Entrepreneurship and knowledge spillovers from the public sector

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Abstract:

A compelling body of research has found that investments in knowledge from other firms and universities spill over to enhance the performance of entrepreneurial firms. This literature has shown that firm performance is positively related to investments in new knowledge by other firms and research universities. This paper addresses a gap in the literature by positing that public sector knowledge is also conducive to enhancing performance by knowledge intensive entrepreneurial (KIE) firms. Our findings suggest that the public sector provides a fertile source of knowledge for enhancing KIE firm performance.

Keywords: entrepreneurship | performance | knowledge spillovers | public sector

Article:

Introduction

An important finding in the entrepreneurship literature is that the performance of new firms, some of which are entrepreneurial firms, is shaped not just by their own investments but also by the investments of other third-party firms and organizations (Gilbert et al. 2008; Woolley 2014; Fritsch and Wyrwich 2018; Frederiksen et al. 2016). John Donne's insight that "no man is an island" is apparently relevant for many new firms. A compelling body of research has found that investments in knowledge from other firms and from universities spill over (Jaffe 1989; Jaffe et al. 1993) to enhance the performance of firms (Link and Rees 1990; Coomes et al. 2013; Guerrero and Peña-Legazkue 2018). In particular, this literature has found that firm growth, which is considered to reflect firm performance, is positively related to the investments in new knowledge made by other firms and universities.

However, a limitation of the relevant literature linking knowledge spillovers to firm performance is that the sources of knowledge spawning the spillovers have generally been restricted to firms engaging in research and development (R&D) and to research universities (Kritikos and Baumanna 2016; Griliches 1990; Kolympiris et al. 2015; Li et al. 2017). Limiting spillovers to these two sources of knowledge has unintentionally missed other important sources that may also have a positive impact on entrepreneurial performance. In particular, a different strand of

research, more typically associated with the innovation literature, has identified the public sector as a rich source of knowledge fueling innovative activity (Link and Link 2009; Leyden and Link 2015). The purpose of this paper is to address this gap in the literature by positing that the same public sector knowledge that the innovation literature has identified as being a crucial source for knowledge spillovers spawning innovative activity in the private sector may also be relevant for enhancing the performance of new firms.

Drawing on the relevant literature linking knowledge spillovers to entrepreneurial performance, we develop an important hypothesis in the second section of the paper. Our hypothesis is that greater investments in the use of public sector knowledge will enhance new firm performance, as measured by firm growth rates. The database and measurement issues for subjecting our hypothesis to empirical scrutiny are explained in the third section. The main results are presented in the fourth section. Finally, our summary and conclusions are presented in the last section of the paper in which we discuss our finding that firm R&D and university research are not the only important sources for knowledge spillovers driving entrepreneurial performance. More specifically, we emphasize that we found that the public sector, as a key source for new knowledge, contributes significantly (in a statistical sense) to enhanced performance. And, we show that among new firms, knowledge from the public sector has a greater measured impact on performance than does knowledge from universities.

The public sector as a source of knowledge spillovers

Within the span of a generation, knowledge has emerged as the key driver of innovation and economic performance. In models of macroeconomics, the role of knowledge shifted from being exogenous in the prevalent approach following the Solow (1957) model to being endogenous in the growth models of Romer (1986, 1990, 1994) and Lucas (1988, 1993). Knowledge per se was assumed to be particularly vital for innovation and economic performance because of its propensity to spill over from the organizations creating it to non-paying third-party firms able to capture benefits from the knowledge even in the absence of undertaking the investments to create the knowledge.

At the firm level, innovation and performance were modelled as being influenced by firm strategies and investments. The model of the knowledge production function introduced by Griliches (1979) links the innovative activity of firms to knowledge inputs such as R&D and human capital. A plethora of subsequent research confirmed the validity of the knowledge production function in the sense that firm innovation was found to be positively related to investments in knowledge-generating inputs, such as R&D and human capital. In particular, increasing firm investments in knowledge-generating inputs was found to have a positive and statistically significant impact on innovative activity (Hall 2011; Mohnen and Hall 2013).

