Drivers of Competitiveness in European High-Tech Industries

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Abstract Our paper builds on the importance of high-tech manufacturing and knowledge-intensive services as significant competitiveness and economic growth drivers in the European Union and offers a fresh approach of the study on the competitiveness of secondary and tertiary high-tech industries across EU member states. Our analysis covers the 2008–2015 period and includes twelve old and new EU members. We opt for a balanced panel data approach in OLS and ARIMA frameworks to investigate the competitiveness of high-technology industries in the EU with the aim of uncovering the nature of the main explanatory factors behind their performance. Our results show that the number of persons employed and the investment rate are both determinants of labour productivity and business profitability, while turnover and personnel costs have a specific influence on productivity and profitability, respectively. The GDP level and the percentage of population with tertiary education are the most significant location-related drivers for high-tech industries' competitiveness. Overall, industry-related factors are more important for explaining the competitiveness of high-tech sectors compared to location-related factors, while external factors have a marginal impact on high-tech industries' performance.

Keywords Competitiveness · Performance · High-tech industries · Location · European Union

Jel Classification F23 · L16 · C23

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1 Introduction

The explanations of business competitiveness are generally focused on two approaches, according to existing literature. As such, the "structure-based" view emphasizes the role of industry factors for businesses' performance, while the "resource-based" view is centred on the firm's advantages, resources and capacities in building its competitiveness. More recently, due to globalization, scholars started to emphasize the role of the external factors—such as the country's openness towards exports and foreign investments—in influencing performance and competitiveness. While literature is abundant, empirical studies have not yet reached clear-cut results on the main drivers of companies or industries' competitiveness. Moreover, a distinction between the various categories of industries is seldom provided.

In this paper, we focus on the factors that influence the competitiveness of the high-tech manufacturing and knowledge-intensive services, due to their emerging importance for the European Union (EU) as drivers of economic growth and productivity. The strategies of the EU in the last two decades, i.e. the Lisbon Strategy and the Europe 2020 Strategy, emphasize the role of the knowledge economy, which encompasses "from high-tech manufacturing and ICTs through knowledge intensive services" (Kok Report 2004, p. 19), as an accelerator for development. As Kranjac et al. (2013) state, the need for new ideas and innovative products, services and processes replaces nowadays the necessity of increased production, and this lies at the heart of the Europe 2020 Strategy. In fact, according to the taxonomy advanced by the European Commission on the high-tech industries and knowledge-intensive services, the EU high-tech sectors covered 4.56% of total number of EU enterprises, 5.9% of the total EU enterprises turnover and 9.6% of the total value added in EU enterprises in 2014, while high-tech manufacturing sectors hired 1.1% of total labour force and high-tech knowledge-intensive services accounted for 2.9% of total employment in EU-28 in 2014 (Horobet et al. 2018).

As compared to previous studies, firstly, this paper widens the sphere of analysis by relating to determinants of companies' performance grouped in three major categories: industry-related factors, location-related factors and international exposure or external factors. Secondly, since the general landscape of high-tech industries in EU suggests significant differences in performance and competitiveness between the old and the new EU countries, we consider that country individualization is required; thus, the panel empirical models used in this paper are built for taking into account the countries' specificities. Thirdly, our analysis is designed for allowing for the distinction between the factors influencing the competitiveness of firms in the secondary and tertiary sectors, as the services sector exhibit special characteristics. Finally, we try to compensate a gap in the literature, which is more focused on the situation of developed economies; therefore, our analysis takes into account both older and newer EU members, thus enriching the literature related to the investigation of Central and Eastern Europe industries' competitiveness.

The paper is organized as follows: Sect. 2 outlines the theoretical and empirical framework that supports our study, Sect. 3 presents the data and methodology, Sect. 4

discusses the main results and Sect. 5 concludes and points towards directions for future research.

2 Literature Review

The first strands of the literature related to the competitiveness or performance of a company were developed under the theory of industrial organization, during 1940–1950, through the work of Bain and Mason (Porter 1981). The major theoretical framework explaining the profitability of a company was the "structure-conduct-performance" model, with a special emphasis on the market or industry structure. While the "structure" includes the environment given by the firm's affiliation in terms of industry—i.e. technological endowment and competition—"conduct" is encompassing the economic choices of the firm in terms of pricing and product strategies, advertising, etc. while "performance" is the result of the decisions related to the efficient allocation of resources, cost minimization, innovation and technological advancement (Porter 1981; Waldman and Jensen 2016). These characteristics would also lead to differences in firm's performance depending on the industry. Porter (1979) also emphasizes the role of the industry and market structure (e.g. the existence of strategic groups and mobility barriers) in explaining the differences in companies' profitability.

The literature sees another turn starting with 1980, when more emphasis is put on the firm's ability to sustainably generate competitive advantages, as in the "resource-based" view of the firm (Ramsay 2001). There are the firm-specific idiosyncrasies or the "dynamic collections of specific capabilities" (Hawawini 2003, p. 6) that determine the profit level of the firm. Once with globalization, the capacity of countries to become integrated in the world value chain—through either trading internationally or attracting foreign direct investments (FDI)—is another component that shapes the competitiveness of firms acting inside the national boundaries.

Therefore, the framework explaining the competitiveness or profitability of companies is inextricably linked to the industry-related factors, location-related factors and external factors. Besides, the empirical studies do not provide a clear-cut conclusion related to the factor that is of the highest importance among them.

The empirical research in this area starts with the work of Schmalensee (1985) who, distinguishing between the contribution of the firm, industry and market share factors to the firm performance, concludes that industry effects are crucial, while market shares poorly explain performance and firm factors are insignificant in the case of the American manufacturing firms. The results of Hansen and Wernerfelt (1989) indicate the interdependence between economic and organizational factors, but with a higher importance for the firm factors over the profit rates; Rumelt (1991) points to the larger impact of industry on the profitability of manufacturing firms, while corporate effects are not important. Hawawini et al. (2003) reach a similar conclusion, but only after excluding from the sample the outliers—namely the best and the worst performers.

A series of studies generally point to the more important influence of the firm over industry effects in explaining business performance and competitiveness (Mauri and Michaels 1998; McGahan and Porter 1997; Ruefli and Wiggins 2003; Hough 2006). The authors usually make the distinction between the “industry effects” emerging from the membership in a particular industry, the “corporate parent effects” as a result of the membership in a particular corporate family (similar, therefore, with “firm effects”) and “business segment” or “business specific” factors, for pointing to the influence of “a part of a corporate family working in a particular industry” (Furman 2000, p. 1). Therefore, for encompassing all these effects, we will relate, in this study, to the general notion of industry-related factors.

