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The impact of new goods and service products on firm growth: evidence from Austrian-linked firm-level data

Martin Falk*

Austrian Institute of Economic Research, WIFO, Vienna, Austria

Using a matched innovation survey and structural business statistics, we investigate the impact of the introduction of new service products and other types of technological innovations on firm growth measured as subsequent two-year employment growth. Results, based on median and robust regression methods for manufacturing firms, show that, on average, both the introduction of new goods and process innovations have a significant and positive impact on subsequent firm growth. In contrast, the introduction of new services does not, on average, have a significant impact on firm growth for both manufacturing and service firms. However, quantile regressions show that the introduction of new service products has a significant and positive impact on firm growth for high-growth service firms. Finally, in manufacturing, the introduction of product innovations has a positive impact on firm growth at both the lower and higher ends of distribution (i.e. for both high-growth and shrinking firms).

Keywords: new service products; technological innovations; firm growth; employment growth; quantile regressions

JEL Classification: O31; O32; O33; C31

1. Introduction

According to the Community Innovation Survey (CIS), 12.5% of European firms in the manufacturing and service sector introduced new or significantly improved service products between 2006 and 2008.[1] New service products are not the exclusive domain of service firms; they are also highly relevant to manufacturing firms (Vandermerwe and Rada 1988; Bryson and Monnoyer 2004; Dachs et al. 2013). In manufacturing, service offerings are often used to encapsulate goods (Howells 2004). Based on CIS 2008, about 10.5% of manufacturing firms in EU countries have introduced new service products. Despite the importance of new service goods, previous research on the relationship between different types of innovations and performance and/or firm growth has traditionally focused on the impact of product and process innovations (as well as that of non-technological innovations) without distinguishing between the introduction of new goods and of new services (see Coad 2009 for a survey of the literature).

The aim of this study is to analyse the impact of the introduction of new service products and other technological innovations on firm growth measured as subsequent employment growth for both manufacturing and service firms. Its main contribution lies in our use of a new and unique Austrian firm-level data set that links the CIS 2006 to the structural business

*Email: martin.falk@wifo.ac.at

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statistics (SBS) for the period 2004–2008. Unlike most previous studies based on the CIS – where employment growth and technological innovations refer to the same time period – this data set makes it possible to investigate the impact of past innovations on employment growth in the future.

Service innovations can be broadly or narrowly defined. While it is difficult to define service innovations in general, there seems to be a consensus in the literature that the introduction of new or improved service products can be regarded as a narrow definition of service innovations. In this paper, we focus on the narrow definition of service innovations in investigating effects on firm growth. Few studies explicitly focus on the impact of new service product innovations on firm growth (for exceptions, see Evangelista and Savona 2003; Aas and Pederson 2011). For manufacturing firms, there seems to be a consensus in the literature that those firms that engage in servitization outperform those that do not (Fang, Palmatier, and Steenkamp 2008; Neely 2008; Eggert et al. 2011). Although there is an increasing number of studies that investigate the impact of service innovations based on a broad definition of the term, relatively little is known about the impact of the introduction of new service products on firm growth for manufacturing and service firms. Knowledge of the performance impact of new service offerings is important for managers and scholars alike. The business and management literature suggests that manufacturing firms should increasingly include service offerings to increase performance and firm growth (Cohen, Agrawal, and Agrawal 2006). Therefore, we investigate the impact of new service products on firm growth separately for manufacturing and services firms.

Another contribution of the current paper is to investigate to what extent the impact of technological innovations and new service products varies between shrinking and fast growing firms. This is investigated using quantile regression techniques. Previous studies find a large degree of parameter heterogeneity in the impact of technological innovations on productivity and employment growth at the firm level, with larger effects of innovation witnessed for fast-growing firms than for shrinking firms (see, e.g. Coad and Rao 2006, 2008; Goedhuys and Sleuwaegen 2009; Hölzl 2009; Zimmermann 2009; Falk 2012; García-Manjón and Romero-Merino 2012; Bartelsman, Dobbelaere, and Peters 2013). These studies show that the impact of innovation activities (measured either as R&D activities or innovation output) tends to increase when moving from the bottom to the top of the conditional distribution of firm growth. In particular, the impact of innovation output and/or R&D is only significant for the higher quantiles, while the average effect is quite small and often insignificant. In contrast, Damijan, Kostevc, and Rojec (2012) find that firms with low productivity growth benefit more from product and process innovation than firms with high productivity growth based on firm-level data for Slovenia.

Finally, the study employs a unique database linking the CIS 2006 with SBS. The literature increasingly employs linked innovation survey and production survey data to study the impacts of technological innovations. Studies include Colombelli, Haned, and Le Bas (2013) for France; Bartelsman, van Leeuwen, and Nieuwenhuijsen (1998), Klomp and van Leeuwen (2001), and Raymond et al. (2010) for the Netherlands; Cainelli, Evangelista, and Savona (2004, 2006) for Italy; Aas and Pederson (2011) for Norway; Damijan, Kostevc, and Rojec (2012) for Slovenia; Lööf and Heshmati (2006) for Sweden; and Tether and Bascavusoglu-Moreau (2012) for the UK. However, to the best of our knowledge, no other empirical study at the firm level investigates the impact of new service products on subsequent employment growth using matched innovation survey and business statistics data, and the quantile regression technique.

The structure of this paper is as follows. Section 2 presents the theoretical background and Section 3 introduces the empirical model. In Section 4, we present various summary

statistics and a description of the data before providing the empirical results in Section 5. Section 6 contains concluding remarks.