Where the model of the knowledge production function was less convincing was for new firms. Despite their inability to generate their own knowledge inputs, and in particular their own R&D investments, studies consistently found a robust amount of innovative activity emanating from new firms. There are several interpretations possible from the literature. One argument, with at least some empirical support, suggests that, in fact, informal R&D, which is typically not measured as formal R&D, plays an important role in new firms (Kleinknecht 1987). As

Kleinknecht (1987) concludes, “Surveys on R&D are considerably biased towards underestimating R & D in small firms.” A second interpretation focuses on the greater flexibility in smaller organizations as an innovative strategy (Broekaert et al. 2016). A third interpretation is based on the ability of the founder to leverage her/his human capital for innovative activity (Colombo et al. 2004). Yet a different interpretation of this so-called new firm innovation paradox lies in knowledge spillovers. Entrepreneurs are able to harness the knowledge created within the organizational context of an incumbent firm when starting their own new firm (Audretsch 1995).

At the firm level, innovation and performance have been modeled as being influenced not only by the investments of the firm itself but also by its ability to harness external knowledge created in a different organizational context. Thus, the model of the firm knowledge production function was subsequently extended by Griliches (1979) and Jaffe (1989) to incorporate externally generated knowledge spillovers.

Cohen and Levinthal (1989, 1990), for example, analyzed firm strategies conducive to accessing and absorbing external knowledge, thereby enhancing knowledge spillovers from the organization creating the knowledge to the firm actually commercializing it through its own innovative activity. Audretsch (1995) explained why an entrepreneurial startup provides the conduit for knowledge, created but not commercialized in the context of an incumbent organization, to spill over for innovative activity by the new firm actually commercializing those ideas.

A rich body of empirical literature found that knowledge spills over from the investing firm to create that knowledge for commercialization and innovative activity by third party firms (Jaffe 1989; Jaffe et al. 1993). In addition, research also identified new firms as particularly fertile recipients for knowledge spillovers (Acs et al. 1992; Link and Rees 1990; Audretsch and Link 2018).

To date, empirical studies identifying and measuring the existence and extent of knowledge spillovers have generally identified two distinct organizational sources of knowledge spillovers—other firms and universities (Jaffe 1989; Link and Rees 1990; Griliches 1990; Massón-Guerra and Ortín-Ángel 2018; Shu et al. 2014). However, there are compelling reasons to consider an additional source of knowledge that can potentially provide a source of knowledge for third party firms—the public sector.

The public sector funds and undertakes substantial research initiatives. For example, in the United States, government agencies such as the Department of Defense, the Department of Energy, the National Institutes of Health within the Department of Health and Human Services, and the National Aeronautics for Space Administration (NASA), and their national laboratories, undertake substantial research programs generating fertile results with potential spillover benefits. Other countries, such as France, make similar investments in new knowledge through their national laboratory system: one example is the French National Centre for Scientific Research (*Centre national de la recherche scientifique*). Just as universities throughout the OECD countries have initiated offices of technology transfer, commercialization, and engagement, so too have public agencies and national laboratories in the United States and

elsewhere similarly opened their own doors, often incentivized by public policies, to facilitate technology transfer and knowledge spillovers (Link and Oliver 2018). Most recently in the United States, the National Institute of Standards and Technology (NIST) and the White House Office of Science and Technology Policy (OSTP) sponsored the Unleashing American Innovation initiative in response to the Trump Administration's President's Management Agenda that little is known about the economy's return on its investment in Federal R&D. Thus, while we expect that public knowledge, or knowledge from any new source, will have a positive impact on firm performance, our hypothesis for this empirical study is:

> H1: The performance of new firms, measured by their growth, is enhanced, in a statistical sense, through greater investments in the use of public sector knowledge.

