.452			0.213	
Diff-in-Hansen test (p-value)	0.388			0.315	

Notes: Asterisks *, ** and *** mean statistically significant at the 10, 5and 1 per cent levels, respectively. The table provides the results of the two-step system GMM estimator where the Z-values are based on the small sample correction of the variance estimates proposed by Windmeijer (2005) and are robust to heteroscedasticity. The subsample includes the following NACE rev 1.1 industries: 15a6, 17t9, 20, 21, 22, 23a4, 25, 26, 27, 28, 29, 30a3, 31, 32, 34, 34a5, 35 and 36a7. The model uses data for 9 European countries (AT, DK, FI, FR, IT, NL, NO, SE and UK) for the years: 2002, 2004, 2006 and 2008. All explanatory variables (relative wages, ratio of turnover of new market novelties, broadband connected employees and capital stock) are treated as predetermined. See table 3.

Appendix B

Table I. Industry definitions (NACE 1.1)

TOT	Total Economy
15t37	Manufacturing
15a6	Food, beverages and tobacco
17t9	Clothing
20	Wood and of wood and cork
21a2	Pulp, paper, publishing
21	Pulp, paper and paper
22	Publishing and printing
23t25	Refining, chemicals, and rubber
23a4	Refining and chemicals
25	Rubber and plastics
26	Other non-metallic mineral
27a8	Metals and machinery
27	Basic metals
28	Fabricated metal
29t33	Machinery and equipment
29	Machinery, nec
30t3	Equipment
30a3	Office, accounting and computing machinery; sc. eqpt.
31	Electrical equipment
32	Electronic equipment
34a5	Motor vehicles and transport equipment (in case of Austria)
34	Motor vehicles, trailers and semi-trailers
35	Transport equipment
36a7	Misc manufacturing
40a1	Electricity, gas and water supply
45	Construction
50t74	Market services
50t5	Trade, hotels, restaurants
50t2	Trade, hotels, restaurants
50	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel
51	Wholesale trade and commission trade, except of motor vehicles and motorcycles
52	Retail trade, except of motor vehicles and motorcycles; repair of household goods
55	Hotels and restaurants
60t4	Transport and communications
60t3	Transport
64	Post and telecommunications
65t7	Banking
70t4	Real estate and bus services
70	Real estate activities
71t4	Business services
71a4	Renting of machinery and equipment; oth. bus. svc.
72	Computer and related activities
73	Research and development
75t99	Social services
75	Public admin and defence; compulsory social security
80	Education
85	Health and social work
90t3	Personal services
90t3x	Personal services excl. media
921t2	Media activities

Note: Shaded fields represent industry groups included in the analysis.
Source: Bartelsman, Hagsten and Polder (2013).

Table II. EUKLEMS alternative industry definitions

ALT	Description
Elecom	ELECTRICAL MACHINERY, POST AND COMMUNICATION SERVICES
MexElec	TOTAL MANUFACTURING, EXCLUDING ELECTRICAL
ConsG	Consumer manufacturing
IntmdG	Intermediate manufacturing
InvesG	Investment goods, excluding hightech
OtherG	OTHER PRODUCTION
MServ	MARKET SERVICES, EXCLUDING POST AND TELECOMMUNICATIONS
Distr	DISTRIBUTION
FinBu	FINANCE AND BUSINESS, EXCEPT REAL ESTATE
Pers	PERSONAL SERVICES
NonMar	NON-MARKET SERVICES

Note: Shaded fields represent industry groups included in the analysis.
Source: Bartelsman, Hagsten and Polder (2013).