2. Theoretical background and previous literature

The measurement and definition of service innovations and the distinction between process, managerial, and organizational innovations are difficult (Gallouj and Weinstein 1997; Den Hertog 2000; Drejer 2004; Pires, Sarkar, and Carvalho 2008). Service innovations can be broadly or narrowly defined and there seems to be no agreement on the preferred approach. Based on CIS 2006, Aas and Pederson (2011) introduce a broad definition, suggesting that nearly all types of innovations by service firms can be regarded as service innovation. For manufacturing firms, the introduction of new services can be regarded as service product innovation, whereas the introduction of new logistics, delivery, distribution, product placement, or sales channel methods can be regarded as service process innovation (Aas and Pederson 2011). Daniels (2010) also distinguishes between service product and service process innovation, holding that the former occurs when a new or significantly improved service is introduced and the latter when a method of supplying services is improved. Bryson, Rubalcaba, and Ström (2012) suggest that service innovations consist not only of the development and design of new service products, but support activities that also contribute to the marketing and selling of services. Finally, Hipp, Tether, and Miles (2000) distinguish between service innovations, process innovations, and organizational innovations, narrowly defining service innovations as the introduction of new service products or the improvement of existing services.

In this article, we focus on a narrow definition of service innovations, restricting it to the introduction of new or improved service products. The narrow definition is also used by Santamaría, Nieto, and Miles (2012) based on the Spanish Technological Innovation Panel drawn from the Spanish Community Survey as well as by Lin and Chen (2007). Examples of the new service products include call centre services, 24-hour service, the introduction of e-commerce services, and new training methods through e-learning (Table 1). Note that the distinction between goods innovation and service products is less clear for service firms since borders between the two types of innovations can be fuzzy.

We focus on the direct effects of new service products on firm growth measured as subsequent employment growth. It is important to note that the link between firm growth and new service products is only one aspect. There are several other possible effects of the introduction of such products, such as increases in consumer satisfaction (Aas and Pederson 2011).

Table 1. Examples of introduction of new services.

New financing, insurance, maintenance, and leasing services linked to the purchase of new equipment
Introduction of telematics in cars
Faster installation time of new equipment
R&D and testing service
Online customer support
Training through e-learning
Call centre service
24 hour service
Introduction of e-commerce services (e.g. iTunes Music Store)

Source: Own collection based on Howells (2004).

However, effects other than that on employment growth cannot be investigated due to a lack of data.

Barras' (1986, 1990) model of 'reverse product cycle' in service firms is particularly helpful in understanding the effects of service innovations on firm growth. The author argues that service innovations are often enabled by the introduction of information and communication technologies. This leads to incremental process innovations in a first stage and to radical process innovations in a second stage. In a third stage, this can eventually lead to improvements in service delivery. Thus, the first two phases involve process innovations, whereas the final phase is dominated by service product innovations. Barras (1990) characterizes new service products as the most radical type of service innovations. Hence, one might expect that the impact of new service products on firm growth is larger than those of service process innovations because they occur in the latter stage of the innovation process.

The theory of complementary assets developed by Teece (1986) is also helpful for understanding the effects of the new service products on firm growth. Complementary assets are resources or capabilities that allow firms to capture the profits associated with an introduction of new technology or innovation. Examples of complementary assets are after-sales activities and other new service offerings. However, it is an empirical question as to whether these complementary assets have an impact on firm growth.

New or improved services often consist of incremental innovations that are jointly offered with new goods (Howells 2004). Since new goods and services are often jointly introduced, it is important to control for the impact of good innovations when studying the partial effect of new service products. Hence, bivariate correlations between measures of firm growth and the introduction of new service products can lead to biased conclusions.

Previous research on the impact of different types of technological innovations on performance and/or firm growth has traditionally focused on the impact of product and process innovations (as well as that of non-technological innovations) without distinguishing between the introduction of new goods and of new services (see, amongst others, Pianta 2005; Harrison et al. 2008; Vivarelli 2012 for recent surveys of the literature and Dachs and Peters 2014 using CIS data for 16 countries). Many of these studies have been restricted to manufacturing firms (Van Reenen 1997; Smolny 1998; Calvo 2006; Lachenmaier and Rottmann 2011). In recent years, there have been an increasing number of studies investigating the effects of technological and non-technological innovations on employment growth for service firms (Djellal and Gallouj 2007; Evangelista and Savona 2011, for recent surveys of the literature). For instance, Harrison et al. (2008) use data on service firms in four EU countries to find that product innovations have a large positive impact on employment growth, whereas process innovations tend to have a small negative impact. Dachs and Peters (2014), using CIS data for 16 European countries, find that process innovations have a negative effect on employment in manufacturing and no impact on services. Based on linked CIS data on service firms in Italy, Cainelli, Evangelista, and Savona (2004) find that technological innovations (i.e. product and/or process innovations) have a positive and significant impact on the subsequent employment growth (see also Evangelista and Savona 2002). Using firm-level data for the USA, Mansury and Love (2008) find that the introduction of service innovations has a significant and positive impact on firm growth in business services. Using CIS 4 data for six EU countries, Evangelista and Vezzani (2012) find that the introduction of new or improved organizational practices has a significant and positive impact on employment growth. The same authors (2010) find similar evidence for sales growth. More recently, Frenz and Lambert (2012) find that combinations of changes in management and business strategy (including new sales and distribution methods) have

a significant and positive effect on employment growth in both manufacturing and services in 5 out of 10 EU countries based on CIS 2006 data.

Few studies explicitly focus on the impact of new service product innovations on firm growth and/or employment change. One exception is presented by Evangelista and Savona (2003), who show that service firms introducing new service products are more likely to report a positive impact of innovation on total employment. Aas and Pederson (2011), meanwhile, find that the introduction of service innovations (broadly defined) has a significant and positive impact on performance in terms of productivity growth. This holds true for both manufacturing and service firms. However, based on a narrow definition of service innovations, the authors find that the productivity advantage service innovators enjoy over non-innovators is only significant at the 10% level.

Another strand of the literature investigates the impact of service offerings on manufacturing firms' performances. These studies find that manufacturing firms that engage in servitization outperform those that do not (Fang, Palmatier, and Steenkamp 2008; Neely 2008; Eggert et al. 2011). Using the linked innovation survey and Annual Business Survey for UK manufacturing, Tether and Bascavusoglu-Moreau (2012) find that the introduction of new service products is positively related to the level of labour productivity.

In summary, the effects of the introduction of goods, new services, and process innovations on firm performance may differ. Product innovations (i.e. introduction of new goods) are usually attributed to positive effects on firm growth, while the impact of process innovations is not clear-cut. Relatively little is known about the impact on form growth when introducing new service products. Knowledge of the performance impact of new service offerings is important for managers and scholars alike. The effect of new service products is likely to be small.