The AEGIS database

The AEGIS (Advancing knowledge-intensive entrepreneurship and innovation for growth and social well-being in Europe) project was funded by the European Commission (EC) under Theme 8 "Socio-Economic Sciences and Humanities" of the 7th Framework Programme (FP7) for Research and Technological Development (2007–2013).[1] The focus of the AEGIS project was on knowledge intensive entrepreneurship (KIE). The implicit assumption was that KIE is one potential means through which to generate economic growth and societal well-being. According to Caloghirou et al. (2011, p. 4):

> Knowledge-intensive entrepreneurship is [the] core interface between two interdependent systems: the knowledge generation and diffusion system, on the one hand, and the productive system, on the other. Both systems shape and are shaped by the broader social context—including customs, culture and institutions—thus also pointing at the linkage of entrepreneurship to that context.

The AEGIS database contains information on 4004 KIE firms established between 2002 and 2007 across 10 European countries. The AEGIS survey, which was structured after the EC's Community Innovation Survey (CIS), was conducted beginning in late 2010 and going into 2011; at a minimum a firm in the AEGIS sample would have been active for 4 years. The countries represented in the database are (alphabetically): Croatia, Czech Republic, Denmark, France, Germany, Greece, Italy, Portugal, Sweden, and the United Kingdom. And, across these countries a number of firms from the high-tech and low-tech sectors, and from the knowledge-intensive business services sector are represented in the database (but sectoral representation did not drive the construction of the database). Table 1 shows the distribution of firms across countries and sectors; the database has been described in greater detail in Amoroso and Link (2018), Audretsch and Link (2018) and Hodges and Link (2017).

[1] In Greek mythology, the word *Aegis* refers to the powerful shield carried by Athena and Zeus.

Table 1. Distribution of firms in the AEGIS database, by country and sector

Country	Sector			Total
	High-Tech[a]	Low-Tech[b]	KIBS[c]	
Croatia	35	115	50	200
Czech Republic	25	92	83	200
Denmark	34	69	227	330
France	68	196	306	570
Germany	67	160	330	557
Greece	22	184	125	331
Italy	57	316	207	580
Portugal	31	170	130	331
Sweden	34	108	192	334
United Kingdom	47	192	332	571
Total	420	1602	1982	4004

Source: Caloghirou et al. (2011) and the AEGIS database

[a]High-tech sector includes aerospace; computers and office machinery; radio-television communication equipment; manufacture of medical, precision and optional instruments; pharmaceuticals; manufacturer of electrical machinery and apparatus, manufacturer of machinery and equipment, chemical industry

[b]Low-tech sector includes paper and printing; textile and clothing; food, beverage and tobacco; wood and furniture; basic metals; fabricated metal products

[c]Knowledge-Intensive Business Services (KIBS) sector includes telecommunications; computer and related activities; research and experimental development; selected business services activities

Analytical model and empirical findings

To test empirically Hypothesis 1 above with respect to KIE firms as defined by the AEGIS data, consider the following model which is motivated by our discussion above of a gap in the relevant literature:

$$Performance = \mathrm{f}(OtherFirmKnowledge, UniversityKnowledge, PublicKnowledge, \mathbf{X}) \quad (1)$$

where the variable *Performance* characterizes the firm's economic performance as measured alternatively by its employment growth and by its sales growth between 2009 and 2010. The other variables in Eq. (1) control for the firm's ability to identify and use knowledge from other sources: *OtherFirmKnowledge* represents the firm's ability to harness or absorb spillover knowledge from other firms, *UniversityKnowledge* represents the firm's purposeful search and use of knowledge from universities be it in the form of human capital or technical capital, and *PublicKnowledge* represents the firm's ability to internalize knowledge from public sector sources.

The vector **X** represents firm-specific controls related to its past performance, which might influence its current performance, as well as country controls and sector controls to hold constant factors related to the firm's national and industrial context. Current employment and sales growth of a firm is influenced by founder characteristics, market characteristics, and institutional characteristics; and, those variables are not represented in Eq. (1). Absent precise measures of such variables in the AEGIS database, we assume that their influence is captured by a firm's past performance.

