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Izak Atiyas* Ozan Bakis†

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Özet:

Yerli firmalarla kıyaslandıklarında yabancı kontrollü firmaların (i) daha büyük (ii) hem işgücü hem toplam faktor verimliliği olarak daha verimli; ve (iii) daha yenilikçi (hem hakiki yenilik hem de ihracat yönelimi ve ARGE faaliyetleri bağlamında) oldukları gözlenmektedir. Regresyon analizi sonuçlarına göre yaş ve büyüklük kontrol edildiğinde yabancı firmaların yenilik, ihracat ve ARGE eğilimleri daha yüksektir. Yabancı sermayenin yatay, ileri ve geri bağlantılar vasıtası ile yarattığı dışsallıkların ARGE ve yenilik faaliyetleri üzerindeki etkisi hakkındaki sonuçlar muğlak olsa da ihracat yönelimi için her üç bağlantının da istatistiki olarak anlamlı olduğu görülmektedir.

Anahtar Kelimeler: Verimlilik; Doğrudan Yabancı Yatırım; Yenilik; ARGE Harcamaları; Yatay-İleri-Geri Bağlantılar

Abstract:

Relative to domestic firms, foreign firms in Turkey are (i) larger, (ii) more productive (both in the sense of labor productivity, and in the case of manufacturing, TFP), and (iii) more engaged in innovative activities (both for innovation properly defined as well as export orientation and R&D activities). Our econometric analysis suggests that controlling for age and size, the propensity to do innovation, export and R&D is higher for foreign firms. Regarding spillover effects of foreign ownership on innovation and R&D, we find mixed results for horizontal, backward and forward linkage effects. By contrast, export orientation seems to benefit from all three types of linkages.

Keywords: Productivity; Foreign Direct Investment; Innovation; R&D expenditures; Horizontal-Forward-Backward Linkages

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1) INTRODUCTION

Attracting foreign capital has been an important goal of policy makers in developing countries. The general presumption is that foreign direct investment (FDI) flows generate positive spillovers by bringing new technologies and know-how and thereby help improve productivity and competitiveness in the host country. While there is ample evidence that firms with foreign capital are more productive than domestically owned firms, evidence on spillovers is generally mixed.

The focus of his paper is on the link between innovation activities of firms in Turkey and flows of foreign direct investment. We use micro-level data from several data sets put together by the Statistical Office of Turkey to examine the innovative activities of domestic and foreign firms. We focus on three types of innovative activities: the first type entails product, process and organizational innovations as covered by innovation surveys. Second, we treat export orientation as a type of innovation in itself. Third, we focus on firms' research and development (R&D) expenditures. In each case we ask two questions: first whether foreign ownership plays a significant role in firms' propensity to engage in innovative activities. Second, we inquire whether the presence of foreign ownership at the level of two-digit industries affect firms' tendency to engage in innovative activities through horizontal, backward and forward linkages.

The paper is organized as follows: section 2 provides summary information on the data sets used in the paper. More detailed information can be found in the Data Appendix. Section three provides descriptive statistics on the innovative activities of domestic and foreign firms as well as on their regional, sectoral and size distribution. The fourth section undertakes econometric analysis of the role of foreign ownership in firms' propensity to innovate and test for the existence of horizontal, backward and forward linkages. Section 5 concludes.

2) THE DATA

In this paper we use firm level data from various data sets to examine the link between innovation and R&D activities of firms and flows of foreign direct investment. We refer the reader to the data appendix at the end of the paper for details on the data used in this paper. Here we present a short summary. We use four main data sets to carry out the analysis, all prepared by the Turkish Statistical office. Details about data sets are provided in the Data Appendix. The central data set is the Annual Industry and Service Statistics. This data set provides detailed information on revenue, costs, employment, investment, sector of activity (at 4 digit detail, NACE Rev. 1.1 for 2003-2009 and NACE Rev.2 for 2009-2011, and at 2 digit detail, NACE Rev.2 for 2003-2011) (foreign and public) ownership and the region of location (NUTS2 level). Data pertaining to the years 2003 and 2004 are generally considered unreliable so we concentrate on the years 2005-2011. The AISS covers almost all non-agricultural businesses. We also aggregate the 26 NUTS2 regions into three regions n the manner of Atiyas et. al. (2014): The West, consisting of traditional industrial centers, the Anatolian Tigers, consisting of NUTS2 regions that include Anatolian provinces that have displayed superior growth in

the last three decades, and the Other region, consisting the remainder of NUTS2 regions. The classification is based on relative per capita value added in 2004 and employment growth between the years 2004 and 2012. See the Data Appendix for details.

The AISS covers all firms with 20 or more employees (20+) and representative samples of firms with 1-19 employees. Most of the empirical presented in this paper will be based on 20+ enterprises.

Data on innovation comes from TurkStat's Innovation Statistics database (henceforth called Community Innovation Surveys, CIS). This database covers samples of 10+ firms ad is collected in accordance with the Oslo Manual jointly developed by Eurostat and the OECD for defining and measuring innovation. The data set covers between 2000-6000 firms, depending on the year. From the CIS we obtain information on firms' product, process and organizational innovation and we supplement these with information on ownership, region etc. from the AISS using common firm ID codes. The total number of matches between the IASS and CIS vary between 1.4 to 3.8 firms, depending on the year. Statistics reported below on innovation activities are based on CIS firms that get matched to the AISS data set. In the econometric work reported below, the CIS sample is further restricted to 10+ firms for the sake of consistency. The reader will note that because the CIS consists of relatively small samples of firms (relative to the AISS) both statistical information and econometric work pertaining to product, process and organizational innovation rely on a much smaller number of observations relative to those of export or R&D (see below).

In this chapter, exporting is treated as a type of innovation activity. Information on firm level exports is obtained from TurkStat's Foreign Trade (FT) database which covers all export transactions at the firm level. Again, export information obtained from the FT is supplemented with information on other firm characteristic such as ownership and region from the AISS. One problem with this procedure is that some firms export not directly but through intermediaries. Unfortunately the data set does not provide any information that could be used to correct possible biases that may be caused because of export sales through intermediaries. Export information is available for all years for which the AISS is available.

Information on firms' R&D activities is obtained from TurkStat's Research and Development Activities Survey (RDAS). RDAS covers all R&D activities carried out by firms in Turkey. In this paper we assume that total R&D expenditures of those firms that are in the AISS and not in the RDAS data set are equal to zero. We further justify this assumption in the Data Appendix.

Most of the results reported in this paper are based on all industries covered by the AISS. We chose not to focus exclusively on manufacturing because data suggests that here is quite a bit of foreign ownership present in non-manufacturing industries as well. The only exception to this rule is that information on firm-level total factor productivity (TFP) is calculated for manufacturing firms only. Calculation of TFP is explained in detail in the Data Appendix.

3) DESCRIPTIVE ANALYSIS

In this section we take various cuts into the data to provide information on foreign firms, as well as innovation, export and R&D activities of foreign versus domestic firms. We also provide comparisons on the basis of industry (at the 1-digit level) and region. The aim is to provide a somewhat comprehensive map of foreign ownership of firms in Turkey and their role in innovation, R&D and export activities. In the tables below, a firm is defined as foreign if at least 10 % of its equity is controlled by foreign partners.

a) Characterization of foreign firms (size, industry, region) and comparison with domestic companies.

We start with a bird's eye view of regional distribution of domestic and foreign firms in Turkey. Domestic and foreign firms' shares in total number of firms, employment, value added and sales is provided in Table 1 and Table 2. Table 1 shows that only about 3 percent of 20+ firms have foreign ownership that exceeds 10 percent of their capital. However, foreign firms' shares in value added and sales are much larger, over 20 percent. Table 2 shows that more than 90 percent of foreign firms' value added and sales are realized in the West region. By contrast the share of the West in domestic firms' value added and sales are about 62 percent each. Hence foreign firms are more concentrated in the traditional industrial centers. Foreign firms are particularly scarce in the Other region.

Table 1: Regional distribution of firms (2005-2011 averages)

Foreign	Region	Nf_sh	emp_sh	va_sh	sal_sh
domestic	West	72.44	68.41	61.37	62.48
domestic	Tiger	18.08	17.12	12.72	11.97
domestic	Other	6.28	4.87	2.75	2.80
Foreign	West	2.94	9.02	21.98	21.78
Foreign	Tiger	0.22	0.51	0.94	0.87
Foreign	Other	0.04	0.06	0.23	0.11

Source: Authors' calculations using AISS, 20+ firms, 2005-2011 averages. Nf_sh: share of firms in total firms, sal_sh: share of sales, emp_sh: share of employment, va_sh: share of value added. Columns add up to 100.

Table 2: Regional distribution of domestic and foreign firms: employment, value added and sales (2005-2011 averages)

Foreign	Region	Nf_sh2	emp_sh2	va_sh2	sal_sh2
domestic	West	74.83	75.67	79.86	80.88
domestic	Tiger	18.68	18.94	16.55	15.49
domestic	Other	6.49	5.38	3.58	3.63
Foreign	West	92.06	94.02	94.92	95.71
Foreign	Tiger	6.77	5.32	4.08	3.81
Foreign	Other	1.17	0.67	1.00	0.47

Source: Authors' calculations using AISS, 20+ firms2005-2011 averages. Nf_sh2, sal_sh2, emp_sh2, va_sh2 are defined as Nf_sh, sal_sh, emp_sh, va_sh but domestic and foreign categories separately add up to 100.

Table 3 compares the logarithms of labor and total factor productivity of foreign vs domestic firms across regions. The table shows that foreign firms have higher labor productivity (LP) and TFP than domestic firms in all regions. Note that labor productivity is averaged across all sectors whereas TFP is calculated for firms in manufacturing only.

Table 3: Productivity of firms by region and foreign ownership (2005-2011 averages)

Foreign	region	lnLP	lnTFP
domestic	west	10.16	0.98
domestic	tiger	9.97	0.86
domestic	other	9.71	0.83
Foreign	west	11.16	1.61
Foreign	tiger	10.87	1.38
Foreign	other	11.53	1.19

Source: Authors' calculations using AISS, 20+ firms, 2005-2011 averages. Labor productivity is measured as value added per employee expressed in 2003 constant TL prices. To calculate TFP, we estimate a Cobb-Douglas production function with constant returns to scale at 2 digit NACE Rev. 2. Then, for each firm TFP is computes as a residual, using value added, capital and employment at the firm level. While lnL is computed for all firms, lnTFP is computed only for manufacturing.

