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Jože P. Damijan, Črt Kostevc, Matija Rojec

Katholieke Universiteit Leuven

LICOS Centre for Institutions and Economic Performance
Huis De Dorlodot
Deberiotstraat 34 – mailbox 3511
B-3000 Leuven
BELGIUM

TEL:+32-(0)16 32 65 98
FAX:+32-(0)16 32 65 99
http://www.econ.kuleuven.be/licos

Does Innovation Help the Good or the Poor Performing Firms? *

Jože P. Damijan[1], Črt Kostevc[2], Matija Rojec[3]

Abstract

Using firm-level innovation data for a large sample of Slovenian firms in the period 1996-2002, the paper finds surprising results that innovation is not benefitting all firms. We find that only manufacturing firms with below average productivity growth (the lowest four deciles) are likely to experience significant benefits from successful innovation, while faster growing firms do not extract any additional benefits from innovation. This evidence demonstrates how innovation can affect the observed convergence of firms in terms of productivity in the manufacturing sector.

Keywords: Research and development, innovation, knowledge spillovers, productivity growth

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1 University of Ljubljana; Institute for Economic Research, Ljubljana; LICOS, KU Leuven, Belgium. address: Faculty of Economics, University of Ljubljana, Kardeljeva ploscad 17, 1000 Ljubljana, Slovenia, e-mail: joze.damijan@ef.uni-lj.si

2 University of Ljubljana; Institute for Economic Research, Ljubljana, address: Faculty of Economics, University of Ljubljana, Kardeljeva ploscad 17, 1000 Ljubljana, Slovenia, e-mail: crt.kostevc@ef.uni-lj.si,

3 University of Ljubljana; Institute for Macroecopnomic Analysis and Development, Ljubljana. address: Institute for Macroecopnomic Analysis and Development, Gregorciceva 27, 1000 Ljubljana, e-mail: matija.rojec@gov.si

1 Introduction

Endogenous growth theory suggests that a firm's R&D activity and innovation are central to its technological progress and productivity growth. Firm's technological leadership is reinforced by its deliberate investments into R&D. Crepon et al. (1998) present a model, which combines a knowledge-production function, relating R&D activity to patenting or innovative activities, with economic performance as measured by labor productivity. They propose that causality runs from higher productivity to higher innovative activity (propensity to innovate) and subsequently from higher innovative activity to higher productivity growth. The first part of the causality link between higher productivity level and subsequently higher innovative activity has been supported in the data (Crepon et al., 1998; Lööf et al., 2002, Mohnen et al., 2006).

The second part of the link - from innovation activity to firm productivity growth, however, has proven more difficult to corroborate empirically. There seem to be two opposite effects at work when accounting for the impact of innovation on firm productivity growth. On one hand, there is a labor displacement effect of process innovation, while on the other there is a compensation effect caused by higher demand following product innovation (Griffith et al., 2006). Parisi et al. (2006) find that process innovations significantly impacted productivity growth of Italian firms in the late 1990s, while product innovations had a much less significant effect. Harrison et al. (2005) and Hall et al. (2007), demonstrate that due to increased demand product innovation may result in employment growth, and therefore in lower productivity, while process innovation is likely to have labor saving effects and hence improve productivity. Net effect of innovation on firm productivity growth therefore depends on the relative importance of the two types of innovation.

The aim of this paper is to study the impact of innovation on firm productivity growth. We use firm-level innovation (CIS) data combined with balance sheet data for a large sample of Slovenian firms in the period 1996-2002 and, controlling for different types of innovation, we study whether innovation effects on productivity growth change across the distribution of firms according to productivity growth.

The paper is structured as follows. Section two describes the data set and discusses the empirical approach used. Section three presents results. The last section concludes.

2 Data and empirical approach

2.1 Data

We use data from the Community Innovation Surveys (CIS) for Slovenian firms, covering the years 1996, 1998, 2000 and 2002,[4] which are combined with the firm balance sheet data. Table 1 reveals that the rate of innovation activity, which captures both product innovation and process innovation, is only about 20% among Slovenian firms.[5] Table 1

[4] The innovation surveys are carried out every second year.
[5] Firms that have claimed to innovate product or process in the respective 2-year period.

shows that innovative firms are on average larger in terms of employment, have higher R&D expenditures, are more export oriented, and are more likely to be foreign owned. At the same time, the innovation activity of firms is shown to be highly persistent over time.

