BİLGESEL

İktisat İşletme ve Finans 26 (298) 2011 : 9-20

www.iif.com.tr

doi: 10.3848/iif.2011.298.2827

Sectoral human capital spillovers: Evidence from Turkey

Ozan Bakis[*], *Nurhan Davutyan*[**], *Haluk Levent*[*], *Sezgin Polat*[*]

Received 7 April 2010; received in revised form 14 October 2010; accepted 28 October 2010

Abstract

Evidence based on the data from the 2004-2008 Household Labor Surveys, demonstrates the existence of within sector knowledge spillovers in Turkey. Estimates from a two step confirm prior findings for different countries. Job tenure proxying for on the job training is a source of human capital externality. We further discuss various labor market characteristics pertaining to this result. We show that the externality effects of education and job tenure reinforce each other once a threshold is crossed. Our results confirm the findings of recent literature emphasizing social interactions between workers as major sources of spillover. For bigger firms, the estimated externality effect is stronger.

Keywords: *human capital, externalities, returns to education, growth*

JEL Classification: *I20 C21 J24*

Özet . Türkiye'de sektörel beşeri sermaye bilgi taşması

2004-2008 arası Hanehalkı İşgücü Anketleri kullanılarak elde edilen bulgular Türkiye'de sektörel bilgi taşması etkisi olduğunu ortaya koymaktadır. İki aşamalı kestirimler diğer ülkelerdeki bulgularla paralellik taşımaktadır. İşbaşında eğitimin bir göstergesi olarak değerlendirilebilecek "mevcut işteki kıdem" bir beşeri sermaye dışsallığına yolaçmaktadır. Çalışmanın diğer bir bulgusu da Türkiye'deki sektörel bilgi taşması anlamında eğitim ve kıdemin birbirlerini ikâme eden değil tamamlayan bir etki oluşturduklarıdır. Bu pozitif dışsallık ancak belirli bir eşikten sonra etkili olabilmektedir. Gerçekleştirilen tahminlerde de "işyeri büyüklüğü" değişkeni dışsallık etkisini kuvvetlendirmektedir. Bu bulgular, teorik olarak ortaya konan, çalışanlar arasında işyeri içi etkileşiminin önemli olduğuna dair görüşü desteklemektedir.

Anahtar Kelimeler: beşeri sermaye, dışsallık, eğitimin getirisi, büyüme

JEL Sınıflaması: *I20 C21 J24*

[*] Galatasaray Economic Research Center (GIAM), Galatasaray University, Istanbul. E-posta: ozanbakis@gmail.com, levhaluk@gmail.com, sezginpolat@gmail.com

[**] Marmara University, Istanbul. E-mail: ndavutyan@marmara.edu.tr

Introduction

Human capital as well as research and development are the main determinants of growth according to new endogenous growth theory. From this perspective, external effects associated with human capital and knowledge are the main source of growth (Acemoglu, 2009; Lucas, 1988; Romer, 1990).

A great deal of effort has been expended to empirically establish the existence of these external effects. Similarly measuring their magnitude has attracted attention and effort. Early literature used cross-country growth regressions, Barro (1997). Recent literature focuses on micro data (See Rauch, 1993; Sakellariou and Maysami, 2004; Kirby and Riley, 2008 among others). The idea is to see how wages are correlated with individual and/or aggregate human capital. A widely used proxy for human capital is years of schooling. If there were no external effects, that portion of a person's wage due to education should depend only on her/his years of schooling. But if individual wages depend on average years of schooling (or number of educated people) in a given environment (region, sector, city), then external effects may be operative.

We contribute to this growing literature by presenting evidence on external returns to sectoral level human capital in Turkey[1]. Using a two-stage econometric approach with 2004-2008 Household Labor Survey (HLS), we find strong evidence for knowledge spillovers within Turkish industrial sectors.