Tables 4 and 5 provide information on the sectoral (1 digit) distribution of number, value added, employment and sales of domestic vs foreign firms.[1] The difference between the two tables is that in Table 4 columns add up to 100, whereas in Table 5 columns add up to 100 for domestic and foreign firms separately. Table 4 shows that manufacturing, construction, wholesale and retail trade and the financial-real estate industries account for the bulk of employment and value added. In turn, Table 5 shows that the distribution of these variables across industries is not that different between foreign and domestic firms. For example, the shares of manufacturing in the total value added of domestic and foreign firms are 43 and 46 percent, respectively. The share of wholesale and retail trade in total manufacturing is 17 percent for domestic firms and 19 percent for foreign firms.

Table 6 compares domestic and foreign firms' LP and TFP on a sectoral basis. The first two columns report logarithms of LP and TFP, respectively. For ease of comparison, the third column reports the ratio of foreign to domestic LP on a sectoral basis. Labor productivity is calculated in 2003 constant TL liras. Hence in construction the ratio of domestic to foreign LP is 4.6, whereas in manufacturing it is 2.7. The smallest gap in LP is in finance, real estate, insurance and business services (FIRE) sector. In manufacturing TFP of foreign firms is about 90 percent higher than TFP of domestic firms.

[1] The abbreviations for sectors are as follows: agriculture (AGR); mining (MIN); manufacturing (MAN); public utilities - electric, gas, water (PU); construction (CONS); wholesale and retail trade (WRT); transport, communication and storage (TSC); finance, insurance, real estate and business services (FIRE); community, personal and government services (CSPSGS).

Table 4: Sectoral distribution of firms (2005-2011 averages)

Sector	Foreign	Nf_sh	emp_sh	va_sh	sal_sh
CON	domestic	10.20	7.85	6.25	4.23
CPGS	domestic	6.15	5.35	3.38	1.21
FIRE	domestic	8.08	11.70	5.86	2.55
MAN	domestic	40.32	37.51	32.51	30.36
MIN	domestic	1.35	1.84	1.63	0.81
PU	domestic	0.76	2.54	6.47	5.26
TSC	domestic	5.83	6.48	7.41	5.65
WRT	domestic	24.13	17.15	13.35	27.20
CON	Foreign	0.06	0.07	0.31	0.19
CPGS	Foreign	0.07	0.10	0.16	0.06
FIRE	foreign	0.33	0.93	0.99	0.48
MAN	foreign	1.46	4.58	10.63	9.85
MIN	foreign	0.05	0.07	0.31	0.10
PU	foreign	0.04	0.05	0.55	0.39
TSC	foreign	0.28	1.46	5.77	2.33
WRT	foreign	0.90	2.32	4.42	9.32

Source: Authors' calculations using AISS, 20+ firms, 2005-201 averages. Nf_sh: share of firms in total firms, sal_sh: share of sales, emp_sh: share of employment, va_sh: share of value added.

Table 5: Sectoral distribution of firms by ownership (2005-2011 averages)

Sector	foreign	Nf_sh2	emp_sh2	va_sh2	sal_sh2
CON	domestic	10.54	8.68	8.13	5.48
CPGS	domestic	6.35	5.91	4.40	1.56
FIRE	domestic	8.35	12.94	7.63	3.30
MAN	domestic	41.65	41.49	42.29	39.29
MIN	domestic	1.39	2.04	2.12	1.04
PU	domestic	0.78	2.81	8.42	6.81
TSC	domestic	6.02	7.17	9.64	7.31
WRT	domestic	24.92	18.97	17.37	35.21
CON	foreign	2.03	0.77	1.34	0.85
CPGS	Foreign	2.31	1.05	0.67	0.27
FIRE	Foreign	10.50	9.69	4.26	2.12
MAN	Foreign	45.61	47.79	45.96	43.32
MIN	Foreign	1.42	0.78	1.33	0.44
PU	Foreign	1.28	0.50	2.38	1.70
TSC	Foreign	8.76	15.21	24.94	10.27
WRT	Foreign	28.10	24.20	19.11	41.02

Source: Authors' calculations using AISS, 20+ firms, 2005-2011 averages. Nf_sh2, sal_sh2, emp_sh2, va_sh2 are defined as Nf_sh, sal_sh, emp_sh, va_sh but each domestic and foreign categories adds up to 100.

Table 6: Productivity of firms by sector and foreign ownership (2005-2011 averages)

sector	foreign	lnLP	lnTFP	LP_foreign/LP_domestic	TFP_foreign/TFP_domestic
CON	domestic	10.04		4.58	
CPGS	domestic	9.81		2.58	
FIRE	domestic	9.56		2.23	
MAN	domestic	10.13	0.95	2.67	1.89
MIN	domestic	10.14		4.82	
PU	domestic	11.19		4.60	
TSC	domestic	10.40		3.47	
WRT	domestic	10.02		2.46	
CON	foreign	11.56			
CPGS	foreign	10.76			
FIRE	foreign	10.36			
MAN	foreign	11.11	1.59		
MIN	foreign	11.72			
PU	foreign	12.71			
TSC	foreign	11.65			
WRT	foreign	10.92			

Source: Authors' calculations using AISS, 20+ firms, 2005-2011 averages. Labor productivity is measured as value added per employee expressed in 2003 constant TL prices. We estimate a Cobb-Douglas production function with constant returns to scale at 2 digit NACE Rev. 2. Then, for each firm TFP is computes as a residual, using value added, capital and employment at the firm level. The first two columns display the logarithms of LP and TFP, respectively. The last two columns display the ratios of domestic firms' LP and TFP to those of foreign firms, where LP and TFP are simply the exponentials of ln_LP and ln_TFP, respectively.

Information on the size distribution of firms is provided in Tables 7 and 8. In Table 7 the distribution is over the whole set of firms. More than 60 % of 20+ firms are in 20-49 size group. Share of 500+ firms is below 3% in total, however 1/3 of employment 2/5 of value added and sales come from these firms. Table 8, which shows distribution within domestic and foreign firms separately, exhibits a clear contrast between domestic and foreign firms. Foreign firms are far more homogeneously distributed among size groups. In particular, the share of small firms in value added, employment and sales is much lower among foreign firms; by contrast, the share of the largest group of firms (500+) in employment, value added and sales is higher among foreign firms relative to domestic firms. In short, foreign firms' size distribution is more concentrated towards larger firms.

Table 7: Size distribution of firms (%, 2005-2011 averages)

Size	Foreign	Nf_sh	emp_sh	va_sh	sal_sh
20-49	Domestic	62.38	20.98	13.33	17.99
50-99	Domestic	17.40	12.45	8.36	9.89
100-249	Domestic	11.52	18.10	13.88	14.36
250-499	Domestic	3.38	12.03	10.26	8.75
500+	Domestic	2.14	26.86	31.04	26.28
20-49	Foreign	1.11	0.39	1.24	1.31
50-99	Foreign	0.66	0.49	1.18	1.30
100-249	Foreign	0.72	1.17	2.56	2.91
250-499	Foreign	0.35	1.27	3.13	3.03
500+	Foreign	0.35	6.27	15.01	14.18

Source: Authors' calculations using AISS, 20+ firms, 2005-2011 averages. Nf_sh: share of firms in total firms, sal_sh: share of sales, emp_sh: share of employment, va_sh: share of value added.

Table 8: Size distribution of firms by ownership (%, 2005-2011 averages)

Size	Foreign	Nf_sh2	emp_sh2	va_sh2	sal_sh2
20-49	Domestic	64.44	23.20	17.34	23.28
50-99	Domestic	17.97	13.76	10.88	12.80
100-249	Domestic	11.90	20.02	18.05	18.58
250-499	Domestic	3.49	13.30	13.35	11.33
500+	Domestic	2.21	29.71	40.38	34.01
20-49	Foreign	34.78	4.07	5.38	5.76
50-99	Foreign	20.71	5.07	5.12	5.70
100-249	Foreign	22.54	12.17	11.05	12.81
250-499	Foreign	11.00	13.26	13.54	13.35
500+	Foreign	10.97	65.43	64.91	62.38

Source: Authors' calculations using AISS, 20+ firms, 2005-2011 averages. Nf_sh2, sal_sh2, emp_sh2, va_sh2 are defined as Nf_sh, sal_sh, emp_sh, va_sh but each domestic and foreign categories adds up to 100.

Table 9 gives an interesting detail about firm productivity. Foreign firms have higher productivity across all size groups. While both LP and TFP are positively correlated with size for domestic firms, only TFP is positively correlated with size for foreign firms. Still, the TFP gap between foreign and domestic firms is higher among small and medium sized firms.[2] Hence even though foreign firms are larger (in terms of employment), this is not the only source of productivity gaps between domestic and foreign firms. In fact, productivity differentials between large domestic and foreign firms are smaller than between small domestic and foreign firms. Foreign firms are more productive than domestic firms, but the gap is even larger among small domestic and foreign firms.

[2] For example, taking the exponentials of lnTFP, one can calculate that the ratio of TFP of foreign firms to that of domestic firms is 2.25 for the 1-19 size group, and only 1.48 for the 500+ group.

Table 9: Productivity of firms by size and ownership (2005-2011 averages)

Size	foreign	lnLP	lnTFP
20-49	domestic	9.82	0.42
50-99	domestic	9.87	0.57
100-249	domestic	10.00	0.75
250-499	domestic	10.11	1.00
500+	domestic	10.41	1.26
20-49	foreign	11.42	1.23
50-99	foreign	11.16	1.35
100-249	foreign	11.06	1.35
250-499	foreign	11.17	1.47
500+	foreign	11.15	1.65

Source: Authors' calculations using AISS, 20+ firms. Labor productivity is measured as value added per employee expressed in 2003 constant TL prices. We estimate a Cobb-Douglas production function with constant returns to scale at 2 digit NACE Rev. 2. Then, for each firm TFP is computes as a residual, using value added, capital and employment at the firm level. lnLP is computed for all firms while lnTFP is computed only for firms in manufacturing.