3. Empirical model

We follow the recent firm growth literature in studying the impact of process and product innovation on employment growth (Coad and Rao 2008, Coad 2009, Hölzl 2009). In particular, we extend the specification of Gibrat's law by including different types of innovations. The resulting model relates three types of innovations on firm growth measured as subsequent employment growth, controlling for initial size at the beginning of the period. The firm growth equation is specified as follows:

$$\frac{(\ln L_{i,2008} - \ln L_{i,2006})}{2} = \alpha_1 \text{ GOODSINNO}_{i,2004-2006} + \alpha_2 \text{ SERINNO}_{i,2004-2006} + \alpha_3 \text{ PCINNO}_{i,2004-2006} + \beta \ln L_{i,2006} + \varepsilon_i.$$

Here, ln is the natural logarithm. The dependent variable, $(\ln L_{i,2008} - \ln L_{i,2006})/2$, represents average annual employment growth, calculated as the logarithm of employment for 2008 minus the logarithm of employment for 2006 divided by two. $\ln L_{i,2006}$ measures initial size, measured as the logarithm of employment. GOODSINNO, SERINNO, and PCINNO denote the introduction of new goods, new services, and process innovations (all measured as 0/1 variables), and ε_i is the error term with the usual assumptions. We assume that the direction of causality is going from technological innovations in the past to subsequent employment growth. The underlying assumption is that there is a time lag in the employment change response due to the successful introduction of new service products, new goods, and process innovations.

Note that firm growth can be measured in terms of sales (or revenues), value added (each in constant prices) instead of employment. The previous firm growth literature tends

to prefer real sales growth as the measure of firm growth. We use employment instead of value added or sales revenues to calculate firm growth. The reason is that information on value added is not directly available in the linked data set, but has to be constructed by subtracting materials from sales revenues. When doing so, we find very low or even negative values for value added for some firms. For these firms, value added cannot be used to construct growth rates. Nominal sales revenues are principally available, but have to be deflated by appropriate output prices. Industry-specific price indices are often used to construct real sales at the firm level. However, this may lead to a bias. This may particularly hold true for services where prices are difficult to measure. Thus, we use the average growth in employment over two years as the measure of firm growth.

Three different estimation methods are used to test the relationship between new service products and employment growth: OLS with robust standard errors, a robust regression technique, and quantile regressions, including the median regression method. In principle, the employment growth equation can be estimated by OLS. Since the results based on cross-sectional data are likely to be sensitive to influential observations, the employment growth equation is estimated by the robust regression method. This regression technique is a weighted least-squares procedure that puts less weight on outliers. This is achieved by using Cook's distance and then performing Huber iterations. Compared with the least-squares regression, the median regression estimator (also known as the least absolute deviation (LAD) estimator) is more robust to the non-normality of the error distribution. In comparing different robust estimators, Rousseeuw and Leroy (1987) state that the LAD estimator is generally preferable to least-squares methods in the case of extreme outliers of the dependent variable. In fact, the LAD model is believed to be one of the earliest robust regression techniques (Rousseeuw and Leroy 1987). However, the LAD estimator is vulnerable to outliers in the x-direction (i.e. among explanatory variables). Yaffee (2002) suggests that the robust regression method should be preferred over the LAD estimator in the case of influential observations in the X-direction. In this application, outliers among the explanatory variables are unlikely to play a significant role because they consist of a set of dummy variables and the initial level of employment, which can be measured quite easily.

Overall, both OLS and the robust regression method will provide estimates of the mean effect of innovations for the average firm. Quantile regressions are useful to get information about the impact of the independent variable on different points in the conditional distribution of the dependent variable other than the conditional mean (Koenker and Hallock 2001). Here, we use the quantile regression technique to investigate whether the effects of different types of technological innovations on firm growth differ across the specific percentiles (or quantiles) in the conditional distribution of firm growth. It might be that the impact of technological innovations and new service products differ between growing and shrinking firms. In particular, the impact of innovations may be larger in high-growth firms because the characteristics of high-growth firms are likely to be different from moderate-growth firms. For instance, high-growth firms tend to employ a higher share of highly skilled workers. Another interesting question is whether the effects of new service products are larger for high-growth than for low-growth firms.

It is obvious that the innovation outcome is not exogenous to firm growth, with a two-way relationship likely to be at hand (Cainelli, Evangelista, and Savona 2006). In particular, the positive correlation between employment growth and innovation output could also arise from the fact that growing firms are more innovative than stagnating or shrinking firms. The problem of reverse causality is partially mitigated by our study of the impact of past innovations on subsequent employment growth. In particular, the introduction of technological innovations and new service products refers to the period 2004–2006, while employment

growth refers to the period 2006–2008. Hence, the effects of successful innovations on firm performance will be examined after, rather than during, their introduction. The coefficients can be directly interpreted as percentage-point effects on the employment growth rate as compared to non-innovators. It should be noted that firm exit information is not available in the data; the results thus only hold for surviving firms, resulting in a survivor bias (Lotti, Santarelli, and Vivarelli 2009). We provide separate estimation results for service and manufacturing firms. The reason is that while in manufacturing, the distinction between the introduction of new product innovation and process innovation is generally easy to understand, this is not the case for services where the product and the process are often inextricably linked together.

4. Data and descriptive statistics

The database consists of a combination of two databases, namely that of Austria's SBS ('*Leistungs- und Strukturerhebung*') and the CIS. The CIS is a representative random sample of firms that is stratified by industry, firm size, and region. It covers the manufacturing, mining, energy, water supply, and other specific service industries (e.g. wholesale trade, transport, banking and insurance, computer and related activities, architectural and engineering activities, and technical testing and analysis). All enterprises with at least 10 employees in the target industries are included. The CIS 2006 questionnaire was sent out to 5412 firms, of which 3513 provided reliable information. This resulted in a response rate of 65.5% (Statistics Austria 2008).