Hawawini et al. (2004) assess the impact of home country on companies’ performance through the generation of biases—such as the tendency to support more the domestic than the international trade and the low financing capacity. Ghemawat (2003) has a rather extensive view, indicating the lack of countries’ capacity to integrate in the global flows from the perspective of international trade, FDI or production factors as a cause for poorer firm development. Goldszmidt et al. (2011) investigate the impact of the country effects on company performance and conclude that the influence depends on the development level of the country, being more important in emerging economies than in more developed ones. We consider that, compared to previous studies, the location country influence should be approached from two directions: the capacity to provide a proper environment for companies in order to increase their performance and the ability to integrate in the international value chains, through which both domestic and foreign companies inside the country could enhance their competitiveness. Therefore, our study distinguishes between location-related factors (such as the prospects of economic development, the skilled labour force and the development of innovation) and external factors (the FDI importance, the country’s competitiveness level against its partners, etc.). Due to globalization, an important factor in explaining business performance is company’s ownership—either foreign or domestic. For the German economy, Weche Gelubcke (2011) emphasizes the difference in terms of employees, wages and export propensity, which are higher for the foreign-owned than for the domestic-owned companies, as compared with labour productivity, in whose case differences are insignificant. Grasseni (2010) supports the heterogeneity of factors influencing the performance gap between domestic multinationals and foreign-owned firms in Italy in 1995 and 1997; interestingly, the author emphasizes a lack of significant difference in labour productivity, capital intensity and profitability between the two types of companies in the high-tech sectors, but recognizes the importance of taking into account industries’ characteristics in further studies.

From a different perspective, though, high-tech industries require, in addition, special endowments of the location. Dunning (2004, 2010) uses the notion of “created assets” when emphasizing the actual type of resources that shape a location attractiveness for investors. This concept is especially interesting in the case of high-tech sectors, as literature points to their specific types of structure and outcomes for the economy (Arthur 2000) and, therefore, specific requirements in terms of location advantages for enhancing their performance, such as knowledge endowments (Arvanitis and Hollenstein 2009), government and business R&D investments (Varum and Cibrao 2008), spillovers and rich technological activities (Cantwell and Piscitello 2005). Ortega-Argiles et al. (2015) conclude that the impact of R&D on productivity in the manufacturing high-tech sectors is higher than for the rest of the sectors. One of the major factors mentioned in the literature as relevant for increasing the performance of either high-tech manufacturing or services sectors is the foreign ownership (Buckley et al. 2002; Patibandla and Petersen 2002; Kafouros et al. 2008; Liu 2008).

3 Data and Research Methodology

Our analysis is undertaken for the period 2008–2015 and includes twelve EU countries, of which eight are older members of the EU—Austria, France, Germany, Italy, Netherlands, Portugal, Spain and the UK—and four are newer EU members—Czech Republic, Hungary, Poland and Romania. The industries that we investigate were selected from the high-technology (high-tech) sectors in the EU based on the Eurostat classification according to technological intensity in both manufacturing and services, at two-digit level, as follows: (i) two high-tech industries from the manufacturing sector—"Manufacture of basic pharmaceutical products and pharmaceutical preparations" (C21) and "Manufacture of computer, electronic and optical products" (C26); (ii) five high-tech knowledge-intensive services—"Motion picture, video and television programme production, sound recording and music publishing activities" (J59), "Programming and broadcasting activities" (J60), "Telecommunications" (J61), "Computer programming, consultancy and related activities" (J62), and "Information service activities" (J63).[1]

The countries included in our research were selected to a large extent based on data availability—all data used in our research is collected from Eurostat— but the sample is significant at EU level from the perspective of high-tech industries. The countries in our sample collectively held a share in EU turnover between 68.61% (C21) and 89.58% (J60) and in persons employed between 79.28% (C21) and 88.34% (J63), based on average shares between 2008 and 2015 but, as expected, the older EU members hold, both collectively and individually, the highest shares at EU level in these industries. At the same time, the four newer EU members tend to held higher shares in turnover (12.35% as 2009–2015 average) and in persons employed (16.36% as 2009–2015 average), both in industry C26.[2] Another interesting remark is that the shares of newer EU members in the total number of persons employed at EU level for our panel of industries are higher than the respective shares in turnover, which suggests a more intensive use of labour in these economies by companies in the high-tech industries and, as consequence, a lower level of competitiveness compared to the

[1] All codes are based on NACE Rev.2.

[2] All data and computations are available from authors.

old member states' industries. This also points towards the use of newer EU member states as locations for more labour-intensive operations of companies from high-tech industries, while keeping the more capital and technology-intensive operations in the older and more developed EU members.

The competitiveness of high-tech industries is described in our study by two indicators provided by Eurostat: (i) apparent labour productivity (ALP)—defined as the "value added at factor costs divided by the number of persons employed" and (ii) gross operating rate (GOR)—defined as the "ratio of gross operating surplus to turnover"; ALP is a labour productivity indicator, while GOR is closest to a profitability ratio at industry level. Various profitability measures were used in previous research for explaining company performance, but by taking into account both perspectives on competitiveness, productivity and profitability, a more comprehensive view on the high-tech industries' performance at EU level is advanced by our research.

Table 1 presents descriptive statistics—mean, median, minimum and maximum values—of ALP and GOR for each industry, country and year included in our research. These statistics show that significant differences in both measures of competitiveness across high-tech industries for all years and between countries are persistent—more importantly between the older and newer EU countries, with significant competitiveness gaps in the favour of the former. More worrying, though, is the lack of any systematic pattern of correction of these competitiveness gaps between 2008 and 2015.

We explain the competitiveness of high-tech industries in EU by considering three types of factors—industry-related, locational- or country-related and international exposure factors—in balanced panels in the following general two forms:

$$Y_{it} = \alpha + \beta_{it} X'_{it} + \delta_{it} Z'_{it} + \theta_{it} W'_{it} + \gamma_{it} + \varepsilon_{it} \quad (1)$$

$$Y_{it} = \alpha + \beta_{it} X'_{it} + \delta_{it} Z'_{it} + \theta_{it} W'_{it} + Y_{it-1} + \gamma_{it} + \varepsilon_{it} \quad (2)$$

where Y_{it} is the dependent variable—an industry competitiveness indicator (ALP or GOR), X'_{it} is a vector of industry characteristics that provide the differentiation in competitiveness across industries, Z'_{it} is a vector of country characteristics that are relevant for explaining the high-tech industries' competitiveness across countries, W'_{it} is a vector of international exposure of high-tech industries, Y_{it-1} is the one-year lagged value of the dependent variable, γ_{it} capture the cross-sectional specific fixed effects, α is the overall constant of the model and ε_{it} is the error terms for i = 1,2, …, M cross-sectional units observed for periods t = 1,2, .., T; $\varepsilon_{it} \sim N(0, \sigma_\varepsilon^2)$, where M = 12 and t = 7.[3] Data series used in our panels represent the first difference in the natural logarithm of raw data.