Graph 1 Average Hourly Real Wage and Education level, Region by Industry (2004-2008)

[1] See for further discussion on human capital in Turkey; Ay and Yardimci (2007) and Karataş and Deviren (2005)

Graph 1 displays the relation between average real wages[2] and education for 420 industry-region-year pairs. We have 7 sectors[3] in 12 NUTS1 regions for 5 years (2004-2008). Average real wage values plotted against average schooling levels, reveal a positive relationship. According to the human capital externality hypothesis, individual differences - in education levels or in tenure and experience –alone, cannot account for this pattern. Endogenous Growth Theory stresses knowledge spillovers as an additional source and emphasizes their importance for economic growth.

The key mechanism is social interactions between workers that enhance their productivity. Workers in the same industry and location are expected to have more and deeper interactions. Even if we do not know precisely how a worker's knowledge improves the productivity of her/his colleagues, it is believed such interaction is at the source of knowledge spillovers[4]. In this paper we test this hypothesis by considering industries in different locations as units of interaction and learning. Since interactions and learning from others are central to spillover effects we treat both average years of schooling and job tenure as potential sources.

The recent empirical literature based on endogenous growth theory has documented some evidence in support of external returns to education. Rauch (1993), Sakellariou and Maysami (2004) and Moretti (2004), Kirby and Riley (2008) find positive and significant human capital externalities while Sakellariou (2001) and Ciccone and Peri (2006) report insignificant estimates. Acemoglu and Angrist (2000) find positive estimates with ordinary least squares, however when instrumental variables technique is used they find no significant effect of human capital externalities. This paper falls in the first strand and uses industrial sectors as the locus of interaction. We use a two-stage approach to estimate external effects of human capital.

Data and methodology

Micro level labor surveys in Turkey are not disaggregated enough at industry level to reflect the full extent of wage differentials across sectors. We disaggregated HLS data consisting of only 7 sectors in 12 NUTS1 regions into 84 sector-region units. Since we have the 2004-2008 HLS surveys, we constructed a pooled time-series cross section data comprising 420 "cells". The 5-year average real hourly wages of wage earners in 7 industries by nut1 regions (Table 1) roughly displays how wages vary across these sectors.

---

[2] Hourly real wages are expressed at 2004 prices and adjusted at NUTS1 level to take into account regional variation.

[3] We omitted the agricultural sector and merged mining with gas and electricity to avoid the small sample size problem.

[4] See Lucas (1988, p.37) and Glaeser et al. (1992) for further discussion.

Table 1

Average Hourly Real Wages by sector-by-region (average of 5 years - 2004-2008)

Nuts 1	Electricity, gas, water + Mining and quarrying	Manufacturing	Construction	Wholesale and retail trade + Restaurants and hotels	Transportation, communication and storage	Financial institutions + Real estate renting	Community services
1	2.80	4.64	3.14	2.89	4.02	4.50	4.44
2	2.51	3.95	2.25	1.77	2.76	3.14	4.71
3	2.42	4.22	2.48	2.10	3.18	3.31	4.58
4	2.62	4.15	2.41	2.02	2.90	2.92	4.45
5	2.61	4.32	2.79	2.06	3.62	3.87	5.12
6	2.15	4.88	2.13	1.91	3.13	2.91	4.71
7	2.29	3.74	2.34	1.68	3.05	2.97	4.82
8	2.53	5.56	2.06	1.60	2.85	3.01	4.71
9	2.08	5.44	2.38	1.85	3.56	3.32	4.98
10	2.27	4.76	2.18	1.67	3.21	2.82	4.77
11	2.22	4.16	2.33	1.55	3.40	2.98	4.74
12	1.78	5.03	1.65	1.41	2.07	2.82	4.28