From CIS (IV) 2004 onwards, product innovations can be separated into two distinct categories: (i) introduction of new goods and (ii) introduction of new service products (see Vergori 2013) for an overview of innovation measurement in the CIS). The CIS provides a wide range of information on innovation activities. CIS 2006 covers different types of technological innovations stemming from the three-year period of 2004–2006, which are defined as follows: (i) introduction of new or significantly improved goods; (ii) introduction of new or significantly improved service products; and (iii) implementation of a new or significantly improved production process, distribution method, or support activity for goods or services ('process innovations'). Process innovation, meanwhile, comprises three subgroups: (i) new or significantly improved methods of manufacturing or producing goods or services; (ii) new or significantly improved logistics, delivery, or distribution methods; and (iii) new or significantly improved supporting activities for processes, such as maintenance systems or operations in purchasing, accounting, or computing.

The second data source, SBS, contains information on turnover, gross output, value added, total materials, and materials by type for the period 2004–2008. The majority of firms included in the CIS are also covered in this database. After merging CIS and SBS data, 3152 firm observations remain; 90% of the firms included in the CIS are thus covered in the linked data set.

However, the merged CIS-SBS data set is not publicly available. SAS codes have been written for execution by Statistics Austria, at which point the regression output is sent back to the users.[2] Table 2 shows the descriptive statistics based on estimation sample. About 18.5% of the firms have introduced new or improved services, whereas 28.8% have introduced new goods and 37.5% new processes. As expected, the percentage of firms with new service products is lower in manufacturing than in services (16.4% vs. 20.7%). The average employment growth rate measured as the median is 1.9% per year with little differences between service and manufacturing firms.

Table 2. Descriptive statistics.

	Quantitative variables				
	Q1	Median	Q3	Mean	Standard deviation
	Total sample (no. of observations: 3152)				
Log employment in 2006	2.6	3.2	4.2	3.6	1.3
Average annual growth rate of employment 2006–2008	−3.2	1.8	7.2	1.0	21.1
	Manufacturing firms (no. of observations: 1644)				
Log employment in 2006	2.7	3.4	4.8	3.9	1.4
Average annual growth rate of employment 2006–2008	−2.7	1.9	7.0	1.7	18.5
	Service firms (no. of observations: 1508)				
Log employment in 2006	2.6	3.0	3.8	3.4	1.2
Average annual growth rate of employment 2006–2008	−3.9	1.7	7.7	0.3	23.6
	Qualitiative variables (percentages of firms)				
	Total	Manufacturing	Services		
Introduction of new processes	37.5	43.4	31.0		
Introduction of new goods	28.8	37.9	19.0		
Introduction of new services	18.5	16.4	20.7		

Note: Calculations are based on unweighted data.
Source: CIS 2006 Statistics Austria.

In the first step, the employment growth rate is calculated for firms with and without specific types of technological innovations in the past. Table 3 shows the average annual employment growth for the period 2006–2008 for firms that have introduced different types of technological innovations compared to those that have not introduced these specific types of innovations. In particular, Table 3 contains the average employment growth rate by different types of technological innovations (i.e. two types of product innovations and three types of process innovations, separated by the manufacturing and service sectors). In addition to the arithmetic mean, the median employment growth rate is calculated. The descriptive statistics show that, on average, firms with new or improved goods and/or services during the period 2004–2006 exhibited significantly higher employment growth in the subsequent period (2006–2008). For the total sample, the median annual employment growth rate of goods and/or service innovators is 2.7%, compared to 1.1% for firms without goods and/or service innovations.

Unreported results show that the F-test rejects the null hypothesis of there being no difference between the two groups at the 5% significance level. This holds true for the introduction of both new goods and new services. However, the difference in employment growth between innovators and non-innovators seems to depend on the type of innovation. New service products are associated with a smaller increase in employment growth than the introduction of new goods and process innovations (differences of 1.7 and 1.6 vs. 0.8 percentage points). The descriptive statistics and bivariate correlations should nevertheless be interpreted with caution, as they may represent spurious results driven by the exclusion of the remaining types of technological innovations. As mentioned above, different types of innovations are often introduced simultaneously. Therefore, a multivariate regression

Table 3. Employment growth and different types of technological innovations.

	Manufacturing		Services		Total	
	Introduction of new or improved goods and/or services					
Employment growth of	Mean	Median	Mean	Median	Mean	Median
No innovations (of each type)	1.4	0.0	−0.2	1.6	0.6	1.1
Innovations (of each type)	1.9	2.8	1.6	2.3	1.8	2.7
Difference	0.5	2.8	1.8	0.7	1.2	1.6
	Introduction of new goods					
	Mean	Median	Mean	Median	Mean	Median
No innovations (of each type)	1.3	0.0	0.4	1.6	0.8	1.1
Innovations (of each type)	2.2	2.9	0.2	2.5	1.6	2.8
Difference	0.9	2.9	−0.2	0.9	0.8	1.7
	Introduction of new or improved services					
	Mean	Median	Mean	Median	Mean	Median
No innovations (of each type)	1.9	1.6	−0.1	1.8	1.0	1.7
Innovations (of each type)	0.5	2.7	2.1	2.1	1.3	2.5
Difference	−1.4	1.1	2.2	0.3	0.3	0.8
	New or significantly improved production process, distribution method or support activity for your goods or services (all three types)					
	Mean	Median	Mean	Median	Mean	Median
No innovations (of each type)	2.1	0.0	0.0	1.6	1.0	1.1
Innovations (of each type)	1.0	2.7	1.1	2.3	1.1	2.7
Difference	−1.1	2.7	1.1	0.7	0.1	1.6
	New or significantly improved methods of manufacturing or producing goods or services					
	Mean	Median	Mean	Median	Mean	Median
No innovations (of each type)	1.7	0.8	0.0	1.8	0.8	1.4
Innovations (of each type)	1.5	2.9	2.6	2.4	1.8	2.9
Difference (of each type)	−0.2	2.1	2.6	0.6	1.0	1.5
	New or significantly improved logistics (delivery or distribution methods for your inputs, goods, or services)					
	Mean	Median	Mean	Median	Mean	Median
No innovations (of each type)	1.9	1.6	0.2	1.8	1.1	1.7
Innovations (of each type)	0.1	2.7	1.0	1.9	0.5	2.5
Difference	−1.8	1.1	0.8	0.1	−0.6	0.8
	New or significantly improved supporting activities for your processes (e.g. maintenance systems or operations for purchasing, accounting, or computing)					
	Mean	Median	Mean	Median	Mean	Median
No innovations (of each type)	1.6	1.0	0.1	1.5	0.9	1.2
Innovations	1.6	2.9	1.3	3.0	1.5	2.9
Difference	0.0	1.9	1.2	1.5	0.6	1.7