Industry-related factors considered in our analysis are: (i) turnover or gross premiums written (TURN); (ii) the number of persons employed (PERSEM); (iii) the average personnel costs or personnel costs per employee (PERSCOST); (iv) the

[3]The period under analysis is 2008–2015 (8 years), but variables in our panels are the first difference of logarithmic data, which reduces t from 8 to 7.

Table 1 Descriptive statistics of competitiveness indicators across high-tech industries, 2008–2015

	Apparent labour productivity—ALP							
	2008	2009	2010	2011	2012	2013	2014	2015
C21—Manufacture of basic pharmaceutical products and pharmaceutical preparations								
Mean	101.90	96.88	102.78	104.04	107.19	102.37	101.55	103.08
Median	106.60	105.05	110.50	107.95	109.45	114.15	117.00	111.85
Min.	23.00	21.80	33.60	30.20	28.10	31.50	31.50	31.70
Max.	243.00	217.40	220.50	208.22	263.50	208.22	190.70	190.70
C26—Manufacture of computer, electronic and optical products								
Mean	54.36	48.61	56.56	57.48	57.77	57.18	59.62	64.40
Median	55.35	52.35	59.15	56.65	57.80	55.85	58.10	61.15
Min.	14.70	14.20	16.30	15.40	16.20	15.50	15.50	15.30
Max.	115.37	98.20	127.30	108.70	123.50	110.20	124.30	143.70
J59—Motion picture, video and television programme production, sound recording and music publishing								
Mean	43.05	45.21	47.10	50.73	52.15	50.81	51.96	50.86
Median	34.25	41.75	43.25	46.00	46.55	47.15	48.20	50.30
Min.	11.60	10.20	16.70	11.90	14.70	11.70	21.40	13.40
Max.	129.04	129.04	123.20	136.80	130.40	129.50	125.30	106.40
J60—Programming and broadcasting activities								
Mean	100.62	110.50	107.83	110.68	99.13	94.49	97.42	100.24
Median	99.19	89.00	100.40	101.35	98.70	91.05	90.45	101.55
Min.	14.00	8.50	8.00	18.50	17.10	18.20	27.00	32.90
Max.	223.90	378.60	238.68	226.20	194.20	182.60	178.70	194.70

(continued)

Table 1 (continued)

	Apparent labour productivity—ALP							
	2008	2009	2010	2011	2012	2013	2014	2015
J61—Telecommunications								
Mean	164.88	157.85	164.24	162.58	160.00	151.68	148.51	149.56
Median	162.24	160.39	160.20	157.25	158.25	153.20	155.30	166.85
Min.	50.00	44.70	44.60	41.70	41.80	42.20	40.80	38.10
Max.	273.10	271.00	266.20	264.70	260.50	253.10	240.30	233.80
J62—Computer programming, consultancy and related activities								
Mean	52.54	50.84	51.86	53.50	54.33	54.32	55.02	57.24
Median	54.95	53.15	56.05	58.00	58.85	57.70	59.70	59.75
Min.	18.80	16.60	18.60	19.70	20.00	20.40	23.10	24.10
Max.	90.80	82.30	78.90	82.30	97.30	90.40	91.90	112.20
J63—Information service activities								
Mean	46.76	46.09	48.93	53.87	51.01	54.03	54.46	54.74
Median	39.35	39.85	42.35	44.20	43.60	46.25	47.10	45.95
Min.	12.80	13.10	12.30	11.10	13.90	12.70	14.10	15.20
Max.	99.20	110.50	150.20	162.10	138.10	150.20	150.20	150.20
	Gross operating rate—GOR							
	2008	2009	2010	2011	2012	2013	2014	2015
C21—Manufacture of basic pharmaceutical products and pharmaceutical preparations								
Mean	20.35	18.53	20.19	20.70	19.75	18.34	17.75	18.10
Median	18.95	19.15	18.65	19.65	16.85	17.05	17.95	18.50

(continued)

Table 1 (continued)

	Gross operating rate—GOR							
	2008	2009	2010	2011	2012	2013	2014	2015
Min.	10.70	9.30	11.10	10.40	10.90	9.90	5.80	8.50
Max.	38.40	31.20	36.70	41.50	36.10	25.90	24.00	25.50
C26—Manufacture of computer, electronic and optical products								
Mean	8.05	6.60	8.92	9.24	9.55	9.26	8.85	8.98
Median	8.03	6.40	8.65	8.60	8.05	8.30	8.70	8.35
Min.	2.50	0.20	2.00	1.80	4.20	0.80	4.10	4.40
Max.	17.00	15.80	23.70	22.00	20.20	18.40	16.10	18.60
J59—Motion picture, video and television programme production, sound recording and music publishing								
Mean	13.55	15.99	17.75	17.91	19.10	18.01	19.89	17.81
Median	16.25	15.70	20.00	18.55	19.55	18.35	20.50	17.25
Min.	−13.50	−11.10	−7.20	7.30	5.80	5.90	5.60	10.70
Max.	24.80	36.00	33.20	30.10	33.20	31.00	32.30	31.70
J60—Programming and broadcasting activities								
Mean	19.91	20.29	20.05	22.80	19.62	18.88	20.36	25.64
Median	21.70	23.05	24.90	21.30	17.50	18.35	20.85	20.60
Min.	−11.30	−21.00	−20.50	3.40	−3.80	0.80	1.30	5.20
Max.	41.00	57.70	47.60	40.20	40.80	33.90	33.60	60.80
J61—Telecommunications								
Mean	32.25	31.89	31.88	30.63	30.68	29.13	29.48	27.97
Median	32.75	32.55	33.00	28.85	31.15	29.20	29.60	28.95

(continued)

Table 1 (continued)