We can summarize findings in this section as follows. Foreign firms are small in number but sizeable in terms of shares in value added and sales. Their distribution among sectors is not very different from the sectoral distribution of domestic firms. Foreign firms are more productive than domestic firms. The productivity differential is smaller in manufacturing. Productivity differential between domestic and firms is more pronounced among small firms.

b) Characterization of foreign firms' innovative and export activity (size, industry, regions) and comparison with domestic firms

This section provides information on innovation, export and R&D activities of domestic and foreign firms. The basis for the descriptive statistics on innovation activities is the CIS, supplemented by additional information on variables such as ownership and region from the AISS data set. Hence the tables describe not the population of firms but firms in the CIS data set (more specifically, those for which corresponding information was available in the AISS data set). As discussed in section 2 above, the basis of data on R&D and exports are the RDAS and FT data sets, respectively, each merged with AISS. Hence for R&D and exports, the tables are based on all 20+ firms.

We first provide information on regional distribution of domestic and foreign firms' innovation, export and R&D activities. We then provide information on sectoral distribution and size distribution. Table 10 provides information on the share of innovating foreign and domestic firms. First of all, the table shows that the share of innovating firms in total firms is higher among foreign firms compared to domestic firms. For example, about 25 percent of domestic firms undertook new product innovation. By contrast, 42 percent of foreign firms undertook new product innovation

Table 10: Share of innovating foreign and domestic firms (2006-2010 averages)

foreign	new_product_sh	new_commo_sh	new_serv_sh	new_process_sh	new_org_sh
domestic	24.98	19.26	12.05	25.64	29.05
foreign	42.08	35.56	17.32	44.45	47.69

Source: Authors' calculations using AISS and CIS, 10+ firms, 2006-2010 averages. new_product_sh: share of firms having product innovation; new_commo_sh: share of firms having new goods (commodities); new_serv_sh: share of firms having new services; new_org_sh: share of firms having organizational innovation. See the Data Appendix for detailed definitions. For each innovation type the shares are defined as the number of innovating firms in that region over total domestic(or foreign) firms in the corresponding year.

Regarding R&D activities, we use two indicators of R&D intensity in this section. The first is the share of R&D personnel expenditures in to the total wage bill of the firms and the second one is total R&D expenditures divided by sales. Table 11 shows that as measured by either of these indicators, foreign firms have higher R&D intensity, both in the West and in the Tiger region. The differences between the R&D intensity of domestic and foreign firms in the two regions appear very high. By contrast, R&D intensity of foreign firms in the Other region is quite low, even compared to domestic firms in that region.

Table 11: R&D indicators domestic vs foreign firms (2005-2010 average)

Foreign	region	RD_pers_exp_in_wcomp	RD_in_sales
Domestic	west	0.97	0.17
Domestic	tiger	0.36	0.08
Domestic	other	0.06	0.01
Foreign	west	1.37	0.28
Foreign	tiger	3.15	0.51
Foreign	other	0.01	0.00

Source: Authors' calculations using AISS and RDAS datasets, 20+ firms, 2005-2010 averages. RD_pers_exp_in_wcomp: R&D personal expenditures in wage compensation, RD_in_sales: R&D expenditures divided by sales.

Next we provide information on the regional dimension of export activities among domestic and foreign firms. Table 12 shows that foreign firms are more export oriented. The first column reports data on average export intensity, defined as total exports divided by total sales of each cell. Average export intensity among is higher among foreign firms in all regions. The rest of the table reports propensity to export as measured by number of firms that do some export vs. those that do no exports at all. The second column shows that about 27 percent (column sum) of all 20+ firms in the AISS data set undertake some export. The third column shows that whereas 81 percent of domestic exporting firms are in the West, this ratio is 92 percent among foreign firms. So again, relative to domestic exporting firms, foreign exporting more are more concentrated in the West. The fourth column shows, separately for domestic and foreign firms, the distribution of exporting firms across regions as a share of total domestic and foreign firms, respectively. Hence it shows, first of all, that while about 26 (21.4 + 4.1 + 0.8) percent of domestic firms undertake some export, this ratio is about

67 percent for foreign firms. The last column of the table shows the share of exporting firms in total number of firms in that ownership/region category. It can be seen that the higher propensity to export among foreign firms is prevalent across all regions: For example, in the West, the share of exporting firms among domestic firms is only about 30 percent, whereas for foreign firms this ratio is 66 percent. The same contrast exists in the Tiger and Other regions as well. Whether one uses the measure f export intensity or exporting incidence (ie whether a firm exports or not) foreign firms seem more export oriented.

Table 12: Export orientation: domestic vs foreign firms (2005-2011 averages)

Foreign	region	exp_in_sales	Nfexp_sh	(%)	Nfexp_sh2	Nfexp_sh3
Domestic	west	8.67	21.47	81.43	22.17	29.81
Domestic	tiger	11.40	4.11	15.59	4.24	22.47
Domestic	other	9.24	0.79	2.98	0.81	12.05
Foreign	west	15.00	1.93	91.71	61.19	66.46
Foreign	tiger	12.72	0.15	7.26	4.85	71.62
Foreign	other	37.91	0.02	1.03	0.69	59.54

Source: Authors' calculations using AISS and FT datasets, 20+ firms, 2005-2011 averages. exp_in_sales: export revenues in sales, Nfexp_sh: share of exporting firms in total firms, %: distribution of exporting firms across regions, separately for domestic and foreign firms, Nfexp_sh2: share of exporting firms over all domestic and all foreign firms separately, Nfexp_sh3: share of exporting firms by region and foreign ownership.

We now provide information on the sectoral patterns of domestic vs foreign firms' innovation, export and R&D activities. We start with innovation. Table 13 reports the following information: In each column, and for domestic and foreign firms separately, column sums are equal to the ratio of innovating firms to total number of firms. Hence for domestic firms, the ratio of firms undertaking new product innovation to total number of domestic firms is about 27 percent. Of this, about 14 percent is in manufacturing and 7 percent in construction. The table shows that for all types of innovation, and for both domestic and foreign firms, innovating firms are concentrated in manufacturing and then in construction. Note the high share of the construction industry in the case of foreign firms.

Table 14, by contrast, shows the share of innovating firms within each sector-ownership category. In each industry except for Public utilities, larger share of foreign firms innovate compared to domestic firms. In manufacturing, for example, while about half of firms engage in product innovation, this ratio is one third for domestic firms. While the gaps between domestic and foreign firms are large across all industries, the contrast is especially stark in construction.

Table 13: Sectoral distribution of domestic and foreign innovating firms (2006-2010 averages)

sector	foreign	new_product_sh	new_commo_sh	new_serv_sh	new_process_sh	new_org_sh
AGR	domestic	0.19	0.18	0.10	0.24	0.32
CON	domestic	7.26	5.48	5.35	7.96	8.10
FIRE	domestic	0.94	0.40	0.72	0.95	1.42
MAN	domestic	13.56	12.41	4.26	13.35	14.52
MIN	domestic	1.40	1.27	0.78	1.68	1.26
PU	domestic	0.10	0.03	0.09	0.13	0.19
TSC	domestic	0.98	0.28	0.85	1.03	1.62
WRT	domestic	3.03	2.42	1.09	3.14	4.46
AGR	foreign	0.00	0.00	0.00	0.08	0.12
CON	foreign	14.55	12.55	9.55	18.15	15.12
FIRE	foreign	2.39	0.49	2.16	2.38	3.52
MAN	foreign	15.67	15.05	5.13	16.63	22.18
MIN	foreign	1.21	1.21	0.85	1.27	1.86
PU	foreign	0.02	0.00	0.02	0.13	0.13
TSC	foreign	1.42	0.67	1.35	1.60	2.64
WRT	Foreign	3.42	2.56	0.97	3.91	7.73

Source: Authors' calculations using CIS, 10+ firms, 2006-2010 averages. new_product_sh: share of firms having product innovation; new_commo_sh: share of firms having new goods (commodities); new_serv_sh: share of firms having new services; new_org_sh: share of firms having organizational innovation. For each innovation type the sectoral share is defined as the number of innovating firms in that sector over total domestic (or foreign) firms in the corresponding year.

Table 14: Share of innovating firms by sector and foreign ownership (2006-2010 averages)

sector	foreign	new_product_sh	new_commo_sh	new_serv_sh	new_process_sh	new_org_sh
AGR	domestic	14.77	13.98	7.78	18.38	24.69
CON	domestic	26.36	19.90	19.41	28.88	29.37
FIRE	domestic	24.02	10.08	18.27	24.32	36.30
MAN	domestic	32.74	29.97	10.30	32.25	35.06
MIN	domestic	22.60	20.57	12.65	27.16	20.37
PU	domestic	15.31	3.99	13.41	19.35	27.90
TSC	domestic	16.64	4.82	14.35	17.53	27.44
WRT	domestic	23.17	18.54	8.31	24.08	34.13
AGR	foreign	0.00	0.00	0.00	4.96	7.45
CON	foreign	49.79	42.96	32.67	62.11	51.74
FIRE	foreign	39.80	8.10	35.93	39.60	58.48
MAN	foreign	48.94	47.02	16.03	51.93	69.28
MIN	foreign	21.55	21.55	15.13	22.74	33.16
PU	foreign	3.31	0.00	3.31	18.18	18.18
TSC	foreign	15.99	7.55	15.13	17.96	29.60
WRT	foreign	21.62	16.19	6.16	24.67	48.82

Source: Authors' calculations using CIS, 10+ firms, 2006-2010 averages. new_product_sh: share of firms having product innovation; new_commo_sh: share of firms having new goods (commodities); new_serv_sh: share of firms having new

services; new_org_sh: share of firms having organizational innovation. For each innovation type the shares are defined as the number of innovating firms over the total number of firms in the corresponding sector-ownership combination.

Table 15 provides information on sectoral patterns of the two measures of R&D intensity. R&D intensity is generally higher among foreign firms, especially in manufacturing, construction and wholesale and retail trade. Note that these are the sectors that account for most of employment and value added, as we have seen above. Still, there are exceptions. In the case of the share of R&D personnel expenditures in total expenditures, domestic firms dominate in mining and TSC. In the case of R&D expenditures as a ratio of total sales, domestic firms dominate in FIRE, mining and TSC.

