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The Demand for Researchers
Does Public R&D Support Make a Difference?[+]

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Abstract
We estimated demand functions for researchers by using panel data on R&D performing manufacturing firms in Turkey for the period 1993-2001. Estimation results show that R&D support receiving firms increase substantially their demand for researchers.

Keywords: Public R&D support, demand for researchers, policy evaluation

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1. Introduction

The literature on technology policy has emphasized the importance of public support as an instrument to affect the rate and direction of technological change. The primary output of R&D activities is knowledge. The non-excludability and non-rival features of knowledge make the returns to the investment in R&D to be incompletely appropriated by the firm undertaking the investment, and, consequently, social returns exceed private returns. Public support for R&D is introduced to raise private returns (optimally, to the level of social returns) and to promote private investment in R&D.

There is a substantial literature that assesses the effects of public support on R&D (for surveys, see David et al., 2000; Klette et al. 2000). Empirical analyses have so far relied almost entirely on the data on R&D *expenditures*, either as a proportion to sales (R&D intensity), or as nominal expenditures deflated by a common industry price index. However, some researchers suggest that increases in R&D expenditures may lead to increases in researchers' wages (see Goolsbee, 1998; Marey and Borghans, 2000; Jaumotte and Pain, 2005). The wage effect could be even higher for R&D support receiving firms that may share a part of R&D subsidies with their scientists and engineers. In such a case, empirical analyses that use R&D *expenditures* as the outcome indicator will overestimate real effects on R&D *activities*. An accurate assessment of public R&D support requires the data on quantitative measures of R&D inputs.

We use here the data on the number of researchers because researchers' labor is the main input for R&D activities. To the best of our knowledge, this paper provides the first direct test in the literature on the effect of public R&D support programs on the demand for researchers.[1]

2. R&D support policies in Turkey

The first institution to provide R&D support in Turkey, the Technology Development Foundation of Turkey (TTGV), was established in 1991 and has provided interest-free loans denominated in US dollars for industrial R&D projects since 1992. The Scientific and Technical Research Council of Turkey (TUBITAK) initiated an R&D grant program in 1995 for industrial R&D projects and established a special division (TIDEB) in charge of the program. TIDEB provides grants up to 60 percent of R&D expenditures of industrial firms.

Although the number of R&D conducting firms has increased gradually in the 1990s, they constituted only 2 percent of all manufacturing firms in our database in 2001 (Table 1)[2]. The share of R&D support receiving firms increased rapidly in the mid-1990s, especially after the TIDEB program was initiated in 1995. The 2001 economic crisis in Turkey had a negative effect on R&D activities, and the number of R&D performers declined sharply during the crisis. The share of support receiving

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[1] Suetens (2002) studies the effect of R&D subsidies on R&D employment in the Flemish region. Her findings are inconclusive.

[2] For this study, we matched three data sets for the 1993-2001 period: the *Annual Surveys of Manufacturing Industries* (ASMI) that contain data on all manufacturing establishments employing 10 or more people, the *R&D Surveys* that cover all firms known to perform R&D activities, and a data set for all TTGV and TIDEB clients. The ASMI and R&D surveys are conducted by the Statistical Institute of Turkey (Turkstat).

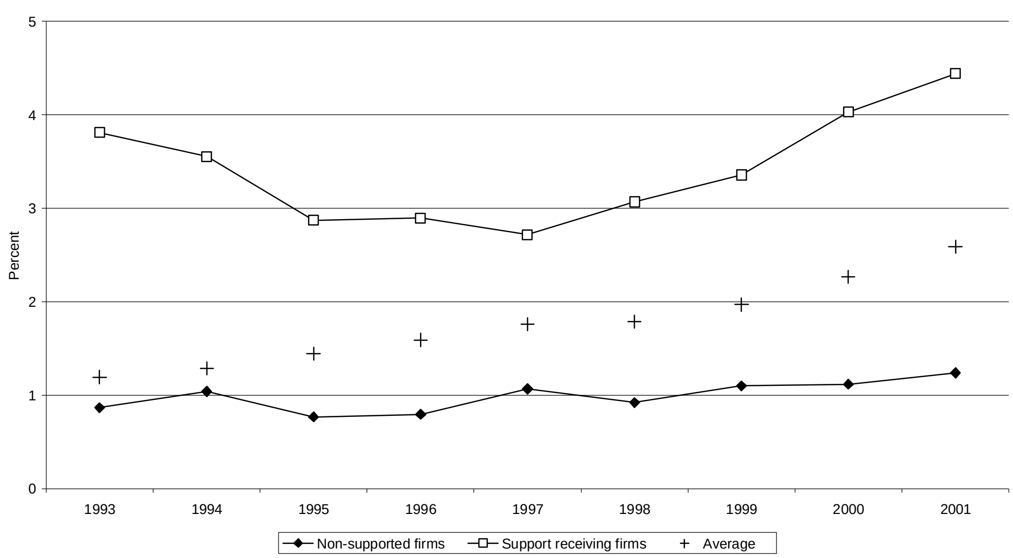
firms in R&D performers increased from nil to 30 percent in only five years (from 1991 to 1996) right after two support programs were initiated and fluctuated around 30 percent level in the late 1990s.