	Gross operating rate—GOR							
	2008	2009	2010	2011	2012	2013	2014	2015
Min.	25.40	25.00	23.60	19.80	21.10	21.70	20.40	19.00
Max.	40.10	39.30	39.40	39.30	39.50	34.90	35.90	33.40
J62—Computer programming, consultancy and related activities								
Mean	15.04	14.02	14.57	14.49	13.89	13.87	14.28	13.97
Median	14.00	12.55	14.35	14.45	13.20	13.90	14.00	13.70
Min.	8.20	6.70	7.00	6.80	6.80	6.90	6.90	7.10
Max.	23.60	22.40	23.10	24.10	24.10	24.90	23.80	28.00
J63—Information service activities								
Mean	17.08	18.33	18.96	19.36	18.29	19.14	19.30	19.11
Median	18.25	17.50	18.80	16.50	18.00	18.75	18.30	18.30
Min.	−0.60	5.10	6.20	8.60	9.10	8.60	9.60	7.70
Max.	33.60	42.00	38.70	41.00	35.30	41.20	39.50	38.00

Source Authors' calculations based on Eurostat data investment rate, defined as investment (or gross fixed capital formation) divided by value added at factors cost (INVR).[4] The expected signs of coefficients are positive for TURN—higher levels of productivity and profitability are expected in higher-sized companies, negative for PERSEM and PERSCOST—the more personnel companies employ and the higher the average cost per employee they pay should negatively alter their productivity and profitability and negative for INVR, as in the case of smaller companies this indicator tends to have higher values compared to bigger companies.

The vector of country characteristics includes: (i) gross domestic product at current market prices (GDP)—we use these variable to test whether a higher level of economic development is reflected in the performance of high-tech industries; (ii) the percentage of population with tertiary education (TERTED)—this variable reflects the human resources quality in the countries under investigation; (iii) the support for high-tech industries, measured by the overall economy's research and development (R&D) expenses per inhabitant (RDEXP_INHAB)—we expect this variable to be positively connected to the performance of high-tech industries; and (iv) digital infrastructure availability, measured as the percentage of enterprises with broadband access (BROAD_COMP) in the total number of enterprises[5]—a priori, a more extensive Internet connectivity should positively influence the performance of high-tech industries.

The international exposure of the high-tech industries is taken into account through two variables: (i) The importance of FDI in these industries (FDI_TURN), measured by the ratio of turnover obtained by foreign controlled companies to the turnover obtained by locally controlled companies in each industry; this variable allows us to investigate whether the presence of foreign capital in an industry improves the competitiveness of the respective industry; and (ii) The overall level of country competitiveness, measured by the real effective exchange rate against the main 42 trading partners (REER)[6]; with this variable, we investigate whether the high-tech industries' competitiveness is influenced by the country's competitiveness in terms of prices, reflected by REER, which shows the weighted average value of a country's currency relative to a basket of 42 currencies, belonging to the country's main trading partners, and adjusted for the effects of inflation.

Data for all variables are collected form Eurostat. Panels are estimated under two main specifications, i.e. no effects (NE) and fixed cross-effects (FE). Since NE is a highly restrictive specification that ignores the possible presence of differences in

[4]Definitions of these indicators are available at http://ec.europa.eu/eurostat/statistics-explained/index.php?title=Category:Structural_business_statistics_glossary.

[5]Enterprises with at least 10 persons employed (Eurostat).

[6]The real effective exchange rate (REER) is calculated by the European Commission with the aim of assessing a country's price or cost competitiveness relative to its main competitors in international markets (the groups are the following: (i) the EU member states and euro-area countries; (ii) 37 industrial countries; and (iii) 42 countries). REER is the nominal effective exchange rate deflated by relative price or cost deflators. More information on REER is available at https://ec.europa.eu/info/business-economy-euro/indicators-statistics/economic-databases/price-and-cost-competitiveness_en.

coefficients across countries or time, the intercept α is allowed to vary across countries in the cross-sectional panel specification. Thus, we introduce the assumption of heterogeneity in our sample of countries, induced by different industry characteristics and/or different macroeconomic structures. Panel coefficients are estimated using panel least squares and ARIMA, after applying Durbin–Wu–Hausman test for endogeneity/heterogeneity, with White cross-sectional standard errors and covariance (no d.f. corrected). At the same time, panel estimations take into account the possible presence of cross-sectional heteroskedasticity through the use of cross section weights. Overall, 56 panels with linear specifications were estimated, eight for each industry, and the results are presented in the next section.

4 Main Results and Discussion

Stationarity tests applied on panels were the Levin et al. (2002), Im et al. (2003), ADF Fisher test and PP Fisher test proposed by Maddala and Wu (1999) and Choi (2001). All tests indicated that panels were stationary in all specifications.[7]

The results of our estimations are presented in Tables 2 and 3. In both tables, results are presented for each industry and for both panel specifications considered, i.e. no effects and fixed cross-effects. These results are explained and discussed in the industry—location—international exposure triad.

Industry factors considered in our analysis were turnover (TURN), the number of persons employed (PERSEM), the average personnel costs (PERSCOST) and the investment rate (INVR). Of these, industry turnover and the number of persons employed are by far the most significant influence factors of high-tech industries productivity level—we find statistically significant coefficients in 27 out of 28 panels for turnover and in 24 out of 28 panels for persons employed, in both no effects and cross fixed effects panels. The signs of coefficients indicate a positive link between turnover and productivity for all industries and a negative link between the number of employees and productivity. The number of persons employed is a highly significant factor for industry profitability, as we find statistically significant coefficients, all negative, in 22 out of 28 panels, for all industries and panel specifications. We consider these results robust regarding the link between turnover and productivity, as larger companies should show higher productivity levels as a result of higher production volumes, as well as the results between the number of persons employed and productivity, as a higher number of persons employed is reflected in higher costs that depress both productivity and profitability levels.

The average personnel cost (PERSCOST) is a significant variable for both productivity and profitability across industries, with a higher importance in the case of profitability. In the case of productivity, significant coefficients are found only in the case of two high-tech services (J62 and J63)—with positive coefficients, which is a rather puzzling result; this might point towards industries' specificities that have

[7]Results are available from authors.