Table 2. Definition of variables

Variable	Definition
Dependent	
EmploymentGrowth	Percentage increase/decrease in firm employment from 2009 to 2010.
SalesGrowth	Percentage increase/decrease in firm sales from 2009 to 2010.
Independent	
PreviousEmploymentGrowth	Average percentage increase/decrease in firms employment from 2007 to 2009.
PreviousSalesGrowth	Average percentage increase/decrease in firms sales from 2007 to 2009.
OtherFirmKnowledge	=1 if the firm's average response to the following two statements was greater than 3 on a Likert scale of 1 = strongly disagree to 5 = strongly agree: "Our firm responds rapidly to competitive moves. We change our practices based on customer feedback." Otherwise, *OtherFirmKnowledge* = 0.
UniversityKnowledge	=1 if the firm's response to the following statement was greater than 3 on a Likert scale of 1 = not important to 5 = extremely important: How important are "universities as a source of knowledge for exploring new business opportunities?" Otherwise, *UniversityKnowledge* = 0.
PublicKnowledge	=1 if the firm's response to the following statement was greater than 3 on a Likert scale of 1 = not important to 5 = extremely important: How important is "participation in nationally funded research programs as a source of knowledge for exploring new business opportunities?" Otherwise, *PublicKnowledge* = 0.
Commercialization	=1 if the firm responded in the affirmative to the following survey question: Did your firm "introduce new or significantly improved goods or services during the past 3 years? Otherwise, *Commercialization* = 0.
Croatia	=1 if the firm is in Croatia. Otherwise, *Croatia* = 0
CzechRepublic	=1 if the firm is in the Czech Republic. Otherwise, *CzechRepublic* = 0
Denmark	=1 if the firm is in Denmark. Otherwise, *Denmark* = 0
France	=1 if the firm is in France. Otherwise, *France* = 0
Germany	=1 if the firm is in Germany. Otherwise, *Germany* = 0
Greece	=1 if the firm is in Greece. Otherwise, *Greece* = 0
Italy	=1 if the firm is in Italy. Otherwise, *Italy* = 0
Portugal	=1 if the firm is in Portugal. Otherwise, *Portugal* = 0
Sweden	=1 if the firm is in Sweden. Otherwise, *Sweden* = 0
UnitedKingdom	=1 if the firm is in the United Kingdom. Otherwise, *UnitedKingdom* = 0
High-tech	=1 if the firm is in the high-tech sector. Otherwise, *High-tech* = 0.
Low-tech	=1 if the firm is in the low-tech sector. Otherwise, *Low-tech* = 0.
KIBS	=1 if the firm is in the KIBS sector. Otherwise, *KIBS* = 0.

Each variable in Eq. (1) is defined in Table 2. Our measures of other firm, university, and public knowledge are defined in terms of the AEGIS survey questions and statements. We assume that respondents were accurate in their responses, but that fact does not ensure the construct validity of these measures. The competitive actions of other firms as well as customer feedback represent only one dimension of the knowledge potentially gained from other firms, and it might not be the most important dimension. For example, hiring key employees from other firms or, in a technical sense, reverse engineering competitors' products based on customer feedback, might have a greater influence on firm growth. The importance of universities or of the public sector as a knowledge source for exploring new business opportunities is a broadly defined dimension of knowledge spillovers, and some KIE firms might absorb tacit knowledge from universities and others might find it advantageous to rely on codified knowledge from university publications and/or conferences. The same distinctions could apply to the public sector if some such firms interact with, say, personnel in national research laboratories (tacit knowledge) and others rely

on published public domain information (codified knowledge). Because of such limitations in our knowledge constructs, we offer in the final section of this paper words of caution about generalizing from our findings as well as words of encouragement for others to collect more detailed data on knowledge exchanges and/or to pursue detailed case studies on that topic.

Descriptive statistics on these variables are in Table 3. Table 4 presents a correlation matrix for key variables.