Source: Matched CIS 2006 and SBS 2006–2008. Statistics Austria, Calculations performed by STAT AT.

analysis is needed in which all three types of technological innovations are jointly included. In the next step, employment growth is studied as a function of all three types of innovations and the initial level of employment using OLS, robust regression methods, and quantile regression methods.

5. Empirical results

Table 4 shows both the robust regression and LAD estimates of the effects of the two types of technological innovations and the introduction of new service products on employment growth. We provide separate results for manufacturing and service firms. The results for the total sample show that both process innovations and the introduction of new goods in the past have a significant and positive impact on subsequent employment growth. The results obtained from the robust regression method show that firms that have introduced new goods exhibit 1.7 percentage points higher average annual employment growth as compared to non-innovators, given the impact of initial size and process innovations. The corresponding effect of process innovations on employment growth is about 1.2 percentage points per year on average. The LAD estimates of the coefficients of new goods and process innovations are slightly smaller with 0.010 for process innovations and 0.014 for new goods (Table 4 lower panel).

When distinguishing between manufacturing and services, we find that the introduction of new goods does not lead to higher employment growth for service firms (Table 4, column iii). This holds true for both the robust regression method and the LAD. For manufacturing, both process innovations and the introduction of new goods remain highly significant for both service and manufacturing firms. Using the median estimator, the coefficients for goods

Table 4. Regression estimates of the impact of different types of technological innovations and new service products on employment growth.

	Total (i)		Manufacturing (ii)		Services (iii)	
	Coef.	*t*	Coef.	*t*	Coef.	*t*
Robust regression estimates						
Constant	0.027***	6.05	0.019***	3.45	0.036***	4.88
Introduction of process innovations	0.012***	3.24	0.013***	2.70	0.012***	2.00
Introduction of new goods	0.017***	4.41	0.017***	3.44	0.007	1.02
Introduction of new service products	0.002	0.51	0.003	0.45	0.009	1.36
Log employment 2006	−0.004***	−3.67	−0.003***	−1.87	−0.007***	−3.10
Scale parameter	0.08		0.07		0.09	
No. of observations	3152		1644		1508	
R^2	0.01		0.02		0.01	
LAD estimator						
Constant	0.033***	4.01	0.013	1.17	0.045***	6.13
Introduction of process innovations	0.010**	2.26	0.015**	2.32	0.009	1.19
Introduction of new goods	0.014***	3.04	0.022***	3.63	0.003	0.44
Introduction of new service products	0.001	0.28	−0.001	−0.21	0.004	0.51
Log employment 2006	−0.006***	−3.74	−0.004*	−1.66	−0.008***	−5.12
No. of observations	3152		1644		1508	

Notes: *Significance at the 10% level.
**Significance at the 5% level.
***Significance at the 1% level.
Source: Matched CIS 2006 and SBS 2006–2008. Statistics Austria, Calculations performed by STAT AT.

Table 5. Quantile regression estimates of the impact of introduction of new goods, new services, and process innovations on employment growth (total sample).

	Coef.	*t*-Value	Coef.	*t*-Value	Coef.	*t*-Value
	$q = 0.1$		$q = 0.2$		$q = 0.3$	
Constant	−0.149***	−13.8	−0.068***	−10.07	−0.035***	−7.57
Process innovations	−0.007	−0.53	0.010**	2.06	0.010	2.35
Introduction of new goods	0.041***	3.71	0.017***	3.57	0.020***	4.75
Introduction of new service products	−0.001	−0.04	−0.003	−0.59	0.000	−0.06
Log employment 2006	0.011***	3.97	0.004***	2.82	0.001	1.22
	$q = 0.4$		$q = 0.5$		$q = 0.6$	
Constant	0.002	0.82	0.033***	4.01	0.061***	15.76
Process innovations	0.001	0.46	0.010**	2.26	0.011**	2.51
Introduction of new goods	0.013***	4.90	0.014***	3.04	0.015***	3.43
Introduction of new service products	−0.001	−0.31	0.001	0.28	0.003	0.65
Log employment 2006	−0.001	−0.88	−0.006***	−3.74	−0.009***	−7.79
	$q = 0.7$		$q = 0.8$		$q = 0.9$	
Constant	0.097***	17.81	0.146***	19.49	0.229***	21.64
Process innovations	0.016***	3.32	0.013**	2.10	0.015*	1.93
Introduction of new goods	0.012**	2.49	0.015***	2.73	0.016**	2.48
Introduction of new service products	0.009	1.42	0.020***	3.22	0.020**	2.12
Log employment 2006	−0.013***	−10.91	−0.019***	−11.69	−0.028***	−15.27

Notes: *T*-values are based on bootstrapped standard errors with 500 replications.
*Significance at the 10% level.
**Significance at the 5% level.
***Significance at the 1% level.
Source: Matched CIS 2006 and SBS 2006–2008. Statistics Austria, Calculations performed by STAT AT.

innovations and process innovations are slightly larger than those obtained through a robust regression technique (Table 5). For manufacturing firms, the positive effects of product innovations (measured as new goods) on employment growth are consistent with Harrison et al. (2008). Our findings for the effects of process innovations on employment growth are more optimistic than those of previous studies, which find that process innovations have a negative effect (or none at all) on employment growth (Harrison et al. 2008; Vivarelli 2012).