[Insert Table 1]

The difference in productivity between innovating and non-innovating firms is best demonstrated in Figure 1 showing that the in the initial period (in 1996) distribution of innovating firms in terms of labor productivity[6] is slightly skewed to the right compared with the distribution of all firms. By 2002, the distribution of productivity of innovators has shifted further to the right of the distribution of all firms in the sample. This indicates that innovating firms are performing better in terms of productivity growth than non-innovating firms. It remains to be shown, however, whether superior productivity evolution is common to all innovating firms or specific to particular sub-samples.

[Insert Figure 1]

2.2 Empirical approach

To estimate the contribution of innovation to firms' TFP growth we use a variation of the standard growth accounting approach:

(1) $$y_{it} = \lambda + \alpha k_{it} + \beta l_{it} + \gamma Inov_{it} + \eta X_{it} + \kappa_1 X_{it}^{EU} + \kappa_2 X_{it}^{YU} + \eta F_{it} + \delta T + \sigma S + \varepsilon_{it}$$

where small letters indicate logarithmic rates of change. Variables y_{it}, k_{it} and l_{it}, denote value added, capital stock and employment in firm *i* at time *t*, respectively. *Inov* is a dummy variable [0, 1] indicating whether a firm is innovative in year *t* or not. Variables *EX*, X^{EU} (X^{YU}) denote exporter status dummy, share of exports to the EU (former Yugoslav) countries in firm's total exports. Share of exports to the markets of the European Union (former Yugoslavia) serves to illustrate exposure to different competitive pressures in different markets. *F* is a dummy variable indicating whether firm is foreign owned. *T* and *S* denote year and sector dummies. Note that as (1) is estimated in log first differences of the output and input variables, the firm specific effects related to these variables are wiped out. The remaining firms specific effects are captured by other right-hand-side variables and the remaining error term ε_{it}.

As a robustness check, we regress the total factor productivity growth (tfp_{it}) directly on innovation and other right-hand-side variables, whereby we also control for firm size by including the number of employees (L_{it}). tfp_{it} is estimated either by simple OLS or, alternatively, by the Levinsohn-Petrin (2003) method, which takes account of the simultaneity between input and output variables in (1).

3 Results

3.1 Basic results

[6] Measured as log value added per employee.

OLS results, presented in Table 2, however, do not seem to confirm the initial findings depicted in Figure 1. Pooled OLS regression results do not confirm faster productivity growth of innovating firms for either product or process innovations. Given the implications of Figure 1, there should be sub-groups of firms within the group of innovators that benefited from innovation substantially while the others did not.

[Insert Table 2]

Unfortunately, results of estimating (1) on sub-samples of firms according to deciles of their productivity level (Table 2) do not fully reveal the factors driving this rightward shift of the distribution of innovators. Results indicate that the only group of firms showing significant impact of innovation on productivity growth are firms in the 8th (9th) productivity decile. These results, however, do not fully explain the large right-shift in the distribution of productivity growth of innovating versus non-innovating firms.

Alternatively, (1) can be estimated by productivity-growth deciles, which can be done effectively by using quantile regressions. Compared with least squares regression, quantile regression estimates are more robust to non-normality of the error distribution. Unlike OLS, quantile regressions are based on absolute deviations, therefore placing much less weight on outliers while providing information on higher moments of the distribution.

[Insert Table 3]

Indeed, Table 3 reveals that successful innovation is found to have a significant positive impact on productivity growth for firms in the first four deciles of productivity growth. With higher quantiles, the impact of innovation first dissipates and then becomes even significantly negative. These results imply that the slow growing firms are likely to experience significant benefits from successful innovation, while faster growing firms do not extract any additional benefits from innovation. Discriminating between product and process innovation does not reveal significant differences between the two, suggesting both having similar impact on productivity growth of Slovenian firms.

3.2 Robustness check

As a robustness check to the above findings, we estimate (1) with alternative measures of productivity. Both measures of TFP, obtained either by OLS or by Levinsohn-Petrin method, corroborate the results obtained with labor productivity. Both estimatates show that innovations benefit most the slowest growing firms, up to the 3rd or 4th decile, while afterwards this positive effect of innovation on productivity growth first dissipates and become significantly negative from the 7th decile onwards. This diminishing effect of innovation on firm productivity growth is graphically presented in Figure 3, which shows quantile regression results by productivity-growth centiles. Slowest growing firms are, again, shown to benefit most from their engagement in innovation activity, while fastest growing firms are shown to be negatively affected by innovation as compared to their non-innovating counterparts.