Table 3. Descriptive statistics on the variables in Table 2 ($n = 4003$)

Variable	Mean	Standard deviation	Range
EmploymentGrowth	6.753	35.434	−300 − 800
PreviousEmploymentGrowth	18.263	70.584	−500 − 1300
SalesGrowth	13.799	51.745	−300 − 1000
PreviousSalesGrowth	25.181	125.573	−200 − 6000
OtherFirmKnowledge	0.758	0.428	0/1
UniversityKnowledge	0.160	0.336	0/1
PublicKnowledge	0.139	0.346	0/1
Commercialization	0.636	0.481	0/1
Croatia	0.050	0.217	0/1
CzechRepublic	0.050	0.218	0/1
Denmark	0.082	0.275	0/1
France	0.143	0.349	0/1
Germany	0.139	0.346	0/1
Greece	0.083	0.275	0/1
Italy	0.145	0.352	0/1
Portugal	0.083	0.275	0/1
Sweden	0.083	0.277	0/1
UnitedKingdom	0.143	0.350	0/1
High-tech	0.105	0.306	0/1
Low-Tech	0.400	0.490	0/1
KIBS	0.495	0.500	0/1

One firm respondent did not report previous sales growth and previous employment growth

Table 4. Correlation matrix for key variables from Table 2 ($n = 4003$)

	Employment Growth	***Previous Employment Growth***	***SalesGrowth***	***PreviousSales Growth***	***OtherFirm Knowledge***	***University Knowledge***	***Public Knowledge***	***Commercialization***
EmploymentGrowth	1							
PreviousEmploymentGrowth	0.252***	1						
SalesGrowth	0.590***	0.223***	1					
PreviousSalesGrowth	0.300***	0.410***	0.338***	1				
OtherFirmKnowledge	0.072***	0.073***	0.083***	0.022	1			
UniversityKnowledge	0.039**	0.051***	0.027*	0.061***	0.007	1		
PublicKnowledge	0.041***	0.055***	0.032**	0.047***	−0.001	0.395***	1	
Commercialization	0.056***	0.116***	0.079***	0.069***	0.073***	0.099***	0.116***	1

One firm respondent did not report previous sales growth and previous employment growth
*** significant at .01-level, ** significant at .05-level, * significant at .10-level

Table 5. Regression results from Eq. (1) ($n = 4003$)

	Dependent variable is *EmploymentGrowth*			Dependent variable is *SalesGrowth*		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
PreviousEmploymentGrowth	0.120***	0.120***	0.120***	–	–	–
	(0.008)	(0.008)	(0.008)			
PreviousSalesGrowth	–	–	–	0.135***	0.134***	0.134***
				(0.006)	(0.006)	(0.006)
OtherFirmKnowledge	4.373***	4.312***	4.307***	7.613***	7.525***	7.520***
	(1.405)	(1.405)	(1.405)	(1.983)	(1.983)	(1.984)
UniversityKnowledge	3.309**	–	2.205	2.784**	–	1.350
	(1.510)		(1.628)	(1.183)		(2.305)
PublicKnowledge	–	3.994**	3.119*	–	4.589**	4.054*
		(1.599)	(1.724)		(2.262)	(2.439)
CzechRepublic	3.902	3.714	4.127	11.535**	11.577**	11.832**
	(3.437)	(3.425)	(3.438)	(4.862)	(4.845)	(4.865)
Denmark	9.675***	9.458***	9.793***	15.926***	15.875***	16.085***
	(3.123)	(3.113)	(3.123)	(4.423)	(4.408)	(4.423)
France	7.815***	7.594***	7.977***	16.709***	16.683***	16.919***
	(2.846)	(2.833)	(2.847)	(4.027)	(4.007)	(4.028)
Germany	10.128***	10.152***	10.398***	20.536***	20.735***	20.888***
	(2.853)	(2.851)	(2.856)	(4.038)	(4.034)	(4.043)
Greece	5.558*	4.953	5.224	8.780*	8.178*	8.343*
	(3.239)	(3.237)	(3.243)	(4.581)	(4.578)	(4.587)
Italy	6.224**	5.794**	6.011**	16.227***	15.813***	15.945***
	(2.822)	(2.820)	(2.824)	(3.991)	(3.987)	(3.993)
Portugal	3.492	3.688	3.601	9.358**	9.551**	9.499**
	(3.062)	(3.061)	(3.061)	(4.331)	(4.330)	(4.331)
Sweden	14.269***	14.203***	14.485***	28.137***	28.242***	28.417***
	(3.099)	(3.094)	(3.101)	(4.385)	(4.376)	(4.387)
UnitedKingdom	5.233*	5.001*	5.366*	17.062***	17.010***	17.236***
	(2.849)	(2.837)	(2.849)	(4.032)	(4.014)	(4.032)
High-tech	2.239	2.082	2.070	7.050***	6.835**	6.826**
	(1.883)	(1.885)	(1.885)	(2.662)	(2.665)	(2.665)
KIBS	3.604***	3.629***	3.552***	3.199*	3.177*	3.130*
	(1.187)	(1.185)	(1.187)	(1.678)	(1.676)	(1.678)
Intercept	−8.409***	−8.191***	−8.630***	−13.771***	−13.989***	−14.258***
	(2.800)	(2.783)	(2.802)	(3.850)	(3.936)	(3.963)
R^2	0.080	0.080	0.080	0.136	0.137	0.137
F-level	24.62***	24.73***	23.21***	44.96***	45.16***	42.16***