Table 2 Panel estimation results for ALP as dependent variable

Panel specification	α	TURN	PERSEMP	PERSCOST	INVRATE	GDP	TERTED	BROAD_C OMP
C21—Manufacture of basic pharmaceutical products and pharmaceutical preparations								
No effects	−0.0151	0.4750	−0.7763*	0.1105	−0.1066*	0.2651	0.2729**	0.2318
No effects	−0.0094	0.4296*	−0.8023*	0.0927	−0.1142*	0.2553	0.3144*	0.1685
Fixed effects	−0.0325**	0.5533*	−0.7770*	0.1127	−0.0991**	0.3288	0.3012**	0.3506
Fixed effects	−0.0099	0.3769**	−0.7547**	0.1119	−0.1310*	0.4820	0.2633**	0.0286
C26—Manufacture of computer, electronic and optical products								
No effects	−0.0185	0.3526*	−0.5712**	−0.0814	−0.1715*	1.6566*	0.0620	0.0968
No effects	−0.0170	0.3103*	−0.7656*	−0.1731	−0.1528*	1.1504*	0.1705	0.1808
Fixed effects	−0.0232	0.3546*	−0.5280**	−0.0100	−0.1849*	1.6982*	0.0007	0.3180
Fixed effects	−0.0045	0.2203*	−0.5689**	0.0306	−0.1431*	0.9468*	0.0046	0.3473
J59—Motion picture, video and television programme production, sound recording and music publishing activities								
No effects	0.0082	1.4622*	−1.0647*	0.0509	−0.1783*	−1.0455**	−0.3349**	0.5234
No effects	0.0074	1.1264*	−0.9498*	0.0800	−0.0935*	−0.1113	−0.1445	0.2554
Fixed effects	−0.0234	1.5042*	−1.1666*	−0.0332	−0.1446*	−1.2413*	−0.4756**	1.2521
Fixed effects	−0.0225	1.1157*	−0.9920*	−0.0406	−0.0848**	−0.4985	−0.2699**	1.0467
J60—Programming and broadcasting activities								
No effects	−0.0153	0.7338*	−1.1197*	−0.0439	−0.1071*	0.0610	−0.1114	0.2720
No effects	−0.0371	0.6007**	−1.1034*	−0.1062	−0.0949*	0.6869	−0.0533	0.2689
Fixed effects	−0.0365**	0.7687*	−1.3127*	−0.2693	−0.0949*	0.0507	−0.1289	0.5114
Fixed effects	−0.0491*	0.7225*	−1.1292*	−0.2634	−0.0702*	0.7503	−0.0931	0.3643

(continued)

Table 2 (continued)

Panel specification	α	TURN	PERSEMP	PERSCOST	INVRATE	GDP	TERTED	BROAD_C OMP
J61—Telecommunications								
No effects	−0.0263**	0.4898*	−0.8790*	0.0250	−0.0424**	0.6377*	0.0200	−0.1388**
No effects	−0.0450*	0.2565*	−0.7556*	0.0245	−0.056**	1.2988*	0.0817	−0.1786**
Fixed effects	−0.0255**	0.4552*	−0.8584*	0.0364	−0.0407**	0.5582*	0.0704	−0.0078
Fixed effects	−0.0580*	0.2040*	−0.6679*	0.0140	−0.0562	1.3526*	0.1551	0.0884
J62—Computer programming, consultancy and related activities								
No effects	0.0029	0.3105*	−0.5351*	0.3375*	−0.0048	0.2767*	0.0019	0.2510*
No effects	0.0020	0.3009*	−0.5024*	0.3233**	−0.0021	0.2554*	0.0071	0.2404*
Fixed effects	0.0049	0.3233*	−0.5687*	0.2808**	−0.0051	0.2961*	0.0269	0.2068**
Fixed effects	0.0066	0.2485**	−0.5009*	0.2324	0.0006	0.3266*	0.0462	0.1400
J63—Information service activities								
No effects	−0.0054	0.2939*	−0.2634	0.5555*	−0.0280	−0.2432	0.0012	0.3233**
No effects	0.0022	0.1184	−0.0303	0.8793*	−0.0259	−0.1678	−0.0017	0.0839
Fixed effects	−0.0082	0.3078*	−0.2136	0.5763*	−0.0366	−0.2060	0.0296	0.5279*
Fixed effects	−0.0043	0.0857	0.0606	0.8527*	−0.0499**	0.1403	0.0225	0.2443**

Panel specification	RDEXP_ INHAB	FDI_TURN	REER	ALP(−1)	Adj. R^2	S.E. of regression	F-stat
C21—Manufacture of basic pharmaceutical products and pharmaceutical preparations							
No effects	−0.0774	0.1177*	0.3193		0.5555	0.1171	11.3711*
No effects	−0.1553	0.1483*	0.1756	−0.2002	0.6145	0.1111	11.2871*
Fixed effects	−0.0858	0.1212**	0.2056		0.5083	0.1238	5.0855*
Fixed effects	−0.0611	0.1960*	0.3902	−0.2566*	0.5666	0.1192	5.2190*

(continued)

Table 2 (continued)

Panel specification	RDEXP_ INHAB	FDI_TURN	REER	ALP(−1)	Adj. R^2	S.E. of regression	F-stat
C26—Manufacture of computer, electronic and optical products							
No effects	−0.3232	−0.1006*	−1.3099*		0.5435	0.1034	10.8804*
No effects	−0.1450	−0.0951*	−1.3699*	−0.1810	0.5303	0.0908	8.2877*
Fixed effects	−0.4370	−0.1013*	−1.4034*		0.5887	0.1075	6.6566*
Fixed effects	−0.1320	−0.0725*	−1.5607*	−0.2391*	0.5678	0.0902	5.2401*
J59—Motion picture, video and television programme production, sound recording and music publishing activities							
No effects	0.2386	−0.0763*	−0.3457		0.6165	0.1517	14.3445*
No effects	0.0282	−0.0491*	−0.2448	−0.1607*	0.4866	0.1345	7.1175*
Fixed effects	0.3968	−0.0752*	−0.5755**		0.6042	0.1459	7.0328*
Fixed effects	0.2988	−0.0069	−0.5436**	−0.1836*	0.4935	0.1339	4.1443*
J60—Programming and broadcasting activities							
No effects	0.2222	−0.0032	0.1694		0.5127	0.1576	9.7327*
No effects	0.1054	0.0025	−0.3091	−0.0033	0.4894	0.1565	7.1858*
Fixed effects	0.5265*	0.0137	0.1391		0.5376	0.1584	5.5960*
Fixed effects	0.4606*	0.0158	0.1519	−0.0849	0.5583	0.1554	5.0799*
J61—Telecommunications							
No effects	−0.0959	0.0068	0.0266		0.6732	0.0484	18.0986*
No effects	−0.1568	0.0014	−0.2934	0.1208**	0.6536	0.0486	13.1796*
Fixed effects	−0.1314*	−0.0004	0.0360		0.6739	0.0498	9.1680*
Fixed effects	−0.1131**	−0.0072	−0.3616**	0.0834	0.6498	0.0501	6.9891*