Source: Turkstat Household Labor Surveys

We use two-step estimation strategy proposed by Winter-Ebmer (1994) and further elaborated by Sakellariou (2001), Sakellariou and Maysami (2004). This strategy was first used by Solon et al. (1994) to eliminate the intragroup correlation causing downward biased standard errors. As first pointed out by Moulton (1986, 1990) when a regression model has both aggregate and individual explanatory variables, the error term of the regression can have two components: an individual one and an aggregate one faced by all individuals in the same cell. (This aggregate component may be caused by cell specific shocks e.g. a fashion trend favoring Aegean coast housing). In this case, OLS estimates are inefficient and estimates of standard errors are biased and inconsistent. Technically the error term is said to be nonspherical, i.e. the variance-covariance matrix has off-diagonal terms equal to the variance of the random part associated to the aggregate variable. Efficient estimates may be obtained by either using GLS or using a 2-step method. We chose the second alternative. In the first step, a standard wage regression[5] isolates private returns to education by controlling for individual characteristics and using dummies for each 420 industry[6] by year-region cells. First step regression is estimated using standard OLS at the individual level.

$$\log w_{ijrt} = \delta X_{ijrt} + \alpha_{jrt} F + u_{ijrt} \tag{1}$$

where w_{ijrt} stands for real hourly wage of individual i in industry j of region r at year t. α_{jrt} denotes an industry-by-region-by-year dummy variable vector that is obtained by interacting industry dummies, Z_j, regional dummies, DR_r, and year dummies, DT_t. In total we obtain F=$Z \times DR \times DT = 7 \times 12 \times 5 = 420$ dummy variables for α_{jrt}. The inclusion of dummies in Eq. 1 picks up the relationship between the fixed industrial, regional and yearly effects by excluding aggregate variables or cell means. Prior work has typically considered only sector or only region specific shocks, e.g. Sakellariou and Maysami (2004). However idiosyncratic shocks specific to all three sources may coexist and interact[7]. The idea is to capture the effect of unobserved factors on wages that may vary across industries, regions and years in the first stage regression.

$$\hat{\alpha} = Cons + \beta H_{jrt} + \gamma C_{jrt} + Z_j + DR_r + DT_t + \nu_{jrt} \tag{2}$$

[5]Individual characteristics control for gender, education, age, age square, tenure, tenure square marital status, firm size (3 dummies), social security coverage and 9 occupation dummies. Table 4 displays the results of the first regression.

[6] In addition to HLS's high sectoral aggregation, substantial heterogeneity in local labor markets is another justification for creating industry-region pairs.

[7] Concretely a shock to the manufacturing sector can impact, say, Diyarbakır and Istanbul differently; similarly a regional shock may affect, say, the construction and manufacturing industries in a different manner. We thank an anonymous referee who helped us sharpen our exposition on these points.

In the second stage, estimated industry wage differentials using Eq.1 in the first step, $\hat{\alpha}_{jrt}$, are regressed on average industry human capital, H_{jrt}, and other industry control variables, C_{jrt}. We use average education level and job tenure of the industry as human capital proxies. The share of workers having formal contract, the share of small firms (less than 50 workers), share of female workers and the share of unqualified workers (workers with elementary qualifications according to ISCO 88 occupation classification) are used as industry controls in the second regression equation.

In the second step, external effects of human capital are found by regressing industry wage differentials on average industry human capital and other industry control variables. The error terms of different individuals in the same cell may share some joint component of variance which is not entirely attributable either to their measured characteristics or to their specific cell characteristics. Neglecting this cross-sectional positive correlation across people in the same cell may understate the conventional standard error estimates (Park and Shin 2008). To have appropriate standard errors in the second step, we used weighted least squares to estimate the second equation as proposed by Solon et al (1994). The weights of each industry and region by-year observation are taken as the number of wage earners in each cell in the first regression. Industry, region and time effects are also controlled in the second step.

We have to mention that the wage differentials or wage premia across industries may arise from several other factors like the degree of centralization of wage negotiations[8] or industry-specific capital intensity. The lack of data at the local industry level prevents the inclusion of such important factors that would affect wage premia in the first regression. We expect that formal sector dummy (workers having formal contracts) and firm size dummies may help to capture the lack of institutional factor of local labor market[9]. As for the second step, the Industry wide averages of education and job tenure are key variables in testing the empirical validity of the knowledge spillover hypothesis. Job tenure can account for amount of on-the-job-training or firm-specific human capital, since its length will enhance such training or capital.

