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THE IMPACT OF HIGHER EDUCATION INSTITUTION-FIRM KNOWLEDGE LINKS ON FIRM-LEVEL PRODUCTIVITY IN BRITAIN.

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The Impact of Higher Education Institution-Firm Knowledge Links on Firm-level Productivity in Britain

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Abstract

This paper estimates whether knowledge links with universities impacts on establishment-level TFP. Using propensity score matching, the results show a positive and statistically significant impact although there are across production and non-production industries and domestically- and foreign-owned firms.

JEL codes: D24, I23

Keywords: Universities Firm-level productivity

1. Introduction

This paper estimates whether both sourcing knowledge from and/or cooperating on innovation with HEIs (Higher Education Institutions)[1] impacts on establishment-level total factor productivity (TFP) using a dataset created by merging the UK government's Community Innovation Survey (CIS) with the Annual Respondents Database (ARD). It also considers whether higher graduate employment (as a measure of human capital) also impacts positively on TFP at the establishment-level.

Many studies have investigated the relationship between university-firm knowledge links and innovation (see, for example, Mansfield, 1991; Becker, 2003; Thorn et al, 2007). Most of these studies find a positive impact. Fewer studies have investigated the impact of university-firm knowledge links on productivity. Belderbos et al. (2004), using the Dutch CIS, find that cooperation with universities has no statistically significant impact on the growth of labour productivity. Medda et al. (2005) find no statistically significant effect of collaborative research undertaken by Italian manufacturing firms and universities on the growth of TFP. Arvanitis et al. (2008), using Swiss data, show that university-firm knowledge and technology transfer has both a direct impact on labour productivity and an indirect impact through its positive impact on innovation. In sum, there is as yet no clear consensus as to the impact of university-firm knowledge links on productivity.

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[1] The actual questions used to define HEI collaboration are Q.16 and Q.18 (see http://www.bis.gov.uk/policies/science/science-innovation-analysis/cis/cis4_questionnaire for details).

2. Data

The dataset has been created by merging the results from the 2007 CIS (covering the period 2004 to 2006) with the ARD for 2006. The former gives information on the innovative activities of some 14,872 UK establishments; while the latter consists of returned financial data on a stratified sample of reporting units from the Annual Business Inquiry (ABI) which can be used to calculate Gross Value Added (GVA), factors inputs and thus TFP (see Robjohns, 2006). Merging took place establishment level information, with all the relevant CIS establishments successfully linked to the ARD.[2]

Weights are constructed (based on employment covered by the merged CIS-ARD dataset relative to total employment in the ARD)[3] so that the results are representative of the population of establishments. Based on such weighted CIS data, in 2006 on average 22.8% of UK establishments collaborated with HEIs, ranging from over 70% in the Coke & Petroleum sector to 3.3% of Air Transport companies. Larger enterprises were much more likely to link with HEIs (e.g., 41.4% of production sector establishments employing 200+ workers, compared to around 4% of establishments employing 0-9 workers). The CIS data also shows that some 17.9% of the UK workforce held a degree, with higher proportions in establishments that exported, were foreign-owned, or were involved in producing innovation outputs.

3. Econometric Model

The basic model estimated is the following production function:

$$y_i = \alpha + \beta_E e_i + \beta_K k_i + \beta_x x_i + \beta_{ATT} HEI_i + \varepsilon_i, \qquad (1)$$

where y_i is the log of GVA for establishment i; e_i is the log of employment; k_i is the log of the capital stock; x_i is a vector of control variables; and HEI_i is a dummy variable that equals 1 if the establishment collaborates with HEIs. The x_i variables consist of the following: the percentage of the workforce that are graduates, the log of establishment age, the log of industrial diversification, the log of the Herfindahl index, a foreign-ownership dummy, a single plant enterprise dummy, an exporting dummy, industry dummies, region dummies and seven knowledge sourcing strategy dummies.[4] Because employment and capital are included in the GVA equation, the impact of other variables is channelled through TFP (Harris, 2005).

A priori we assume that the impact of collaborating with HEIs can differ across domestically owned and foreign-owned firms. To test for this, in a second specification, an interaction variable between collaborating with HEIs and foreign ownership is added to equation (1).

[2] Some industrial sectors are omitted from the ARD – such as agriculture and much of financial services.
[3] We calculated the weights at the 2-digit industry level, split into 5 employment size-bands.
[4] More detail on these variables is available in an unpublished appendix, available on request.

4. Estimation Strategy

Because establishments that collaborate with HEIs are a self-selected group of the population of establishments, they will tend to have different characteristics from establishments that do not collaborate with HEIs. This makes causal inference difficult as these differences in characteristics will lead to differences in productivity performance that are unrelated to whether HEIs have any impact on TFP (see, for example, Blundell and Costa Dias, 2009, for a more detailed exposition of self-selected bias).