Table 15: R&D indicators across sectors, foreign vs. domestic (2005-2010 averages)

Sector	foreign	RD_pers_exp_in_wcomp	RD_in_sales
CON	domestic	0.01	0.00
CPGS	domestic	0.03	0.02
FIRE	domestic	0.39	0.31
MAN	domestic	1.35	0.27
MIN	domestic	0.09	0.06
PU	domestic	0.03	0.01
TSC	domestic	1.88	0.37
WRT	domestic	0.19	0.02
CON	foreign	1.31	0.11
CPGS	foreign	0.54	0.13
FIRE	foreign	0.67	0.22
MAN	foreign	2.17	0.56
MIN	foreign	0.01	0.00
PU	foreign	0.17	0.01
TSC	foreign	1.29	0.25
WRT	foreign	0.41	0.03

Source: Authors' calculations using AISS and RDAS datasets, 20+ firms, 2005-2010 averages. RD_pers_exp_in_wcomp: R&D personal expenditures in wage compensation, RD_in_sales: R&D expenditures in sales.

Table 16 provides sectoral patterns in export orientation. Foreign firms have higher export intensity (column 1) than domestic firms in almost all industries (except the finance, insurance and real estate industry, which is not a major exporting industry). The last column reports the ratio of the number of exporting firms to the total number of firms in that ownership-industry category. The column shows that, in every industry, the share of the number of firms that do some export to the number of all firms is much higher among foreign firms relative to domestic firms. In manufacturing, while only one half of all domestic firms make some exports, this ratio is 88 percent for foreign firms. Again, the contrast in construction is interesting: while only 98 percent of all domestic firms in that industry undertake some exports, this ratio is 46 percent among foreign firms. One wonders if part of these large gaps would be explained by more prevalence of exports through intermediaries among domestic firms but we cannot think of a systematic reason why this should be the case.

Table 16: Sectoral distribution of exporting firms (2005-2011 averages)

sector	foreign	exp_in_sales	Nfexp_sh	%	Nfexp_sh2	Nfexp_sh3
CON	domestic	1.78	0.82	3.11	0.85	7.76
CPGS	domestic	0.08	0.09	0.35	0.09	1.46
FIRE	domestic	0.27	0.20	0.75	0.20	2.43
MAN	domestic	15.65	19.49	73.95	20.13	49.10
MIN	domestic	6.36	0.31	1.16	0.32	23.05
PU	domestic	0.25	0.08	0.30	0.08	10.39
TSC	domestic	1.67	0.67	2.55	0.69	11.41
WRT	domestic	7.53	4.70	17.84	4.85	19.38
CON	foreign	2.83	0.03	1.40	0.93	46.12
CPGS	foreign	0.56	0.01	0.42	0.28	11.89
FIRE	foreign	0.04	0.04	1.77	1.18	11.15
MAN	foreign	31.32	1.25	59.68	39.82	87.89
MIN	foreign	30.96	0.03	1.58	1.05	72.07
PU	foreign	0.69	0.02	0.79	0.53	41.00
TSC	foreign	0.22	0.09	4.36	2.91	33.20
WRT	foreign	3.02	0.63	30.00	20.02	70.93

Source: Authors' calculations using AISS and FT datasets, 20+ firms, 2005-2011 averages. exp_in_sales: export revenues in sales, Nfexp_sh: share of exporting firms in total firms, %: distribution of exporting firms across sectors, separately for domestic and foreign firms, Nfexp_sh2: share of exporting firms over all domestic and all foreign firms separately, Nfexp_sh3: share of exporting firms by sector and foreign ownership.

Table 17: Size distribution of domestic and foreign innovating firms (2006-2010 averages)

Foreign	Size	new_product_sh	new_commo_sh	new_serv_sh	new_process_sh	new_org_sh
domestic	1-19	8.63	6.91	3.95	8.25	9.16
domestic	20-49	8.98	7.68	3.78	9.45	11.18
domestic	50-99	2.30	1.87	0.87	2.35	2.59
domestic	100-249	1.64	1.42	0.63	1.91	2.10
domestic	250-499	0.51	0.45	0.19	0.60	0.70
domestic	500+	0.37	0.33	0.15	0.41	0.46
Foreign	1-19	7.06	5.24	5.57	8.50	10.25
Foreign	20-49	8.60	7.36	3.92	10.08	16.48
Foreign	50-99	4.45	3.98	1.03	3.61	5.43
Foreign	100-249	3.29	2.86	1.13	4.05	4.85
Foreign	250-499	2.83	2.53	0.72	2.95	3.10
Foreign	500+	3.23	2.59	1.52	3.29	3.71

Source: Authors' calculations using CIS, 10+ firms, 2006-2010 averages. new_product_sh: share of firms having product innovation; new_commo_sh: share of firms having new goods (commodities); new_serv_sh: share of firms having new services; new_org_sh: share of firms having organizational innovation. For each innovation type the shares are defined as the number of innovating firms in that size group over total domestic(or foreign) firms in the corresponding year.

Table 18: Share of innovating firms by size and ownership (2006-2010)

Foreign	size	new_product_sh	new_commo_sh	new_serv_sh	new_process_sh	new_org_sh
Domestic	1-19	20.06	16.08	9.18	19.18	21.29
Domestic	20-49	22.48	19.21	9.47	23.64	27.99
Domestic	50-99	26.38	21.45	9.90	26.91	29.59
Domestic	100-249	29.11	25.29	11.22	33.95	37.27
Domestic	250-499	30.53	27.06	11.27	35.82	41.90
Domestic	500+	37.81	33.73	14.95	41.51	46.52
Foreign	1-19	24.54	18.22	19.34	29.52	35.59
Foreign	20-49	25.40	21.75	11.58	29.77	48.68
Foreign	50-99	32.50	29.10	7.53	26.39	39.67
Foreign	100-249	27.67	24.03	9.48	34.05	40.76
Foreign	250-499	45.68	40.89	11.67	47.69	49.99
Foreign	500+	57.99	46.46	27.21	59.02	66.52

Source: Authors' calculations using CIS, 10+ firms, 2006-2010 averages. new_product_sh: share of firms having product innovation; new_commo_sh: share of firms having new goods (commodities); new_serv_sh: share of firms having new services; new_org_sh: share of firms having organizational innovation. For each innovation the share is defined as the number of innovating firms over the number of firms in the corresponding size group for domestic and foreign firms separately.

Finally we move to size distribution. Table 17 and 18 provides information on the size distribution of innovating firms. As before, for each innovation type, Table 17 distributes the share of innovating firms in that ownership category across sectors so that column sums by ownership provides the ratio of the number of innovating firms to total firms by ownership category . By contrast, Table 18 presents the share of innovating firms for each innovation-sector-ownership category as a ratio of total firms in that category. Both tables seem to tell the same story: The prevalence of innovation among small firms is not that different across domestic and foreign firms. The real difference is in the innovativeness of large firms. For example, while only 27 percent of 500+ domestic firms engage in product innovation, this ratio is 58 percent for foreign firms (Table 18). This finding is interesting and somewhat surprising given that, as shown above, productivity gaps between domestic and foreign firms are larger among small firms.

Relative to domestic firms, foreign firms have higher innovation ratios within each size group. But again, there is a big contrast between foreign and domestic firms for the largest size group. This is important, since, relative to domestic firms, a larger ratio of foreign firms is in the 500+ category.

Table 19 displays measures of R&D intensity indicators by size and ownership. The ratio of R&D personnel expenditures to the total wage bill is uniformly higher among foreign firms for all size groups. The same is also true for the ratio of R&D expenditures to sales except for the 250-499 size group, where domestic firms display a slightly higher ratio.

Table 19: R&D indicators by size (2005-2010)

Size	foreign	RD_pers_exp_in_wcomp	RD_in_sales
20-49	domestic	0.53	0.07
50-99	domestic	0.63	0.10
100-249	domestic	0.74	0.12
250-499	domestic	0.76	0.15
500+	domestic	1.07	0.25
20-49	foreign	0.88	0.09
50-99	foreign	1.16	0.15
100-249	foreign	1.52	0.18
250-499	foreign	0.97	0.14
500+	foreign	1.56	0.37

Source: Authors' calculations using AISS and RDAS datasets, 20+ firms, 2005-2010 averages. RD_pers_exp_in_wcomp: R&D personal expenditures in wage compensation, RD_in_sales: R&D expenditures in sales.

Finally about the size distribution of exports (Table 20). An interesting finding here is that export intensities of domestic and foreign firms are not very different across size groups, except for very large firms, where export intensity of foreign firms is much larger than that of domestic firms (column 1). In addition, relative to domestic firms, a larger percentage exporting firms are relatively large (employ more than 100 firms, column 3). The last column shows that within each size group, the ratio of the number of exporting firms to total firms in that size group is higher among foreign firms.

Table 20: Size distribution of exporting firms (2005-2011 averages)

size	foreign	exp_in_sales	Nfexp_sh	%	Nfexp_sh2	Nfexp_sh3
20-49	domestic	9.76	14.38	54.56	14.85	22.89
50-99	domestic	8.32	5.23	19.84	5.40	30.31
100-249	domestic	10.13	4.28	16.25	4.42	37.70
250-499	domestic	10.36	1.43	5.43	1.48	43.11
500+	domestic	7.98	1.03	3.92	1.07	49.17
20-49	foreign	9.06	0.66	31.37	20.93	59.55
50-99	foreign	6.48	0.40	19.11	12.75	61.50
100-249	foreign	7.70	0.50	23.89	15.94	71.50
250-499	foreign	10.36	0.27	12.62	8.42	76.70
500+	foreign	18.86	0.27	13.01	8.68	79.92

Source: Authors' calculations using AISS and FT datasets, 20+ firms, 2005-2011 averages. exp_in_sales: export revenues in sales, Nfexp_sh: share of exporting firms in total firms, %: distribution of exporting firms across size groups, for domestic and foreign firms separately, Nfexp_sh2: share of exporting firms over all domestic and all foreign firms separately, Nfexp_sh3: the ratio of the number of firms with positive export in each size-ownership category to the total number of firms in that category.

4) REGRESSION ANALYSIS

In this section we undertake econometric analysis of the links between firms' innovative activities and FDI flows. We do this in two steps. First we examine the link between innovation activities and foreign ownership by looking into the determinants of different types of innovation and testing whether foreign ownership plays a significant role. Second, we construct measures of horizontal, backward and forward spillovers and see if these play a significant role in firms' innovation activities.

a) The role of foreign ownership in firms' innovation activities

Following Brambilla (2009), we construct two measures of foreign ownership: the variable FOR1 is equal to 1 if the share of foreign ownership is below 50% and zero otherwise. The variable FOR2 is equal to 1 if the share of the foreign ownership is equal or greater than 50 % and zero otherwise. In all the regressions below we control for firm size through logarithm of number of employees and firm age through logarithm of age (defined as current year minus the year of starting of operations). We also control for public ownership through the variable "Non-private" which takes the value 1 if the firm is 100 percent publicly owned and zero otherwise. Observations for which FOR1=FOR2=Non-private=0 are referred to as "domestic private".