[8] The wage setting process can be characterized as largely decentralized as far as the private sector is concerned. The only official data available on unionization rates is by the Ministry of Labor asserts over 50 percent union membership, yet these official unionization figures are commonly accepted as a gross overestimation. More realistic estimations range between 10 to 18 percent unionization and approximately 25 per cent collective bargaining coverage (Ilkkaracan 2005).

[9] Borjas et al. (1992) propose a test to overcome the potential self-selection problem in the context of efficiency-wage theory. It might be the case that highly qualified worker may choose to work in better-paid industries where average education level is relatively high. A positive correlation between average education/tenure and wage dispersion implies selection bias. We have tested for selection bias. As a measure of wage dispersion, we used, following Borjas et al. (1992), the root mean square error of the industry-by-region wage regressions (standardized dispersion). We found correlation coefficients of -0.059 and - 0.024 for average education and tenure respectively both not significant at 10% level. Thus, we can neglect the self-selection bias regarding the negative and non-significant correlation of both average education and tenure with the standardized wage dispersion.

Thus, via interaction between workers, augmented skill levels lead to industry specific external returns. Mean education has a similar effect on wages. A worker working in an industry with a higher average education level will have more exposure to knowledge than a wage earner working in an industry with a lower average education level.

Table 2

	2 Step Estimations (2004-2008 HLS)				
	Model 1	Model 2	Model 3	Model 4	Model 5
Education	0.014*		0.014*	-0.018	-0.055***
	(0.006)		(0.006)	(-0.013)	(-0.013)
Tenure		0.001	0.00	-0.027**	-0.037***
		(0.003)	(0.003)	(-0.01)	(-0.009)
Education*Tenure				0.003**	0.004***
				(0.001)	(0.001)
Formal Contracts					0.105
					(0.07)
Firm size (small)					-0.332***
					(-0.066)
Unqualified Workers					-0.268**
					(-0.082)
Female Workers					-0.037
					(-0.089)
Cons	-0.689***	-0.580***	-0.690***	-0.421***	-0.038
	(-0.052)	(-0.021)	(-0.053)	(-0.107)	(-0.118)
N	420	420	420	420	420
Adj. R2	0.73	0.726	0.729	0.736	0.785

*note: *** p<0.001, ** p<0.01, * p<0.05, standard errors in parentheses*
For each model, we control for industry, region and year effects.

Table 2 display five specifications for the second stage regressions. HLS data offers a richer picture of the impact of knowledge spillovers in local industries. Throughout 2004-2008, average level of education is capable of explaining wage differentials across local industries. The individual effect education become insignificant when an interaction term is introduced (model 4 in Table 2). Interaction term's significant effect reveals a close relationship between job tenure (firm specific skills) and level of education which reflects learning capacity. This means workers' ability and firm specific job training move in tandem leading to a more pronounced production externality. It is true that given a low level of tenure in an industry region cell, the marginal externality effect of education would be negative (Table 3). Even if this result looks like counterintuitive, it becomes more plausible once we interpret that finding in terms of social interactions between workers. These social interactions are the key mechanism by which knowledge spillovers and externality occur. What the above finding says is that one more year of education (tenure) in a given industry region cell would be associated with positive externality only if there is "enough" tenure (education) in that cell. We interpret the negative externality effects as follows: when the tenure level is very low in an industry region cell, workers are less motivated to share their knowledge given the high job turn-over or high job destruction; similarly when the education level is very low in an industry region cell, there is insufficient knowledge creation and thus lower knowledge spillovers. So, tenure and education are equally important in the learning process, because they both contribute to the social interactions with colleagues. This finding is crucial in pointing out to a complementarity between average education and average job tenure in local industries.

As seen in Table 3, there is a threshold level above which spill-over of both tenure and education becomes effective. Such spillovers do not occur at very low levels of tenure years, below some threshold (this threshold is 6 years for Model 4 and 13.75 years for Model 5). If confirmed by more detailed studies, this result could be invoked to argue for more employment protection which may lead to lower job turn-over or less job destruction. At the local level, we wish to draw attention to the importance of labor market institutions that would play a role in helping materialize the externalities emerging from the interplay of both tenure and education.