One solution to this problem is to create a matched sample in which treated and untreated establishments are observed for all values of the covariates. This was done using propensity score matching (see Dehejia and Wahba, 2002), which involved estimating probit models of treatment status including all variables that determine both productivity and whether an establishment collaborates with HEIs, and then matching on the estimated predicted values.[5] The advantage of propensity score matching over other forms of matching is that it overcomes the difficulties of matching on a large number of variables (Zhao, 2004).

Table 1 – OLS Estimates of Different Versions of Equation (1) using a Matched Sample

	Model 1	Model 2
All Industries		
HEI Link	0.113*** (0.030)	0.119*** (0.035)
HEI Link * Foreign Ownership	–	-0.031 (0.067)
Graduates	0.404*** (0.051)	0.405*** (0.051)
Production sector		
HEI Link	0.092** (0.045)	0.151*** (0.055)
HEI Link * Foreign Ownership	–	-0.208** (0.090)
Graduates	0.429*** (0.085)	0.445*** (0.086)
Non-Production sector		
HEI Link	0.140*** (0.040)	0.104** (0.045)
HEI Link * Foreign Ownership	–	0.207** (0.095)
Graduates	0.445*** (0.063)	0.443*** (0.063)

*/**/*** denotes significance at the 10%/5%/1% levels

[5] The results from the (weighted) probit models are available in the unpublished appendix. Different models were estimated depending on sector.

5. Results

Table 1 gives the key coefficients from estimation of the two specifications for all industries, production industries and non-production industries. Table A1 in the appendix gives the coefficients on the other variables for the first specification (i.e. equation 1). The sign and size of the latter are consistent with expectations and vary little across the different specifications.

For all industries, results from estimating equation 1 (the baseline model) show that collaborating with HEIs has a positive and statistically significant impact on TFP (the latter was around 12% higher). Introducing the interaction between HEI link and foreign ownership has little impact.

For production industries (the second part of Table 1), the coefficient on the HEI link is positive and significant in the baseline specification. Introducing the interaction between HEI link and foreign ownership leads to a large increase in the size of the coefficient on the HEI link dummy. This is because the coefficient on the interaction variable is negative and statistically significant. This implies that, for production industries, there is a large difference in the impact of collaborating with HEIs on TFP between domestically owned and foreign-owned firms with the latter experiencing no significant TFP gains from their HEI linkages. This suggests that foreign-owned firms operating in the UK production sector *which also collaborated with HEIs* were on average technology-seeking enterprises rather than exploiting any ex ante technological superiority (see Fosfuri and Motta, 1999; Cantwell et al., 2004; Love, 2003; Driffield and Love, 2007).

For non-production industries, there is again a positive and statistically significant coefficient on the HEI link variable in the basic specification. Unlike for production industries, the introduction of the interaction between HEI link and foreign ownership leads to a diminution in the coefficient on the HEI link variable because the coefficient on the interaction variable is positive and statistically significant. This suggests that in the non-production sector, foreign-owned firms are exploiting their prior technological advantages with the assistance of knowledge gained from HEIs (overall foreign-owned firms with an HEI link were some 36.5% more productive).

The coefficient on the graduates' variable is positive and statistically significant for all specifications. As this variable is not logged, the coefficients presented are not elasticities. Evaluated at the mean, a 10% increase in the percentage of graduates leads to an increase of between 0.6% and 1.4% in TFP, depending on the sector and model chosen.

6. Conclusion

This paper has sought to estimate the impact of collaborating with HEIs on TFP using a dataset created by merging CIS with the ARD. Using a sample created using propensity score matching, the results show that collaborating with HEIs had a positive and statistically significant impact on TFP although there are differences in the strength of this effect across production and non-production industries and domestically owned and foreign-owned firms.

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Appendix

Table A1: Weighted OLS Estimates of Equation (1) using a Matched Sample

	All Industries	Production	Non-Production
HEI Link	0.113***	0.092**	0.140***
	(0.030)	(0.045)	(0.040)
Ln(Employment)	0.872***	0.972***	0.850***
	(0.015)	(0.024)	(0.019)
Ln(Capital)	0.146***	0.075***	0.162***
	(0.013)	(0.021)	(0.015)
Foreign Ownership	0.371***	0.289***	0.457***
	(0.036)	(0.047)	(0.050)
Exporting	0.203***	0.172***	0.203***
	(0.035)	(0.055)	(0.045)
Ln(Age)	-0.184***	-0.226***	-0.192***
	(0.025)	(0.048)	(0.030)
Size of graduates workforce	0.404***	0.429***	0.445***
	(0.051)	(0.085)	(0.063)
Ln(Herfindahl)	-0.039***	0.017	-0.064***
	(0.010)	(0.015)	(0.013)
Ln(Diversification)	0.083***	0.034	0.130***
	(0.017)	(0.023)	(0.024)
Single-plant Enterprise	-0.413***	-0.324***	-0.422***
	(0.038)	(0.051)	(0.054)
R-squared	0.663	0.718	0.633
Observations	6928	2699	4280

A full set of knowledge sourcing strategy, industry and region dummies are included but not reported for all specifications.
*/**/*** denotes significance at the 10%/5%/1% levels