(continued)

Table 2 (continued)

Panel specification	RDEXP_ INHAB	FDI_TURN	REER	ALP(−1)	Adj. R^2	S.E. of regression	F-stat
J62—Computer programming, consultancy and related activities							
No effects	0.0143	−0.0075	0.2747*		0.7285	0.0332	23.274*
No effects	0.0554	0.0021	0.2456**	−0.1092*	0.6175	0.0338	11.4187*
Fixed effects	0.0507	−0.0162	0.2739*		0.7137	0.0344	10.8537*
Fixed effects	0.1208	−0.0104	0.1758	−0.2436*	0.6848	0.0332	8.0116*
J63—Information service activities							
No effects	0.1063	0.0361**	0.2032		0.6308	0.0864	15.1817*
No effects	0.0142	0.0070	0.1822	−0.1518	0.6832	0.0682	14.9185*
Fixed effects	−0.0292	0.0364*	0.1668		0.6315	0.0872	7.7744*
Fixed effects	−0.1352**	0.0150	0.1266	−0.2198*	0.7103	0.0681	8.9111*

Note * and ** denote statistical significance at 1% and 5% level, respectively. Adj. R^2 is the R^2 penalized for the number of regressors, S.E. is the standard error of the panel regression and F-stat is the F statistical test

Table 3 Panel estimation results for GOR as dependent variable

Panel specification	α	TURN_EMP	PERSEMP	PERSCOST	INVRATE	GDP	TERTED	BROAD_COMP
C21—Manufacture of basic pharmaceutical products and pharmaceutical preparations								
No effects	−0.0463	0.0002	−1.1582**	−0.4599	−0.2113*	0.6541	0.6252*	0.3813
No effects	−0.0315	0.1545	−1.6114*	−0.7059**	−0.1644**	0.7452	0.7214*	0.1510
Fixed effects	−0.0712**	0.1463	−1.3150**	−0.4872	−0.2188*	0.9499	0.6502**	0.7653**
Fixed effects	−0.0472	0.1898	−2.0536*	−0.8461*	−0.1601**	1.0907	0.6542*	0.1526
C26—Manufacture of computer, electronic and optical products								
No effects	−0.0940*	0.1614	−1.1189*	−1.6028**	−0.4004*	5.9594*	0.0202	0.5353
No effects	−0.0429	−0.3277*	−0.6224	−0.8280	−0.3209*	3.7560*	0.3308	−0.0168
Fixed effects	−0.0978*	0.2430	−1.2861*	−1.7608**	−0.4191*	6.1691*	−0.0949	0.9513
Fixed effects	0.0158	−0.5200*	−0.3446	−0.6386	−0.3033*	3.5387*	−0.2166	0.9975
J59—Motion picture, video and television programme production, sound recording and music publishing activities								
No effects	0.5038	20.3470*	−13.7236*	−9.4929*	−5.0557*	−12.8363	−11.8408*	9.2376
No effects	0.4254	14.4170	−10.8626*	−6.9066	−3.0814*	6.5457	−8.7448*	6.4048
Fixed effects	−0.3494	20.8463*’	−17.6459	−12.5140*	−4.15230*	−15.7593	−14.2322*	28.9906
Fixed effects	−0.5496	13.5326	−13.8800*	−10.4953*	−2.4470	−3.5608/’	−10.4748*	30.3749
J60—Programming and broadcasting activities								
No effects	−0.7192	20.7825**	−34.2016*	−28.7862**	−3.9904*	13.1272	−5.7131	9.8387
No effects	−1.2398	16.3710	−30.1703*	−26.7312**	−3.0843*	45.6657**	−4.3494	5.0986

(continued)

Table 3 (continued)

Panel specification	α	TURN_EMP	PERSEMP	PERSCOST	INVRATE	GDP	TERTED	BROAD_COMP
Fixed effects	−1.1051**	19.5128*	−42.3387*	−36.6151*	−3.2581*	7.6381	−6.8097**	19.6356
Fixed effects	−2.0234*	16.3224**	−32.4125*	−29.5456*	−2.5868*	42.1275**	−5.6124	13.8258
J61—Telecommunications								
No effects	−0.0355**	−0.3021**	−0.3105**	−0.4911*	−0.0770**	0.87245*	−0.0490	−0.1701
No effects	−0.0600*	−0.5351*	−0.1884	−0.5149*	−0.0766**	1.6582*	−0.0255	−0.2139**
Fixed effects	−0.0341	−0.3298**	−0.2784	−0.4719*	−0.0822*	0.8026*	0.0188	0.0115
Fixed effects	−0.0820*	−0.6598*	−0.0011	−0.5100*	−0.0872	1.8407*	0.1485	0.1633
J62—Computer programming. consultancy and related activities								
No effects	−0.0064	0.0364	−0.7043*	−0.5912**	0.0380	0.9661*	−0.0448	0.6208*
No effects	0.0046	−0.1272	−0.5668*	−0.6282*	−0.0082	0.5544*	−0.0541	0.5536*
Fixed effects	0.0077	−0.0672	−0.8018*	−0.7988*	0.0430	1.2922*	0.0681	0.4645
Fixed effects	−0.0193	−0.2656	−0.3061**	−0.7225**	−0.0170	1.0065*	0.1647	0.6131**
J63—Information service activities								
No effects	0.0290	−0.4112**	0.4474**	−0.1902	−0.1473*	−0.7349	−0.2830**	0.4119
No effects	0.0258	−0.7667*	0.5931*	0.2619	−0.1459*	0.1978	−0.1437	0.1275
Fixed effects	0.0165	−0.3465*	0.6024**	−0.1789	−0.1617*	−0.7188	−0.1029	1.2030*

(continued)

Table 3 (continued)

Panel specification	α	TURN_EMP	PERSEMP	PERSCOST	INVRATE	GDP	TERTED	BROAD_COMP
Fixed effects	0.0012	−0.7559*	0.8921*	0.4661*	−0.1518*	0.6028	−0.0315	0.3247