Table 3 Marginal externality Effects (MEF) of Education and Tenure

	Model 4			Model 5
Years	MEF of Education conditional on Tenure level	MEF of Tenure conditional on Education level	MEF of Education conditional on Tenure level	MEF of Tenure conditional on Education level
1	-0.015	-0.024	-0.051	-0.033
5	-0.003	-0.012	-0.035	-0.017
8	0.006	-0.003	-0.023	-0.005
11	0.015	0.006	-0.011	0.007
15	0.027	0.018	0.005	0.023
Threshold	6.00	9.00	13.75	9.25

Table 3 is based on Models 4 and 5. Given that there is an interaction term between tenure and education the marginal externality effect of education (tenure) depends on the level of the tenure (education). The MEF of education conditional on tenure level is seen in the first and third columns of Table 3. The MEF of education is negative for low values of tenure, but increases with average tenure years of the sector so that for high values of tenure it becomes positive. The threshold level of tenure for education to have positive externality is 6.0 years for Model 4 and 13.75 years for Model 5. The second and fourth columns show the MEF of tenure conditional on the level of education. We have a similar picture whereby at low levels of education MEF of Tenure is negative, but increases with average education years. The threshold level of education for tenure to have positive externality effect is approximately 9 years in both Models 4 and 5.

The negative and significant coefficient of the share of small firms underlines the scale effect having a strong positive externality due to either greater organizational efficiency or superior production technology. Beside the share of small firms, the only significant control variable is the share of unqualified workers –no occupational skills, no job related training.

Conclusion

Our results confirm the findings of recent literature emphasizing social interactions between workers as major sources of spillover. For small firms, the estimated externality effect is lower. This may be due to limited interactions within small firms. Given the interaction term education-by-tenure is found to be significant, educated and tenured workers significantly contribute to sectoral externalities at the local level. More importantly when the interaction term is included, the coefficients of both education and tenure become negative implying that there are critical thresholds for tenure and education to create externalities. For low values of education and tenure the expected externality effect is negative. This finding is compatible with Benhabib and Spiegel (1994): human capital is not an ordinary input like capital which is directly used in the production, but it affects mainly the capacity to implement and adopt new technologies in a changing environment. Such flexibility requires both education and experience.

Acknowledgements

We would like to thank an anonymous referee for his/her valuable comments and suggestions. We also thank to TUIK staff, Enver Taştı and Didem Sezer for their generous help. Any remaining errors are ours.

References

Acemoglu, D. (2009): "An introduction to the economics of growth". Princeton, NJ: Princeton University Press.

Acemoglu, D. and J. Angrist (2000). "How large are human capital externalities ? Evidence from Compulsory Schooling Laws" in B. Bernanke and K. Rogoff, Editors, NBER Macroeconomics Annual **vol. 15**, MIT Press: Cambridge.

Ay,A. and P. Yardimci (2007). "The role of trade and human capital in endogenous economic growth and technological change of Turkey (1963-2002): A cointegration analysis of Peseran's bound test", *İktisat İşletme ve Finans,* **22**. 99-115

Barro, R.J. (1997). "Determinants of economic growth", *The MIT Press*, Cambridge, MA (1997).

Benhabib J. and M. Spiegel (1994). "The role of human capital in economic development: Evidence from aggregate cross-country data". *Journal of Monetary Economics,* **34,** 143-174. doi:10.1016/0304-3932(94)90047-7

Borjas, G.J., S.G. Bronars, and S. Trejo (1992). "Self-selection and internal migration in the united states". *Journal of Urban Economics,* **32**, 159-185. doi:10.1016/0094-1190(92)90003-4

Card, D. (1995). "The wage curve: A review", *Journal of Economic Literature,* **33**, 785-799.