We start with innovation and exports. The probability of innovating and exporting is modeled as a nonlinear logit model. For the case of exporting, the dependent variable "exporter" takes the value 1 if the firm has positive exports and zero otherwise. The results are displayed in Table 21.

The probability of undertaking innovation increases with size. Also, controlling for size, firms with both minority and majority foreign ownership are more likely to undertake process, product and organizational innovation than private domestic firms. Age has a positive effect on the probability of undertaking product innovation but does not seem to affect probabilities of undertaking process or organizational innovation. Probability of exporting increases with size, age as well as both types of foreign ownership. Non-private firms are less likely to export relative to private domestic firms.

For the purposes of this paper, the main message of this section is that foreign ownership appears to be positively associated with firms' innovation activities, as captured by process, product and organizational innovation, as well as exports.

We now turn to determinants of firms' R&D activities and examine the role of foreign ownership. The dependent variable is R&D intensity, defined as R&D expenditures divided by sales. We use two approaches to estimate the impact of foreign ownership. First, we exploit the panel nature of the data and use fixed effect (FE) estimation. The advantage of using the fixed effect estimation method is that we can control for unobserved firm characteristics. The disadvantage is that fixed effect estimation does not address the fact that the majority of firms do not undertake R&D expenditures and the R&D intensity of these firms are zero.

Table 21: Determinants of product, process and organizational innovation and exporting

	Dependent variable			
	Product Innovation	**Process Innovation**	**Organizational Innovation**	**Exporter**
log employment	0.220***	0.262***	0.301***	0.468***
	(0.022)	(0.022)	(0.023)	(0.008)
log age	0.104**	0.035	-0.053	0.367***
	(0.036)	(0.035)	(0.037)	(0.010)
FOR1	0.721***	0.523***	0.737***	1.375***
	(0.150)	(0.149)	(0.151)	(0.068)
FOR2	0.342***	0.439***	0.582***	1.652***
	(0.094)	(0.093)	(0.094)	(0.042)
Non-private	0.049	0.095	-0.199	-1.153***
	(0.239)	(0.228)	(0.242)	(0.148)
constant	-2.645***	-2.869***	-1.206***	-4.797***
	(0.332)	(0.328)	(0.310)	(0.091)
Region effects (3 regions)	Yes	Yes	Yes	Yes
Industry effects (1 digit NACE)	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes
Number of Obs.	7,286	7,286	7,286	136,138
Log-Likelihood	-4464.906	-4343.853	-4009.467	-62715.915
Pseudo-R squared	0.0341	0.0603	0.0705	0.2433

Notes: Logistic regression estimates, *** p<0.001, ** p<0.01, * p<0.05. Standard errors are in parentheses. Dependent variables binary variables which take the value of 1 if the underlying innovation occurs within the firm or firm exports, and 0 otherwise. The first 3 regressions use the CIS data set for the years 2006, 2008 and 2010. The last regression uses the AISS + FT datasets. FOR1 and FOR2 are indicator variables for firms with varying degrees of foreign ownership. FOR1 = 1 if the share of the foreign ownership is below 50%, and FOR1 = 0 otherwise. Similarly, FOR2 = 1 if the share of the foreign ownership is equal or greater than 50 %, and FOR2 = 0 otherwise. Non-private is also an indicator variable which takes the value of 1if this is a non-private firm and 0 otherwise.

One could presume that that the decision to undertake R&D is the result of an optimization procedure resulting in many firms not undertaking R&D. In our case, the share of firms undertaking R&D is below 3 % of the sample. The appropriate estimation procedure that can be used in the presence of such "corner solutions" is the Tobit model. In both cases we control for firm size (as measured by log of employment) and firm age (log age). Estimation results are displayed in Table 22.

Table 22 Determinants of R&D intensity

	FE	Tobit
log employment	0.0003	0.074***
	(0.0003)	(0.002)
log age	-0.003***	0.043***
	(0.001)	(0.003)
FOR1	0.004**	0.120***
	(0.001)	(0.012)
FOR2	0.008***	0.091***
	(0.001)	(0.009)
Non-private	-0.000	0.044
	(0.002)	(0.025)
constant		-1.243***
		(0.030)
Region effects (3 regions)	Yes	yes
Industry effects (1 digit NACE)	No	yes
Year effects	Yes	Yes
Number of observations	136,138	136,138
Log-Likelihood		-10342.68
Pseudo-R squared		0.2272

Notes: Fixed effect (FE) and Tobit estimates, *** p<0.001, ** p<0.01, * p<0.05. 20+ firms over the years 2006-2010. Standard errors are in parentheses. Dependent variable is R&D intensity measured as R&D expenditures in sales. 20+ firms that appear in the AISS data set but do not appear in the in RDAS are assumed to have zero R&D expenditures, as explained in the Data Appendix. FOR1 and FOR2 are indicator variables for firms with varying degrees of foreign ownership. FOR1 = 1 if the share of the foreign ownership is below 50%, and FOR1 = 0 otherwise. Similarly, FOR2 = 1 if the share of the foreign ownership is equal or greater than 50 %, and FOR2 = 0 otherwise. Non-private is also an indicator variable which takes the value of 1if this is a non-private firm (100 percent public ownership) and 0 otherwise.

The first thing to notice from the table is that both minority and majority foreign ownership is positively associated with R&D intensity, irrespective of the estimation method. The coefficients of both FOR1 and FOR2 are positive and significant in both equations. Further, the estimated coefficient is stronger for FOR2 which implies that there is more R&D in firms with greater foreign control. The estimation results show that both size and age are positively associated with R&D intensity. Both minority and majority ownership have a positive effect on R&D intensity. The coefficient on firm size is insignificant under the FE procedure, but positive and significant under the Tobit procedure.

Logarithm of age is significant in both equations but has a negative sign under the FE procedure and positive sign under the Tobit procedure.[3]

For the purposes of this paper, the main message of this section as well is that foreign ownership is positively associated with firms' R&D activities.

b) Spillovers from foreign investment: Horizontal, backward and forward linkages

In this section we attempt to find answers to the following question: Are firms' innovation and R&D activities influenced by spillovers from the presence of foreign firms? We concentrate on three possible dimensions of spillovers emphasized in the literature. The first dimension captures horizontal knowledge spillovers. For example, as in Brambilla et. al (2009), the presence of foreign firms in an industry may provide opportunities for imitation and facilitate firms' product innovation. Alternatively, firms may copy technologies from foreign firms resulting in process or organizational innovation. Potentially the presence of foreign firms may also expand export opportunities of domestic firms, either by disseminating information about foreign markets or through the productivity channel, i.e. horizontal spillovers improve domestic firms' productivity, this may enable them to better afford fixed costs of exporting. Horizontal spillovers may potentially also influence R&D activities of domestic firms as well through similar channels. As emphasized in the literature, the horizontal spillover channel may be muted by foreign firms' incentives to prevent spillovers from taking place. In addition, competition from foreign firms (especially to the extent to which foreign firms are more productive, which is the case in Turkey as suggested by the evidence presented above) may also reduce the profitability of domestic firms, making it harder for them to undertake innovation, export or R&D.

The second dimension is backward linkages. Contacts between foreign firms and their local suppliers may provide positive spillovers both through direct knowledge transfer as well as by increasing demand for local inputs and allowing domestic suppliers to enjoy higher economies of scale. As emphasized by Javorcik (2004) foreign firms have lower incentives to mute spillovers through the backward linkages channel.

The third channel is the forward linkages channel. The story here is that foreign firms' presence may provide improved access to new, better or cheaper inputs.

We follow Javorcik (2004) and calculate the following variables to capture the three dimensions of FDI spillovers at the 2 digit industry level (NACE Rev. 1). All industries covered by the AISS are included in the analysis. For industry j at time t the *Horizontal* variable is defined as follows:

[3] Using the Tobit method, we have also estimated an equation that, in addition to the variables listed in the table, includes a dummy variable that takes the value of one for exporting firms and zero otherwise. The coefficient on this variable is positive and highly significant: Exporting firms are more likely to engage in R&D activities.

$$Horizontal_{jt} = \sum_{i \in j} f_{it} * y_{it}$$

where f_{it} is the share of foreign capital in total equity of firm i at time t and y_{it} is the share of firm i in total output of industry j at time t. So *horizontal* represents the weighted average of share of foreign ownership in each industry where the weights are firms' share in industry output. The variable capturing backward linkages for industry j is defined as follows:

$$backward_{jt} = \sum_{for\ all\ k \neq j} \alpha_{jk} horizontal_{kt}$$

Where α_{jk} is the ratio of industry *j*'s output supplied to industry k. Hence the variables α_{jk} are simply input-output coefficients and they have been obtained from the 2002 domestic input output table prepared by TurkStat. The input output coefficients do not change over time but *backward* does. Note that the value of the *backward* variable increases with the share of foreign ownership in industries k that purchase intermediate inputs from industry *j.*

Finally for each industry *m*, the variable *forward* is in an analogous way:

$$forward_{jt} = \sum_{for\ all\ k \neq j} \alpha_{kj} horizontal_{kt}$$

While the variable *backward* captures spillovers of foreign ownership towards the suppliers to foreign firms, the variable *forward* is expected to capture spillovers toward purchasers of intermediate inputs supplied by foreign firms.

The 2002 input output table uses the Nace Rev. 1 industrial classification. Because the AISS data set switches to the NACE Rev.2 classification after 2009, the variables *forward* and *backward* could only be calculated for the period 2005-2009.[4]

We first assess the effect of spillovers on firms' proclivity to innovate and export. Results for product and process innovation are provided in Table 23. Also, since spillover effects originating from the presence of foreign firms may take time to be realized, along with the contemporaneous values of the spillover variables, their one period lags are also employed.

[4] The World Input Output Database (WIOD) provides annual input-output tables for Turkey for the period 1995-2011. The advantage of using the WIOD data would have been that input output coefficients are updates for the years after 2002 so that the data provides a more dynamic picture of inter-sectoral linkages. The disadvantage is that the WIOD tables use a more aggregated sectoral classification that is in between 1 digit and 2 digit NACE Rev. 1 classification. This would have resulted both in some loss of sectoral detail, and would have required some judgment calls while merging the WIOD tables into the AISS. For the time being we have opted for using the 2002 table.