Table 1. Number of firms in the database, 1993-2001

	1993	1994	1995	1996	1997	1998	1999	2000	2001
All firms	10565	10125	10190	10584	11371	12321	11262	11112	11305
R&D conducting	139	138	146	166	237	270	273	267	226
Support receiving	5	6	30	54	71	84	74	82	66
TTGV client	5	6	12	19	19	22	16	28	19
TIDEB client	0	0	27	54	70	81	70	77	62

To observe the effects of R&D supports on the employment of researchers by manufacturing firms, we first compare the share of researchers in total employment of support receiving and non-supported R&D performing firms. The number of researchers increased steadily from about 1400 in 1993 to 3400 in 2000, followed by a slight decline during the economic crisis in 2001. Total employment in R&D performing firms also expanded, albeit at a lower rate, in the same period. As a result, the share of researchers in total employment increased from 1.2 percent in 1993 to 2.6 percent in 2001. R&D support receiving firms achieved a rapid increase in researcher intensity since the mid 1990s,[3] and employed proportionately more researchers than non-support receiving firms did throughout the period (Figure 1). Thus, the increase in the average share of researchers can be explained by the increase in researcher intensity in supported firms, and increasing share of supported firms among R&D performing firms.

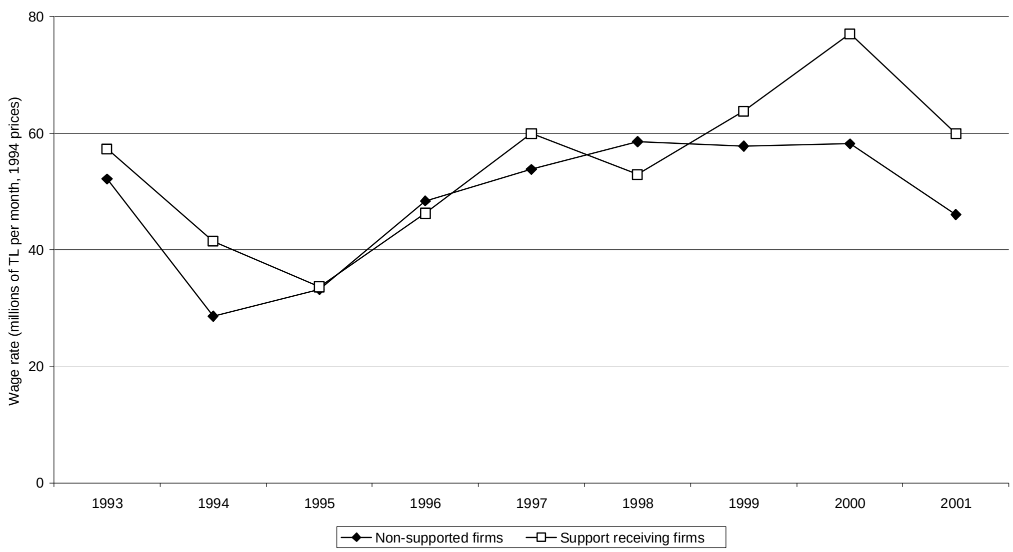
Figure 1. Employment share of researchers by R&D support status, 1993-2001



[3] The share of researchers in support receiving firms declined in 1994 and 1995, but this process simply reflects the fact that the first firms supported in 1993 and 1994 (only 5 firms) had very high share of researchers.

Our findings indicate that R&D support is likely to encourage employment of researchers. However, the increased demand by supported firms may force them to pay higher wages for researchers. We calculated (weighted) average wage rates paid for researchers by support receiving and non-supported firms (see Figure 2). It seems that there is no significant wage differential by support status. Researchers employed by non-supported firms receive, on average, almost the same wage as their colleagues employed by support receiving firms. Moreover, researchers' wages decline sharply during economic crises in 1994 and 2001. It seems that researchers employed by supported firms do not benefit more from public support in the form of higher wages.

Figure 2. Average wage rate of R&D researchers by support status, 1993-2001



3. The model and estimation results

In order to evaluate the effect of public support on the demand for R&D researchers, we estimate a dynamic labor demand model. Since a dynamic labor demand function can be analytically derived under very restrictive assumptions, we follow the common practice in the labor economics literature and estimate an empirical model:

[1] $$L_{i,t} = a_L L_{i,t-1} + a_s s_{i,t} + \Sigma_j a_j p_{j,i,t} + a_q q_{i,t} + a_z z_{i,t} + a_i + a_t + e_{i,t}$$

where L is the number of employees (researchers in our case), s the dummy variable for support status, p_j the price of the j^{th} input ($j \in \{wr, we, m, k\}$), q real output, and z other factors. α_i and α_t account for unobservable firm-specific and time-specific (macroeconomics) effects, and ε is the error term. Support status variable, $s_{i,t}$, takes the value 1 if the firm i receives R&D support from TTGV or TIDEB at time t, 0 otherwise. Labor, prices, and output are all in logarithmic form. Real output is calculated by deflating nominal output by output price index at the ISIC (Revision 2) 4-digit level.