Firms in Croatia and in the low-tech sector are subsumed in the intercept term
One firm respondent did not report previous sales growth and previous employment growth
(standard errors in parentheses)
*** significant at .01-level, ** significant at .05-level, * significant at .10-level

Note from Table 3 that the mean level employment and sales growth in 2010 (*EmploymentGrowth* and *SalesGrowth*), and in the three previous years (*PreviousEmploymentGrowth* and *PreviousSalesGrowth*), is positive but the range on those variables points out that some firms included in the AEGIS database experienced negative growth over the time period of the data. The economic and financial recession throughout Europe in 2009 affected KIE firms differently. Note also from Table 3 that about three-fourths of

the firms agreed with the survey statements about acting in a way to allow them to harness spillover knowledge from other firms (*OtherFirmKnowledge*). In contrast, less than one-fifth of the firms responded to the AEGIS survey that universities or participation in nationally funded research programs are important sources of knowledge for exploring new business opportunities (*UniversityKnowledge* and *PublicKnowledge*).

As well, note from Table 4 that there does not appear to be significant collinearity among the independent variables represented in Eq. (1). The possible exception is the correlation between *UniversityKnowledge* and *PublicKnowledge* (0.395 and highly significant). We revisit this issue below.

The regression results from alternative specifications of Eq. (1) are in Table 5. The results in columns (1) though (3) correspond to performance measured in terms of employment growth; the results in columns (4) through (6) correspond to performance measured in terms of sales growth.

Previous employment and sales growth are positive and highly significant covariates with current employment and sales growth in each specification, respectively. The ability of KIE firms to harness knowledge spillovers from other firms also has a positive and a highly significant impact in each specification.

The results in columns (1) and (4) are for specifications that includes universities as an important source of knowledge for exploring new business opportunities, but not public sector knowledge. Knowledge spillovers from universities are positively and significantly related to both performance variables.

The results in columns (2) and (5) are for specifications that do not include universities as an important source of knowledge for exploring new business opportunities, but do include public sector knowledge as an important source. Knowledge spillovers from the public sector are also positively and significantly related to both performance variables. This finding supports Hypothesis 1.

However, when the variables *UniversityKnowledge* and *PublicKnowledge* are included in the models in columns (3) and (6), along with *OtherFirmKnowledge*, the estimated coefficients on *UniversityKnowledge* remains positive but they are no longer significant at conventional levels whereas the estimated coefficients on *Publicknowledge* are positive and significant (less significant than in columns (2) and (5) when *UniversityKnowledge* is not included in the model as a regressor). The estimated coefficients on *OtherFirmKnowledge* remain positive and significant.