[Insert Table 4]

[Insert Figure 2]

6. Conclusions

The paper analyses the impact of innovation on firms' productivity growth using firm-level innovation (CIS) and accounting data for a large sample of Slovenian firms from 1996-2002. Unlike some recent studies, we do not find the response of productivity growth to successful innovation to be heterogeneous with respect to the type of innovation. Instead, we find that innovation effects on productivity growth change across the distribution of firms. When taking account of the heterogeneity of firms we find that successful innovation benefits slower growing firms only (the lowest four deciles in terms of productivity growth), while fastest growing firms may not extract any additional benefits from innovation. This evidence demonstrates how innovation can shift the distributions of firms according to productivity over time. Innovation is shown to aid the slowest growing firms and thus facilitate the observed convergence of firms in terms of productivity in the manufacturing sector.

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Tables and Figures to be included into text

Table 1: Descriptive statistics of the dataset for Slovenian firms, 1996-2002

	N	INOV$_{t-2}$[1]	Employ-ment	R&D/ Sales[2]	Exports/ Sales	IFDI[3]
	Innovative firms					
1996	**316**	**-**	**346.7**	**0.016**	**0.439**	**0.388**
1998	**409**	**0.643**	**312.9**	**0.016**	**0.431**	**0.397**
2000	**533**	**0.554**	**278.5**	**0.060**	**0.381**	**0.368**
2002	**527**	**0.694**	**283.6**	**0.065**	**0.437**	**0.364**
	Non-Innovative firms					
1996	**1138**	**-**	**122.8**	**0.00026**	**0.257**	**0.254**
1998	**1368**	**0.095**	**96.5**	**0.00003**	**0.273**	**0.237**
2000	**1985**	**0.122**	**68.5**	**0.00021**	**0.216**	**0.201**
2002	**2037**	**0.113**	**67.5**	**0.00015**	**0.228**	**0.215**

Notes: **1/ Past innovation activity, lagged one period; 2/ R&D expenditures as a share of sales; 3/ Foreign ownership.**
Source: **Statistical office of Slovenia; author's calculations.**

Table 2: Impact of innovation on labor productivity growth, by deciles of VA/L and types of innovation, 1996-2002

	Pooled	1st decile	2nd decile	3rd decile	4th decile	5th decile	6th decile	7th decile	8th decile	9th decile	10th decile
Product & process innov.	0.015	0.299	0.102	-0.003	-0.041	0.014	-0.052	-0.012	0.105	0.012	-0.039
	[0.015]	[0.252]	[0.089]	[0.047]	[0.034]	[0.035]	[0.044]	[0.029]	[0.046]**	[0.039]	[0.035]
Product innov.	0.017	0.339	0.107	0.001	-0.034	0.020	-0.064	-0.005	0.089	0.002	-0.025
	[0.015]	[0.278]	[0.090]	[0.048]	[0.035]	[0.036]	[0.043]	[0.029]	[0.044]**	[0.039]	[0.038]
Process innov.	0.024	0.423	-0.001	0.010	-0.046	-0.002	-0.006	0.009	0.096	0.057	-0.016
	[0.016]	[0.420]	[0.097]	[0.041]	[0.036]	[0.037]	[0.039]	[0.028]	[0.047]**	[0.031]*	[0.030]
Observations	5889	216	394	630	679	740	729	731	652	604	514

Notes: **Results of estimating the model (1) by using three different types of innovation indicator. In order to save space, the regression results for all right-hand-side variables and regression statistics are suppressed from the table. Full results can be obtained from the authors upon request. Time and sector dummies included. Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.**

Table 3: Impact of innovation on labor productivity growth, by deciles of growth of VA/L and types of innovation, 1996-2002