The introduction of new service products, however, does not lead to additional jobs when controlling for the two other types of technological innovations and initial firm size. This holds true for both manufacturing and service firms and is also robust with respect to the estimation method. One explanation for the absence of a positive link between the introduction of new service products and firm growth is that new service products can be easily imitated, unlike physical goods. Overall, the results stand in contrast to Evangelista and Savona (2003), who find that the introduction of new service products has a positive impact on the probability of employment growth based on Italian service firms.

Furthermore, the results show that employment growth is significantly negatively related to the level of employment at the beginning of the period, thus rejecting Gibrat's law. However, the magnitude of the effect is relatively small.

Unreported results using OLS show that the coefficient of process innovations becomes insignificant, whereas the coefficient of the introduction of new goods is smaller. This indicates the presence of influential observations. We have also included two digit industry dummies in the regression equation. For the subsample of manufacturing firms, the Wald test shows that industry dummies are not significant at the 5% level. For services, industry dummies are significant at the 10% level with higher employment growth rates for computer services, and engineering and technical services. However, the inclusion of industry dummies has little impact on the coefficients of the different dummy variables for the different types of technological innovations. Therefore, industry dummy variables are not included in the final specification.

Table 5 shows the quantile regression estimates of the employment growth equation for the total sample. It provides estimations for all deciles (10th, 20th, …, 90th percentile of the employment growth distribution). Figures A1 and A2 in the appendix contain the coefficients of the different types of technological innovations along with the 95% confidence interval, where the straight line represents the coefficient estimates based on the robust regression method. Table 6 shows the corresponding results for the subsample of manufacturing and service firms.

The results for the total sample show that the estimated coefficient for new service products increases when one moves from lower to upper deciles. The coefficients are not significantly different from zero between the 10th and 70th percentiles, but become significantly positive in the 80th and 90th percentile. This indicates that the effects of new service products on employment growth differ across the employment growth distribution: they are significant and relatively large for high-growth firms (in terms of employment growth), but insignificant for firms with shrinking employment and average employment growth.

Furthermore, we find that the introduction of new goods is significantly and positively related to subsequent employment growth at all quantiles (deciles in this case). There is also little heterogeneity in the magnitude of the coefficient of new goods across all but the lowest quantile (10th percentile), where we find much larger effects. In general, the effect of the introduction of new goods on employment growth ranges between 1.3 and 2 percentage points across the different quantiles. Overall, the results are consistent with Zimmermann (2009) based on a panel of small- and medium-sized firms in Germany. For the 10th percentile (i.e. for the 10% of firms with the lowest employment growth), however, we find that firms that have introduced new goods grow stronger in terms of employment growth with about 4.1 percentage points. F-tests reject the null hypothesis that the effects of new goods on employment growth are similar for the lowest quantile compared to the other quantiles. Overall, this means that the effects of introducing new goods are highest for the group of firms with the highest employment losses after controlling for initial size and other types of employment growth.

The finding that slowly growing firms benefit more from new goods than firms exhibiting high growth or average performance is consistent with Damijan, Kostevc, and Rojec (2012) based on firm-level data for Slovenia. However, the authors use TFP and labour productivity growth as a measure of performance. For process innovations, we do not find a clear pattern between fast growing and shrinking firms.

Distinguishing between service and manufacturing, we find striking differences in the effects of product (new goods) and process innovations on employment growth between the two industries (Table 6). In the service sector, the introduction of new goods is generally insignificant across the different quantiles. In contrast, in manufacturing the introduction of new goods remains significant for all quantiles. Furthermore, in the manufacturing sector, process innovations are only significant in the middle part of the conditional employment

Table 6. Quantile regression estimates of the impact of introduction of new goods, new services, and process innovations on employment growth in manufacturing and services.

	Manufacturing firms		Service firms	
	Coef.	*t*	Coef.	*t*
$q = 0.1$				
Constant	−0.135***	−9.56	−0.161***	−6.37
Process innovations	−0.011	−0.83	−0.002	−0.08
Introduction of new goods	0.046***	3.15	0.016	0.54
Introduction of new service products	−0.006	−0.35	0.011	0.35
Log employment 2006	0.009***	2.59	0.012	1.54
$q = 0.2$				
Constant	−0.056***	−6.26	−0.081***	−6.10
Process innovations	0.005	0.72	0.017	1.71
Introduction of new goods	0.021***	2.80	0.008	0.76
Introduction of new service products	−0.001	−0.21	0.005	0.44
Log employment 2006	0.002	0.83	0.005	1.96
$q = 0.3$				
Constant	−0.030***	−4.73	−0.046***	−6.57
Process innovations	0.006	1.21	0.007	1.00
Introduction of new goods	0.023***	4.42	0.009	1.12
Introduction of new service products	0.000	−0.03	0.003	0.38
Log employment 2006	0.000	0.20	0.004**	2.30
$q = 0.4$				
Constant	0.007*	1.75	0.015***	3.46
Process innovations	0.003	0.62	0.002	0.23
Introduction of new goods	0.022***	4.20	0.009	1.09
Introduction of new service products	−0.001	−0.14	−0.001	−0.11
Log employment 2006	−0.003*	−1.91		
$q = 0.5$				
Constant	0.013	1.17	0.045***	6.13
Process innovations	0.015**	2.32	0.009	1.19
Introduction of new goods	0.022***	3.63	0.003	0.44
Introduction of new service products	−0.001	−0.21	0.004	0.51
Log employment 2006	−0.004*	−1.66	−0.008***	−5.12
$q = 0.6$				
Constant	0.059***	9.57	0.068***	12.85
Process innovations	0.013**	2.44	0.007	0.98
Introduction of new goods	0.021***	3.65	0.005	0.62
Introduction of new service products	−0.003	−0.42	0.011	1.43
Log employment 2006	−0.009***	−5.25	−0.010***	−7.16
$q = 0.7$				
Constant	0.088***	9.72	0.108***	13.19
Process innovations	0.015**	2.06	0.013*	1.91
Introduction of new goods	0.019***	2.72	−0.001	−0.15
Introduction of new service products	0.003	0.43	0.017*	1.78
Log employment 2006	−0.011***	−5.28	−0.015***	−8.41
$q = 0.8$				
Constant	0.132***	15.05	0.159**	17.00
Process innovations	0.012	1.62	0.013	1.61
Introduction of new goods	0.029***	3.91	0.000	0.03
Introduction of new service products	0.006	0.73	0.036***	2.90
Log employment 2006	−0.016***	−8.15	−0.021***	−10.44