Perhaps the lack of statistical significance of the *UniversityKnowledge* variable in columns (3) and (6) is due to collinearity with *PublicKnowledge*, as mentioned above with reference to Table 4. However, the statistical presence of multicollinearity was tested for in these two regression models, and in no instance was a variance inflation factor (VIF) greater than 4 (generally a VIF of 10 or higher is an indication of multicollinearity among the independent variables). One explanation for the observed pattern of empirical behavior may be that when

other sources of knowledge are held constant, the explanatory power of university knowledge is in reality economically small, especially when compared to other knowledge sources. The estimated coefficients on *UniversityKnowledge* are numerically less than the coefficients on *PublicKnowledge* by sizeable percentages. A second explanation for the statistical insignificance of *UniversityKnowledge* may have nothing to do with statistical nuances; it may have to do with the fact that the AEGIS firms are relatively young; the mean age of the firms in the AEGIS sample is just over 7 years. Marquis and Tilcsik (2013) have argued that young-in-age firm founders experience a sensitive period in which they adjust their firm's strategy. We speculate that new (i.e., young-in-age) firms also need time to mature to learn about the net benefits of university knowledge and how to incorporate that knowledge into a strategic plan. To the extent that university knowledge is tacit in its nature, time too is likely needed for that knowledge to manifest itself in either employment or sales growth.

With respect to the interpretation of the estimated coefficients on the three knowledge variables, consider the following. The specifications in Table 5 include firms in Croatia and in the low-tech sector in the intercept term (see Note to Table 5). Thus, using the coefficients in column (3), and setting each of the other country dummy variables equal to 0, setting *High-tech* and *KIBS* equal to 0, and setting all three of the knowledge dummy variables equal to 0, the predicted employment growth for firms in Croatia that are in the low-tech sector is −6.44%, evaluated at the mean value of *PreviousEmploymentGrowth*: [predicted employment growth = −8.630 + (0.120*18.263) = −6.44]. If those same firms had relied on knowledge from other firms, their predicted employment growth would have been 4.307 percentage points greater, if they had also relied on university-based knowledge, their employment growth would have been another 2.205 percentage points greater, and if public sector knowledge was relied on overall predicted employment growth would have been another 3.119 percentage points greater or overall a predicted rate of growth of 3.19%.

As discussed above, measures of previous employment growth and sales growth are included as independent variable to control for firm characteristic variables in Eq. (1) that might influence firm growth. Because of econometric issues that a lagged variable might introduce, we have replaced those variables with a non-lagged variable that measures whether or not the firm previously commercialized a new or significantly improved goods or services, *Commercialization*. It too is defined in Table 2 and as shown in Table 6, the empirical results mirror those in Table 5.

Many of the coefficients on the dummy variables representing specific countries and industrial sectors are statistically significant in Tables 5 and 6. These results suggest that the country-specific and industry-specific institutional contexts make a difference in entrepreneurial performance as we have measured it.

Table 6. Regression results from Eq. (1) ($n = 4004$)