Table 23: **Product and Process Innovation: The effect of spillovers**

	Product Innovation				Process Innovation			
	All firms		Domestic firms		All firms		Domestic firms	
log employment	0.253***	0.249***	0.237***	0.232***	0.317***	0.313***	0.300***	0.297***
	(0.035)	(0.035)	(0.039)	(0.038)	(0.035)	(0.035)	(0.039)	(0.039)
log age	0.116*	0.114*	0.132*	0.128*	0.004	0.003	0.056	0.052
	(0.052)	(0.052)	(0.058)	(0.058)	(0.051)	(0.051)	(0.058)	(0.058)
FOR1	0.770***	0.760***			0.670**	0.663**		
	(0.207)	(0.207)			(0.205)	(0.205)		
FOR2	0.112	0.133			0.208	0.227		
	(0.143)	(0.142)			(0.140)	(0.140)		
Non-private	0.273	0.295			0.230	0.246		
	(0.363)	(0.362)			(0.343)	(0.343)		
horizontal	3.164***		3.292***		2.709***		3.189***	
	(0.343)		(0.384)		(0.341)		(0.387)	
backward	0.852		0.171		3.140**		2.466*	
	(1.022)		(1.089)		(1.025)		(1.100)	
forward	-1.879*		-2.180*		0.197		0.036	
	(0.890)		(0.980)		(0.893)		(0.997)	
hor_lag		3.047***		3.165***		2.593***		3.114***
		(0.351)		(0.394)		(0.350)		(0.397)
bac_lag		1.228		0.622		3.470***		2.950**
		(1.033)		(1.098)		(1.036)		(1.110)
for_lag		-2.115*		-2.413*		-0.047		-0.182
		(0.884)		(0.967)		(0.881)		(0.972)
_cons	-2.973***	-2.876***	-2.554**	-2.475**	-3.265***	-3.180***	-2.650***	-2.563**
	(0.619)	(0.619)	(0.839)	(0.835)	(0.579)	(0.579)	(0.793)	(0.789)
Region effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. obs	3,585	3,585	3,059	3,059	3,585	3,585	3,059	3,059
Log-Likelihood	2016.845	-2023.05	-1711.86	-1716.97	-2018.64	-2023.73	-1693.31	-1697.10
Pseudo-R squared	0.0869	0.084	0.0665	0.0637	0.078	0.0757	0.0628	0.0607

Notes: Logistic regression estimates, *** p<0.001, ** p<0.01, * p<0.05. Standard errors are in parentheses. 20+ firms for the years 2006 and 2008. Dependent variables binary variables which take the value of 1 if the underlying innovation occurs within the firm and 0 otherwise. The variables h*or_lag, bac_lag* and *for_lag* are one-period lags of *horizontal, backward* and *forward*, respectively.

Starting with product innovation, *horizontal* spillovers are always positively associated with probability of innovation.[5] *Backward* linkages do not seem to have an effect on innovation activities. *Forward* linkages have a negative effect. The results are almost identical when one uses one period lags of the spillover variables.

[5] We have also run the same equations only with the *horizontal,* variable, leaving out *backward* and *forward*. The coefficient on the *horizontal* variable was always positive and significant.

In the case of process innovation, both *horizontal* and *backward* spillover effects appear significant and positive. The statistical significance of the coefficient on the *backward* spillover variable increases when one uses the one period lags of the spillover variables. By contrast the *forward* variable does not seem to affect process innovation, irrespective of whether one uses the contemporaneous or the one period lag of this variable. The results are similar when one restricts the sample to domestic firms.

Table 24: Determinants of being an exporter: The role of spillovers

	Logit				Tobit	
	all firms		private domestic firms		all firms	
log employment	0.518***	0.517***	0.574***	0.573***	0.076***	0.076***
	(0.011)	(0.011)	(0.012)	(0.012)	(0.003)	(0.003)
log age	0.353***	0.355***	0.361***	0.364***	0.059***	0.059***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.003)	(0.003)
FOR1	1.262***	1.262***			0.237***	0.237***
	(0.082)	(0.082)			(0.017)	(0.017)
FOR2	1.517***	1.522***			0.235***	0.236***
	(0.054)	(0.054)			(0.011)	(0.011)
Non-private	-1.110***	-1.110***			-0.226***	-0.226***
	(0.182)	(0.182)			(0.046)	(0.046)
horizontal	2.995***		2.987***		0.463***	
	(0.110)		(0.114)		(0.025)	
backward	3.602***		3.406***		0.271***	
	(0.271)		(0.279)		(0.068)	
forward	1.892***		1.479***		0.331***	
	(0.227)		(0.236)		(0.057)	
hor_lag		3.060***		3.072***		0.485***
		(0.114)		(0.118)		(0.026)
bac_lag		3.661***		3.431***		0.260***
		(0.282)		(0.290)		(0.071)
for_lag		1.636***		1.184***		0.266***
		(0.241)		(0.252)		(0.061)
_cons	-5.356***	-5.277***	-4.812***	-4.752***	-1.150***	-1.135***
	(0.114)	(0.115)	(0.288)	(0.289)	(0.026)	(0.026)
Number of observations	78,506	78,506	72,394	72,394	78,506	78,506
Log-Likelihood	-36866.33	-36924.39	-34050.46	-34099.33	-36051.46	-36065.08
Pseudo-R squared	0.2578	0.2567	0.233	0.232	0.195	0.195

Notes: 20+ firms for the years 2006-2009. The first four columns report logistic regression estimates whereas the last two columns report Tobit regressions estimates. *** p<0.001, ** p<0.01, * p<0.05. Standard errors are in parentheses. In the first four columns the dependent variable is a binary variable which take the value of 1 if the firm is an exporter, and 0 otherwise. In the last two columns the dependent variable is the ratio of exports to sales. The variables h*or_lag, bac_lag* and *for_lag* are one-period lags of *horizontal, backward* and *forward*, respectively.

Table 24 shows the results of a similar analysis for exporters. We concentrate on the first four columns first, which report the results of logistic regressions. The dependent variable in these

regressions takes the value of one if the firm is an exporter and zero otherwise. Results show that horizontal, backward and forward linkages all have a positive effect on the probability of exporting, and that the effect is highly significant. Using the lagged values of these variables do not change the results. Also, restricting the sample to private domestic firms does not seem to change the results either.

Using a binary dummy variable for exporters may cause loss of information. Another alternative would be using export intensity defined as export intensity (the value of exports divided by total sales) as dependent variable. This specification captures better the variation in the export intensity. As in the case of the R&D intensity, for a substantial fraction of the sample there is zero exports. This calls for a Tobit model specification. The last two columns of Table 24 report results of Tobit regressions, where the dependent variable is defined as export intensity. These have been run on the sample of all firms only. Qualitative results remain unchanged. All spillover variables have positive and significant coefficients, irrespective of whether one uses contemporaneous or one period lagged values.

Note also that in all regressions, size, as measured as log of number of employees, age and foreign presence, all have a positive effect on exporting. Presence of public ownership, by contrast, has a negative and statistically significant coefficient.

We next investigate the impact of spillovers on R&D intensity. As before, we adopt two different approaches: First, we use the fixed effect estimation method. As mentioned above, the advantage of the FE approach is that one is able to control for unobserved firm characteristics. The disadvantages are that the FE method may not be suitable in situations where dependent variable is zero for an important part of the sample. The second approach is the Tobit estimation method, which does address this particular characteristic of the data but which does not address unobserved firm characteristics.

We also try to address the following question: Does the impact of the presence of FDI flows on firms' propensity to engage in R&D differ according to firm characteristics. There are various reasons why such heterogeneity could exist. Brambilla et. al. (2009) present a model where (horizontal) spillovers from foreign firms benefit mainly firms in the middle of the productivity distribution. The presence of foreign firms provides domestic firms with opportunities for imitation. Firms with high productivity are highly sophisticated and they concentrate on innovation rather than exploiting imitation opportunities provided by foreign firms. Firms with low productivity do not have the ability to finance the fixed costs of either innovation or imitation. It is firms in the middle of productivity distribution that find it profitable to exploit enhanced imitation opportunities.

One could also hypothesize that the impact of potential spillovers may depend on firms' capacity to absorb or appropriate potential externalities. Firms hiring a larger number of engineers, for example may better take advantage of knowledge spillovers originating from foreign firms. Unfortunately we

do not have data on the skill composition of firms. Below we try to capture heterogeneity by inquiring whether the impact of spillovers varies according to firm size, ownership type and whether the firm is an exporter or not. For this purpose, the spillover variables are interacted with log employment, the indicator variables for foreign ownership and the indicator variable capturing whether the firm is an exporter or not.

We first report the results of the FE approach in Table 25.[6] Interaction terms appear in the second column. The spillover variables do not appear to be associated with R&D activities under the FE estimation method.[7] Looking at the interaction terms under the second column, one sees that *horizontal* spillovers do have a positive impact of R&D activities of foreign firms: the coefficients of FOR1**horizontal* and FOR2**horizontal* are both positive and significant. This results suggests that foreign firms benefit from horizontal spillovers while domestic firms do not. *Backward* linkages remain insignificant irrespective of whether the firm is domestic, foreign, or an exporter. The impact of *backward* linkages remain insignificant across firms of different sizes as well. As for *forward* linkages, they gain significance only in the case of foreign firms, but with a negative sign (the coefficients of FOR1**forward* and FOR2**forward* are both negative and significant).

Tobit estimates, reported in Table 26 present a somewhat different picture. *Horizontal* and *backward* are both significant and positive whereas *forward* is significant and negative. Interaction terms suggest that positive *horizontal* spillover effects diminish with firm size. This is somewhat consistent the Brambilla (2009) result that medium sized firms benefit more from horizontal spillovers than large firms (though in her case small firms do not benefit from spillovers either). Negative interaction terms on *horizontal* also suggest that majority foreign owned firms and exporters benefit less from *horizontal* effects relative to domestic firms and non-exporters, respectively. Again, these results are consistent with the idea that less sophisticated firms may benefit more from horizontal spillovers.

The benefits generated by *backward* linkages do not appear to vary with size, ownership or export status. None of the interaction variables involving *backward* are significant statistically.