Panel specification	RDEXP_ INHAB	FDI_TURN	REER	GOR(−1)	Adj. R^2	S.E. of regression	F-stat
C21—Manufacture of basic pharmaceutical products and pharmaceutical preparations							
No effects	−0.0787	0.2990*	0.4430		0.3919	0.1842	6.3487*
No effects	−0.4178	0.2429**	−0.3983	−0.2635*	0.5107	0.1820	7.7356*
Fixed effects	−0.0955	0.2889*	0.1998		0.4243	0.1928	3.9129*
Fixed effects	−0.2131	0.2652**	−0.2690	−0.3270*	0.4906	0.1936	4.1076*
C26—Manufacture of computer, electronic and optical products							
No effects	−1.2965*	−0.3453*	−5.0552*		0.4405	0.4977	7.53572*
No effects	−0.8216*	−0.1975*	−4.7842*	−0.3065	0.5247	0.3542	8.1248*
Fixed effects	−1.3816*	−0.3681*	−5.0937*		0.3729	0.5235	3.3499*
Fixed effects	−0.7239	−0.1390	−5.0235*	−0.3257*	0.5954	0.3611	5.7497*
J59—Motion picture, video and television programme production, sound recording and music publishing activities							
No effects	3.1458	−1.7006*	−3.6998		0.4213	4.1255	7.0434*
No effects	−1.2120	−1.4622*	−3.2881	−0.2114*	0.1316	3.7998	1.9782**
Fixed effects	6.7424	−1.6873**	−14.6663		0.3840	4.0237	3.4640*
Fixed effects	8.4572	−0.6326	−14.8050	−0.2489*	0.1899	3.7941	1.7566***
J60—Programming and broadcasting activities							
No effects	10.9541	0.2648	10.1616		0.3729	6.9380	5.9354*
No effects	3.5548	0.8605	2.2350	−0.0832	0.3038	6.5967	3.8167*

(continued)

Table 3 (continued)

Panel specification	RDEXP_ INHAB	FDI_TURN	REER	GOR(−1)	Adj. R^2	S.E. of regression	F-stat
Fixed effects	27.0630*	0.7474	4.1974		0.4309	6.7138	3.9922*
Fixed effects	23.6530*	0.5650	7.1207	−0.1959**	0.3917	6.5081	3.0778*
J61—Telecommunications							
No effects	−0.1031	0.0050	0.1651		0.6280	0.0735	15.0114*
No effects	−0.1402	0.0019	−0.2859	0.0785	0.6023	0.0765	10.7742*
Fixed effects	−0.1816**	−0.0046	0.1755		0.6620	0.0760	8.7401*
Fixed effects	−0.1213	−0.0128	−0.3957	0.0225	0.5555	0.0796	5.0330*
J62—Computer programming. consultancy and related activities							
No effects	−0.0603	−0.0043	0.0624		0.1459	0.1020	2.4181**
No effects	0.2725	0.0113	0.6974**	−0.3648	0.2732	0.0923	3.4261*
Fixed effects	−0.0381	−0.0354	0.1762		0.0552	0.1069	1.2308
Fixed effects	0.2526	−0.0251	0.6388**	−0.42356*	0.2590	0.0892	2.1280**
J63—Information service activities							
No effects	0.2077	0.0040	0.4814		0.1594	0.2782	2.5738**
No effects	−0.0754	−0.0148	0.0105	−0.0946	0.3691	0.1597	4.7769*
Fixed effects	−0.0547	0.0008	0.2525		0.1816	0.2790	1.8769*
Fixed effects	−0.3670	−0.0240	−0.0386	−0.1333	0.3415	0.1708	2.6736*

Note * and ** denote statistical significance at 1 and 5% level, respectively. Adj. R^2 is the R^2 penalized for the number of regressors, S.E. is the standard error of the panel regression and F-stat is the F statistical test not been captured in our analysis and remain to be investigated. On its turn, industry profitability is more influenced by the average personnel cost, as we find negative statistically significant coefficients in 20 out of 28 panels, for all industries and panel specifications.

The last variable included under industry attributes is the investment rate (INVR); in its case, results indicate a negative relationship between both productivity and profitability, on the one hand, and industry investment rate on the other hand. Thus, when ALP is considered, we find negative panel regression coefficients for INVR for the two manufacturing high-tech industries and for four out of five services industries (except J62) in both panel specifications, which suggest that the negative relationship between productivity and investment rate is a consistent one. For what concerns industry profitability, the negative influence of the investment rate is even stronger than in the case of productivity, as we find statistically significant coefficients in 23 out of 28 panels, making the investment rate the most important industry factor for profitability. For both competitiveness measures, the negative influence of the investment rate is, in our opinion, a reflection of higher investment rates in the case of smaller companies with smaller turnover, and of lower investment rates for bigger companies with higher turnover; this actually reinforces the positive link between turnover and competitiveness discussed above.

Turning to *location or country-related variables*, the best panel regressions' results (the higher number of statistically significant coefficients) for high-tech industries competitiveness are obtained for GDP, followed by the percentage of population with tertiary education (TERTED) and the percentage of enterprises with broadband access (BROAD_COMP), but for all these variables, the number of statistically significant coefficients across industries is smaller compared to industry-related variables. For GDP, we find statistically significant coefficients in 13 out of 28 panels for productivity, positive in the case of C26, J61 and J62, and negative in the case of J59, and in 14 out of 28 panels for profitability, all positive, but only in the case of C26, J59, J61, J62 and J63. This means that a higher GDP in a specific country is reflected in higher high-tech industries' productivity and profitability levels, which is a result that is not necessarily specific to these industries. At the same time, this finding is connected to the performance gap in terms of productivity and profitability between the older, more developed, members of the EU and newer, less developed member states.

We find somehow surprising results, at least at first sight, for the percentage of population with tertiary education (TERTED), as only one manufacturing high-tech industry and one services industry show statistically significant coefficients in productivity panels (C21—positive coefficient; J59—negative coefficient). Slightly better results are found in profitability panels, as for C21 coefficients are again positive and for services industries negative—now, tertiary education is a significant variable for three industries (J59, J60 and J63). These results might be interpreted as a lack of dependence of industries' performance on the level of education in the countries where they operate, and a global instead of local setting of both productivity and profitability in high-tech industries.

The level of broadband availability for businesses (BROAD_COMP) as a significant variable for productivity and profitability in the high-tech industries is not a surprise, but the different coefficient signs across industries is. We find more positive than negative significant regression coefficients in both productivity and profitability panels, but in only two services industries (J62 and J63—positive coefficients) against one (J61—negative coefficient). The last variable included under location factors, the R&D expenditure per inhabitant (RDEXP_INHAB) shows another puzzling result, as statistically significant coefficients also change their signs depending on industries—positive for J60 and negative for J61 (for both productivity and profitability), and negative for J63 (for profitability). Still, these coefficients are identified only in fixed cross-effects specifications, which might indicate that country specificities play an important role in terms of R&D expenditure and high-tech industries competitiveness.