(*Continued*)

Table 6. Continued

	Manufacturing firms		Service firms	
	Coef.	*t*	Coef.	*t*
$q = 0.9$				
Constant	0.234***	17.66	0.227***	12.78
Process innovations	0.004	0.42	0.036**	2.13
Introduction of new goods	0.029**	2.36	0.009	0.53
Introduction of new service products	0.009	0.80	0.037*	1.84
Log employment 2006	−0.028***	−10.42	−0.030***	−9.12
No. of observations	1644		1508	

Notes: *T*-values are based on bootstrapped standard errors with 500 replications.
*Significance at the 10% level.
**Significance at the 5% level.
***Significance at the 1% level.
Source: Matched CIS 2006 and SBS 2006–2008. Statistics Austria, Calculations performed by STAT AT.

distribution, while for service firms process innovations are only significant for high-growth firms.

Separate estimation results for both manufacturing and service firms also shows that the positive effects of the introduction of new services on employment growth can be only observed for high-growth service firms rather than for high-growth manufacturing firms. For services, we find that the effects of new service products on employment growth are significant at the 0.8 quantile and 0.9 quantile. This indicates that the introduction of new services leads to new jobs for high-growth service firms, but not for service firms with average employment growth rates.

We also conduct several robustness checks in order to investigate the sensitivity of the results. In particular, we have included other factors that might have an impact on employment growth, such as outsourcing activities. Unreported results show that the results of the impact of innovations remain robust with respect to the inclusion of these variables.

6. Conclusions

This study investigates the impact of new service products and other technological innovations on subsequent employment growth based on Austrian firms in the manufacturing and service sectors. The empirical analysis is based on a new and unique data set that links the CIS 2006 with the SBS database for the period 2004–2008. This linked data set makes it possible to examine the impact of past innovations on subsequent employment growth using Gibrat's law specification. The analysis is based on 3150 firms in the manufacturing and service sectors. The results of the median regression model and the robust regression model show that the introduction of new goods and process innovations has a significant and positive impact on employment growth on average in the next two years. Specifically, firms that have introduced new goods exhibit 1.7% higher employment growth per year on average than non-innovators. The introduction of process innovations, meanwhile, increases the employment growth rate by an average of 1.2 percentage points per year. However, separate estimates for manufacturing and service firms show that the introduction of new goods is only significant for manufacturing firms, whereas the results for service firms are not clear-cut.

Furthermore, the introduction of new service products does not lead to higher employment growth on average when the other types of technological innovations and initial firm

size are taken into account. This holds true for both manufacturing and service firms. This may be because new service products are often characterized by imitation rather than radical innovation. However, quantile regression estimates show that new service products have a significant effect on employment growth for high-growth service firms only, but not for firms with shrinking employment or average employment growth rates. In particular, we find that the introduction of new service products leads to a two-percentage-point increase in annual employment growth for high-growth firms in the service sector. For the manufacturing firms, we find that the introduction of new goods leads to higher employment growth not only for high-growth firms, but also for shrinking firms. Here, the impact of new goods is highest for firms with shrinking employment.

These findings have some important implications for innovation policy. Since just one-third of firms have introduced new goods and about 40% have implemented new processes, increasing the share of innovators is a reasonable policy objective. In order to enhance firm growth, high priority should be given to the introduction of new goods. This particularly holds true for manufacturing, where new products and new services can be more easily distinguished than in services. Although new service products do automatically result in higher firm growth measured as employment change on average, this does not mean firms should not introduce new service offerings. The business literature shows that new service offerings can lead to higher customer loyalty and customer satisfaction, which in turn can increase sales revenues in the medium term future period. However, longer lags may be more appropriate if new service products take time to realize their benefits.

This study is bound by several limitations. First, it was conducted based on Austrian firm-level data and the results may be difficult to generalize to other countries. Descriptive evidence based on CIS 2008 data for the EU countries shows that there are large differences in the percentage of firms with new service product innovations: This figure ranges from less than 5% in the Central and Eastern European (CEE) countries to 15% or more in the more advanced EU countries (e.g. Finland, Germany, and Sweden). Given the cross-country differences in the percentage of firms with service product innovations, future research should apply the same methodology to other EU countries. Second, this study measures new service products as a dummy variable. It would be interesting to investigate the relationship between firm growth and the proportion of sales due to new service products as well as how this correlation changes over time. However, data on the proportion of sales due to new services are not available in the CIS. Instead, one can use the European Manufacturing Survey, which contains information on the share of sales from product-related services (Dachs et al. 2013). The third limitation of this study lies in its assumption that new service innovations are endogenous to employment growth. It is obvious that the introduction of both new services and other technological innovations are choice variables of the firm and that they might therefore depend on a number of other factors (such as human capital). Indeed, Cainelli, Evangelista, and Savona (2006) find a two-way relationship between product and process innovations and performance in service firms. Finally, this study is based on cross-sectional data, which makes it impossible to control for unobservable firm effects. In principle, one can also match different CIS waves with SBS data. However, due to the rotating nature of the CIS data, the same firms rarely overlap across different CIS waves; panel data methods would thus offer no additional insights. Future research could extend the analysis by studying the impact of organizational and marketing innovations. Damanpour, Walker, and Avellaneda (2009) suggest that combinations of different types of innovations may have a larger impact on firms' performances. This could be tested by including interaction terms between different types of innovations.