Interaction terms involving *forward* linkages suggest that negative spillovers from forward linkages are felt less by relatively large firms as well as exporting firms.

[6] The estimation includes region and year effects. Industry effects were not included due to the presence of firm fixed effects, reflecting the concern that firms may not change industries over time.

[7] We have also tried a version where we use only *horizontal* in the equation and omit *backward* and *forward*. The coefficient on *horizontal* was still not statistically significant.

Table 25: R&D intensity: The role of spillovers; FE estimation

	(1)	(2)
Log Employment	0.000917**	0.0013
	(0.000458)	(0.00089)
Log age	-0.00546***	-0.00529***
	(0.00112)	(0.00112)
FOR1	0.00481***	0.00541
	(0.00160)	(0.00346)
FOR2	0.00879***	0.01228***
	(0.00163)	(0.00311)
Non private	0.000297	0.000393
	(0.00273)	(0.00272)
Exporter	0.00118**	0.00055
	(0.000497)	(0.0012)
Horizontal	0.00221	0.00565
	(0.00409)	(0.00130)
Backward	-0.00102	-0.0272
	(0.0128)	(0.0325)
Forward	-0.00282	0.0318
	(0.00915)	(0.024)
Horizontal interaction terms		
c.lnL#c.horizontal		-0.0018665
		0.0029972
c.for1#c.horizontal		0.05006***
		0.0127703
c.for2#c.horizontal		0.0284***
		0.0092809
c.exporter#c.horizontal		-0.0032221
		0.0042502
Backward interaction terms		
c.lnL#c.backward		0.0057498
		0.0075277
c.for1#c.backward		-0.041245
		0.0361117
c.for2#c.backward		-0.0343392
		0.0278974
c.exporter#c.backward		0.0173535
		0.0113367
Forward interaction terms		
c.lnL#c.forward		-0.0048308
		0.0054164
c.for1#c.forward		-0.06107***
		0.0223889
c.for2#c.forward		-0.0681***
		0.0200629
c.exporter#c.forward		0.0036416
		0.0085788
Constant	0.00823**	0.00835**
	(0.00376)	(0.00330)
No. of observations	78506	78506
Number of firms	43771	43771

Note: *** p<0.01, ** p<0.05, * p<0.1. 20+ firms over the years 2006-2009. Standard errors are in parentheses. Dependent variable is R&D intensity measured as R&D expenditures in sales. 20+ firms that appear in the AISS data set but do not appear in the in RDAS are assumed to have zero R&D expenditures, as explained in the Data Appendix. Exporter is an indicator variable that takes on the value of 1 when the firm is an exporter and zero otherwise. Year and region and year effects are included in both equations.

Table 26 R&D intensity: The impact of spillovers; Tobit estimates

	(1)	(2)
Log employment	0.0588***	0.0585***
	(0.00243)	(0.00568)
Log age	0.0271***	0.0268***
	(0.00347)	(0.00343)
FOR1	0.0721***	0.0953***
	(0.0128)	(0.0303)
FOR2	0.0180*	0.0695***
	(0.00948)	(0.0232)
Non private	0.0712***	0.0688**
	(0.0274)	(0.0273)
Exporter	0.126***	0.0867***
	(0.00630)	(0.0147)
horizontal	0.573***	1.083***
	(0.0205)	(0.0756)
backward	0.230***	0.476*
	(0.0673)	(0.256)
forward	-0.802***	-2.376***
	(0.0584)	(0.227)
Horizontal interaction terms		
c.lnL#c.horizontal		-0.0441***
		(0.0161)
c.for1#c.horizontal		-0.00977
		(0.0852)
c.for2#c.horizontal		-0.306***
		(0.0563)
c.exporter#c.horizontal		-0.359***
		(0.0445)
Backward interaction terms		
c.lnL#c.backward		-0.0392
		(0.0549)
c.for1#c.backward		-0.0278
		(0.308)
c.for2#c.backward		0.305
		(0.201)
c.exporter#c.backward		-0.209
		(0.139)
Forward interaction terms		
c.lnL#c.forward		0.118***
		(0.0455)
c.for1#c.forward		-0.281
		(0.229)
c.for2#c.forward		0.0488
		(0.162)
c.exporter#c.forward		1.439***
		(0.132)
Constant	-0.922***	-0.882***
	(0.0334)	(0.0417)
Observations	78506	78506
Log Likelihood	-5270.98	-5120.36
Pseudo R-squared	0.334	0.353

Note: *** p<0.01, ** p<0.05, * p<0.1. 20+ firms over the years 2006-2009. Standard errors are in parentheses. Dependent variable is R&D intensity measured as R&D expenditures in sales. 20+ firms that appear in the AISS data set but do not appear in the in RDAS are assumed to have zero R&D expenditures, as explained in the Data Appendix. Exporter is an indicator variable that takes on the value of 1 when the firm is an exporter and zero otherwise.

5) CONCLUSION

The main findings of the paper can be summarized as follows:

Foreign firms in Turkey are larger than domestic firms and are predominantly situated in the traditional industrial centers (referred to as the West regions in this paper). They are predominantly active in manufacturing and retail and wholesale trade. When one compares the size distribution, we see that relative to domestic firms, employment and especially value added in foreign firms are more concentrated among large firms. Foreign firms are more productive (both in the sense of labor productivity, and in the case of manufacturing, TFP). Productivity gaps between domestic and foreign firms are smaller in manufacturing and among large firms. In particular, productivity gap between small domestic and foreign firms is larger than the productivity gap between large domestic and foreign firms.

Relative to domestic firms, foreign firms are more engaged in innovative activities. This is true for innovation proper (new products, new processes and organizational innovation) as well as export orientation and R&D activities (as measured by R&D expenditures divided by sales and the share of payments to R&D personnel in total wage payments).

Our econometric analysis regarding the link between innovation activities and foreign ownership strongly suggests that controlling for age and size, the propensity to do innovation, export and R&D is higher for foreign firms. For the case of R&D intensity, while the role of foreign ownership seems robust to the estimation methodology, the impact of firm size and age changes according to whether one use of FE or Tobit.

Regarding the role of spillovers the results are more nuanced. For the case of product and process innovation there is robust evidence of a positive *horizontal* spillover effect. Results on *backward* and *forward* are mixed and in some cases there is evidence of a negative forward linkage effect, a finding that deserves further exploration.

By contrast, export orientation seems to benefit from all three types of linkages and this result is robust to the method of estimation (logit vs tobit). Hence evidence so far seems to suggest that as far as potential to benefit from spillovers are concerned firms' export activities and innovation proper (i.e. product, process and organizational innovation) are qualitatively different processes.

We get mixed results regarding the role of spillovers on firms' R&D activities and results are sensitive to the estimation procedure used. Under fixed effects estimation, none of the spillover channels seem to work for private domestic firms and there is evidence that foreign firms benefit from *horizontal* linkages.

By contrast, when the Tobit estimation procedure is used, *horizontal* and *backward* linkages seem to have be positively and significantly associated with R&D intensity. There is also evidence that foreign

owned firms and exporters' R&D activities benefit less from horizontal linkages relative to private domestic firms and non-exporters, respectively, a finding that is consistent with the idea that relatively less sophisticated firms may benefit more from *horizontal* spillovers. Forward linkages seem to be negatively associated with R&D intensity, a finding similar to the obtained for product and process innovation, which, again, deserves further exploration.

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DATA APPENDIX

a) Annual Industry and Service Statistics (AISS, 2003-2011)

The AISS data provides detailed information on revenue, costs, employment, investment, sector of activity (at 4 digit detail, NACE Rev. 1.1 for 2003-2009 and NACE Rev.2 for 2009-2011, at 2 digit detail, NACE Rev.2 for 2003-2011) and the region of location (NUTS2 level).

NACE Rev. 1.1 sections from letter C to I, and letters K, M, N and O are covered. NACE Rev.2 sections B to J and letters L, M, N, P, Q, R and S are covered. The AISS does not cover the following NACE Rev. 1.1 sections:

A - Agriculture, hunting and forestry

B - Fishing

J – Financial Intermediation

L - Public administration and defense; compulsory social security

O - Other community, social and personal service activities

P - Activities of households

Q - Extra-territorial organizations and bodies

For NACE Rev. 2 (years 2009 and 2010) sectoral coverage is similar to the NACE Rev. 1.1. Here, the sectors that are not covered are:

A - Agriculture, forestry and fishing

K - Financial and insurance activities

O - Public administration and defense; compulsory social security

T - Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use

U - Activities of extraterritorial organizations and bodies

A division of J - "Programming and broadcasting activities" in Information and Communication activities is not covered.

Two classes of L - "Buying and selling of own real estate" and "Renting and operating of own or leased real estate" in the Real estate activities (section L) are not covered.

A division of S - "Activities of membership organizations" in Other service activities (section S) is not covered.

The AISS dataset covers all firms with 20 or more employees, and a representative sample of small firms with 1-19 employees. However, all firms with more than one plant (regardless of number of employees) are covered if they are in one of the sectors C (mining and quarrying), E (electricity, gas and water supply) or I (transport, storage and communications).

In 2009, the industrial classification changed from NACE Rev. 1.1 to NACE Rev.2. This switch creates a discontinuity in the data set and makes it impossible to undertake analysis that involves data at the 4 digit level. Fortunately, TurkStat provides NACE Rev.2 2 digit codes for 20+ sample for 2003-2008 period, so that we have a continuous series at 2 digit (NACE Rev.2) level for 2003-2011 period.

We use 2 digit producer price index for deflating value added, sales, exports and imports. For materials we use the manufacturing price index. For wage compensation we use Consumer Price Index. For investment in R&D and intangibles (Knowledge based capital) we use investment price index (derived from national accounts).

As a general rule, we exclude observations with negative value added. For TFP computations, we trim as follows: we exclude observations if firm's labor or material cost share is less than one-tenth or more than times compared to the industry (2D) average of that year. Also we exclude observations when labor or material cost share is more than one or negative. Finally, to deal with remaining outliers we exclude observations whose log(TFP) is 3 sd above/below compared to industry(2D)-year average.