The *international exposure* of high-tech industries is investigated in our research through two variables: the importance of FDI in these industries (FDI_TURN) and the country's general level of competitiveness (REER). The results for FDI_TURN are less consistent in contrast to the results found for other independent variables; as such, productivity is positively linked to FDI_TURN in the case of two industries (C21 and J63) and negatively linked in the case of two industries (C26 and J59), while profitability is positively linked to FDI_TURN in the case of one industry (C21) and negatively linked to FDI_TURN in two industries (C26 and J59). This might be partially explained by the value of FDI_TURN—a ratio between the turnover generated by foreign- versus local-controlled companies: in industries where the value of this ratio is small and, more important, lower than one, which indicates a reduced presence of foreign investors, and FDI do not have a strong impact on industry competitiveness; at the same time, industries that benefit from a more palpable presence of foreign investors tend to enjoy it through an improved performance. As such, the highest means of this ratio for the 2008–2015 period—also above one—across countries are found for industries C26 (4.77), C21 (2.47) and J61 (2.48), while the lowest belong to industries J59 (0.70) and J62 (0.61). The general level of countries' competitiveness, described by REER, is significant for high-tech industries' competitiveness, but with specificities across industries. The coefficients are statistically significant for four industries in productivity panels (negative for three industries—C26, J59 and J61—and positive for one industry—J62) and for two industries in profitability panels (positive for J62 only in cross fixed effects specifications and negative for J59 in both specifications). Overall, we find more negative than positive coefficients, which suggests a positive link between countries' competitiveness and high-tech industries' performance, but the low number of significant coefficients might confirm the global rather than local determination of competitiveness in these industries.

Panels specified according to Eq. (2) include the one-year lagged values of ALP and GOR as independent variables, as a way of testing whether previous levels of competitiveness, both in productivity and profitability terms, influence current high-tech industries' performance. The results are slightly better in the case of productivity, with mostly negative coefficients, which might indicate a "reversion to the mean" process for competitiveness in these industries, but also a lack of sustained good performance in high-tech industries over a higher number of years.

All our panels have been implemented in two specifications, no effects and cross-fixed effects, which allowed us to observe whether potential country-related idiosyncrasies are reflected in our results. On one hand, this might be noticeable at the level of statistically significant coefficients' signs identified in no effects versus cross-sectional effects panels. From this perspective, coefficients' signs remain the same in all estimated panels in the two specifications, which is an indication of the robustness of our results but, at the same time, of the lower than expected differences between countries in terms of industries' performance. On the other hand, panels estimated using cross-sectional fixed effects show slightly better performance than panels estimated using no effects—overall, we find better adjusted R-squared values in 57% of the total number of such no effects—cross- fixed effects panel pairs, while standard error's values are similar in both specifications. This is a sign that countries' specificities matter for the relationship between industry, location an international exposure factors and high-tech industries' competitiveness.

5 Conclusions

Our research proposes a newer approach to the study of high-tech industries given our aim of uncovering the role of industry, locational and international exposure drivers of competeviness of these industries. The landscape of high-tech industries in EU is diverse and suggests significant differences between the older and more developed economies, on the one hand, and the newer and less developed economies, on the other hand, for what concerns industries' structures and, in the end, their competitiveness. Thus, a division of labour versus capital and technology-intensive activities of companies in the high-tech industries between older and newer member states seems to exist at EU level, whereby the newer member states are used as locations for the affiliates of multinational corporations that perform more labour-intensive activities, while the older member states benefit from more capital-intensive activities of MNCs' affiliates. This should not be a surprising result, as businesses are searching for more favourable economic environments for their development in any industry—and, most likely, to a higher extent in high-tech industries whose progress depends on connectivity and digitalization, more available and accessible in developed economies.

These industry structures are consequently reflected in a significant and persistent "competitiveness gap" between older and newer EU member countries in all high-tech industries, with no systematic declining pattern over the years, which signals the need for consistent EU policies towards encouraging the growth of high-tech industries in the newer member states as a mean for improved competitiveness at EU level and for increasing real convergence among its members.

The most important result of our research is that, by far, industry-related factors are more important than location-related or international exposure factors for the competitiveness of high-tech industries. From this perspective, a few conclusions emerge, as follows. First, when referring to industry-related attributes, turnover, the number of persons employed and the investment rate are the most significant influencers for labour productivity—higher turnover, a lower number of employees and a smaller investment rate (linked to higher turnover) lead to improved productivity in high-tech industries. For profitability, the number of persons employed, the average personnel cost and the investment rate are the most important industry factors of influence—profitability is positively influenced by a lower number of employees, a lower average personnel cost and a low investment rate.

Second, the GDP level and the percentage of population with tertiary education are the most significant location-related factors of influence for high-tech industries' competitiveness; in both variables' case, we find that more developed economies with more educated populations tend to attract more competitive industries. The link between high-tech industries' competitiveness and R&D expenses is less conclusive and the findings seem to indicate that high-tech industries enjoy better productivity in countries with less expense on R&D. This is not a surprising result, though, as these countries also have lower average personnel costs and are the least developed from our sample. At the same time, we might imply that when businesses in a country spend more on R&D the overall level of productivity increases, but this increase is industry-specific and is not necessarily matched by an increase in profitability. Moreover, the relationship seems to be intermediated by the size of businesses' spending in the respective industries across countries, as an R&D spending gap is also found here, with industries from developed countries spending more and those from developing countries spending less.

Third, foreign ownership is less important in explaining the performance gap between local- versus foreign-owned companies compared to other factors. We rely on the value of the ratio between foreign versus locally generated turnover in high-tech industries—we might call it "foreign turnover intensity"—as an explanation for these results; as such, in the high-tech industries where this ratio is small and lower than one, indicating a reduced presence of foreign investors, foreign ownership does not have a say on industry performance, but high-tech industries with a more solid presence of foreign ownership enjoy better performance. Consequently, we might interpret these results as a need for a "critical" foreign ownership level in high-tech industries in order for the higher productivity and profitability of foreign-owned companies to be reflected in overall industry performance.

We consider our research insightful and thought-provoking, as it represents the first attempt to investigate the differences in performance and competitiveness between older and newer EU members in a sector that is at the forefront of EU competitiveness agenda for the years to come. We intend to extend our research by exploring these industries' competitiveness at company level, but also by contrasting the factors of influence on industry performance for these industries against the ones for industries with lower technological level, in order to identify competitiveness triggers that might be used as stimulants for industry development and included in future economic measures and policies at country and EU level.

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