Since real output is included, equation 1 defines the demand for labor conditional on a given output level. In such a case, the demand function should be homogenous of degree zero in input prices ($\Sigma a_j = 0$). The unconditional labor demand function is estimated by excluding the real output variable. The coefficient of the lag dependent variable, a_L, defines the speed of adjustment.

Average wage rates for researchers at the firm level (p_{wr}) are calculated by dividing gross wage bill by the number of researchers. Average wage rates for other employees (p_{we}) are calculated similarly. Since the demand function is estimated, (nominal) average wages are deflated by output price indices, i.e., real product wages are used. Material input and services prices (p_m) are defined at the ISIC 4-digit level, whereas gross fixed capital formation deflator is used for the cost of capital (p_k). Both series are deflated by output price indices. The model includes a technology transfer dummy variable, z, (taking the value 1 if the firm transferred technology from abroad through license or know how agreement) to test if technology transfer complements or substitutes indigenous technological activity.

There are a number of issues regarding estimating the demand function. First, it includes unobserved firm-specific effects that could be eliminated by using first differences. Second, the wage variables (and, possibly the output variable) are likely to be endogenous because the quantity demanded and wages are determined jointly by demand and supply conditions. Third, the support status variable is also endogenous due to selection (receiving R&D support) effect. Since standard panel estimation techniques would produce biased and inconsistent estimates under these conditions, the System Generalized Method of Moments (GMM-System) is chosen to estimate the demand function.[4]

Estimation results are presented in Table 2. The diagnostics tests do not reveal any specification problem. The homogeneity test for conditional demand function (Model 2) does not reject the hypothesis that the degree of homogeneity is zero in prices. Hansen tests of overidentifying restrictions do not reject the validity of instruments. The Arellano-Bond test for autocorrelation, applied to the differenced residuals, detects first order but not second order autocorrelation, as required by the model.

The coefficient of the support status variable is significant at the 1 percent level in both models. The short run R&D support elasticity of demand for researchers is about 0.35, and the long run elasticity is about 0.85–0.90. These findings suggest that R&D support has substantial impact on the demand for researchers, and the increase in the number of researchers employed by manufacturing firms in Turkey in the 1990s could partly be explained by this effect.

Estimation results suggest that half life of adjustment is about 1.3 years, i.e., the employment of researchers in Turkey adjust to its optimum rather quickly. Short and long run own wage elasticities (about -0.2 and -0.5, respectively) show that the demand for researchers is not inelastic. Firms are quite cost-sensitive in employing researchers. Other input prices seem to have only a weak effect. Interestingly, the technology transfer variable has a significant positive impact on the demand for researchers: indigenous R&D and technology transfer are likely to be complementary

[4] The following variables are used as additional instruments: share of skilled employees (SKILL), profit margin (PM), lag R&D intensity (L.R&D), log number of supported firms in the last two years in the same region (REG_SUP) and in the same sector (IND_SUP), and sectoral R&D intensity (SECT_R&D). We estimated a random effects probit model of support status in which all these variables, and the lag value of the (log) number of researchers (L.NRESEARCH) and time dummies are used as explanatory variables, and found that L.R&D, REG_SUP, SECT_R&D and L.NRESEARCH have all positive and statistically significant coefficients. In other words, those firms that employ more researchers and spend more on R&D are more likely to get R&D support. Moreover, there seems to be regional informational spillovers (REG_SUP), and firms operating in R&D intensive sectors are more likely to benefit from R&D support even after controlling for their own R&D intensity.

activities. Finally, the output elasticity is also significant (0.13 in the short run, 0.31 in the long run).

Table 2. Determinants of demand for R&D researchers

Variables	Model 1			Model 2		
	Coeff	Std err		Coeff	Std err	
L_{t-1}	0.594	0.084	**	0.590	0.081	**
S	0.343	0.107	**	0.358	0.097	**
p_{wr}	-0.196	0.076	**	-0.196	0.073	**
p_{we}	0.277	0.118	*	0.029	0.131	
p_m	0.018	0.167		0.024	0.150	
p_k	-0.014	0.167		0.155	0.161	
Z	0.223	0.085	**	0.182	0.078	*
Q				0.128	0.054	*
Degree of homogeneity	0.085			0.011		
Hansen overidentification test, Chi^2(d.f.)	133.6	(130)		163.2	(161)	
AR (1) test	-3.02	**		-2.98	**	
AR (2) test	1.32			1.33		
N observations	1120			1119		
N establishments	343			343		

Notes: All models include time dummies. Finite-sample corrected two-step covariance matrix is used for standard errors.
** (*) means statistically significant at the 1 % (5 %) level, two-tailed test.

4. Conclusions

We analyze the effect of public support on R&D activities. This study differs from other R&D support assessment studies by its focus on R&D *activities*, not on R&D *expenditures*. Our findings show that support receiving firms demand more researchers, i.e., public R&D support makes a difference.

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