Ciccone, A. and G. Peri (2006). "Identifying human-capital externalities: theory with applications", *Review of economic Studies,* **73**, 381-412. doi:10.1111/j.1467-937X.2006.00380.x

Glaeser, E.L., H.D. Kallal, J.A. Scheinkman and A. Schleifer (1992). "Growth in cities", *Journal of Political Economy,* **100**, 1126-1152. doi:10.1086/261856

Ilkkaracan, I. (2005). "Uluslararası bir Perspektiften Türkiye'de Ücret Merkeziyeti ve Koordinasyonu" (Wage Centralization and Coordination in Turkey from an International Perspective), Dokuzuncu Ulusal Sosyal Bilimler Kongresi, Türk Sosyal Bilimler Derneği, ODTÜ, Ankara.

Karataş,M and N.V. Deviren (2005). "An Analysis of Economic Development in Turkey in light of the Solow Model including Human Capital" *İktisat İşletme ve Finans*, **20,** 68-87

Kirby, S. and R. Riley (2008). "The external returns to education: UK evidence using repeated cross-sections", *Labour Economics,* **15**, 619-630. doi:10.1016/j.labeco.2008.04.004

Krueger, A., and M. Lindahl (2001). "Education for growth: why and for whom?" *Journal of Economic Literature,* **39**, 1101-1136.

Lucas, R.E. (1988). "On the mechanics of economic development", *Journal of Monetary Economics,* **22**, 3-42. doi:10.1016/0304-3932(88)90168-7

Montuenga-Gomez, V. M. and J.M. Ramos-Parreno (2005). "Reconciling the wage curve and the Phillips curve", *Journal of Economic Surveys,* **19**, 735-765. doi:10.1111/j.0950-0804.2005.00266.x

Moretti, E. (2004). "Estimating the social return to higher education: evidence from longitudinal and repeated cross-section data", *Journal of Econometrics,* **121**, 175-212. doi:10.1016/j.jeconom.2003.10.015

Rauch, J. E. (1993). "Productivity gains from geographic concentration of human capital: evidence from the cities", *Journal of Urban Economics*, **34**, 380-400.

Romer, P. M. (1990). "Endogenous technological change", *Journal of Political Economy*, **98**, S71-S102. doi:10.1086/261725

Sakellariou, C. (2001). "Identifying the external effects of human capital: a two-stage approach", *Applied Economics Letters,* **8**, 191-194. doi:10.1080/13504850150504586

Sakellariou, C. and R. Maysami, (2004). "Lucas type external effects of human capital: strong evidence using microdata" , *Applied Economics Letters,* **11,** 343-346. doi:10.1080/1350485042000228169

Solon, G., R. Barsky and J. Parker (1994). "Measuring the cyclicality of real wages: how important is composition bias?", *Quarterly Journal of Economics,* **109**, 1-26. doi:10.2307/2118426

Vandenbussche, J., P. Aghion, and C. Meghir (2006). "Growth, distance to frontier and composition of human capital", *Journal of Economic Growth*, ***11***, 97-127. doi:10.1007/s10887-006-9002-y

Winter-Ebmer, R. (1994). "Endogenous growth, human capital and industry wages", *Bulletin of Economic Research,* **46**, 289-314. doi:10.1111/j.1467-8586.1994.tb00593.x

Table 4 results of the First Regression

Dependent variable log hourly real wage	
Independent variables	
gender (female=1)	-0.044***
age	0.042***
age sqr.	-0.000***
education (years of schooling)	0.033***
tenure	0.019***
tenure sqr.	-0.000***
firm size (<25)	-0.193***
firm size (25-50)	-0.087***
marital status	0.074***
state employee	0.372***
having formal contract	0.180***
Legislators, Senior Officials and Managers	0.499***
Professionals	0.533***
Technicians and Associate Professionals	0.265***
Clerks	0.127***
Service and Sales Workers	0.015***
Skilled Agricultural and Fishery Workers	0.078***
Craft and related Trades Workers	0.080***
Machinery Operators and Assemblers	0.086***
Number of observations	282,494
Adjusted R2	0.835

*note: *** p<0.001, ** p<0.01, * p<0.05*
The omitted categories are firms > 50 worker for firm-size, the elementary occupation for occupation dummies 420 Industry-by-region-by-year dummies are significant at %1 level and are not presented in the table.