	1st decile	2nd decile	3rd decile	4th decile	5th decile	6th decile	7th decile	8th decile	9th decile	No.obs.
Product & process innov.	0.068	0.046	0.030	0.020	0.006	-0.011	-0.021	-0.033	-0.061	5889
	[0.021]***	[0.014]***	[0.011]***	[0.008]**	[0.008]	[0.008]	[0.011]*	[0.014]**	[0.023]***	
Product innov.	0.070	0.049	0.034	0.021	0.005	-0.008	-0.019	-0.031	-0.058	5889
	[0.021]***	[0.014]***	[0.011]***	[0.009]**	[0.009]	[0.009]	[0.011]*	[0.014]**	[0.024]**	
Process innov.	0.103	0.042	0.031	0.019	0.008	-0.006	-0.013	-0.033	-0.068	5889
	[0.023]***	[0.015]***	[0.012]**	[0.009]**	[0.010]	[0.011]	[0.013]	[0.015]**	[0.025]***	

Notes: **Results of estimating the model (1) by using three different types of innovation indicator. Full results can be obtained from the authors upon request. Time and sector dummies included. Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.**

Table 4: Impact of innovation on TFP growth, by deciles of TFP growth, 1996-2002

	1st decile	2nd decile	3rd decile	4th decile	5th decile	6th decile	7th decile	8th decile	9th decile	No.obs.
TFP based on OLS	0.079	0.040	0.018	0.021	0.006	-0.009	-0.020	-0.032	-0.080	5430
	[0.023]***	[0.012]***	[0.011]	[0.009]**	[0.009]	[0.010]	[0.010]*	[0.014]**	[0.022]***	
TFP based on Levinsohn-Petrin	0.032	0.014	0.007	0.005	0.003	-0.003	-0.008	-0.016	-0.028	5430
	[0.008]***	[0.005]***	[0.004]*	[0.004]	[0.003]	[0.003]	[0.003]**	[0.005]***	[0.007]***	

Notes: **Results of estimating the model (2) by using the indicator of product and process innovation. Full results can be obtained from the authors upon request. Time and sector dummies included. Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%.**

Figure 1: Distribution of value added per employee of innovating firms and all firms in 1996 and 2002

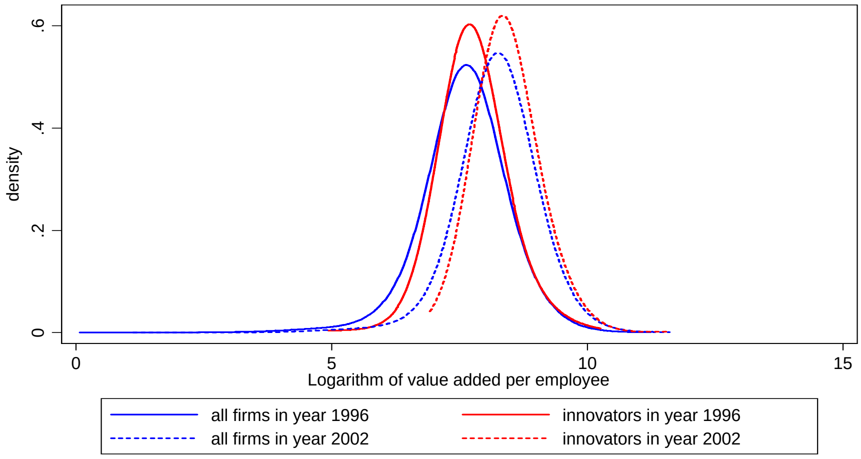
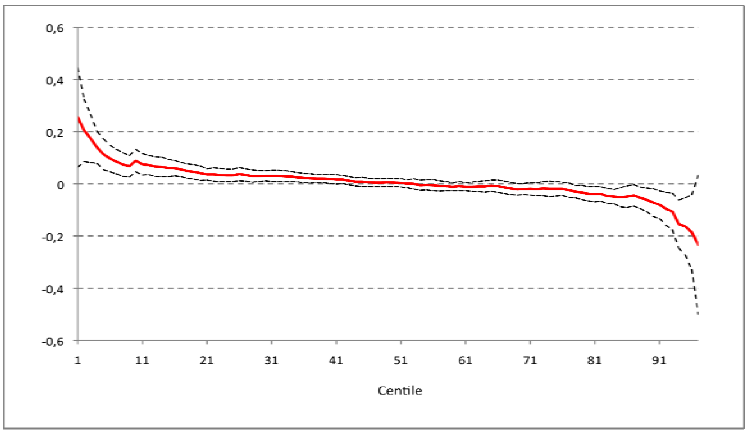


Figure 2: Quantile Regression: Dependent variable growth in log value added per employee, 1996 and 2002[b]



Notes: Estimated coefficient on the vertical axis. Quantile of growth in value added per employee on the horizontal axis.