	Dependent variable is *EmploymentGrowth*			Dependent variable is *SalesGrowth*		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Commercialization	4.074***	4.007***	3.909***	8.685***	8.584***	8.465***
	(1.173)	(1.174)	(1.175)	(1.703)	(1.704)	(1.706)
OtherFirmKnowledge	5.275***	5.178***	5.179***	6.954***	6.862***	6.863***
	(1.449)	(1.449)	(1.449)	(2.104)	(2.104)	(2.104)
UniversityKnowledge	4.150***	–	2.808*	5.161**	–	3.376
	(1.556)		(1.675)	(2.258)		(2.433)
PublicKnowledge	–	4.928***	3.820**	–	6.414***	5.082**
		(1.649)	(1.776)		(2.393)	(2.578)
CzechRepublic	3.946	3.699	4.226	13.052**	12.791**	13.424***
	(3.504)	(3.518)	(3.531)	(5.126)	(5.108)	(5.127)
Denmark	11.371***	11.084***	11.497***	21.787***	21.458***	21.955***
	(3.207)	(3.197)	(3.206)	(4.655)	(4.641)	(4.654)
France	9.856***	9.557***	10.026***	21.292***	20.955***	21.517***
	(2.923)	(2.910)	(2.923)	(4.244)	(4.225)	(4.244)
Germany	11.808***	11.819***	12.117***	25.348***	25.400***	25.759***
	(2.929)	(2.926)	(2.931)	(4.252)	(4.248)	(4.255)
Greece	6.080*	5.334	5.682*	9.158*	8.210*	8.629*
	(3.329)	(3.327)	(3.333)	(4.833)	(4.830)	(4.839)
Italy	7.628***	7.096**	7.370**	17.811***	17.138***	17.467***
	(2.897)	(2.894)	(2.898)	(4.206)	(4.202)	(4.208)
Portugal	4.303	4.556	4.438	11.298**	11.606**	11.463**
	(3.144)	(3.143)	(3.143)	(4.564)	(4.563)	(4.563)
Sweden	16.856***	16.757***	17.101***	33.503***	33.416***	33.829***
	(3.179)	(3.174)	(3.180)	(4.615)	(4.607)	(4.616)
UnitedKingdom	7.200**	6.893**	7.342**	21.648***	21.298***	21.837***
	(2.924)	(2.912)	(2.923)	(4.245)	(4.227)	(4.244)
High-tech	2.992	2.804	2.791	6.979**	6.728**	6.712**
	(1.937)	(1.939)	(1.939)	(2.812)	(2.815)	(2.815)
KIBS	4.054***	4.089***	3.989***	3.718**	3.751**	3.631**
	(1.220)	(1.219)	(1.220)	(1.771)	(1.769)	(1.771)
Intercept	−11.380***	−11.057***	−11.559***	−19.559***	−19.193***	−19.795***
	(2.939)	(2.925)	(2.939)	(4.267)	(4.246)	(4.267)
R^2	0.026	0.026	0.027	0.034	0.038	0.038
F-level	7.59***	7.73***	7.40***	11.06***	11.20***	10.59***

Firms in Croatia and in the low-tech sector are subsumed in the intercept term
(standard errors in parentheses)
*** significant at .01-level, ** significant at .05-level, * significant at .10-level

Conclusions

An important finding in the entrepreneurship literature is that small firms are able to compensate for their size-inherent disadvantages, such as an ability to invest in R&D and other knowledge creating inputs, by harnessing knowledge created in other organizational contexts, or by accessing external knowledge spillovers. A rich body of empirical evidence suggests that the performance of entrepreneurial firms has been enhanced through knowledge spillovers emanating from two main sources of knowledge: other firms and universities.

While the results of our paper are specific to KIE firms, they do not contradict this important and robust general finding prevalent in the literature, that both the R&D investments of other firms and research undertaken by universities provide an important source of knowledge spillovers, our findings do suggest an additional performance-enhancing source of knowledge of entrepreneurial firms—the public sector. In fact, the performance of KIE firms, measured in terms of employment growth and sales growth, responds positively to higher levels of public sector investments in new knowledge.

Future research might consider more detailed sources of knowledge obtained through in-depth surveys or case studies that may enhance knowledge spillovers to a broader age spectrum of firms or to established compared to nascent firms This expanded effort would overcome the narrow measures of knowledge spillovers that we were constrained to consider through our analysis of information in the AEGIS database. A welcome contribution for future research would be to probe those specific aspects of the national institutional context that alternatively impede or enhance knowledge spillovers from the public sector or even from the university sector given that many universities are publicly supported. Still, the results of our analysis of KIE European firms make clear that the public sector is an area for greater study regarding its provision of performance enhancing knowledge.

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