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Notes

1. Eurostat New Cronos downloaded January 2013
2. We thank Mr Bachner (Statistics Austria) for running the regressions.

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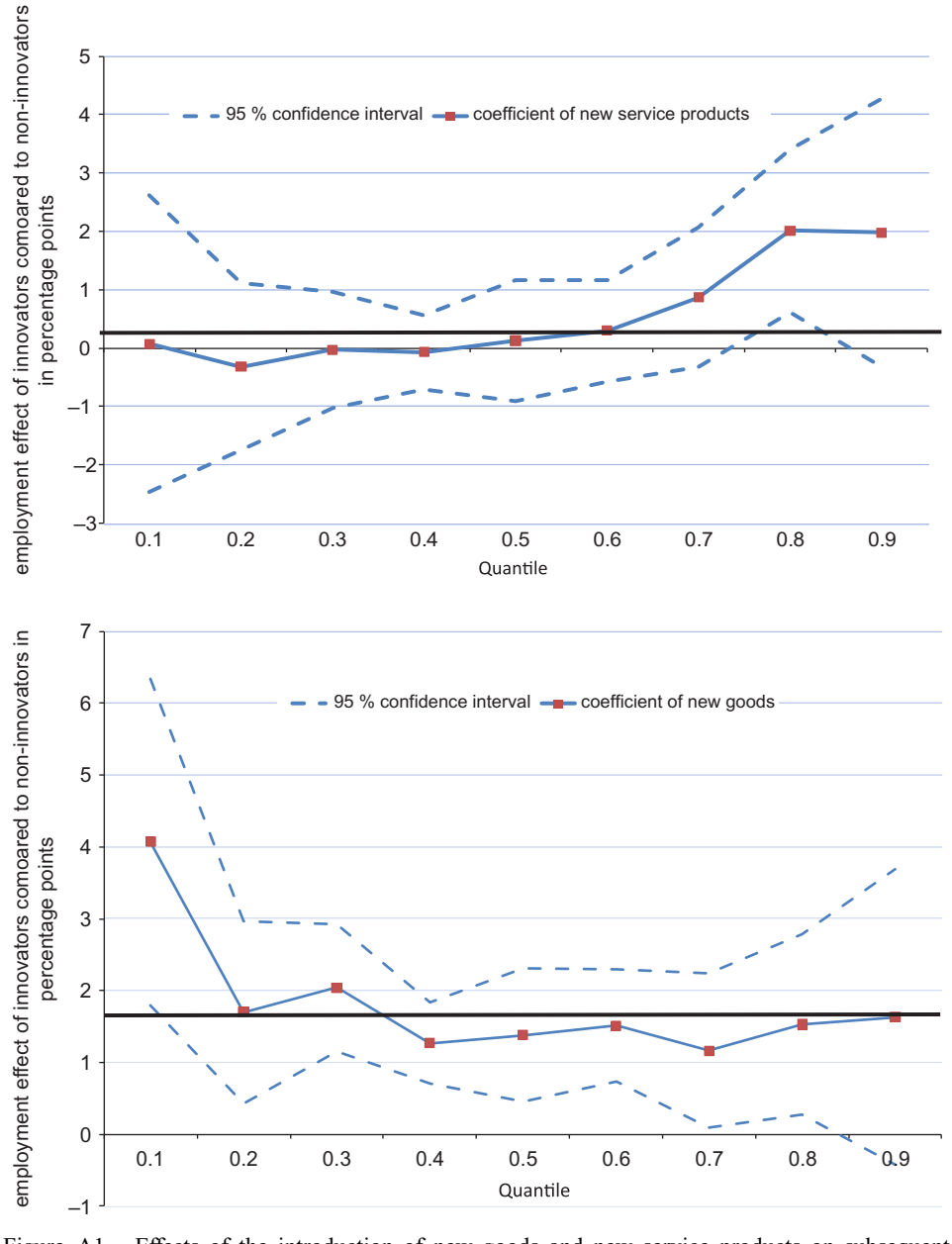
Appendix



Colour online, B/W in print

Figure A1. Effects of the introduction of new goods and new service products on subsequent employment growth.
Notes: The straight line represents robust regression estimates. The coefficient is significantly different from zero if the lower line of confidence interval (lower line) is larger than zero. *T*-values are based on bootstrapped standard errors with 500 replications.

Colour online, B/W in print

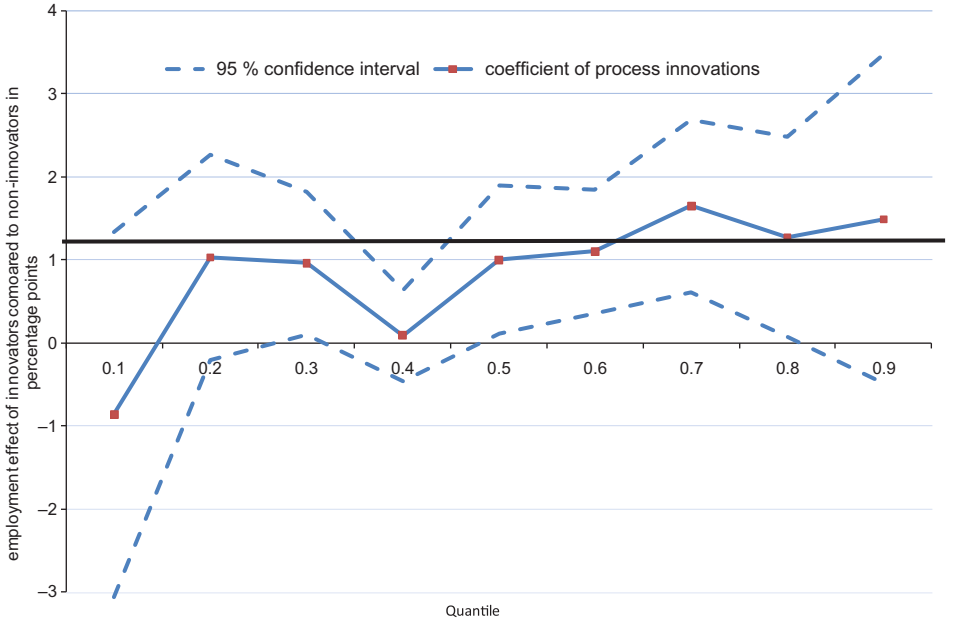


Figure A2. Effects of the introduction of process innovations on employment growth.
Notes: The straight line represents robust regression estimates. The coefficient is significantly different from zero if the lower line of confidence interval (lower line) is larger than zero. *T*-values are based on bootstrapped standard errors with 500 replications.