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Barriers to Technology Adoption, International R&D Spillovers and Growth[#]

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Abstract

Panel data is used to investigate the extent of R&D spillovers between OECD countries, and the importance of barriers to technology adoption in affecting the benefits of such spillovers. Our results indicate that countries with less regulated goods and labour markets benefit more from foreign R&D.

Keywords: R&D Spillovers, Technology Adoption, Economic Growth
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1. Introduction

Parente and Prescott (1999, 2000) have emphasised the role of vested interests and absorption barriers in limiting a country's ability to adopt technology (see also Bridgman et al., 2007). We examine this hypothesis by considering whether the extent of international R&D spillovers is dependent upon indicators of such barriers to technology absorption in advanced countries.

2. Background

Coe, Helpman and Hoffmaister (1997) (CHH) identify several channels whereby foreign knowledge can be transferred including: imports of intermediate and capital goods; cross-border learning of production methods, product design and organization; imitation of new products; development of technologies and imitation of foreign technology. These arguments underlie tests of links between knowledge spillovers through trade and output or productivity growth. In a seminal paper Coe and Helpman (1995) test for trade related R&D spillovers among 22 OECD countries for 1971-1990. A stock of knowledge is constructed for each country with access measured by weighting stocks with trade flows. They conclude that both foreign and domestic stocks are important for productivity growth, with more open economies gaining most. CHH find similar results for North-South spillovers.

Parente and Prescott (1999, 2003) argue that barriers to technology adoption lead to the inefficient use of inferior technologies. This argument is based on the fact that many of these barriers are assumed to be put in place to protect the interests of groups vested in current production processes. Intuitively, as long as firms are not threatened by the prospect that their competitors might introduce more productive technologies, they may prefer to stick to their current technology, although better ones are available. While barriers protecting industry insiders are likely to be considerable, labour market institutions are likely to be a further relevant barrier to technology adoption. Labour unions are another group with vested interests that may potentially oppose the introduction of possibly labour-saving technologies and could also be considered to be a group with vested interests in limiting technology adoption.

In this paper we combine these two strands of literature. We examine whether the extent of international R&D spillovers through trade is influenced by indices capturing institutional characteristics of product and labor markets that may give rise to barriers to technology adoption. The following section describes the method employed.

3. Empirical Specification

We consider the importance of trade-related spillovers and the importance of vested interests for such spillovers between a sample of 21 OECD countries using data on five-year averages over the period 1973-1997.

The approach we adopt is similar to that of Coe and Helpman (1995), but rather than construct a measure of TFP we choose not to impose coefficients on the share of capital and labour, allowing the data to determine the coefficients. The initial estimating equation is thus,

$$\Delta \ln y_{it} = \alpha \Delta \ln k_{it} + \gamma_1 \Delta \ln S_{it}^{D} + \gamma_2 \ln S_{it}^{F} + \mu_i + \upsilon_t + \varepsilon_{it},$$

where $\Delta \ln y$ is the average growth of per capita GDP in each five year period, $\Delta \ln k$ is the growth in the capital-labour ratio, S^D and S^F are the domestic and foreign knowledge stocks, μ_i and ν_t are country and time specific effects and ε the remaining error term. To account for the importance of barriers to technology adoption, we allow the coefficient associated with foreign knowledge to depend on variables representing barriers to adoption in a potentially non-linear way. In the case of a two-regime model we can write,

$$\Delta \ln y_{it} = \alpha \Delta \ln k_{it} + \gamma_1 \Delta \ln S_{it}^{D} + \gamma_{2,1} I(B_{it} \leq \lambda) S_{it}^{F} + \gamma_{2,2} I(B_{it} > \lambda) S_{it}^{F} + \mu_i + \upsilon_t + \varepsilon_{it},$$

where B_{it} is the index of absorption barriers, *I(.)* is the indicator function, taking value one if the argument is true and zero otherwise, and λ is the estimated threshold. Here the impact of foreign R&D spillovers is given by $\gamma_{2,1}$ for observations with $B_{it} \leq \lambda$ and by $\gamma_{2,2}$ for observations with $B_{it} > \lambda$.

We estimate the model using the approach advocated in Hansen (1999), which allows us to identify the value of the threshold, λ, and the regression coefficients. The threshold parameter is estimated as the value of λ that minimises the concentrated sum of squared residuals from the above equation[1]. The test of whether the threshold is significant is not straightforward since the threshold is not identified under the null. We use the bootstrap procedure of Hansen (1999) to test this. If the threshold is found to be significant the method can be extended to consider more than one threshold.

Data on GDP and labour force are taken from the World Development Indicators, while capital stock data is from the OECD's Economic Outlook. The domestic R&D stock is constructed using the perpetual inventory method with the data coming from the ANBERD database. Foreign R&D stocks are constructed, using the approach of Coe and Helpman, as the import-share weighted averages of the domestic R&D of country *i*'s trade partners,

$$S_{it}^{F} = \sum_{j \neq i} \frac{\eta_{ijt}}{\eta_i} S_j^{D}$$

where η_{ij} is the volume of total imports from country *j* to country *i* and η_i is the total volume of imports of country *i* from all countries in the sample. The trade data comes from the OECD's International Trade by Commodity Statistic database.