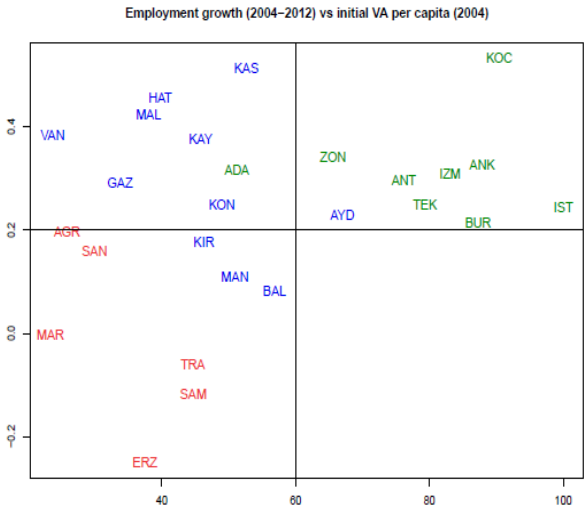
It was stated above that firms with less than 20 employees are covered on a sampling basis. AISS also reports sampling weights. For some analysis in the text, it makes sense to use the whole data set (i.e. including firms with less than 20 employees) along with the appropriate sampling weights. For example, the analysis of employment shares of firms in different size classes uses the whole data set. Other questions, for example decomposition of productivity growth, require to focus only on firms with at least 20 employees ("20+ firms"). Whether the whole data set or only 20+ firms are used is indicated in the text.

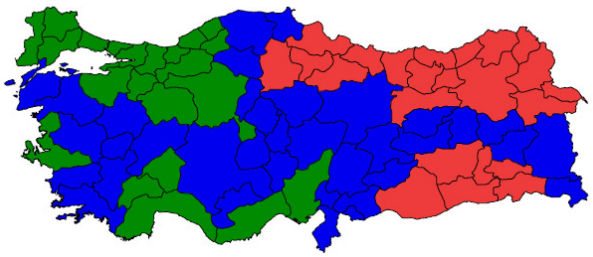
The AISS data set does not contain information on physical capital stocks. We use depreciation allowances to impute capital stocks at the firm level. Unfortunately, for almost half of the firms reported depreciation is zero. We find that implausible, assuming that the depreciation is rate is some nonnegative number. Thus, we impute depreciation allowances for such firms using sector (2 digit NACE Rev. 2), year dummies along with value added, number of employees, electricity and oil expenditures. We assume that depreciation rate is 10 % in the baseline specification. In the baseline specification we estimate a Cobb-Douglas production function with constant returns to scale at 2 digit NACE Rev. 2. Then, for each firm TFP is computes as a residual, using value added, capital and employment at the firm level. TFP is computed only for firms in the manufacturing industry for the years 2003-2011.

The data set contains information on geographic location at the NUTS 2 level. However, we find it useful to work at a higher level aggregation of regions. Following previous work [reference to Ch 4 of Flagship report or Working Paper], we use NUTS 2 information o create 3 regions: The West, which includes the traditional industrial centers, the Anatolian Tigers, which capture new growth centers that have appeared in the last 2-3 decades, and the Other region, which captures the rest. NUTS 2 information is used to assign firms to these three regions. Some firms have multiple plants (units) in different NUTS 2 regions. At the plant level, only information on the share of the plant in total employment and sales of the firm are available. To assign a geographic location for such firms we use the employment shares. Specifically, we assign each multi-plant firm in every year to the region where the plant with the highest employment share is located in that year. Because plants do not have unique ID codes that are constant over time and because not all information is available at the plant level, we cannot carry out the whole analysis on the basis of plant level information. However, we have calculated regional shares of employment and sales using plant level information as well,

and the shares turn out to be very close to those calculated on the basis of firms assigned to regions in the way described above.

The three regions are created in the following way: We identify as Tigers those NUTS2 sub-regions that had relatively low value added per capita in 2004 and which have experienced high job growth between 2004 and 2012 (see Atiyas and Bakis, 2013 for details.)





(i) = **West**,
(ii) = **Anatolian Tigers**,
(iii) = **Others**

Source: Authors' calculations using per-capita value added and employment data at the NUTS2 level obtained from the TurkStat website. Each label in the figure on the right refers to a NUTS2 region as defined by TurkStat. The x-axis represents per-capita value added in 2004 relative to the per-capita value added in Istanbul in 2004. The y- axis represents NUTS2 level employment growth between 2004 and 2012.

b) The Foreign Trade Statistics (FT, 2002-2011)

The FT data set covers all exports and imports transactions by all firms in Turkey since 2002 on a monthly basis. The data are collected by the Turkish Customs Authority and processed by TurkStat. Thanks to the unique firm ID one can follow individual firms through time. For any firm, we know each transaction's (export and import) value, its quantity and destination at product level. In Turkey, product codes are 12 digit- the first 8 of which correspond to the Combined Nomenclature classification, and the last 4 digits are national. Hence, for international comparisons one has access to 6 digit Harmonized System classification. Thanks to the firm ID we can merge the FT data set with the AISS data set. This gives detailed information on sales, value added, costs, location, employment alongside exports and imports at firm level. The match between the two data sets is not perfect, because while the FT data set covers all firms that have export and import transactions, the AISS covers only a sample of firms with less than 20 employees. However, the match quite reliable: total exports in the matched data amounts to 83 percent of total exports in the FT data set in 2010. [to be re-checked with more recent data]

c) The Research and Development Activities Survey (RDAS, 2003-2010)

The RDAS data set contains information on Research and Development (R&D) expenditures and R&D personnel. The following enterprises are covered according to the survey frame: Enterprises funded by government agencies that provide R&D support, the top 500 enterprises in industry and services sectors by turnover and value added, enterprises in Technology Development Zones and Technoparks, enterprises benefiting from the insurance Premium support (article 3/3) stated in the Law on Supporting Research and Development, no.5746, enterprises which are known as R&D performers from the AISS survey, and public and private universities. Again, we can link this data set to the AISS data set via unique firm ID. The RDAS data set contains about 15 thousand observations over the period 2003-2010. The merging operation results in about 9000 matches.

We note that the AISS data set also contains information on R&D expenditures, in two instances. First, the data set reports expenditures on "intangible assets", which includes R&D expenditures (though , not separately, but as part of investment into "other intangible assets". In addition, the survey instrument used for the AISS includes a separate section on R&D expenditures. However, data related to that section is not provided to researchers. According to TurkStat officials R&D data in the RDAS data set is more reliable. This is why R&D expenditures in the AISS data are not provided. Our understanding is that information gathered during the assembly of the AISS is then used by TurkStat to gather more reliable and detailed data during the implementation of the R&D survey. Based on this information, we conclude that the R&D data set is highly exhaustive in its coverage. Hence, , for firms in the AISS that do not get matched to the RDAS data set, we think it is quite safe to assume that their R&D expenditures are zero, which is what we do in the empirical work carried out in this paper. With this assumption, Information based on the merged RDAS and AISS provides fully comprehensive information on 20+ firms, including their R&D behavior.

d) The Community Innovation Survey (CIS, 2004-2010)

The CIS data set contains information on innovation activities within enterprises, the effects of innovation, sources of information used, costs etc. The CIS compiled by TurkStat is based on the Oslo Manual jointly developed by Eurostat and the OECD for defining and measuring the innovation concept.

The CIS 2004-2006 and 2006-2008 use NACE Rev.1.1 for economic activity classification, while the CIS 2008-2010 uses NACE Rev.2.

The CIS dataset covers a representative sample of firms with 10 or more employees. Unfortunately, the lack of a panel component (like 20+ in the AISS dataset) limits the potential benefits of the CIS. The CIS is not representative at the NUTS2 (regional) level either. The 2004 and 2004 surveys cover less than 3000 firms. The 208 and 2010 surveys cover about 5800 firms.

The CIS 2008-2010 cover the following NACE Rev. 2 industries:

-Mining and quarrying (05-09),

-Electricity, gas steam and air conditioning supply (35),

-Manufacturing (10-33),

-Water supply; sewerage, waste management and remediation activities (36-39),

-Wholesale trade, except of motor vehicles and motorcycles (46),

-Transportation and storage (49-53),

-Publishing activities (58),

-Telecommunications (61),

-Computer programming, consultancy and related activities (62) ,

-Information services activities (63),

-Financial and insurance activities (64-66),

-Architectural and engineering activities; technical testing and analysis (71),

-Scientific research and development (72)

The CIS have been produced for the periods 1995-1997 (CIS2), 1998-2000 (CIS3), 2002-2004 (CIS4), 2004-2006 (CIS2006), 2006-2008 (CIS2008) and 2008-2010 (CIS2010). But, given that AISS is available only for 2003-2011 period, the last 3 surveys are really usable, because using unique firm ID the CIS can be linked to the AISS and other firm-level statistics produced by TurkStat.

The main activity of the firm (if she has more than one activity) is defined according to the sales. The activity with greatest sales is defined as main activity. If the gross sales are equal for two activities, then, the main activity is determined by the number of employees.

The CIS defines the following innovation types:

Product innovation: The term "product" covers both goods and services. Product innovations refer to both the introduction of new goods and services and significant improvements in the functional or user characteristics of existing ones. To distinguish between "new products" and "significant improvements", it helps to compare "characteristics" vs "performance". The CIS defines new product as goods and services that "differ significantly in their characteristics or intended uses from products previously produced by the firm". Significant improvements to existing products are defined as performance enhancements due to changes in materials, components and other characteristics". For services sector, product innovation may be limited to the way they are provided, for instance a difference in efficiency or speed may describe a product innovation.

Process innovation: Process innovation refers to the implementation of a new or significantly improved production or delivery method. The motivation behind such an innovation are various: decreasing unit costs, increasing quality, or producing new or significantly improved products.

Organizational innovation: Organizational innovation is defined as the implementation of a new organizational method. This new method may be related to business practices, workplace organization or external relations. Mergers or acquisitions (even if they are occurring for the first time) are not considered as organizational innovations, because organizational innovations are required to be result of strategic decisions taken by management.

Marketing innovation: Marketing innovation is the implementation of a new marketing method. This innovation may be related to the product design, packaging, product placement, product promotion or pricing.

The CIS data has firm level ID codes which can be used to obtain information from the AISS data set on variables (such as ownership) that is not available in the CIS data set. Because firm size, firm ownership, or sectoral or regional variation are not used in the sampling of firms for the CIS survey, the CIS data is not representative along these dimensions. Hence tables reported in this paper that use breakdowns along these variables should be taken as providing information only about the CIS sample, with no country-wide representativeness. Because the CIS sample is random, econometric work that is based on the firms in the CIS data set and that uses information from both the CIS and AISS, will provide unbiased results.