The indicators of absorption barriers (B_{it}) are taken from either Nicoletti et al (2000) or Nickell et al (2001) and are indices of product market regulation (PMR), inward-oriented product market regulation (IO-PMR), barriers to entrepreneurship (ENT), employment protection regulation (EPL) and coordination of wage bargaining (CO). Higher values of these variables imply increased regulation and increased coordination in the case of wage bargaining, and are thus associated with higher barriers to technology adoption.

4. Results

The estimation results are presented in Table 1. From the second column of Table 1 it can be seen that the results from the base specification are largely as expected.[2] The coefficient on the capital-labour ratio, α, is in line with previous estimates. The coefficient on domestic R&D, γ_1, provides evidence on the importance of innovation-driven technological progress

[1] To ensure a reasonable number of observations in each regime we restrict our attention to the central 60 percent of the distribution.
[2] All specifications include a dummy for the recession in Finland. If this observation is not dummied out, the Jarque-Bera test indicates significant deviations from normality in the residuals.

for a nation's growth performance. In this specification, the coefficient capturing the importance of foreign R&D, γ_2, does not depend on potential barriers to technology adoption. The point estimate for γ_2 is positive as expected, though not significant, a result in line with Kao et al (1999).

The results for the threshold model are reported in columns 3 to 6 of the table. Here we allow indices of product market regulation, entrepreneurship and employment protection to impact upon γ_2. The results are consistent across specifications, indicating a positive and statistically significant impact of foreign R&D on growth for countries with low values of the indices, and insignificant coefficients for countries with high levels of the indices[3]. The results indicate therefore that countries with lower levels of product market regulation, employment protection and lower barriers to entrepreneurship benefit to a greater extent from foreign R&D. While these results are supportive of the Parente and Prescott hypothesis we find that the coefficients in the two regimes are not different from each other at standard levels of significance for the overall indicator of product market regulation and barriers to entrepreneurship .

For the coordination of wage bargaining we find two significant thresholds. The results indicate that foreign R&D has a positive impact on growth in countries with low and high levels of wage coordination, but not for intermediate levels. This finding is in line with the arguments of Dowrick and Spencer (1994) who argue that unions organised at intermediate levels welcome innovation less than unions organised either at the firm or national level.

5. Conclusions

This paper presents results suggesting that the relationship between trade-related R&D spillovers and growth is dependent upon indices reflecting barriers to technology adoption in OECD countries. In particular, we find that the importance of foreign R&D is stronger in countries with lower levels of product market regulation and lower levels of employment protection. These results provide evidence in favour of the hypotheses proposed by Parente and Prescott who argue that vested interests can act as a barrier to technology adoption. The results on wage coordination indicate that spillovers are relevant for countries with the lowest

[3] Results when using simple interaction terms and when imposing a threshold exogenously are consistent with the results from the threshold analysis reported here.

and highest levels of wage coordination, but not for countries with intermediate levels of coordination. This latter result is in line with existing theoretical results.

Table 1: Empirical results: Regulation and R&D spillovers

	Base	*PMR*	*IO-PMR*	*ENT*	*EPL*	*CO*
α	0.229	0.262	0.267	0.267	0.357	0.201
	(0.144)	(0.148)	(0.151)*	(0.149)*	(0.147)**	(0.145)
γ_1	0.352	0.319	0.322	0.315	0.320	0.367
	(0.100)***	(0.090)***	(0.093)***	(0.094)***	(0.088)***	(0.092)*
γ_2	0.014					
	(0.009)					
$\gamma_{2,1}$		0.036	0.032	0.032	0.035	0.034
		(0.021)*	(0.016)**	(0.016)*	(0.018)*	(0.012)*
$\gamma_{2,2}$		0.007	0.003	0.004	0.001	-0.002
		(0.010)	(0.011)	(0.011)	(0.01)	(0.011)
$\gamma_{2,3}$						0.04
						(0.017)**
λ		1.30	1.72	1.30	1.10	0.40, 2.11
(percentile)		(20th)	(33rd)	(25th)	(25th)	(33rd and 55th)
p-value		0.15	0.10*	0.14	0.08*	0.04**
Obs	105	105	105	105	100	105
JB Test	0.606	1.31	1.08	1.16	1.24	0.982
$\bar{R}^2$	0.506	0.518	0.516	0.528	0.528	0.552

Notes: Robust standard errors in parenthesis. Significance at the 1, 5 and 10 percent levels is indicated by ***, ** and *. JB stands for the Jarque-Bera test statistic of the normal distribution of the residuals. The p-value for the likelihood ratio test of the significance of the model with threshold effects was computed using the bootstrap procedure of Hansen (1999) with 500 replications.

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